Volume 3 of 3
FY93 & FY94
SubTerra Inc. Products

LANL Subcontract 9–X52-Z9658–1

Thu, Dec 15, 1994

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TEST PLANNING PACKAGE INPUT

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
TEST PLANNING PACKAGE APPROVAL AND RELEASE

Test Planning Package Title: Geologic Mapping of the Exploratory Studies Facility

Test Planning Package Number: TPP 92-10, Rev. 1

Responsible PE: Ron Oliver

Summary of Scope: Geologic Mapping and Photogrammetry of ESF. Previous version, Rev. 0, has been revised to better focus the TPP on general ESF testing requirements. The associated job package will provide implementing detail for carrying out this test in defined phases during ESF construction.

Job Package Number: JP 92-20A

VBS Number (third level): 1.2.3.2.2.1.2

Participants Affected: USGS

Concurrence of requirements by affected Technical Project Officers:

PO: L. Hayes Date: ______________

PO: ___________________________ Date: ______________

PO: ___________________________ Date: ______________

PO: ___________________________ Date: ______________

PO: ___________________________ Date: ______________

PO: ___________________________ Date: ______________

Release to: RCB for job package assembly

for non-field work

YMPO Approvals:

RSED Director: __________________ Date: ______________

Affected Division Directors:

DD: (DQA) __________________ Date: ______________

DD: N/A __________________ Date: ______________

DD: N/A __________________ Date: ______________
TEST PLANNING PACKAGE 92-10

GEOLOGIC MAPPING OF THE EXPLORATORY STUDIES FACILITY

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1.0 LIST OF STUDY PLANS OR SCIENTIFIC INVESTIGATION PLANS USED IN SCIENTIFIC INVESTIGATION

Study Plan 8.3.1.4.2.2 "Characterization of the Structural Features in the Site Area," is a controlled Yucca Mountain Site Characterization Project (YMP) document that describes U.S. Geological Survey (USGS) plans for geologic mapping activities in the Exploratory Studies Facility (ESF). Information currently provided in this Test Planning Package (TPP) is limited to activity 8.3.1.4.2.2.4 "Geologic Mapping of the Exploratory Studies Facility."

2.0 INVESTIGATIONS CONTROLS

Section 2.0 References:

R2.1 "Exploratory Studies Facility Design Requirements," YMP/CM-0019, Rev. 0.


The following controls are based on section references, including evaluations to address potential test interference and waste isolation impacts (including planned use of tracers, fluids, and materials) and input from principal investigators (PIs).

The following controls supplement or amend performance criteria and constraints found in Appendix B of reference R2.1.

2.1 Interference

Supplemental performance criteria are required; see attachment 1, F (i) and F (ii).

2.2 Impacts to Waste Isolation

No modifications to existing performance criteria or constraints are required.

2.3 Environmental Impacts

No modifications to existing performance criteria or constraints are required.
2.4 Consolidated Performance Criteria and Constraints

See attachment 1 for a list of consolidated test-specific performance criteria and constraints.

3.0 OTHER INSTRUCTIONS

3.1 Order for Performing Multiple Investigations

A supplemental performance criterion is required; see attachment 1, A (ii).

3.2 Hold Points (AP-5.20)

No project-level hold points are required for this activity.

3.3 Interfaces (AP-5.19Q)

No applicable Level C or D interfaces within the scope of AP-5.19Q exist.

3.4 Data Submittals (AP-5.1Q)

Participants are responsible for collection, management, submittal of data, and for compliance with Project and participant plans and procedures as described in applicable study plans.

All transfers of data between YMP participants, submittal of data to the YMP database, or transfer of data to outside parties shall be conducted in accordance with AP-5.1Q and other applicable plans and procedures.

Supplemental performance criteria are required; see attachment 1, H and I.

4.0 REFERENCE TO SCP COMMENTS THAT HAVE BEEN CONSIDERED RELATIVE TO INVESTIGATION(S) (AP-1.14)

Section 4.0 References:


No open constraints or commitments associated with the Site Characterization Plan (SCP) have been identified for this activity.

5.0 REFERENCES TO DESIGN REQUIREMENTS

Section 5.0 References:

R5.2 "Exploratory Studies Facility Design Requirements," Sections 3.2.1 through 3.3.1, YMP/CM-0019, Rev. 0.

Functional requirements, performance criteria, and constraints in Sections 3.1.2 through 3.3.1 YMP/CM-0019 provide the basis and control for the common facility design and its interfaces with ESF testing. Requirements are implemented under the formal ESF Title II design and fielded for this phase of construction under JP 92-20. In addition, requirements for underground test support are provided in Section 3.2.1.6.

YMP/CM-0019 establishes the common facility design basis; consolidated performance criteria and constraints (attachment 1) are consistent with, and do not require alteration of the current ESF design.

Development of test-specific construction specifications and drawings is not required for this activity.

6.0 COST AND SCHEDULE DATA

Section 6.0 References:


Participant WBS
USGS 1.2.3.2.2.1.2

See Attachment 2 (illustration) for further detail on the cost and schedule planning basis. The task dates and estimated durations are based on current design and construction strategies. These tasks, dates, and durations are subject to change. Changes will be controlled through the Project planning basis and reflected in applicable job packages or approved Project schedules.

7.0 QA PREPARATION

7.1 Closure of QA Concerns

No relevant QA concerns have been identified.

7.2 Grading

General guidance for application to site characterization activities is provided by the USGS in conjunction with the Quality Assurance Requirements and Description (QARD) DOE/RW/0333P, Project Office "Q-List" YMP/90-55, Quality Activities List (QAL), YMP/90-56, and Project Requirements List (PRL) YMP/90-57. The quality affecting elements for this activity are limited to data and samples collected in support of the Study Plan listed in section 1.0.
The following quality assurance grading (QAG) report associated with the testing activities has been approved:

<table>
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<th>QAGR</th>
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</tr>
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<td>USGS</td>
<td>G1232212</td>
<td>1.2.3.2.2.1.2 Characterization of Structural</td>
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**Features**

**8.0 READINESS REVIEW**

The Regulatory and Site Evaluation Division Director determined that a readiness review is not required.
TEST-SPECIFIC PERFORMANCE CRITERIA AND CONSTRAINTS FOR GEOLOGIC MAPPING OF THE EXPLORATORY STUDIES FACILITY

Attachment 1 References:


A.2 YMP/TPP 91-5, Rev. 0, "Preliminary Test Planning Package for Support of Pre-Title II Design Studies; Planned Exploratory Studies Facility Tests."


A consolidated list of performance criteria and constraints, derived from section references and focused on specific testing needs for this phase of the activity, is found below. Appendix B of the YMP/CM-0019 provided a verbatim statement of applicable performance criteria and constraints for this ESF testing activity. TPP 91-5 provided the controlled basis for testing activities planning based on the selected Alternatives Study ESF facility configuration. Reference A.3 provided the basis for constraints to address potential impacts to waste isolation and test interference. References A.4 and A.5, along with a review of the study plan by the Los Alamos National Laboratory Test Coordination Office, provided the basis for additional design and test-related information. Note: performance criteria and constraints follow the format established in YMP/CM-0019.

The following performance criteria and constraints represent the controlled requirements basis for tests to be conducted in the Exploratory Studies Facility. Not all portions of these tests will be conducted at all locations; however all tests will be conducted in a manner consistent with these
requirements. (Test requirements will be implemented through job packages and referenced design specifications and drawings, controlled procedures). Compliance with test requirements will be demonstrated through records submissions and reporting requirements.

Performance Criteria (Reference A.1: Section B.2.20.3)

A. The test organization will map all ESF excavations, on a daily basis, usually mapping the extent of daily progress, up to an expected maximum of 75 m (246 ft.) in tunnel boring machine drifts. Mapping will generally be done prior to installation of any chain-link, mesh, or shotcrete. Where ground conditions require fabric or shotcrete, the excavation and mapping sequence will need to be modified to permit mapping near the heading.

In roadheader and/or mobile miner excavations, mapping will be done as near the heading as possible. The machines will need to pull back from the face while mapping is being done.

If a shaft is excavated as part of the ESF, mapping will be either from the bottom deck of the galloway (if drill/blast) or from platform designed for the purpose of mapping (machine excavation). In both cases, the walls must be mapped prior to the installation of any wire mesh, shotcrete, or permanent utilities.

i. Only the first paragraph applies to ESF tunnel mapping.

ii. Mapping will be coordinated with construction and other tests.

iii. Hand specimens (samples) may be obtained for petrographic evaluations.

B. Survey accuracy for the Geologic Mapping Test shall be ±1cm for the benchmarks. The ability should be retained to resurvey and upgrade the initial mapping survey and reference points.

i. Survey accuracy for mapping and sampling in the starter tunnel is ±2cm (horizontally and vertically from the benchmark).

C. A securable, underground space of about 5x6 m with a height of 2.5 m is required for storage of mapping equipment. If the North and South ramps are developed separately, a storage room is required in each one.

D. A geological storage and staging trailer or building of at least 18 m² (200-sq-ft) area shall be provided at the ESF surface facility in Midway Valley. This building shall be equipped with heating, air conditioning, electricity, running water at a sink, smoke detectors, first aid kit, and shelving.
i. As provided in north ramp surface facility design (Package 1A), storage during early ESF construction will be provided in a testing trailer located on the north ramp pad.

E. If the optional shaft is required, the shaft sinking galloway must be provided with equipment to assure a stable platform for photography. In drifts other than those excavated by full face TBM, a collapsible platform must be provided to allow geologists access to all surfaces of the excavation.

F. The construction contractor will clean the walls using compressed air/water following procedures developed during prototype testing.

i. Tracers for Construction Water. For water applied underground in dust suppression; blasthole drilling; in grout, mortar, concrete and shotcrete; wall washing (blowdown) prior to mapping; and other construction applications, addition of a universal tracer is required. Lithium bromide shall be the only tracer (universal) required and acceptable from the standpoint of ESF testing. The concentration of lithium bromide tracer in construction water should be 20 ppm (as bromide) with an acceptable tolerance of ±10% and a maximum range of 10 ppm to 30 ppm. Tracer system verification should include an automated volumetric analyzer (electrode) and periodic sampling for laboratory analysis.

ii. Tracers for construction usage of compressed air. For the ESF north ramp starter tunnel, the use of compressed air in blasthole drilling, other pneumatic tool usage, and in blowdown operations prior to geologic mapping does not require tagging with a chemical tracer. This exemption does not include any test-related drilling for later tests such as hydrochemistry and radial boreholes, planned for an alcove off the ESF north ramp starter tunnel.

iii. An air mist blow pipe system has been previously developed and will be used in ESF north ramp tunnel mapping.

G. A light-tight photography laboratory (in a trailer or building) approximately 2.5m by 4m (8 ft by 14 ft, with a minimum of 100 sq ft) shall be provided at the ESF surface facility, adjacent to or in the geological storage and staging trailer or building. This laboratory shall be equipped with heating, air conditioning, and the following: (1) sink with hot and cold running water and (2) two 110-V, 20-A circuits and one 220-V, 30-A circuit.

H. Key data to be obtained in the starter tunnel include fracture orientation, lengths, apertures, descriptions of fracture filling materials and decorations on the fracture surfaces. Stratigraphic data, information on the characteristics and abundance of lithophysae, mineralogy, and contacts between the units and zones in the various volcanics.
Constraints (reference A.1: Section B.2.20.4)

A. In TBM drifts and ramps, a distance of at least 75m must be left directly behind the trailing gear, where utilities are confined to one quadrant of the circumference of the excavation. This confinement is necessary to allow an unobstructed view of as much of the exposed rock as possible for photogrammetric mapping.

B. Ground support in the form of rock bolts and anchors may be installed as near the working face as necessary without detriment to mapping. The installation of chain-link fabric, wire mesh, or application of shotcrete may not take place until mapping is completed.

i. Ground conditions encountered during initial ESF north ramp tunnel excavation may impose safety-related limitations on access to, or exposures for, mapping activities.

C. Mapping in the TBM drifts will require construction of a mapping platform which will allow access to all portions of the crown and walls for sampling and detailed mapping. The platform may also be used for installation of ground support, surveying, installation of utilities, etc., as long as these operations are coordinated with the mapping effort.

Mapping in the roadheader/mobile miner drifts may be done from a collapsible platform (i.e., scissor lift).

i. A platform lift, provided by the constructor, will provide access to the tunnel back for mapping and sample collection.

D. During drift wall mapping, all unnecessary equipment will be removed from the section of the drift being mapped.

E. Citation from reference A.1 is not applicable to the current ESF configuration.
CONSTRUCTION MONITORING IN THE NORTH RAMP AND TEST ALCOVES

Work Plan ID: WP 92-20D.2 Rev. 7/02/94
(Administrative Only)
CONSTRUCTION MONITORING IN THE NORTH RAMP AND TEST ALCOVES

This work plan (WP) implements and operates within the constraints and requirements established in Test Planning Package (TPP) T-93-2 and Job Package (JP) 92-20D and guides field interactions. This WP will be revised as necessary by the TCO and changes will be communicated to all participants identified herein. Final illustrations will be provided as field work proceeds and will be included as revisions to this WP.

This WP is administrative only and has been prepared to facilitate work to be conducted in the field. This plan has been reviewed (1) to ensure that it is fully consistent with the controlled requirements basis represented in the TPP T-93-2 and JP 92-20D, and (2) to ensure that it contains no quality affecting requirements. The WP does provide a planned method to meet requirements in the TPP and JP listed above. Any anticipated deviations from this plan should be brought to the immediate attention of the TCO. The TCO will ensure that proposed changes are evaluated to determine if they are consistent with the requirements basis. Approved changes will be documented by the TCO prior to proceeding with the work. If changes are determined to be inconsistent with the requirements basis, work will not proceed until inconsistencies are resolved.

This work plan covers SCP activities directed by the Excavation Investigations and In Situ Design Verification Study Plans. The relationship between these study plans and the ESF tests that are covered by this work plan is shown below.

Excavation Investigations (8.3.1.15.1.5)

Access Convergence (8.3.1.15.1.5.1)

- Rock mass response measurements (includes both convergence and rock mass displacement measurements)
- In situ stress measurement
- Induced stress/stress change measurement
- Liner contact and rock bolt load measurement

In Situ Design Verification (8.3.15.1.8)

Evaluation of Mining Methods (8.3.15.1.8.1)

- Blast monitoring
- Blast damage assessment
- Documenting methods and equipment

Monitoring of Ground Support Systems (8.3.15.1.8.2)
The following activities will be performed in support of the listed tests:

**1. PROJECT SCHEDULING AND COORDINATION**

1.1 The DOE Field Test Coordinator (FTC), the Exploratory Studies Facility (ESF)/TCO, the Reynolds Electric and Engineering Co., Inc. (REECo) Construction Department Manager (CDM); Test Survey Coordinator (TSC), the Photo Support Section Leader (PS), the M&O Construction Manager (CM), and the Principal Investigator (PI) or their representative, will mutually review and accept the WP and any subsequent ESF/TCO revision and will mutually agree upon a tentative schedule, implementation methods, and representative or approval authority for the work described below.

Organizational Participants

FTC________________________________________Date_______

TCO________________________________________Date_______

CM________________________________________Date_______

CDM________________________________________Date_______

TSC________________________________________Date_______
The ESF/TCO Field Test Representative (FTR) and the Project Engineer (PE) for this activity have been delegated to authorize the initiation of procurement or the initiation of tasks required by the planning package as necessary to support the contractors' procedural requirements for the Yucca Mountain Site Characterization Office (YMSCO) FTC. Attachment 1 of this work plan presents the recommended format to accomplish this communication.

2.0 GENERAL INSTRUCTIONS

2.1 TEST INSTALLATION INITIATION AND INSTALLATION CLOSE-OUT

Attachment 3 of this work plan presents the recommended format to accomplish and administratively document "Construction Monitoring Activity Requests", "Authorizations" and "Releases to Construction" communications. These forms will be used to initiate and close each of the test installation activities described in Sections 3. through 17.

2.2 ESTABLISH CONSTRUCTION EXCLUSION AREA

The CM will provide effective means acceptable to the TCO/PI to ensure the safety, accessibility, and continued functioning of each completed test installation until notice of test completion. The construction exclusion area may be established around the instrument location using illustration 1 (Attachment 2) of this work plan.

3. CONVERGENCE MEASUREMENTS INSTALLATIONS

3.1 IDENTIFY TEST INSTALLATION LOCATIONS

The TCO, CM and the PI will agree when to initiate the convergence test activity, and the time and approximate location for the test. The PI will provide written verification to the TCO that the test and installation equipment is ready.

3.1.1 When, in the opinion of the CM and the TCO, the selected test location is in a condition suitable for the test or support activity (i.e., the location may
be safely accessed), the CM will issue to the TCO an access authorization permitting the activity to commence.

3.1.2 At the approximate location for the convergence test the PI will select and mark the locations for the test drill holes. The location(s) will be noted in the log book and weekly report.

3.2 INSTRUMENTATION DRILLING AND CORING

3.2.1 Following completion of drilling at a single location and prior to demobilization of the drilling equipment, the PI will inspect and accept the holes or direct additional drilling in the event that any completed holes are found to be unsuitable for the test purposes.

3.3 INSTALL CONVERGENCE PIN INSTRUMENTATION SYSTEM

Upon acceptance of the test drill holes the TCO will direct the Constructor to support the installation of the convergence pins which will be installed under the direction of the PI. The installation will be monitored and witnessed by the PI. Attachment 4 of this work plan presents the format to administratively document the instrument installation configuration.

3.3.1 The TCO will ensure that the system is functioning to the satisfaction of the PI.

3.4 REPORTING REQUIREMENTS.

3.4.1 Convergence measurements are part of the data set defined by the M&O as being required for input to Title II design. Convergence data will be reported to the M&O field engineer in accordance with the requirements contained in the Test Planning and Job Packages.

3.4.2 Other reporting instructions are contained in Section 19 of this work plan.

4. ROCK MASS RESPONSE (MULTIPOINT BOREHOLE EXTENSOMETER - MPBX) INSTALLATION

4.1 IDENTIFY TEST INSTALLATION LOCATIONS

The TCO, CM, and the PI will agree when to initiate the MPBX experiment, and the time and approximate location of the MPBX anchor installation.
4.1.1 When, in the opinion of the CM and the TCO the selected test location is in a condition suitable (i.e., allows for safe access) for the test activity, the CM will issue to the TCO an access authorization permitting the test activity to commence at the proposed test location.

4.2 INSTRUMENTATION DRILLING AND CORING

The MPBX drill hole locations selected by the PI will be drilled by the constructor. Attachment 7 provides an estimate of the length and diameter of boreholes required for MPBX installation.

4.2.1 The PI will observe the drilling of the MPBX holes and make final acceptance.

4.3 BOREHOLE VIDEO LOGGING AND INSPECTION

The PI will inspect the holes with a video camera (see "Blast Damage Assessment," Section B.3.7.)

4.4 INSTALL MPBX INSTRUMENTATION SYSTEM

The PI will advise the TCO when to have the Constructor install the MPBX gauge. The PI will provide installation tools for the MPBX. The Contractor will assist the PI during installation of the MPBX equipment and will provide all necessary support equipment. Attachment 4 of this work plan presents the format to be used by the PI to administratively document the instrument installation configuration.

4.4.1 The PI will wire the MPBX instrument to a temporary junction box on the rib of the tunnel. The Contractor will provide permanent wiring to the data logger.

4.5 The TCO will ensure that the system is functioning to the satisfaction of the PI.

4.6 Reporting Requirements.

4.6.1 MPBX measurements are part of the data set defined by the M&O as being required for input to Title II design. Displacement data will be reported to the M&O field engineer in accordance with the requirements contained in the Test Planning and Job Packages.

4.6.2 Other reporting instructions are contained in Section 19 of this work plan.

5. IN SITU STRESS MEASUREMENT INSTALLATION

5.1 IDENTIFY TEST INSTALLATION LOCATIONS
The TCO, CM, and the PI will agree when to initiate installation of the in situ stress measurement instrumentation and the timing and approximate location for constructing boreholes within which the test will be deployed. Optional test equipment is described in the Test Planning Package and TPP references.

5.1.1 When, in the opinion of the CM and the TCO, the selected test location is in a condition suitable for the test activity, the test activity will commence at the proposed test location.

5.2 DRILLING AND CORING

5.2.1 The required hole location, depth and angle will be selected by the PI. The holes will be cored from a location within one of the north ramp test alcoves or from a platform located behind the TBM. Attachment 7 provides an estimate of the length and diameter of boreholes required for in situ stress measurement.

5.2.2 If the overcoring method is selected, the PI will observe the sequential operations of borehole drilling, gage installation, and overcoring.

5.2.3 If borehole slotting is selected as the test method, the PI will observe the drilling of the boreholes and will verify final acceptance of the borehole for testing purposes. If the hole is cored, core sampling and preservation will be carried out as described in the Construction Monitoring Sample Plan.

5.2.4 If required by the PI, the Constructor will provide a plug/cover for completed holes.

5.3 BOREHOLE VIDEO LOGGING AND INSPECTION

The PI may inspect the holes with a video camera (See "Blast Damage Assessment").

5.4 INSTALL INSTRUMENTATION SYSTEM

Upon acceptance of the test drill holes the TCO will direct the Constructor to support the PI to install the test equipment in accordance with the PIs procedures. The installation will be monitored and witnessed by the PI. The PI will document the test configuration using the form in Attachment 4.

5.4.1 The PI will provide installation tools and will record the approximate instrument location within the hole. The Constructor will provide all support equipment required for installation.

5.5 Reporting Requirements.
5.5.1 In situ stress measurements are part of the data set defined by the M&O as being required for input to Title II design. In situ stress data will be reported to the M&O field engineer in accordance with the requirements contained in the Test Planning and Job Packages.

5.5.2 Other reporting instructions are contained in Section 19 of this work plan.

6. INDUCED STRESS /STRESS CHANGE MEASUREMENT INSTALLATION

6.1 IDENTIFY TEST INSTALLATION LOCATIONS

The TCO, CM, and the PI will agree when to initiate installation of the induced stress and stress change instrumentation and the timing and approximate location for constructing boreholes within which the test will be deployed. Optional test equipment is described in the Test Planning Package and TPP references.

6.1.1 When, in the opinion of the CM and the TCO, the selected test location is in a condition suitable for the test activity, the test activity will commence at the proposed test location.

6.2 DRILLING AND CORING

6.2.1 The required hole location, depth and angle will be selected by the PI. The holes will be drilled full face or cored from a location behind the TBM. Attachment 7 provides an estimate of the length and diameter of boreholes required for induced stress and stress change measurement.

6.2.2 If required by the PI, the Constructor will provide a plug/cover for the completed holes. The instrument will not be installed until after mining is completed (or at the direction of the PI).

6.2.1 The PI will observe the drilling of the boreholes and will verify final acceptance of the borehole for testing purposes. If the hole is cored, core sampling and preservation will be carried out as described in the Construction Monitoring Sample Plan.

6.3 BOREHOLE VIDEO LOGGING AND INSPECTION

The PI will inspect the holes with a video camera (See "Blast Damage Assessment,").
6.4 INSTALL INSTRUMENTATION SYSTEM

Upon acceptance of the test drill holes the TCO will direct the Constructor to support the PI to install the test equipment in accordance with the PIs procedures. The installation will be monitored and witnessed by the PI. The PI will document the test configuration using the form in Attachment 4.

6.4.1 The PI will provide installation tools and will record the approximate instrument location within the hole. The Constructor will provide all support equipment required for installation.

6.4.2 Where appropriate, the PI will wire instrumentation to a temporary junction box on the rib of the tunnel. The Constructor will provide permanent wiring from the junction box to the data logger.

6.4.3 The TCO will ensure that the system is functioning to the satisfaction of the PI.

6.5 Reporting requirements are provided in Section 19 of this work plan.

7. Liner Contact Stress Measurement Installation

7.1 IDENTIFY TEST INSTALLATION LOCATIONS

The TCO, CM, and the PI will agree when to initiate the liner contact stress measurement activity, and the time and approximate location for installing the instrumentation.

7.1.1 When, in the opinion of the CM and the TCO the selected test location is in a condition suitable (i.e., is safe for access) for the test activity, the test activity will commence at the proposed test location.

7.2 INSTALL INSTRUMENTATION SYSTEM

The TCO will ensure that the pressure cell(s) and all other directly related materials required for the functioning of the test are present and ready at the test location when required.

7.2.1 The PI will select and mark the location where each liner contact pressure cell will be installed.
7.2.2 The Constructor will furnish at the test location all the required equipment, lighting, power, and experienced personnel to efficiently install the pressure cells.

7.2.3 The PI will direct and witness the installation of the liner contact pressure cells and will observe subsequent installation of the liner. The PI will document the test configuration using the form in Attachment 4 of this work.

7.2.4 The PI will wire the pressure cells to a temporary junction box located on the rib of the tunnel. The PI will verify that the completed load cell is functioning to his satisfaction.

7.3 ESTABLISH CONSTRUCTION EXCLUSION AREA

The pressure cells and cables will be protected by the Constructor prior to shotcreting. After shotcreting the permanent installation to the data logger will be completed by the Constructor.

7.3.1 The Constructor will provide effective means to ensure that the completed test fixtures are protected from damage and tampering. The CM will also ensure that the test fixtures are accessible for as long as required.

7.4 Reporting requirements are contained in Section 19 of this work plan.

8. Rockbolt Load Cell Installation

8.1 IDENTIFY TEST INSTALLATION LOCATIONS

The TCO, CM, and the PI will agree when to initiate the rockbolt load cell activity, and the time and approximate location for installing the rockbolt load cells.

8.1.1 When, in the opinion of the CM and the TCO the selected test location is in a condition suitable (i.e., is safe for access) for the test activity, the test activity will commence at the proposed test location.

8.2 INSTALL INSTRUMENTATION SYSTEM

The TCO will ensure that the rockbolt load cell and all other directly related materials required for the functioning of the test are present and ready at the test location when required.
8.2.1 The PI will select and mark the rockbolt to be monitored by the rockbolt load cell. Approval of the selected rockbolt(s) will be obtained from the CM.

8.2.2 The Constructor will furnish at the test location all the required equipment, lighting, power, and experienced personnel to efficiently install the rockbolt load cells.

8.2.3 The PI will direct and witness the installation of the rockbolt load cells, and cans to cover the load cells. The PI will document the test configuration using the form in Attachment 4 of this work plan.

8.2.4 The PI will wire the load cells to a temporary junction box located on the rib of the tunnel. The PI will verify that the completed load cell is functioning to his satisfaction.

8.3 ESTABLISH CONSTRUCTION EXCLUSION AREA

The load cells and cables will be protected by the Constructor prior to shotcreting. After shotcreting the permanent installation to the data logger will be completed by the Constructor.

8.3.1 The Constructor will provide effective means to ensure that the completed test fixtures are protected from damage and tampering. The CM will also ensure that the rockbolt test fixtures are accessible for as long as required.

8.4 Reporting Requirements.

8.4.1 Rock bolt load measurements are part of the data set defined by the M&O as being required for input to Title II design. Rock bolt load data will be reported to the M&O field engineer in accordance with the requirements contained in the Test Planning and Job Packages.

8.4.2 Other reporting instructions are contained in Section 19 of this work plan.

9. Blast Monitoring Activity

9.1 IDENTIFY TEST ACTIVITY LOCATIONS

The TCO, CM and the PI will agree on the timing of blast monitoring activities and on the locations for installation of the blast recording equipment.
9.1.1 The TCO, PI, and CM will agree to a schedule of monitoring blast activity. The PI will install seismographs to monitor the blast activity at the monitoring equipment at the agreed-to locations.

9.1.2 The CM/Constructor will give to the TCO/PI, copies of the following information: (1) The design of each blast round requested (2) an assessment of the blast performance; overbreak, underbreak, fragmentation, condition of the remaining surface, and commentary as appropriate.

9.2 BLAST MONITORING

The PI will obtain peak particle velocity (ppv) and wave form data associated with blasts. In addition, the PI will obtain the blast location data to permit analysis of the ppv data. Preliminary field information will be provided to the CM from the PI on request.

9.2.1 The designated PI will furnish and operate the seismograph and all other equipment required to measure ppv.

9.2.2 Upon request to the PI or the TCO, the PI or designee will, in a timely manner, furnish the ppv information data to the FTC and the CM to assist in blast design refinement.

9.3 REPORTING REQUIREMENTS.

9.3.1 Upon request to the PI or the TCO, the PI or designee will, in a timely manner, furnish the ppv information data to the FTC and the CM to assist in blast design refinement.

9.3.2 Blast monitoring data are part of the data set defined by the M&O as being required for input to Title II design. Data will be reported to the M&O field engineer in accordance with the requirements contained in the Test Planning and Job Packages.

9.3.3 Other reporting instructions are contained in Section 19 of this work plan.

10. Blast Damage Assessment Activity

10.1 IDENTIFY TEST ACTIVITY SESSION LOCATIONS
The CM, TCO, and the PI will agree when to perform blast damage assessments.

10.1.1 The TCO, after receiving a request from the PI, will give reasonable notice to the CM of the time and approximate locations for instrumenting and monitoring the blasts and blast effects. At the same time the PI will furnish a description of the equipment and procedures which will be followed during the conduct of this test.

10.1.2 When, in the opinion of the CM and the TCO, a selected test location is in a condition suitable for the test activity (i.e., permits safe access) the CM will allow the test activity to commence.

10.1.3 At the designated time and location for the test, the PI will identify existing drill holes in support of this test. If new drill holes are required, they will be drilled by the Contractor.

10.2 DRILLING AND CORING

10.2.1 The required hole location, depth and angle will be selected by the PI. The holes will be drilled full face or cored. Attachment 7 provides an estimate of the length and diameter of boreholes required for blast damage assessment.

10.2.2 If required by the PI, the Constructor will provide a plug/cover for the completed holes.

10.2.3 The PI will observe the drilling of the boreholes and will verify final acceptance of the borehole for testing purposes. If the hole is cored, core sampling and preservation will be carried out as described in the Construction Monitoring Sample Plan.

10.3 BOREHOLE VIDEO LOGGING AND INSPECTION

The Constructor will provide a platform and operator suitable for the TCO/PI to access the drill holes and the PI will operate a borehole video camera and ancillary equipment. The Constructor will provide lighting and power as required.

10.3.1 The PI will provide the video camera, bore scope, and ancillary equipment for the operation of the test. The PI will direct the operation of the test and verify its satisfactory completion. The TCO will notify the FTC and CM/Constructor when the test is completed and that the support equipment may be removed.
10.3.2 The PI will analyze the borehole video data and will furnish to the FTC/TCO in a timely fashion, an assessment of the blast effects on the excavation perimeter for possible future blast design modification.

10.4 REPORTING REQUIREMENTS

Reporting requirement are contained in Section 19 of this work plan.

11. Documenting Methods and Equipment

11.1 ACCESS TO THE TBM

Controlled access will be provided by the Contractor to the TBM so that the PI can collect the required information.

11.1.1 All required data, timing of data collection activities, and arrangements for access will be pre-approved by the CM through the TCO.

11.1.2 Where possible, data will be obtained from the Construction Contractor so that access to the TBM is not required for this activity. Under this option, the Construction Contractor will supply the required data through the CM according to the pre-arranged schedule.

11.2 REPORTING REQUIREMENTS

Reporting requirements are contained in Section 19 of this work plan.

12. ROCK MASS CLASSIFICATION ACTIVITY

12.1 TEST ACTIVITY LOCATIONS

12.1.1 The Sandia National Laboratory (SNL) PI and/or his representative(s) will perform rock mass quality assessments from the forward platform of the TBM. Information will be collected by SNL field engineers on all production shifts.

12.1.2 Rock mass quality data may also be collected from other locations on the TBM including, but not limited to, the mapping gantry and drill platforms.
Authorization to access these locations will be provided by the CM and TCO.

12.2 ROCK MASS CLASSIFICATION

Upon completion of the Rock Mass Classification analysis, the PI will transfer the preliminary Rock Mass Classification field information to the FTC for further distribution to affected and interested parties.

12.3 The TCO will verify the effectiveness of the classification recommendations during subsequent construction excavation operations.

12.3 REPORTING REQUIREMENTS:

12.3.1 Rock mass quality data are part of the data set defined by the M&O as being required to confirm rock support selection and for input to Title II design. Data will be reported to the M&O field engineer in accordance with the requirements contained in the Test Planning and Job Packages.

12.3.2 Preliminary assessments of rock mass quality indices will be recorded on mapping forms and provided to the M&O MK field engineer.

12.3.3 Other reporting instructions are contained in Section 19 of this work plan.

13. STEEL SET LOAD MONITORING

13.1 IDENTIFY TEST INSTALLATION LOCATIONS

The TCO, CM, and the PI will agree when to initiate the steel set load monitoring activity, and the time and approximate location for installing the monitoring instrumentation.

13.1.1 When, in the opinion of the CM and the TCO the selected test location is in a condition suitable (i.e., is safe for access) for the test activity, the test activity will commence at the proposed test location.

13.2 INSTALL INSTRUMENTATION SYSTEM
The TCO will ensure that the load cell(s), strain gages, pressure cell(s) and all other directly related materials required for the functioning of the test are present and ready at the test location when required.

13.2.1 The PI will select and mark the location where each instrument will be installed.

13.2.2 The Constructor will furnish at the test location all the required equipment, lighting, power, and experienced personnel to efficiently install the monitoring instrumentation.

13.2.3 The PI will direct and witness the installation of the instrumentation and will observe subsequent installation of the liner components in the vicinity of the test equipment. The PI will document the test configuration using the form in Attachment 4 of this work plan.

13.2.4 The PI will wire the monitoring instrumentation to a temporary junction box located on the rib of the tunnel. The PI will verify that the completed instrument array is functioning to his satisfaction.

13.3 ESTABLISH CONSTRUCTION EXCLUSION AREA

Instrumentation and cables will be protected by the Constructor prior to completing any additional construction activities that may detrimentally affect the monitoring instrumentation.

13.3.1 The Constructor will provide effective means to ensure that the completed test fixtures are protected from damage and tampering. The CM will also ensure that the test fixtures are accessible for as long as required.

13.4 REPORTING REQUIREMENTS.

13.4.1 Steel set load monitoring data are part of the data set defined by the M&O as being required to confirm rock support adequacy and for input to Title II design. Data will be reported to the M&O field engineer in accordance with the requirements contained in the Test Planning and Job Packages.

13.4.2 Other reporting instructions are contained in Section 19 of this work plan

14. SEISMIC MONITORING
14.1 IDENTIFY TEST INSTALLATION LOCATIONS

The TCO, CM, and the PI will agree when to initiate the seismic monitoring experiment, and the time and approximate location for the installation of both surface mounted and borehole accelerometers.

4.1.1 When, in the opinion of the CM and the TCO the selected test location is in a condition suitable (i.e., allows for safe access) for the test activity, the CM will issue to the TCO an access authorization permitting the test activity to commence at the proposed test location.

14.2 DRILLING AND CORING

Boreholes required for installing accelerometers will be drilled by the constructor. Attachment 7 provides an estimate of the length and diameter of boreholes required for installation of borehole accelerometers.

14.2.1 The PI will observe the drilling of the boreholes and make final acceptance.

14.3 BOREHOLE VIDEO LOGGING AND INSPECTION

The PI will inspect the holes with a video camera (see "Blast Damage Assessment," Section 10)

14.4 INSTALL INSTRUMENTATION SYSTEM

The PI will advise the TCO when to have the Constructor install the accelerometers. The PI will provide tools for installing both the surface mounted and borehole accelerometers. The Contractor will assist the PI during installation of the instrumentation and provide all necessary support equipment. The PI will document the test configuration using the form in Attachment 4 of this work plan.

14.4.1 The PI will wire the instrumentation to a temporary junction box on the rib of the tunnel. The Contractor will provide permanent wiring to the data logger.

14.5 The TCO will ensure that the system is functioning to the satisfaction of the PI.

14.6 REPORTING REQUIREMENTS.

14.6.1 Seismic monitoring data are part of the data set defined by the M&O as being required to confirm rock support adequacy under seismic loading and for input to Title II design. Data will be
reported to the M&O field engineer in accordance with the requirements contained in the Test Planning and Job Packages.

14.6.2 Seismic monitoring data are also required by the USGS as input to the site seismic monitoring network. Data will be reported to the USGS field representative in accordance with the requirements contained in the Test Planning and Job Packages.

12.3.3 Other reporting instructions are contained in Section 19 of this work plan.

15. RADON MONITORING IN BOREHOLES

The TCO, CM, and the PI will agree when to initiate the radon monitoring in borehole(s) experiment, and the timing and approximate location for constructing boreholes within which the test will be deployed.

15.1.1 When, in the opinion of the CM and the TCO the selected test location is in a condition suitable (i.e., allows for safe access) for the test activity, the CM will issue to the TCO an access authorization permitting the test activity to commence at the proposed test location.

15.2 DRILLING AND CORING

Required boreholes will be drilled by the constructor. Attachment 7 provides an estimate of the length and diameter of boreholes required for radon monitoring.

15.2.1 The PI will observe the drilling of the boreholes and make final acceptance.

15.3 BOREHOLE VIDEO LOGGING AND INSPECTION

The PI will inspect the holes with a video camera (see "Blast Damage Assessment," Section 10).

15.4 INSTALL INSTRUMENTATION SYSTEM

The PI will advise the TCO when to have the Constructor install the radon measuring requirements. The PI will provide tools for installing the test equipment. The Contractor will assist the PI during installation of the instrumentation and provide all necessary support equipment. The PI will document the test configuration using the form in Attachment 4 of this work plan.
15.4.1 The PI will wire the instrumentation to a temporary junction box on the rib of the tunnel. The Contractor will provide permanent wiring to the data logger.

15.5 The TCO will ensure that the system is functioning to the satisfaction of the PI.

15.6 Reporting requirements are contained in Section 19 of this work plan.

16. AIR QUALITY SURVEYS

16.1 IDENTIFY LOCATION FOR INSTRUMENTATION INSTALLATION

The SNL PI currently anticipates that data required for this test will be supplied by the Construction Contractor. If required information is not being collected by the Construction Contractor, the PI will initiate tests to collect the required data.

16.1.1 The TCO will modify this section of the workplan based on requirements identified by the PI.

16.2 TEST AREA PREPARATION

16.3 INSTALL AIR QUALITY MONITORING INSTRUMENTATION

16.4 ESTABLISH CONSTRUCTION EXCLUSION AREA

17. BULK SAMPLE COLLECTION AND RADON MEASUREMENT

Bulk sample collection and preservation is covered by the Consolidated Sampling Work Plan (WP 92-20C.2)

18. SAFETY

18.1 Safety is primarily the responsibility of the Construction Contractor. All testing personnel will be trained to the standards set by the Construction Contractor and will abide by the Construction Contractors rules for access, scientific and general work.
19. REPORTING REQUIREMENTS

19.1. The TCO will submit a weekly activity report to the FTC. The report will include the identification of conditions that affect data gathering and agreed to specific requirements such as drill hole length location and size.

19.2. The TCO will submit a monthly status report to the FTC and will submit a copy to DRC-. Copies of construction exclusion area forms will be attached to the monthly report.

19.3. REECo will provide to the appropriate DRC file (tracking number DRC-067) and to the TCO the following information:

A. Report of underground Spills of fuels, lubricants and coolants.

B. Record of underground fuel use by class of equipment.

C. Record of underground volume of water, tracers, fluids, and materials as specified in Job Package 92-20.

D. Design of each blast round and assessment of blast performance (see Blast Monitoring Activity Section).

E. Other records identified in subsections of this workplan.

REECo will notify the FTC and TCO of any noncompliance and known problems during any phase of construction monitoring.

19.4. The PI or designee will notify the LANL FTR in writing that the field portion of the activity is complete and data collection has entered a monitoring phase, and will provide status of associated milestones and commitments.

20. VERIFICATION

20.1. CONFIRM INSTRUMENTATION INSTALLATIONS

Raytheon Services Nevada will verify location and number of test boreholes and installed instrumentation using an approved verification plan for the ESF starter tunnel.

21. WORK PLAN CLOSE OUT
20.1. At the conclusion of the field activity, the TCO will submit a close out report under JP 92-20D.

20.2 Concurrence from the job package coordinator (JPC) that record package turnover requirements have been met.

Signature: ___________________________ (JPRC)/ Date: __________

22. **Concurrence of the Completion of the Construction Monitoring Workplan**

22.1 PI or Representative

Signature: ___________________________ / Date: __________

22.2 ESF Test Coordination Office (TCO) Representative

Signature: ___________________________ / Date: __________

22.3 YMP- Assistant Manager for Site Programs (AMSP) FTC

Signature: ___________________________ / Date: __________
Attachment 1  Work Plan / Work Order Interface
ATTACHMENT 5  ESF TEST COORDINATION OFFICE SAMPLE PLAN

CONSTRUCTION MONITORING IN THE NORTH AND SOUTH RAMPS, TEST ALCOVES, AND MAIN DRIFT

Sample Plan ID: SP 92-20D.1 Rev. 7/__/94
(Administrative Only)
This sample plan (SP) implements and operates within the constraints and requirements established in Test Planning Package (TPP) T-93-2, Job Package (JP) 92-20D, and supplements instructions provided in WP 92-20D. This SP will be revised as necessary by the TCO and changes communicated to all affected participants for concurrence.

This SP is administrative only and has been prepared to facilitate work to be conducted in the field. This plan has been reviewed (1) to assure that it is fully consistent with the controlled requirements basis represented in the TPPs and JPs listed above and (2) to assure that it contains no quality-affecting requirements. The SP does provide a planned method to meet requirements in the TPPs and JPs listed above. Any anticipated deviations from this plan should be brought to the immediate attention of the TCO. The TCO will assure that planned deviations are evaluated to determine if they are consistent with the requirements basis. If so, the TCO will give direction to proceed with the work and document the deviation. If the deviation is not consistent with the requirements basis, work will not proceed until inconsistencies are resolved.

The following activities will be performed in support of this test:

1. **PROJECT SCHEDULING AND COORDINATION**

1.1 The DOE Field Test Coordinator (FTC), the TCO, the M&O Construction Manager (CM), REECo Construction Department Manager (CDM), USGS/USBR geologic mappers, and the Principal Investigators (PIs) for whom samples will be collected (or their representatives) will mutually review and accept the SP and any subsequent TCO revision and will mutually agree upon a tentative schedule, implementation methods, and representative or approval authority for the work described below.

Concurrence:

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<th>Role</th>
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<tr>
<td>PI (SNL)</td>
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2. **CORE COLLECTION AND HANDLING**
Instrumentation boreholes will be drilled potentially producing core at the selected locations in the ESF north ramp and test alcoves as described in the Construction Monitoring Work Plan (WP92-20D.2). Current plans call for coring only those boreholes drilled behind the tunnel boring machine (TBM) trailing gear. Boreholes may be drilled wet or dry.

Planned borehole diameters and lengths are provided in Attachment 7 of the Work Plan.

The principal investigator for this ESF test activity is J. Grant (SNL). All core has been allocated to C. Chocas (SNL) and may only be released to J. Grant or C. Chocas. Any unused or unaltered specimen remnants will be returned to the SMF for curation and allocation in coordination with the Sample Overview Committee (SOC).

2.1 CORE HANDLING

DS&SM will receive the core barrel from the constructor, as directed by the FTR.

2.2 CORE DESCRIPTION

A preliminary lithologic log and structural description of the core will be developed after the core is removed from the core barrel by DS&SM staff. Any occurrence of grouting material as well as any naturally occurring moist or wet zones or lithologic anomalies will be reported to the ESF TCO immediately in order to allow for unique sample collection. A videotape of the core shall be recorded by DS&SM after the core is removed from the core barrel. A copy of the core video will be provided to the Sandia National Laboratories (SNL) PI and to the ESF TCO. If any photographs of the core or packaged core are taken, a copy will be provided to the ESF TCO.

2.3 CORE STORAGE AND SHIPPING

Core should be protected from mechanical damage during storage and shipping. Standard SMF core boxes are sufficient. This core will be used for determination of thermomechanical properties and does not need refrigeration. Core will be curated at the SMF until shipment is requested by either J. Grant or C. Chocas.

3. EQUIPMENT & MATERIALS

Refer to the applicable work plan(s).

4. SAFETY
Refer to the applicable work plan(s).

5. **TRAINING**

5.1 All DS&SM/SMF sample handlers will be trained to YAP-SII.4Q-2 and related procedures, as appropriate.

6. **REPORTING & RECORDS**

Refer to the applicable work plan(s).

7. **VERIFICATION**

Refer to the applicable work plan(s).

8. **SAMPLE PLAN COMPLETION**

Refer to the applicable work plan(s).

9. **CONCURRENCE OF THE COMPLETION OF THE SAMPLE PLAN**

Refer to the work plan
ATTACHMENT 6 POINTS of CONTACT

FOC Visitor Control  L. Camp  5-5915
LANL ESF PE/JPC  R. Oliver  4-7095
LANL ESF JPRC  A. Mitchell  4-7156
LANL ESF FTR  R. Kovach  5-6180
LANL ESF TCO Representative  N. Elkins  4-7097
M&O Construction Manager  L. Renegar  5-3699
REECo Construction Department Manager  T. Leonard  4-7255
RSN Survey Engineer  L. Watson  5-5804
SNL PI  J. Pott (505)-844-1580
SNL (JFTA) Field Technical Coordinator  C. Brechtel (303)-242-4220
SNL (JFTA) Field Design and Implementation  A. Richardson (303)-242-4220
SNL Field Support  J. Grant  5-6867
YMP AMSP FTC  A. Girdley  5-7927
### Attachment 7 Planned Drilling Quantities

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<td>Total two (2) inch</td>
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<td>1515</td>
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“CONSTRUCTION MONITORING ACTIVITY REQUEST / AUTHORIZATION AND RELEASES TO CONSTRUCTION” FORM

Construction Monitoring Activity Request

Test Planning Package | Job Package | WBS Element ID | Principal Investigator
--- | --- | --- | ---

Requested By _______________ Organization/Date _______________

ESF/TCO Concurrence / Date _______________

Spatial Extent of Activity or Sessions:

[-] Mapping Gantry  [-] TBM Shield  [-] Alcove ID  [-] Drifts or Extension

From Construction Station _______________ To Construction Station _______________

Construction Monitoring Access Authorization

ESF/TCO Concurrence / Date _______________

Construction Manager (CM) _______________ Organization/Date _______________

Comments or Restrictions:

[-] Alcove  [-] Drifts or Extension

From Construction Station _______________ To Construction Station _______________

ESF/TCO Concurrence _______________ PI Rep / Date _______________

YMPO Field Test Coordinator (FTC) _______________ Date _______________

Comments or Restrictions:

This form constitutes an administrative preliminary record of the Construction Monitoring activities. The form is to be completed by the responsible PI or designee and provided to the TCO Field Test Representative as a part of the Test implementation process.
"CONSTRUCTION MONITORING ACTIVITY NOTIFICATION" FORM

Releases to Construction - Test Exclusion Area Locations

Construction Monitoring Instrumentation Installation Request Reference

Request #

[ ] Mapping Gantry

[ ] Alcove ID

[ ] Drifts or Extention

From Construction Station [ ] To Construction Station [ ]

Issued By _____________________ Organization/Date ____________

Activity Supports _____________________ WBS Identifier ________

Responsible PI _____________________ Responsible Org. ________

Sample or Test Location Sketch

Provide Sufficient Detail for Sketch of As-Built Configuration

Location Survey Description

CS plus Offset: _____________________
Field Note ID’s: ___________________
Survey Engineer: ___________________
Survey Organization: ________________

Physical Location Description

Supplemental Data

Photo Set ID’s: _____________________
Photographer Name & Organization: _____________________
Comments: _____________________

Other Photo’s (ListReference): _____________________

Comments or Restrictions:

This form constitutes an administrative preliminary record of the Construction Monitoring activities. The form is to be completed by the responsible PI or designee and provided to the TCO Field Test Representative as a part of the Test implementation process.
TO: J. Pott, SNL
FROM: J. Hollins, LANL
SUBJECT: REQUEST FOR DESIGN AND TEST RELATED INFORMATION FOR TESTS TO BE PERFORMED IN THE ESF MAIN DRIFT

The ESF TCO is requesting that Sandia National Laboratory provide design and test related information for planned tests in the ESF main drift and alcoves. Specifically, the TCO requests input with regard to:

1) Confirmation of the completeness of Attachment 1 with regard to SNL tests planned for the main drift and test alcoves.

2) Review and comment on supplemented sections of Appendix B tests for which SNL is the lead organization. This is the format for the D&TRI submittal for Design Package 8 (Main Drift).

3) Any other test related information that may have an impact on the design and construction of the main drift.

Please provide your response by close of business on August 25, 1994 for incorporation in LANL's letter to the CRWMS M&O that must be forwarded on August 29, 1994.

Attachments:

1. Proposed Attachment 1 to the 8A D&TRI submittal titled "Phase 3B Main Drift Tests (Preliminary Draft)
2. Proposed Attachment 2 to the 8A D&TRI submittal titled "Design and Test Related Information For ESF Main Drift Tests" (Preliminary Draft)
This form constitutes an administrative record of the installation of an instrument or piece of test equipment (including geophysical logging activities). The form is to be completed by the responsible PI or designee and provided to the TCO Field Test Representative as a part of the end of the installation process.
TO: R. Craig, USGS
FROM: N. Z. Elkins, LANL

SUBJECT: CLARIFICATION OF COMPRESSED AIR QUALITY REQUIREMENTS FOR USGS TESTING AND RELATED ACTIVITIES IN THE ESF NORTH RAMP

Selection of the existing compressed air filtration system, currently being used to remove contaminants from air for drilling radial boreholes in Alcove #1, was verbally agreed to by the LANL TCO, USGS, RSN, and REECo during a meeting held at the FOC in October, 1993.

Through this letter, the LANL TCO requests written confirmation of the suitability of the INGERSOLL RAND compressed air filter module (model NLM-3) for continued use in ESF testing for which the USGS is responsible. Confirmation of the suitability and/or additional compressed air filtration requirements will be submitted to the CRWMS M&O as input to the design of the ESF compressed air system (Design Packages 1C and 1D).

Please provide your response by February 23, 1994 for incorporation in LANL’s letter to the CRWMS M&O.

Enclosure: Performance Specifications for the NLM series of filter modules
SUBJECT: REQUEST FOR DESIGN AND TEST RELATED INFORMATION FOR TESTS TO BE PERFORMED IN THE ESF MAIN DRIFT

As discussed in our meeting with Bob Craig of 8-17-94, the ESF TCO is requesting the U.S. Geological Survey (USGS) to provide design and test related information for planned tests in the ESF main drift and alcoves. Specifically, the TCO requests input with regard to:

1) Confirmation of the completeness of Attachment 1 with regard to USGS tests planned for the main drift and test alcoves.

2) Review and comment on the attached sketches showing (i) location of alcoves 6 and 7; (ii) proposed layout of alcove 6; (iii) proposed layout of alcove 7; (iv) plan view of alcove general arrangement.

3) Criteria that are important to performing the Hydrologic Properties of Major Faults tests in Alcoves 6 and 7. For example:
   (a) Minimum distance of test alcove roof from TSW1-TSW2 contact.
   (b) Required borehole configuration and size(s) (length, diameter) and orientation; proposed collar pattern; required drilling methodology; location and orientation of geothermal boreholes.
   (c) Minimum/maximum offset between pairs of drifts excavated along and parallel to each fault.
   (d) Etc.

4) Review and comment on supplemented sections of Appendix B tests for which the USGS is the lead organization. This is the format for the D&TRI submittal for Design Package 8A (Main Drift).

5) Comments on the potential for additional alcoves that need to be constructed in-line with main drift construction (if any).

6) Comments on the potential for additional alcoves that will need to be mined in a westerly direction from the main drift.

7) Any other test related information that may have an impact on the design and construction of the main drift.

Please provide your response by August 24, 1994 for incorporation in LANL's letter to the CRWMS M&O that must be forwarded on August 26, 1994.

Attachments:
1. Proposed Attachment 1 to the 8A D&TRI submittal titled "Phase 3B Main Drift Tests" (Preliminary Draft)
2. Proposed Attachment 2 to the 8A D&TRI submittal titled "Design and Test Related Information For ESF Main Drift Tests" (Preliminary Draft)
3. Proposed Attachment 3 to the 8A D&TRI submittal containing figures showing location and layout of Alcoves 6 and 7 in the Main Drift (Preliminary Draft)
The following information and requirements are consistent with the preliminary ESF test planning basis contained in TPP 91-5 and ESF Design Requirements contained in the ESFDR Appendix B (YMP/CM-0019, Revision 0). Detailed test support and implementation requirements for tests will be developed and approved through the formal test planning process prior to test authorization. The input is provided in the Los Alamos Test Coordination Office (TCO) format for ESFDR Appendix B (Reference 2) submittals and supplements previous inputs.

Items shown in *italics* amend, supplement or revise the ESFDR Appendix B (7/2/92) section to which they belong.
MEMORANDUM

RE: REQUEST OF 4-18-94 FOR HIGHWALL STABILITY DATA REQUIREMENTS (INPUT TO BE SUPPLIED BY HK TO THE M&O)

Date: 4-20-94

This memorandum has been prepared to document the data required for static and dynamic analysis of the portal, portal highwall, and box-cut at the Yucca Mountain ESF. A risk analysis will also be performed to quantify any uncertainties in the stability analyses and potential impacts on safety and ESF construction. The memorandum has been prepared at the request of H. Kalia, Los Alamos National laboratory.

Stability analyses of the portal highwall should be completed consistent with prudent engineering practice. It is anticipated that both static and dynamic analyses will be performed to determine portal and highwall stability, and any additional ground support requirements, for the planned facility life. It is further anticipated that this work will involve re-examining the original slope and portal ground support designs in light of changed or differing conditions (e.g., with respect to actual ground conditions and actual ground support installed).

Data required for static and dynamic stability analyses includes:

- Seismic criteria (peak surface accelerations and probability of occurrence)
- Structural map of the highwall showing discontinuity traces, joint descriptions, joint orientations (dip and dip direction), discontinuity spacing, RQD and fracture frequency, stereoplots (if available), and rock mass classifications. Photographs (preferably stereo pairs) of the highwall after excavation, following portal construction, and showing current condition.
- As-built plan and sections defining the configuration of the portal, highwall, and box-cut.
- As-built rock support map of the highwall showing bolt locations. This map should be accompanied by the QA/QC data collected during and following rock support installation (e.g., installation records, bolt testing records, instrumentation records) and highwall displacement monitoring records.
- Structural map of the first 100 feet of the ESF starter tunnel showing discontinuity traces, joint descriptions, joint orientations (dip and dip direction), discontinuity spacing, RQD and fracture frequency (from scanlines), stereoplots (if available), and rock mass classifications.
- As-built rock support details for the first 100 feet of starter tunnel including: longitudinal section showing highwall, portal brow, and excavation limit; lattice girder and rock bolt locations; sections representing the range in shotcrete thickness along the tunnel; and QA/QC data for installed lattice girders, rock bolts, and shotcrete.
- Ground support (e.g., rock bolt load cell) and tunnel deformation (e.g., convergence and extensometer) monitoring records for the first 100 foot of the starter tunnel.
Available rock mechanics laboratory test data (e.g., rock strength, young's modulus, etc.)

Records which provide statistical analyses of the parameters reference above will facilitate preparation of the risk analysis and should be provided where available.
The meeting was convened to present and discuss currently available data on ground conditions immediately beyond the Bow Ridge fault and to determine actions required to address ESF tunnel construction concerns that are currently based on that data.

Presentations, made by personnel listed on the agenda, are provided in attachments. Key issues are discussed below:

**Issue 1: Current understanding of the geology beyond the Bow Ridge Fault**

- Geologic conditions are inferred from geophysical exploration (magnetic and gravity) and borehole data.
  - approximately 250 ft of the proposed tunnel alignment will be in a material characterized as non-lithified, pyroclastic fallout consisting of well sorted pumice and rock fragments (Buesh, Brechtel).
  - faulting, inferred from geophysical exploration, may affect the limits of non-lithified strata of potential concern to tunnelling (Buesh).
  - Strata underlying the non-lithified zone, and representing the western limits of the zone of concern to tunnelling, is characterized as a pyroclastic flow deposit (Tuff X) (Buesh).

**Issue 2: Current understanding of Ground Conditions and Available Ground Improvement Techniques that can be used Beyond the Bow Ridge Fault.**

- Anticipated ground conditions are inferred from geotechnical data obtained from surface boreholes. Ground improvement techniques are based on the current program plan (i.e., use of the CTS TBM) and geotechnical data from surface boreholes.
- material, in the 250 ft wide zone of concern to tunnelling, is dry (3%>moisture content<21%, ave mc - 10%) and cohesionless (Brechtel).
- particle gradations, based on current borehole data, indicate that the formation is probably groutable using chemical grouting techniques. Cementitious grouting is not considered feasible (Brechtel).
- sodium silicate is a potential chemical grout suited to the currently defined conditions (deStwolinski).
- waste isolation considerations are unlikely to restrict the use of sodium silicate (Houseworth).

Previous experience from site investigation and tunnelling projects on the NTS.

- If the description of material within the zone of concern is accurate, the material has not previously been mined or drilled on the NTS (Townsend).
- the mechanical properties of the recovered material may have been altered by dry drilling (Townsend).

Issue 3: Design Considerations and Impact on Current Program

- TBM is a hardrock machine and not configured for excavating cohesionless materials (deStwolinski).
- Proposed package 2C design will be affected by currently identified ground conditions. Ground support anticipated for package 2C will not be affected if grouting is used (Saunders).
- Need to obtain representative in situ data to (a) assess the feasibility of normal TBM operations, (b) confirm the feasibility of grouting, and (c) permit excavation and ground support design.
- waste isolation impacts from all proposed activities will need to be evaluated.

Issue 4: Potential Site Characterization Techniques

- Based on trenching

- proposed arrangement on C. Brechtel slides. Direct exposures of the non-lithified materials may be used to indicate the extent of the zone of concern and to provide samples for comparison with previous core based results.
- Trench collapse would further indicate that grouting is required. However, trench stability would not enhance confidence in tunnel stability as trenches will not be excavated in the actual horizon to be mined by the TBM.

- Additional subsurface exploration may be conducted below the base of the trench using auger methods to obtain relatively undisturbed samples.

- Based on testing in small diameter boreholes.

  - Potential suite of tests shown on C. Brechtel slides. In general, tests provide index values that may be of limited value in determining stability issues at the scale of the TBM driveage.

  - Boreholes to be augered with relatively undisturbed sampling through the hollow stem.

  - Part of the potential suite of tests will be needed to confirm grouting feasibility.

  - Borehole collapse after casing removal would further indicate that grouting is required. However, borehole stability would not enhance confidence in tunnel stability.

  - Surprises often result from site investigation programs that rely solely on small diameter boreholes (Hansmure).

- Based on large (4 ft) diameter borehole.

  - The Designer (MK) and tunnelling contractor (K/PB) support the use of a large diameter (4 ft) borehole configured to permit underground inspection of actual conditions.

  - Grouting may still be required after boring.

  - One borehole will not confirm the feasibility of grouting and will therefore be an additional requirement to the characterization program.

Issue 5: Impacts to ESF Testing

- Grouting will impact the ESF program. Consideration should be given to obtaining any lost data from surface boreholes.

- Geothermal testing of major faults will, in general, be affected by drilling access constraints imposed by tunnel boring. Consideration should be given to obtaining required Bow ridge fault characteristics from surface boreholes.
Issue 6: Cost and Schedule

- Costs
  - Cost of trenching and 3 boreholes (2C, 2D, and 2E) approximately $250,000 (DOE).
  - Cost of large diameter borehole approximately $450,000 (REECO).
  - Cost of grouting (external contractor costs) approximately $1.5 million (Kiewitt).

- Schedule
  - Tunnel Boring to commence in July/August, 1994.
  - Trenching and boring program will take approximately 5 months.
  - Large diameter boring program will take from 1 - 8 months.
  - Grouting program will take from 3 - 4 months (depends on availability of equipment).

CONCLUSIONS

1. Dean Townsend was invited to inspect the core samples from NRG 2 series boreholes.

2. Trenching, to expose non-lithified strata representative of the actual tunnelling conditions, was generally accepted by the group. However, there is some uncertainty regarding the ability of a trench to intersect representative materials.

3. The tunnelling contractor (K/PB) has little confidence that small boreholes will provide data necessary to confirm or refute the need for a ground modification (currently identified as chemical grouting) program.

4. The Designer (MK) and tunnelling contractor (K/PB) support the use of a large diameter (4 ft) borehole configured to permit underground inspection of actual conditions.

5. Based on current information, the designer's (MK's) preferred option is to chemically grout the non-lithified zone from surface.
Additional information is needed to assess construction approach, to confirm the feasibility of grouting and for excavation and ground support design.

EDITORIAL COMMENTS

There are several issues that must be resolved prior to implementing the designer's preferred option (based on current information) of chemical grouting.

1. Actual ground conditions, and characteristic data required to assess constructability and to determine grouting feasibility and excavation/ground support design. The actual extent of the zone to be grouted may be determined during drilling of the grout holes.

   (a) Dean Townsend should inspect the core from NRG 2 series boreholes to determine whether the materials are similar to those previously encountered on the NTS (or not).

   (b) Design data requirements should be prepared by the Designer (MK).

   (c) A testing program should be developed by the SBT Contractor (SNL) based on the design data needs (in (b)).

   (d) Trenching, to confirm limits of the zone of concern, and to provide access for relatively undisturbed sampling should be given a high priority.

2. Inferred long lead items need to be accurately scheduled and costed, currently identified items, requiring cost and schedule analysis, include:

   (a) Grouting Contractor (Procurement, Mobe, Site Support, Grouting, and Demobe, etc.)

   (b) Permits and environmental compliance documentation required for small and large diameter borings.
(c) Large Diameter Boring (Planning documentation (SAR, JP/TPP and associated analyses, Work Plan, Study Plan, External Interactions, etc.), Procurement/Equipment Transfer, Site Support, Mobe, Drilling/Casing, Inspection, Sealing, Demobe, etc.)

In addition, it is recommended that the DOE should develop a date by which the entire sequence of necessary activities must be completed.

It is suggested that these comments be deliberated by a smaller group representing the Contractor, Designer, and DOE with the objective of assigning action items that will move the program ahead.
Objectives:

- To determine +ve or -ve effects of microorganisms on actinide transport.
- Essential that population (numbers) and activities of microorganisms are determined.

ESF Constraints

- All ESF samples to be collected aseptically (p 13)
- Samples to be collected from upper, middle, and lower parts of each lithologic unit at Yucca Mountain. Explicitly from the top to the bottom of the ESF (p 14)
- 500 grams of sterile rock comprises a sample (p 14)
- Requires 3 samples per location (p 14)
- Procedures to be developed for sample collection in the ESF and sample shipment (30 to 60 days prior to work initiation) (p 16)
- Crushed rock to be obtained from Calico Hills and Topopah Spring members for column studies (p 19)
- Crushed tuff samples required (p 20)

Interfaces

- Outputs data to 8.3.1.3.7.1 "Retardation Sensitivity Analysis (p 23)
- Inputs data from 8.3.1.2.2 (unsaturated zone hydrologic system) and 8.3.1.2.3 (saturated zone hydrologic system). (p 23)
Attachments

- ESFDR Appendix B (B 2.18, Rev 0)
- TPP 91-5 write-up (needs some work pending formalization of outline)
MEMORANDUM

February 18, 1994

To: D. Boak
Copies: Bob Rommel, Jim Beckett
Fr: C. Breeds

RE: TRANSMITTAL OF REECO RECORDS ON "AS-BUILT" WATER DATA TO THE TDB

I have followed up on your request of 1-12-93 to set up a system with EG&G/EM to track information collected by REECo on water usage. This data would subsequently be used by the PIs, PEs, and others to evaluate the potential impacts of water usage on ESF tests.

I met with Jim Beckett on January 14, 1993 to discuss their requirements and protocol for transferring this type of data. The results of this meeting are as follows:

1. The data submittal should contain locations where the water was used. Location data could include:
   - Chainage in the Starter Tunnel (or Alcove).
   - Actual coordinates (N,E)

   Suggest we ask REECo to add this column to their report.

2. Data Transfer
   - If the data type is not currently contained in the Project Data Dictionary, it can be submitted with a simple transmittal letter. It will then be reported in the GIS catalog which appears quarterly (LANL is on distribution).
   - If the data type is contained in the Project Data Dictionary, a TDIF must accompany the submittal.
   - The data dictionary currently contains all those data types currently noted in the study plans. Water usage information would probably be addressed by the man made material study plan, if it exists. I can research this issue further when I return on Jan 24.
If the man made materials study plan does not exist or has not progressed to the point where referenced data types have been incorporated in the TDB Data Dictionary, we can proceed using a simple letter of transmittal (accompanied by disk and hardcopy).

- We can limit access to the data by noting restrictions on the TDLF or transmittal letter if we so wish.

3. Jim Beckett expects that we should have on-line access this FY to the TDB which would include access to this type of information as well as the TFMDB and other TDB items.

4. Recommendations:
   - Request that REECo add location data to their existing spreadsheet; Locations should be specified relative to Starter Tunnel stations.
   - Request that REECo provide us with an amended report illustrating how location information has been referenced.
   - The TCO should review the new data submittal and determine whether it meets the potential data user's needs. Any additional changes should be forwarded to REECo (a meeting may facilitate this process).
   - REECo will then transmit the "As-Built" water usage data, contained on a disk, to EG&G. As noted above, this data transmittal should be accomplished using a cover letter which, at a minimum, notes the subject matter, the format of the data submitted (e.g., Lotus 1-2-3 Vs 3.0 file), and attaches a paper copy of the raw data.
DATA/INFORMATION REQUIREMENTS AND INTERFACES

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<th>FREQUENCY</th>
<th>INTERFACE</th>
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<td>1) Preliminary Raw Data (Copy of field logbook)</td>
<td>Ground exposed during shift</td>
<td>End of each shift</td>
<td>M&amp;O MK Designer</td>
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<tr>
<td>2) Interim Reports as available</td>
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<td>As available</td>
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<tr>
<td>3) Final Map, stereo plots, and other recorded data.</td>
<td>Map (format TBD) to cover discrete tunnel sections at a scale of TBD.</td>
<td>As available but no later than two months from date of section completion.</td>
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<td>1) Input data and assumptions</td>
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<td>Continuous During Tunnel Boring</td>
<td>M&amp;O MK Construction Manager</td>
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<td>3) Additional Support Detail (e.g., bolt location, orientation, length)</td>
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<td>Ground Support Evaluation/Analysis in First Test Alcove</td>
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<td>Following completion of mapping (approximate delivery on 12/10/93)</td>
<td>M&amp;O MK Designer (J. Pye)</td>
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<td>1) Input data and assumptions</td>
<td>Completed Test Alcove</td>
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<td>2) Results of kinematic (wedge/key block, ubiquitous joint) analysis (UNWEDGE), including additional support details.</td>
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<tr>
<td>3) Final Map, stereoplots, and any analysis results</td>
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DATA UTILIZATION AND QA REQUIREMENTS

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<tr>
<td></td>
<td>1) As-built Geotechnical/Geological Conditions</td>
<td>To be completed by M&amp;O MK (Designer) and USGS/USBR (Data Provider)</td>
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<td>As-built geotechnical data may be used for: assessing long term performance (i.e., as input to the maintenance requirement), as input to the sealing program, and as input for future testing activities that require construction from the ESF tunnel.</td>
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<td>2) Input to permanent support design.</td>
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<td>Ground Support Evaluation/Analysis in Machine Bored Tunnel</td>
<td>1) To guide supplemental bolting required for safety</td>
<td>To be completed by M&amp;O MK (Designer) and USGS/USBR (Data Provider)</td>
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<td>2) Input to ground support selection.</td>
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<td>Ground Support Evaluation/Analysis in First Test Alcove</td>
<td>1) To guide supplemental bolting required for safety</td>
<td>To be completed by M&amp;O MK (Designer) and USGS/USBR (Data Provider)</td>
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<tr>
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<td>2) Input to permanent support design.</td>
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This short memo is written to update LANL management regarding the TFM transition and transition related activities that may require staff support.

As directed by DOE, an initial TFM Transition planning meeting was held October 6 (minutes attached). As agreed in the meeting, TFM transition will include:

(a) Translation of the existing Paradox version of the TFMDB to INGRESS (GENISES) and subsequent maintenance (data entry and data retrieval) of the database by EG&G
(b) Utilization of the TFMDB running on a PC at the FOC for inputting as-built data.
(c) Utilization of the GENISES TFM database by project participants with linkages provided to other databases (e.g., TIDBITS) by EG&G.

Transition activities will not formally begin until the M&O completes a plan which consolidates Waste Isolation (WI), Test Interference (TI), and Determination of Importance (DI) evaluation processes; this plan will include evaluating, tracking, and reporting TFM.

In the interim, we will continue to process TFM requests and associated documentation and interact with DOE and EG&G with regard to preliminary transfer of the TFM Database. The following interim activities are anticipated:

- Meeting with Jim Beckett (C.Breeds and G. Hall) to discuss detailed aspects of transitioning the TFMDB to EG&G and setting up the FOC link (Oct 21).
- Minor modification of the TFMDB application to facilitate transfer to EG&G and FOC (G. Hall).
o Possible follow up meeting with REECO at the FOC.

o Identification of and preparation of records that must be submitted during transition (C. Breeds, A. Thompson). Process started.

o Complete ESF related data entry to the TFMDB and audit data previously entered (C. Breeds, G. Hall).

o Review of M&O WI/TI/DI plan prepared by Jean Younker (C. Breeds, N. Elkins, J. Hall). Note this plan has been delayed by two weeks (currently); should be available November 1, 1994.
MEETING MINUTES

FIRST TFM TRANSITION MEETING - OCTOBER 6, 1993

Present: Claudia Newbury DOE-YMPO, RSED
Peter Hastings CRWMS M&O, DUKE
Jim Houseworth CRWMS M&O, INTERRA
Jim Beckett EG&G/EM/RSL
Jim Hall CAG/LANL
C. Breeds STI/LANL

Prepared by: Chris D. Breeds

The meeting involved a general discussion of the overall Waste Isolation/Test Interference evaluation (WIE/TIE) and Determination of Importance evaluation (DIE) processes and their data requirements, including TFM.

Issue: Future Use of the LANL TFM Database (TFMDB). Initial agreement was reached on supporting the following actions:

(a) Translation of the existing Paradox version of the TFMDB to INGRESS (GENISES) and subsequent maintenance (data entry and data retrieval) of the database by EG&G.
(b) Utilization of the TFMDB running on a PC at the FOC for inputting as-built data.
(c) Utilization of the GENISES TFM database by project participants with linkages provided to other databases (e.g., TIDBITS) by EG&G.

The following operations would be facilitated by the above noted actions:

- TFM data (i.e., TFM proposed for use and documented on a TFM User Request Form - (may be modified if users request)), initially forwarded to the integrated WIE/TIE group, could be provided to EG&G and entered to the GENISES TFMDB.
- Controls and TFM reporting/verification requirements, resulting from the WIE/TIE/DIE (and potentially other processes) could be forwarded to EG&G and entered to the GENISES TFMDB.
- EG&G would periodically update the FOC TFMDB with proposed and/or approved TFM data. This updated data would appear in data entry screens and reports generated by the FOC TFMDB. FOC TFMDB updates from GENISES and as-built data transfers to GENISES would be moved via floppy disk until network or telecommunication facilities linking the FOC and Las Vegas are available and transfer software is verified.
The GENISES TFMDB would be QA controlled. Use of the FOC TFMDB would be procedurally controlled and non QA; data input would be based on identified quality assured hard copy records.

WIE/TIE/DIE analysts could access the GENISES TFMDB to retrieve historical TFM data (both planned and actual usage) for input to new analyses.

Issue: Schedule for transition activities. Claudia Newbury noted that transition activities would not begin until a plan was in place. A draft plan is currently being prepared by Jean Younker and should be submitted by October 15, 1993.

Actions:
(a) Chris Breeds to forward copy of Users Manual for LANL's TFM Database to group participants.
(b) Chris Breeds to provide copy of TFM procedure and related correspondence to Jean Younker (through Jim Houseworth).
(c) Claudia Newbury to forward copy of new WIE/TIE integration plan to LANL for review (end of next week).
(d) Future transition meeting to be called by Claudia Newbury once the WIE/TIE integration plan has been approved.
MINUTES OF MEETING ON TFM TRANSITION DECEMBER 17, 1993

Present:

Chris D. Breeds  STI/LANL  (4-7217)
Jim Hall  LANL/CAG  (4-7270)
Hemendra Kalia  LANL  (4-7094)
James Arnold  REECo  (4-7258)
Claudia M. Newbury  DOE/RSED  (4-7942)
Gillian Hall  LANL/CAG  (4-7270)
Jim Beckett  EG&G/EM  (4-7448)
Chris Berlien  EG&G/EM  (4-7295)

Minutes by: Chris Breeds

TFM Database Presentation:

Transition to EG&G:

FOC Operation of TFMDB:

REECo Data Collection Procedure:

USGS Request for TFM Usage:
TO: C. T. Statton, CRWMS M&O
FROM: Ned Z. Elkins, LANL TCO

SUBJECT: EXEMPTION FROM USE OF TRACERS FOR CERTAIN PARTS OF THE EXPLORATORY STUDIES FACILITY UNDERGROUND CONSTRUCTION

REFERENCES:


LETTER R. DYER (RSED) TO N. Z. ELKINS: "TRACER EXEMPTION FOR WATER USED IN CONSTRUCTION OF NORTH RAMP PAD AND PORTAL AREA ESF DESIGN PACKAGE 1A", RSED:DRW-1671, 12-24-92.

LETTER R. DYER (RSED) TO N. Z. ELKINS: "TRACER EXEMPTION FOR COMPRESSED AIR USED DURING THE CONSTRUCTION AND GEOLOGIC MAPPING ACTIVITIES OF THE NORTH PORTAL TBM STARTER TUNNEL", RSED:DRW 2966, 03-09-93.

The Test Coordination Office (TCO) supports the CRWMS M&O's request to remove the requirement for tracing water and compressed air used in the following ESF construction applications:

1. Mixing water for concrete, cement grout for rock bolt installation where such installation is approved, and fibercrete/shotcrete.
This exemption acknowledges that the LiBr water tracer, currently in use for tagging construction water, is chemically bound up during hydration and further assumes that both concrete and grout are efficiently mixed to provide minimal bleed water.

2. Compressed air used for general ESF underground construction, except that compressed air utilized for construction of testing access such as boreholes and other related access as deemed important by the TCO.

Restrictions to the general exemption for tracer tagging compressed air cover any use of compressed air that may lead to infiltration of the air into the rock mass and subsequent interference with ESF based site characterization tests. Explicitly, this requires any application that causes pressurized air to be in confined contact with the rock mass to utilize either SF₆ or an alternative approved tracer.

The TCO also supports the proposed CRWMS M&O revisions to the ESFDR that are consistent with the above noted exemptions.

Please contact me at 794-7097 if you require clarification of the above.

Yours Sincerely

Ned Z. Elkins
LANL TCO

<table>
<thead>
<tr>
<th>Test/SCP Activity (SCPB Section) or Construction Activity</th>
<th>Study Plan and Number</th>
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<td></td>
<td>No.</td>
<td>LiBr¹ used for</td>
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Los Alamos National Laboratory

November 13, 1994
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<tr>
<th>(8.3.1.2.2.4.2)</th>
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<td></td>
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</table>

| | Drilling (with air) Uses $^{SF_6}$ | | Uses LiBr$^1$ |
| Construction (with water) | | | |

Notes: $^1$ LiBr has been designated as air tracer number 1  
$^2$ $^{SF_6}$ has been designated as aqueous tracer number 1  
$^3$ Number of new tracers controlled by relative location of tests
Assumptions

- Bulk permeability test will be located so that it is not influenced by other tracer tests.
- Percolation test can be isolated from other tests that use aqueous tracers.
- Diffusion tests will not be conducted in the same alcoves as bulk permeability tests.
- Field Scale Experiments to Study Radionuclide Transport at Yucca Mountain will be conducted in the Calico Hills formation outside of the zone of influence of percolation tests.

Tentative Conclusions

- One new gaseous tracer is required based on ESF testing considerations. This may change when potential interactions with surface based testing are considered.
- One new aqueous tracers is required based on ESF testing considerations. This may change when potential interactions with surface based testing are considered.
Re: Workshop to Define a Geotechnical Facility for Environmental Research at the SSC Site

First, let me say that I enjoyed the crisply presented introductory data on the SSC facility and the spirited discussion of potential experiments that might be supported by a Geotechnical facility at the site. My initial estimate of the probability of success in selling such a venture to the DOE (and Congress) rose slightly as a result of these discussions, however, I believe you still face significant hurdles in accomplishing your goals. The following paragraphs distill some of my thoughts regarding the content of your October proposal to the DOE; comments are made from an engineering rather than from a purely scientific perspective.

- **Potential Clients**

  **EPA and/or Superfund Site Owners (PLPs/PRPs):** Superfund legislation cleared the House ways and means committee on August 19. We may yet see a bill this year that promotes cleaning up these sites.

  As noted on Friday, many superfund sites are located over relatively impermeable bedrock that was relied upon for containment. At those sites that have undertaken some remedial action, several techniques have typically already been applied to contain migrating contaminants (e.g., slurry walls) and wells have been installed as part of “pump and treat” programs. Many wells are required to “guarantee” intercepting fracture flows and certain programs require perpetual remedial pump and treat activities. Enormous amounts of money have typically been invested with minimal return.

  Tunnels could provide for long-term passive collection of migrating fluids that are influenced to drain towards the excavation. Experiments at the SSC facility could be designed to demonstrate the feasibility,
design basis, and performance of such a drain. Demonstration testing could be coupled with scientific experiments aimed at understanding fracture flow in weak rock; monitoring the performance of remedial actions; etc. Methods for increasing contaminant flow towards the drain could be designed and tested.

I believe that the relatively incomplete status of many site clean-ups and the uncertainty associated with clean-up method performance may make this a compelling area of applied research.

Low-Level Radioactive Waste Disposal: As you are most likely aware, shale was abandoned as a high-level radioactive waste repository media primarily due to its performance (and uncertainty in its performance) at high temperature. Nevertheless, it is a candidate media for underground LLW disposal.

The design and performance assessment of underground facilities in shale suffers from a paucity of data and available analogues. Significant data exists for salt, limestone (non-karstic), and igneous/metamorphic rocks based on previous mining and repository based studies. The SSC site could provide access for experiments that demonstrate shale’s suitability as a low-temperature radioactive waste host rock.

Clients in the future may include the host LLW states, possibly the Canadian LLW program, NRC (needs to understand how performance will be predicted and demonstrated), and DOE.

High-Level Radioactive Waste at Yucca Mountain?: One of the primary reasons for my attendance at the meeting was to participate in any discussions that arose regarding the participation of the Yucca Mountain Project in future SSC ventures. My personal opinion is that the proposed facilities at the SSC would be of no benefit to the Yucca Mountain. The summary rationale for that statement is as follows:

(1) Obvious significant differences between the geology and geohydrology of the two sites.
(2) The underground testing program at Yucca Mountain is well advanced. Several of the experiments discussed for the SSC will be performed in FY95 & FY96 in the ESF.
(3) Tests are designed to provide data for repository licensing and must be conducted on-site.
(4) Alternative test locations for “shakedown testing” in bedded Tuff are available to the program.
Please consider this comment in a constructive manner. I believe that it is technically inappropriate to proceed with any reference to Yucca Mountain as a basis for the SSC facility.

**Contribution to Education:** Tunneling has traditionally been taught as a subset of civil engineering or geotechnical/geological engineering programs. The latter disciplines primarily concentrating on rock characterization and ground support detailing. While Illinois and Minnesota have built a substantial reputation in underground space and tunneling related R&D (and graduate programs), neither university offers a “Tunneling” degree. The lack of a precise definition of what constitutes a tunneling engineer is further illustrated by the professional registration process. No one discipline contains questions uniquely related to tunnel engineering.

With the support of existing institutions, an SSC based higher education facility could produce tunneling engineers and tunnel engineering technicians. While not directly supporting the R&D objectives of the steering committee, such a long term proposal may swing the vote. It would most certainly provide the platform for graduate education and hence provide support for planned research activities.

Incidentally, several years ago, Bridgewater College (UK) began offering a course for tunnel engineering technicians. This course has been well received by the UK and European tunneling industry.

**Contribution to Tunneling Technology:** I thought Priscilla did an excellent job of comprehensively summarizing opportunities in this area. Some additional work could be aimed at demonstrating the performance of (a) coatings that prevent air slaking/moisture penetration and/or improve bonding with concrete; (b) composite (possibly laminated) lining systems designed to promote drainage and/or sealing and a dry finished tunnel. Some of the issues that need to be investigated are contained in the attached NATM article.

**Other suggestions:** It may be useful to publish a short paper summarizing the results of the workshop and the proposed SSC experiments. Such a publication would be aimed at galvanizing support from the soft ground/weak rock tunneling, environmental, and waste disposal communities.

Again, I really enjoyed participating in the workshop. If I can be of further help, please do not hesitate to call.
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ATTACHMENT 2

DESIGN AND TEST-RELATED INFORMATION FOR ESF MAIN RAMP TESTS

The following information and requirements are consistent with the preliminary ESF test planning basis contained in TPP 91-5 and ESF Design Requirements contained in the ESFDR Appendix B (YMP/CM-0019, Revision 0). Detailed test support and implementation requirements for tests will be developed and approved through the formal test planning process prior to test authorization. The input is provided in the Los Alamos Test Coordination Office (TCO) format for ESFDR Appendix B (Reference 2) submittals and supplements previous inputs.

Items shown in italics amend, supplement or revise the ESFDR Appendix B (7/2/92) section to which they belong.

8A1 SUPPLEMENTAL PLANNING INFORMATION FOR PERCHED WATER TESTING (B-2.2.9)

8A1.1 PERFORMANCE CRITERIA

1a. Space requirements for this test depend upon the type of perched water zone encountered. Small perched water zones (seeps, etc.) may require an opening in the ramp or drift wall large enough to contain water sampling equipment and a data logger (1m x 1m x 0.5m). In the event that boreholes are required for sampling, testing, and monitoring large volume perched water zones, an alcove large enough to contain a coring rig may be needed to move the drilling operations out of heavy traffic areas in the ESF. Because of the nature of perched water, the location of its occurrence cannot be predicted.

1b. Boreholes cored specifically for this test should be HQ3-sized boreholes, deep enough to retrieve natural state samples, oriented approximately horizontal (this is not critical), and drilled dry (air as the circulating fluid).

1c. Boreholes drilled to develop and concentrate the flow of perched water will be instrumented to conduct hydraulic tests, to monitor pressure and temperature, and to collect water samples. Data loggers will be used to collect and store data from these boreholes.
1. The locations of perched water tests will be controlled by the occurrence of perched water. Access to ramp or drift faces may be required immediately after the detection of any perched water. The orientation of boreholes drilled for this test will be controlled by the nature of the perched water zone.

2. Boreholes are drilled in the ESF for this test to concentrate and collect perched water samples for laboratory testing. Additionally, the boreholes will be instrumented to test and monitor perched water zones. Small flow perched water zones may only require that water samples be collected along with an estimate of the flow rate and total volume of water produced.

3. Standard ESF utilities are required for this test.

4. Perched water zones in the ramps and drifts need to be sampled and examined as soon as they are encountered. This activity may require that the tunnel boring machine be pulled back or driven forward to provide access to the perched water, whichever is faster. After initial sampling, a determination as to the extent of the perched water zone will be made. Based on this information, it will be decided whether to suspend excavation operations to allow for more complete testing and sampling or to allow excavation operations to continue. Long-term sampling and monitoring of perched water zones, either in boreholes or along ESF walls, will continue until the nature of a perched water zone is determined.

i. Use of tracers, fluids, and materials in conduct of this test shall be recorded and reported as described in the applicable job package.

ii. If sample requirements for perched water tests are met, additional samples will be sent to the USGS for hydrochemistry tests (activity 8.3.1.2.2.4.8 in Study Plan 8.3.1.2.2.4). If samples are available in excess of that required for hydrochemistry tests, they will be sent to LANL for analyses specified in Study Plan 8.3.1.2.2.2 (Water Movement).
A. Perched water testing will be initiated as soon as any perched water is encountered in the ESF. This test should not interfere with any other test. Core samples collected from boreholes drilled for this test will be provided to the matrix hydrologic properties test if necessary.

i. As soon as practicable, after potential perched water is observed, an assessment will be made of appropriate steps to be taken for sampling.

B. No Integrated Data System (IDS) requirements are foreseen at this time. Perched water data collected on data loggers may be transmitted and stored on the IDS system.

C. This test will be conducted wherever perched water is encountered in the ESF. No interference envelope is required.

D. If boreholes are needed, dry drilling is required for this test. If grouting of the ramp and drift walls is required, a chemical tracer must be added to the grout. If alcoves are constructed for this test, minimal water may be used in drilling the blast holes.

8A1.3 INTERFACE REQUIREMENTS

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.

Section 2.3.1 Scientific Manpower/Schedule Information
Section 2.3.2 Laboratory/Office/Storage Space Requirements
Section 2.3.3 Electrical Power Requirements
Section 2.3.4 Water System Requirements
Section 2.3.5 Compressed Air System Requirements
Section 2.3.6 Common Sampling Design Requirements
Section 2.3.7 Communications System Requirements
Section 3.0 Integrated Data System

8A1.4 ASSUMPTIONS
The PI or his designated representative will determine what methods are needed to characterize the perched-water each time it is encountered.

The test organization (USGS) will provide all sampling, testing, and monitoring equipment.

Criteria will be developed by the test organization (USGS) to define what constitutes evidence of perched-water.

The USGS data collection system (data loggers) can be interfaced with the IDS for the storage of data collected during long-term monitoring.

8A2 PLANNING INFORMATION - HYDROCHEMISTRY TESTS IN THE ESF (B-2.2.10)

The hydrochemistry tests are described in Study Plan 8.3.1.2.2.4, Characterization of the Yucca Mountain Unsaturated Zone in the ESF.

8A2.1 PERFORMANCE CRITERIA

1a. Core and gas samples will be required from the following locations:

   i. All Radial Borehole Test holes.

   ii. Many of the Bulk Permeability Test holes.

   iii. Many of the Major Faults Test holes.

   iv. From additional coreholes drilled specifically for the Hydrochemistry test to provide gas and core samples from locations not satisfied by the above test locations. These may include 2 or 3 additional locations in the Tiva Canyon welded hydrogeologic unit, and 2 additional locations in the Topopah Spring hydrogeologic unit, the zeolitic and vitric facies of the Calico Hills nonwelded hydrogeologic units, and the bedded tuff of the Paintbrush hydrogeologic unit. This also
may include any wet areas, any unanticipated
geologic formation encountered during ESF
construction, and coreholes cored in three
different orientations from one alcove in each of
the welded units. All of the coreholes will be
61mm in diameter (HQ-3), and dry drilled to a
depth of about 30m.

v. Coring, sampling, and testing of long coreholes
will be coordinated with primary PIs for other
tests.

The time interval between completion of alcove construction and
initiation of drilling for test boreholes should be minimized to
counter the effects of drying (alteration of in situ water
saturations) on unprotected rock of the alcove. Time intervals
will be established for each alcove by the USGS, TCO, and
construction manager prior to alcove construction.

lb. Long-term gas sampling will occur twice per year for a period
of at least 3 years.

i. Sampling intervals will be determined by the
principal investigator (PI).

ii. Sampling will take approximately 2 to 4 weeks or
as needed by the PI.

lc. Gas samples will be provided from short-term boreholes
drilled from the drift in a minimum of 2 locations in each
hydrogeologic unit as soon as possible after excavation.
Additionally, it may be necessary to provide short-term
boreholes from alcoves at each of the locations listed in 1a,
1b, 1c, and 1d (above). Information obtained from the short-
term boreholes drilled from the drift will help determine the
necessity for, and depth of, the alcove short-term boreholes.

i. Short-term boreholes consist of 1-2m boreholes
that are dry drilled to obtain gas samples at
locations determined by the PI.

ld. Alcoves may be required at each gas sampling location as
necessary to provide at least 1.8m by 2.4m space out of the
traffic area for gas sampling equipment.
le. Standard 110V power, lighting, and communications will be adequate. Testing will require that compressed air (345 kPa) be available to inflate the packers.

lf. Samples of all traced water used at the ESF shall be provided for chemical analysis from all water system taps using procedures to be determined.
   i. Samples will be obtained at the request of the PI.

lg. Access must be provided to the test location collar on a continuing periodic basis for gas sample collection.
   i. Long-term access to short (1-2 m) holes is not required.

lh. A location must be provided for short-term core storage. The location should be at least 3m by 3m by 2.4m, out of traffic areas, and the temperature and humidity should not fluctuate by more than 11 degrees Celsius or 20% relative humidity.
   i. The reference to humidity is not currently applicable to this activity.
   ii. The reference to temperature is modified to: the temperature of core storage and handling areas, except as accepted by the PI, shall be maintained between 2 and 18 degrees Celsius.
   iii. Core handling and storage will be addressed in the sampling plan for this activity.
   iv. Core sample weights, when required, shall be recorded to the nearest 0.01 grams. The required accuracy for core sample weights is + 0.05 grams.

li. At this time the precise locations of the test sites are unknown. As the drifting progresses and contacts, faults, wet areas, etc. are determined, the locations will be defined. Due to the many unknowns it is imperative that a great deal of flexibility be maintained in the test site selection.

lj. During the long-term gas sampling, no other hydrologic testing should be done within about 15m (50 ft) of the sampling intervals.
1k. Water used in construction will be minimized to the extent practicable and the use of water by functional category shall be tracked, recorded, and reported.

11. Hydrochemistry (HC) tests will be conducted in Radial Borehole Test and Hydrologic Properties of Major Faults alcoves.

(i) Following drilling, access shall be provided to all boreholes for testing and monitoring.

(iii) For all HC tests conducted in the alcove, the USGS PI will supply all test equipment, including packers, pumps, and data acquisition equipment.

(iv) Clear access to alcoves must be maintained at all times.

(v) The constructor shall coordinate with the TCO prior to application of fibercrete in HPMF, RBT or other permeability testing alcoves; the TCO may preclude application in areas as required by principal investigators (PIs).

(vi) Grouted rockbolts shall not be used in the alcove; split sets (and other mechanical bolts), wire mesh, steel sets, or other materials if approved by the USGS PI through the TCO, are acceptable for ground support.

(vii) Dry drilling of rockbolt holes and blast holes for alcove construction is not required, but water use must be minimized.

1m. Test support (to be further specified in the test planning package) will be required from the constructor and shall include personnel for operation, control, and monitoring of a jackleg or equivalent to drill short (1 to 2 m [3 to 6.5 ft] long, 3 - 5 cm [1.2 to 2 in] diameter) boreholes as alcove and ramp construction progresses for periodic gas sampling by the hydrochemistry PI.

(i) Dry drilling is required for all short (hydrochemistry) boreholes.
(ii) Traced air is not required for drilling of short boreholes.

(iii) Coring is not required for short boreholes. Core will be obtained from RBT and HPMF boreholes for hydrochemistry analyses.

(iv) Short boreholes should be drilled within 1 day after excavation of selected rounds of alcove construction and as soon as practicable from the TBM platform during ramp construction.

(v) Construction support will be required to insert a metal sleeve in short boreholes in preparation for testing by the hydrochemistry PI.

(vi) Space in the alcove is required (at least 1.8m x 2.4m [6 ft x 8 ft]) out of the traffic area for storage and operation of gas sampling equipment.

(vii) The hydrochemistry PI will supply all equipment necessary for collection of gas samples, including pumps.

(viii) Upon request of the TCO, the constructor shall provide samples of materials used in alcove or starter tunnel construction for chemical analysis by the hydrochemistry PI.

(ix) The constructor shall provide access, standard lighting, ventilation, compressed air, and communications in the alcoves during the anticipated 5- to 7-year duration of the test.

8A2.2 CONSTRAINTS

A. Chemically trace all water used at the ESF.

i. Water used in construction will be chemically tagged with lithium bromide, or other approved tracer.

B. Chemically trace all gases used for drilling or testing in the ESF.
i. Short (1-2 m) boreholes do not require chemical tagging of the compressed air stream.

C. Collect samples from all concrete, grouts, and other liquid construction materials as required by the ESF Fluid/Material/Tracer System Plan.

   i. Samples will be obtained at the request of the PI.

D. Long-term monitoring sites can be postponed up to one-half year after excavation as long as alcoves and coreholes are not constructed.

E. Short-term boreholes must be drilled within 4-5 days after excavation of a drift or alcove.

   i. Short (1-2 m) boreholes should be drilled within 1-2 days after excavation of selected round in drill and blast construction of alcoves.

F. Prior to placing any fibercrete or other cementitious material in the alcove for personnel safety, rock support, or other purposes, the constructor must acquire PI concurrence and special instructions through the TCO for minimizing testing impacts.

G. Grouted rockbolts shall not be used during alcove construction in HPMF, RBT or other permeability testing alcoves where EC testing is planned.

H. All water used in alcove construction will be tagged with lithium bromide; concentrations will be monitored and recorded in accordance with appropriate procedures.

I. The constructor will operate under an approved plan to minimize the use of water in construction-related drilling and will track, record, and report all uses of water in alcove construction by application type.

8A2.3 INTERFACES

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.
2. **IDS may be utilized, if available, during the long-term monitoring portion of test implementation.**

### 8A2.4 ASSUMPTIONS

1. No added gas tracer is required for the ventilation air. Freon 11 and 12 existing in environmental air will be used as the tracer.

2. Design, procurement, and operation of the air and water tracer systems will be by the YMP support organizations.

3. Tracer chemical specifications must take into account requirements from all tests, RCRA and other permitting requirements but will be the responsibility of the test organization.

4. The Universal water tracer will be sodium bromide.
   
   i. The Universal water tracer will be Lithium Bromide.

5. Long term gas sampling will occur over a 2-4 week period and be performed every 6 months for 3 years at each gas sampling location.

6. The alcove space required for drilling HQ sized coreholes should be sufficient for assembly and installation of the packer system.

7. The short-term borehole construction and pumping will include: a) hammer drilling; b) insertion of a metal sleeve and grout; c) one hour of prepumping; and d) about a 1 day pumping period.

8. The packer system will be inserted by the investigators.
9. The sampling system (packers, pumps, and sampling vessels) will be transported to the sampling location and core samples will be transported to the drift portal by YMP contract personnel.

10. Core from all Radial Boreholes Tests, and some of the Bulk Permeability and Major Fault Tests will be available for Hydrochemistry Test use.

11. Cores will be sealed by YMP contract personnel according to procedures to be determined by the test organization.

8A3 SUPPLEMENTAL PLANNING INFORMATION - HYDROLOGIC PROPERTIES OF MAJOR FAULTS (B-2.2.12)

The Hydrologic Properties of Major Faults test is described in Study Plan 8.3.1.2.2.4, Characterization of the Yucca Mountain Unsaturated Zone in the ESF.

8A3.1 PERFORMANCE CRITERIA

1a. Special L-shaped alcoves are required at each fault testing location. The maximum dimensions for an alcove shall be 15m x 18m. The dimensions will vary depending on excavation effects.

The major faults or fault zones expected to be tested are the Bow Ridge fault, the Boundary Ridge fault, the Imbricate fault zone, the Ghost Dance fault, a suspected fault in Drill Hole Wash, the Solitario Canyon fault, the fault along Yucca Crest, and any major faults not previously identified, especially if fluid flow is observed. The exact location of these geologic features in the ESF can not be determined at this time. Each ramp or drift intersection with a major fault or fault zone will be tested.

1b(i). A geothermal borehole will be dry drilled, approximately horizontal, at each location at about a
45 degree angle to the ramp\drift wall as soon as possible after the fault is identified. Geothermal boreholes will be HQ3-sized and a minimum of 60m long.

(ii) The facility design and operations shall allow access to these boreholes for temperature logging soon after drilling and at intervals of one or two days initially and weekly thereafter until the effects of drilling have subsided and the effects of ventilation of the drift are detected.

1c. The planned IDS may be utilized for long-term monitoring requirements.

1d. Access to the geothermal boreholes is required for the entire duration of site characterization.

1e(i). Four boreholes parallel to the fault, and three boreholes perpendicular to the fault will be dry drilled at each location. These boreholes will not be drilled until directed to do so by the PI or his designated representative. These boreholes will be approximately 15m long.

(ii) The facility design and operations shall allow access to these boreholes to replace faulty packers, to repair and calibrate instrumentation, to handle the nitrogen gas bottles and associated hardware for trouble shooting, to test the instrumentation, and to test the data collection and IDS equipment.

(iii). Each location will require a space for organizational data collection and IDS equipment.

(iv). Access to the hydrologic boreholes is required for the entire duration of site characterization.

1f. Standard ESF power, lighting, water, compressed air, ventilation, and communications are adequate to conduct these tests.

1g. Alcoves shall be constructed to test structures at the Sundance and Ghost Dance faults.

(i) The exact location of major faults in the ESF main drift cannot be determined at this time. Design
and construction flexibility is required to allow final location of alcoves based on data obtained during ramp construction. Faults will initially be identified during implementation of the Underground Geologic Mapping test (ESFDR Section B-2.2.20)

(ii) Only one major fault is anticipated to intersect the main drift between Station 28+00 and Station 60+00, the Sundance Fault. The PI for the HPMF test has determined that a non-deferred test alcove is not required at this intersection.

(iii) Additional faults may be encountered during ramp excavation. Depending upon the geohydrologic nature of the fault, additional construction-phase alcoves to support hydraulic properties of major faults (HPMF) testing may be required.

(iv) Determination of major faults requiring testing and actual alcove locations shall be selected based on written criteria to be provided by the U.S. Geological Survey (USGS) prior to alcove construction.

(v) Final alcove depth, orientation, and configuration will be determined in the field based on geologic information and written criteria provided by the USGS.

(vi) Unless otherwise specified, Alcove No. 6 will be constructed to intercept the intersection of the Ghost Dance and Sundance faults. Alcove No.7 will be constructed approximately midway between Alcove No. 6 and Station 60+00 to intercept the Ghost Dance fault. Shorter alcoves will be mined from each main alcove; (1) one shallow alcove will be mined from each main alcove along each fault encountered; (2) a longer alcove will be mined from each main alcove parallel to each fault. The offset between the fault and the longer Alcove will be no more than 30m.

(vii) Main alcove construction will accommodate intermittent testing including drilling hydrochemistry and geothermal boreholes.
(viii) Alcove and test boreholes need to be located such that construction activities and other tests will not interfere. Alcove standoff requirements (from other alcoves and from construction activities) will be determined through the Determination of Importance (DIE) process. All other test-related controls and constraints (pertaining to alcove and borehole configurations and test implementation) shall be developed through the test planning process and specified in the test planning package for the test.

(ix) Dry drilling of rockbolt holes and blast holes for alcove construction is not required, but water use must be minimized.

(x) The time interval between completion of alcove construction and initiation of drilling for test boreholes should be minimized to counter the effects of drying (alteration of in situ water saturations) on unprotected rock of the alcove. Time intervals will be established for each alcove by the USGS, TCO, and construction manager prior to alcove construction.

(xi) Additional performance criteria related to hydrochemistry testing are provided in a separate section of this attachment.

1h. Hydrologic Properties of Major Faults tests will be conducted in selected alcoves.

(i) Unless otherwise specified for a specific alcove, the test location must be large enough to allow dry drilling of (1) three, 30-meter (98 ft) boreholes in the shallow alcove (which are oriented parallel to the fault); and (2) three, 30-meter (98 ft) boreholes along the rib of the deeper alcove (which are perpendicular to the fault). Two boreholes in the shallower alcove will be drilled on either side of the fault and each will be drilled from 1m to 3m (3 ft to 10 ft) away from the main trace of the fault, parallel to the invert. A third borehole may be drilled in the shallow alcove between the first two and in the
main fault trace. The three boreholes in the
dereper alcove will be drilled parallel to each
other and at the corners of an equilateral
triangle from the alcove rib; a fourth, single
borehole may be drilled into the opposite rib. All
boreholes will be cored and all core will be HQ-3
(61.1 mm [2.406 in]) diameter. The actual angle
and location of boreholes will be determined after
geologic mapping data, including density and
orientation of fracture and joint systems, is
assessed by the principal investigator (PI).
(ESFDR Section B-2.2.12 PC 1e).

(ii) For design purposes, the longer alcove should be
located no more than 30m (98 ft) from the fault
due to current test equipment limitations. The
alcove should be sized to provide for personnel
access, installation of standard utilities
(including light, ventilation, power, and
compressed air) and to allow access for boreholes.
The final alcove location will be based on
written criteria provided by the USGS prior to
alcove construction.

(iii) For boreholes to be drilled in the deeper alcove,
a standard equilateral triangle should be
considered to be 3m (10 ft) on a side; however,
the equilateral triangle could be up to 5m (16 ft)
. Information on fault fillings, fracture density,
and fracture fillings will be used by the PI to
evaluate the applicability of the 5m (16 ft)
triangle configuration and the final written
criteria specifying the drilling configuration
will be provided by the USGS during the test
planning process. Any associated design or
construction requirements to prepare the test
location will be defined in test-related job
packages.

(iv) Following drilling, access shall be provided to
all boreholes for testing and monitoring.

(v) Clear access to alcoves must be maintained at all
times.
(vi) For all HPMF tests conducted in the alcove, the USGS PI will supply all test equipment, including packers, pumps, and data acquisition equipment.

11. Test support (to be further specified in the HPMF test planning package) will be required from the constructor and shall include personnel for operation, control, and monitoring of a tracer gas injection system and for drilling boreholes.

(i) A dry drilling rig capable of coring HQ-3 sized core using a compressed air system and including all ancillary equipment and facilities required for drilling and operation (including a dust control system, tracer gas injection system, appropriate power, and drill bits) is required to drill boreholes immediately following completion of alcove construction. Boreholes will be dry drilled using compressed air tagged with SF₆ or other approved tracer gas.

(ii) Space shall be provided to store bottled gases on the north portal pad, in the alcove, or in another location acceptable to the PI.

(iii) For boreholes to be drilled in the deeper alcove, a standard equilateral triangle should be considered to be 3m (10 ft) on a side; however, the equilateral triangle could be up to 5m (16 ft). Information on fault fillings, fracture density, and fracture fillings will be used by the PI to evaluate the applicability of the 5m (16 ft) triangle configuration and the final written criteria specifying the drilling configuration will be provided by the USGS during the test planning process. Any associated design or construction requirements to prepare the test location will be defined in test-related job packages.

(iv) Space shall be provided in the alcove for the USGS data acquisition station. An area of 2m x 2m (6.5 ft x 6.5 ft) is required.

(v) The constructor shall provide access, standard lighting, ventilation, compressed air, and
communications in the alcoves during the anticipated 5- to 7-year duration of the test.

8A3.2 CONSTRAINTS

A. The alcoves or the hydrologic boreholes shall not be started until the PI has determined that effects of ventilation in the drift have been detected in the geothermal borehole. After this has occurred, alcove construction and borehole drilling can proceed.

   i. Geothermal boreholes will be drilled from the main alcove (and not from the main ESF drift). Construction of the shorter alcoves will not proceed until either (a) Constrain A has been met, or (b) notification to proceed is provided by the PI and TCO

B. These boreholes will not be drilled until the PI has determined that the effects of ventilation in the ESF have been detected in geothermal borehole.

C. The IDS will be used for data acquisition and storage from the long-term monitoring operations.

D. The interference envelope for air-permeability testing is uncertain. Excavation effects evaluation and prototype testing are required to assess potential interference problems. The use of water in the final stages of testing is also problematic even though tracers will be used to tag the water. By-passing effects of drifts near the fault-testing location may pose a serious problem. It is desirable to locate fault testing locations as far as possible from other underground openings. A conservative minimum distance from other openings would be three-to-four drift diameters. Test boreholes need to be placed such that stress relief effects of the ramp or drift alcove are minimized, and other tests will not interfere.

E. Dry drilling will be required using a tracer gas. Borehole(s) will not be drilled in an alcove until preliminary mapping of the structural geologic features is complete.
F. All water used in alcove construction will be tagged with lithium bromide; concentrations will be monitored and recorded in accordance with appropriate procedures.

G. The constructor will operate under an approved plan to minimize the use of water in construction-related drilling and will track, record, and report all uses of water in alcove construction by application type.

H. Additional constraints related to hydrochemistry testing are provided in a separate section for that test.

8A3.3 INTERFACE REQUIREMENTS

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.

Section 2.3.1 Scientific Manpower/Schedule Information
Section 2.3.2 Laboratory/Office/Storage Space Requirements
Section 2.3.3 Electrical Power Requirements
Section 2.3.4 Water System Requirements
Section 2.3.5 Compressed Air System Requirements
Section 2.3.6 Common Sampling Design Requirements
Section 2.3.7 Communications System Requirements
Section 3.0 Integrated Data System

2. IDS may be utilized, if available, during the long-term monitoring portion of test implementation.

8A3.4 ASSUMPTIONS

1. Excavation of the alcove will be performed on a one-shift per day basis. Some mapping and testing activities may be performed, under construction supervision, during back shifts.

2. The alcove may be used to implement other tests.

3. Tests will be located and conducted in a manner consistent with safe operations.
8A4 UNDERGROUND GEOLOGIC MAPPING IN THE ESF (B.2.2.20)

Geologic mapping is described in Study Plan 8.3.1.4.2.2, Structural Features of the Site Area.

8A4.1 PERFORMANCE CRITERIA

1a. The test organization will map all ESF excavations, on a daily basis, usually mapping the extent of daily progress, up to an expected maximum of 75m in TBM drifts. Mapping will generally be done prior to installation of any chain-link, mesh, or shotcrete. Where ground conditions require fabric or shotcrete, the excavation and mapping sequence will need to be modified to permit mapping near the heading.

In roadheader and/or mobile miner excavations, mapping will be done as near the heading as possible. The machines will need to pull back from the face while mapping is being done.

If a shaft is excavated as part of the ESF, mapping will be either from the bottom deck of the galloway (if drill/blasting) or from platform designed for the purpose of mapping (machine excavation). In both cases, the walls must be mapped prior to any wire mesh, shotcrete, or permanent utilities are installed.

i. Only the first paragraph applies to mapping in the Main Ramp.

ii. Mapping will be coordinated with construction and other tests.

iii. Hand specimens (samples) may be obtained for petrographic evaluations.

iv. Maximum progress is expected to be 45 m (150 ft) as controlled by gantry and trailing floor.

v. Test organization will map all ESF excavations not previously mapped on a daily basis.

1b. Survey accuracy for the Underground Geologic Mapping Test shall be ±1cm for the benchmarks. The ability should be retained to resurvey and upgrade the initial mapping survey and reference points.
i. Survey accuracy for mapping and sampling in the starter tunnel is +2cm (.79 in) (horizontally and vertically from the benchmark).

ii. Survey laser alignment will be at least third order class II quality.

lc. A securable, underground space of about 5 x 6m with a height of 2.5m is required for storage of mapping equipment. If the North and South ramps are developed separately, a storage room is required in each one.

i. This requirement is deferred for Design Package 8A.

d. A geological storage and staging trailer or building of at least 18 m² (200-sq-ft) area shall be provided at the ESF surface facility in Midway Valley. This building shall be equipped with heating, air conditioning, electricity, running water at a sink, smoke detectors, first aid kit, and shelving.

i. As provided in north ramp surface facility design (Package 1A), storage during early ESF construction will be provided in a testing trailer located on the north ramp pad.

e. If the optional shaft is required, the shaft sinking galloway must be provided with equipment to assure a stable platform for photography. In drifts other than those excavated by full-face tunnel boring machine, a collapsible platform must be provided to allow geologists access to all surfaces of the excavation.

f. The construction contractor will clean the walls using compressed air/water following procedures developed during prototype testing.

i. Tracers for Construction Water. For water applied underground in dust suppression; blasthole drilling; in grout, mortar, concrete and shotcrete; wall washing (blowdown) prior to mapping; and other construction applications, addition of a universal tracer is required. Lithium bromide shall be the only tracer
(universal) required and acceptable from the standpoint of ESF testing. The concentration of lithium bromide tracer in construction water should be 20 ppm (as bromide) with an acceptable tolerance of +10% and a maximum range of 10 ppm to 30 ppm. Tracer system verification should include an automated volumetric analyzer (electrode) and periodic sampling for laboratory analysis.

ii. Tracers for construction usage of compressed air. For the ESF north ramp starter tunnel, the use of compressed air in blasthole drilling, other pneumatic tool usage, and in blowdown operations prior to geologic mapping does not require tagging with a chemical tracer. This exemption does not include any test-related drilling for later tests such as hydrochemistry and radial boreholes, planned for an alcove off the ESF north ramp starter tunnel.

iii. An air mist blow pipe system has been previously developed and will be used in ESF north ramp tunnel mapping.

lg. A light-tight photography laboratory (in a trailer or building) approximately 2.5m by 4m (8 ft by 14 ft, with a minimum of 100 sq ft) shall be provided at the ESF surface facility, adjacent to or in the geological storage and staging trailer or building. This laboratory shall be equipped with heating, air conditioning, and the following: (1) sink with hot and cold running water and (2) two 110-V, 20-A circuits and one 220-V, 30-A circuit.

(i) A light-tight photography lab will not be required during main ramp construction

lh. Geologic mapping and sample collection will be done primarily from a mapping platform on the trailing gear of the TBM in a manner consistent with safe operations. Additional sampling, described in the Consolidated Sampling Section, will be done as needed throughout the main ramp.

8A4.2 CONSTRAINTS
A. In TBM drifts and ramps, a distance of at least 75m must be left directly behind the trailing gear, where utilities are confined to one quadrant of the circumference of the excavation. This confinement is necessary to allow an unobstructed view of as much of the exposed rock as possible for photogrammetric mapping.

In road header/mobile miner drifts, utilities (including permanent fan line) must not be installed until an area has been mapped and photographed. Generally, mapping will keep up with the daily excavation process.

i. A distance of at least 45 m (150 ft) must be left directly behind the TBM.

ii. Only non-photogrammetric mapping is planned for the exposed rock.

B. Ground support in the form of rock bolts and anchors may be installed as near the working face as necessary without detriment to mapping. The installation of chain-link fabric, wire mesh, or application of shotcrete may not take place until mapping is completed.

i. Ground conditions encountered during initial ESF north ramp tunnel excavation may impose safety-related limitations on access to, or exposures for, mapping activities.

ii. For normal mapping operations, nothing more than pattern bolting and approximately 15.2 cm (6 inch) or greater wire mesh should be present. If, due to ground conditions, additional ground control is necessary (such as steel rings, lagging, mesh less than 15.2 cm [6-inches], or shotcrete), construction management will advise the TCO and USGS mapping PI and will assist in identification of alternatives to collect geologic data.

C. Mapping in the TBM drifts will require construction of a mapping platform which will allow access to required portions of the crown and walls for sampling and detailed mapping. The platform may also be used for installation of ground support, surveying, installation of utilities, etc., as long as these operations are coordinated with the mapping effort.
Mapping in the roadheader/mobile miner drifts may be done from a collapsible platform (i.e., scissor lift).

i. A platform lift, provided by the constructor, will provide access to the tunnel back for mapping and sample collection.

D. During drift wall mapping, all unnecessary equipment will be removed from the section of the drift being mapped.

i. Unnecessary equipment that may hinder mapping activities, as determined by the PI, will be removed.

E. If a shaft is constructed as part of the ESF, provision must be made to allow unobstructed mapping of the shaft walls prior to the installation of wire mesh, shotcrete, or permanent utilities. Specific requirements will depend on the excavation method (machine vs. drill-blast).

F. Re-mapping, or more detailed mapping, of excavation surfaces may be required to support the site characterization program. Emphasis will be placed on preserving the ability to re-examine areas that have been previously mapped, consistent with the ESF's primary goal of site characterization.

8A4.3 INTERFACE REQUIREMENTS

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.

Section 2.3.1 Scientific Manpower/Schedule Information
Section 2.3.2 Laboratory/Office/Storage Space Requirements
Section 2.3.3 Electrical Power Requirements
Section 2.3.4 Water System Requirements
Section 2.3.5 Compressed Air System Requirements
Section 2.3.6 Common Sampling Design Requirements
Section 2.3.7 Communication System Requirements
Section 3.0 Integrated Data System

2. If required, the shaft sinking equipment must accommodate the shaft mapping equipment.
8A4.4 ASSUMPTIONS

1. Mapping equipment will be provided by the testing organization. This includes strobe lighting for stereophotography, pyramid beam splitter (for deflecting the laser and setting survey control points), and sampling equipment for hand and block samples.

2. The excavation contractor will provide a miner for cleaning of the excavation walls, moving the mapping platform, hooking up utilities, and assistance in sample acquisition and handling.

3. Shaft and drift mapping will be sequenced with construction to minimize interference with construction progress. In the TBM ramps, where advance rates may approach 75m/day, we expect that mapping may require 2 shifts on a daily basis to keep up with excavation. This arrangement will require mapping and mining concurrently.

4. In general, hand sampling of exposed rock by geologists will be performed during the period that mapping is being done.

5. Voice communications from the surface will be provided to a station near each heading during mapping.

6. Office and laboratory space will be provided at the Field Operations Center Building and the Technical Services Building in Area 25.

8A5 SUPPLEMENTAL PLANNING INFORMATION FOR ACCESS CONVERGENCE TESTS IN THE ESF (B-2.2.23)

The access convergence test is described in Study Plan 8.3.1.15.1.5, Excavation Investigations.

8A5.1 PERFORMANCE CRITERIA

1a. No special room or alcove is needed.
The tests will be located in each thermomechanical unit encountered (one in each unit), preferably more than 100m from major thermomechanical contacts and faults. Additional stations may be installed near major structural features. The tests will be performed in both ramps, in order to investigate the different faults that will be encountered and to study the effect of spatial separation. Stress meters will be installed about the faults that are encountered. At a minimum, the tests should be performed within the TSw1, TSw2, Tsw3, and in the different thermomechanical units in the ramps to the Calico Hills. Testing will be performed in the ramps to the Calico Hills in order to validate that the openings will remain stable throughout the testing period in that region.

i. Unless precluded by safety considerations, MPBX holes will be drilled and instrumented as close to the advancing face as possible at selected locations and according to written criteria to be provided by Sandia National Laboratories (SNL) prior to drilling. Locations for MPBXs will be jointly determined by SNL, the TCO, ESF design, and the construction manager.

ii. In situ stress measurements may be performed using boreholes drilled from test alcoves. MPBXs will also be installed in each test alcove.

lb. The test will require drilling holes approximately 15m long, of sufficient diameter to install the MPBXs, and shallow holes to install anchors for the extensometer measurements.

i. MPBX holes (up to approximately 15 m (49 ft) in length) do not require dry drilling and do not require coring, but water use must be minimized.

ii). MPBX holes (approximately 102 to 115 mm diameter [4 to 4.5 in]) and instrumentation (approximately 76 mm [3 in] OD) will be installed as required in the main ramp invert, as well as back and ribs. Invert sections cannot be determined until stations for instrumentation have been selected.

iii. Selected concrete sections should be preformed to facilitate emplacement of MPBX instrumentation,
such as with a sleeve (approximately 203 mm or 8 inches ID).

iv. Boreholes approximately 25m (81.5 ft) long will also be required for in situ stress and induced stress or stress change monitoring.

1c. It is preferable that the tests be more than 400m from major thermomechanical contacts and faults. Additional stations may be installed near major structural features. Stress meters will be installed about faults that are encountered.

1d. Each access convergence measurement station will consist of two sets on instruments installed in adjacent planes, separated by approximately 1m.

i. Each access convergence station will be determined as needed.

1e. Standard underground facilities for water, air and electricity for drilling will be used for this test. Access to the back (roof) will be required. An uninterrupted power supply (UPS) for the Integrated Data System will be needed.

i. Immediately after MPBX installation, cable runs and equipment will be installed by the constructor in the right rib to support transmission of data from MPBXs to a data storage system provide by SNL.

ii. Data may initially be collected using portable data loggers and/or PC notebooks. Uninterruptable power is not required to support this mode of data collection.

iii. The integrated Data System (IDS) has been superseded by the Integrated Data and Control System (IDCS).

1f. Access to the measurement stations will be needed during the test period. It is necessary to maintain access to the monitoring stations over a period of years.

1h. Survey accuracy for verification requirements will be ±2 cm (.8 in) (both horizontally and vertically) from the bench
mark. This requirement shall be applied to all construction monitoring experiments.

8A5.2 CONSTRAINTS

A. This test can be scheduled independently of the scheduling of other tests.

B. The very early time access convergence occurring immediately after excavation will not be measured. Instead, the long term opening stability will be monitored. It is not necessary that the stations be instrumented immediately after the face has been exposed, but test instrumentation should be installed as close to the working face as possible without impacting the progress of the excavation. The use of underground resources (men and equipment) will be based on scheduled availability and preferably coincide with scheduled TBM shut down. Slow down of excavation progress will be avoided. Construction impact will be limited to minor interference with support forces (maintenance crews, ramp transportation vehicles, priority testing, etc.).

C. Provision for data collection by the IDS must exist prior to the beginning of the test.

   i. Data may be monitored manually or with a data logger if an interface to the IDCS is unavailable.

D. The tests will sense rock mass displacements on a line approximately 15m from and perpendicular to the drift wall, floor, and ceiling. Other tests, which in any way affect the thermomechanical response in this region, should be avoided.

   i. Change distance to approximately 25 m (81.5 ft).

E. No constraint on construction is imposed by this test. The purpose of the test is to obtain deformation, in situ stress, and the stress change due to excavation activities. No drilling will be allowed near the MPBX and the pressure cell stations.

F. The rock mass modulus and compliance test will involve simultaneous measurement of TBM gripper pad movement and pressures in the hydraulic rams that move the pads. Access
to install equipment, measure displacements, and record hydraulic pressures is required during TBM operation.

8A5.3 INTERFACE REQUIREMENTS

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.

Section 2.3.1 Scientific Manpower/Schedule Information
Section 2.3.2 Laboratory/Office/Storage Space Requirements
Section 2.3.3 Electrical Power Requirements
Section 2.3.4 Water System Requirements
Section 2.3.5 Compressed Air System Requirements
Section 2.3.6 Common Sampling Design Requirements
Section 2.3.7 Communication Systems Requirements
Section 3.0 Integrated Data System

8A5.4 ASSUMPTIONS

1. None.

8A6 SUPPLEMENTAL PLANNING INFORMATION FOR EVALUATION OF MINING METHODS (B-2.2.33)

The Evaluation of Mining Methods Test is described in Study Plan 8.3.1.15.1.8, In Situ Design Verification

8A6.1 PERFORMANCE CRITERIA

1a. No special rooms or alcoves are required. The tests will be conducted in conjunction with excavation of all openings in the North Ramp, in the South Ramp, in the Main Test Level, and in the Calico Hills. Both ramps will be considered in this experiment, because of the different slopes, lithologies, and faults associated with each ramp. The experiment involves monitoring performance, and is not invasive, and thus should not cause interference with excavation when performed in both ramps.
i. Calico Hills refers to the Calico Hills thermomechanical unit.

1b. No drilling is required for this test.

i. Drilling is required for this test. It is limited to 5m (15 ft) long holes drilled to permit inspection of the blast damaged zone, and holes being drilled to support other construction monitoring experiments.

ii. The 5 m (15 ft) long holes may be instrumented for blast damage assessment.

1c. It is expected that data collection will be performed by the ESF constructor as part of the construction process.

i. Only selected portions of data collection, as directed by the principal investigator and outlined in the work plan, will be collected by the constructor.

1d. No flexibility requirements have been identified.

1e. Because this is a monitoring activity, no sketch of the test configuration is needed.

1f. Because this is a monitoring activity, no utility requirements exist.

i. Standard utilities for power will be needed.

8A6.2 CONSTRAINTS

A. This test can be scheduled independently of the scheduling of the other tests.

B. The test will be performed as the excavation proceeds, following the excavation equipment. The test will be performed near the face, in order to record movement of the mining equipment. However, face advance will not be affected, and underground resources will not be redirected, as the experiment involves only the recording of mining performance and is not invasive.
C. No need for the Integrated Data System has yet been identified.

D. No interference envelope exists; this test is observational only.

8A6.3 INTERFACES

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.

Section 2.3.1 Scientific Manpower/Schedule Information
Section 2.3.2 Laboratory/Office/Storage Space Requirements
Section 2.3.3 Electrical Power Requirements
Section 2.3.4 Water System Requirements
Section 2.3.5 Compressed Air System Requirements
Section 2.3.6 Common Sampling Design Requirements
Section 2.3.7 Communications System Requirements
Section 3.0 Integrated Data System

8A6.4 ASSUMPTIONS

1. No test-specific assumptions have yet been identified for this test

8A7. SUPPLEMENTAL PLANNING INFORMATION FOR MONITORING OF GROUND SUPPORT SYSTEMS IN THE ESF (B-2.2.34)

The Monitoring of Ground Support Systems test is described in study plan 8.3.1.15.1.8, In Situ Design Verification

8A7.1 PERFORMANCE CRITERIA

1a. No special room or alcove is required. The tests will be conducted in all of the thermomechanical units encountered in both ramps, in the Main Test Level and in the Calico Hills. The observational tests will be performed in both
ramps because they are non-invasive, survey type tests and by examining the different lithologies and faults encountered in each, the data base may be increased. The tests will be performed in the Calico Hills in order to monitor the stability of the drifts in the Calico Hills to enhance safety over the time period in which access will be needed. The pull tests will be performed in the North Ramp and the Main Test Level only.

i. Pull tests previously planned for the Main Test Level will be performed in the Main Drift.

1b. No required drilling has been identified for this test.

i. Drilling is required for this test; however, it is limited to holes being drilled for rockbolts.

ii. Survey accuracy for verification requirements will be \( +2\text{cm} \) \((.8 \text{ in})\) (both horizontally and vertically) from the benchmark. This requirement shall be applied to all construction monitoring experiments.

1c. Provision for data collection by the Integrated Data System is required for the rock bolt load cells and the pull tests.

i. Immediately after instrument installation, cable runs and equipment will be installed by the constructor in the right rib to support transmission of data from MPBXs to a data storage system provide by SNL.

ii. Both rock bolt load and pull tests may be monitored manually or with a data logger if an interface to the IDCS is unavailable.

1d. Location will depend on ground conditions. Extra bolts, in addition to those required for safety, will be installed for this test. Where shotcrete is used, cores will be taken for laboratory testing of strength and bonding to the rock. For each location where steel sets are used, two will be instrumented with load cells.

i. Access to selected rockbolts shall be provided for installation of load cells.
ii. Extra rockbolts, in addition to those required for safety, will be installed for this test according to written criteria to be provided by SNL prior to drilling.

iii. Where utilized, selected steel sets or steel rings may be instrumented by SNL.

1e. Because this is a monitoring activity, no sketch is given for this test.

1f. Standard underground facilities for water, air, and electricity for drilling will be used for this test. No other special experimental needs exist.

1g. Accessibility to the rock bolts to be tested using pull tests is required. Accessibility to the rock bolt load cells will be needed only for repair activities.

8A7.2 CONSTRANTS

A. This test can be scheduled independently of the scheduling of the other tests.

B. In general, test preparation for this experiment can be initiated any time after the test location is exposed and will continue over a period of years. The use of underground resources (men and equipment) will be based on scheduled availability and preferably coincide with scheduled TBM shutdown. Slow down of excavation progress will be avoided. Construction progress impact (far behind the face) will be limited to minor interference with support forces (maintenance crews, ramp transportation vehicles, priority testing support, etc.). An exception is that the load cells must be placed when rock bolts are installed.

i. If steel sets are installed, some may be instrumented with load cells.

C. Monitoring must begin when the rock bolts are installed, and the Integrated Data System (IDS) must be available from the start of monitoring and continue over the term of the experiment. The pull tests will also need IDS support, but these tests are of short duration (on the order of a day).
i. Both rock bolt load and pull tests may be monitored manually or with a data logger if an interface to the IDCS is unavailable.

D. No interference envelope exists for this experiment. However, pull tests may temporarily block movement of vehicles in the drifts.

8A7.3 INTERFACE REQUIREMENTS

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.

Section 2.3.1 Scientific Manpower/Schedule Information
Section 2.3.2 Laboratory/Office/Storage Space Requirements
Section 2.3.3 Electrical Power Requirements
Section 2.3.4 Water System Requirements
Section 2.3.5 Compressed Air System Requirements
Section 2.3.6 Common Sampling Design Requirements
Section 2.3.7 Communications System Requirements
Section 3.0 Integrated Data System

8A7.4 ASSUMPTIONS

1. No test-specific assumptions have yet been identified for this test.

8A8 SUPPLEMENTAL PLANNING INFORMATION FOR MONITORING DRIFT STABILITY TESTS IN THE ESF NORTH RAMP (B-2.2.35)

The Monitoring Drift Stability test is described in study plan 8.3.1.15.1.8, In Situ Design Verification

8A8.1 PERFORMANCE CRITERIA

1a. No special room or alcove is required. The tests will be conducted at drift closure monitoring stations in the Tsw2
unit in the South Ramp access, on the Main Test Level, especially near the Ghost Dance Fault, and in the Calico Hills. Drift intersections will be monitored, and will be more heavily instrumented than the tests at locations away from drift intersections. The purpose of the Calico Hills tests in the Calico Hills is to monitor the long term stability of the drifts in order to enhance safety during the time that they are used.

i. Calico Hills refers to the Calico Hills thermomechanical unit.

1b. Drilling requirements for this test include holes for MPBXs that are approximately 15m long and 76mm in diameter and shallow holes for tape extensometer anchors (approximately 230mm long and 29mm in diameter)

i. PI access to all instrumentation is required: tape extensometers and MPBX heads shall be maintained free of shotcrete.

ii. Survey accuracy for verification of all holes to support this activity will be ±2 cm (.8 in) (both horizontally and vertically) from the benchmark.

iii. Accelerometer installation will require up to 23m (75 ft) long, 100mm (4 in) boreholes to be drilled.

iv. Test holes for MPBXs may be approximately 25 m (81.5 ft) long.

v) MPBX holes (approximately 102 to 115 mm [4 to 4.5 in] diameter) and instrumentation (approximately 76 mm [3 in] OD) will be installed as required in the north ramp invert, as well as back and ribs. Invert sections cannot be determined until stations for instrumentation have been selected.

(vi) Tape extensometer anchor holes (approximately 102 to 115 mm [4 to 4.5 in] diameter) will be installed as required in the north ramp invert, as well as back and ribs. Invert sections cannot be determined until stations for instrumentation have been selected.
(vii) Selected concrete sections should be preformed to facilitate emplacement of MPBX instrumentation, such as with a sleeve (approximately 203 mm [8 in] ID).

1c. Field observations of ground conditions will be necessary before final locations of measurement stations can be specified. The design of service hardware in the drifts (such as ventilation ducts, cable trays, etc.) must accommodate these measurements.

i. Ability to install convergence pin anchors (at selected locations) as close to the TBM cutter head as possible should be maintained. In some instances, access must be provided ahead of the mapping platform to install extensometer anchors and MPBXs. Locations will be jointly determined by SNL, the TCO, ESF design, and the construction manager.

(ii) Tape extensometer anchors and MPBXs will be installed for this test as close to the advancing face as possible at selected locations and according to written criteria to be provided by SNL prior to drilling.

1d. Layouts, dimensions, and instrument configuration are TBD.

i. Final layouts, dimensions, and instrument configurations will be determined based on field conditions and construction inputs.

1e. Standard underground facilities for water, air, and electricity for drilling will be used for this test. No other special experimental needs exist.

1f. Access to the monitoring stations will be required periodically during the test.

1g. Rock mass relaxation will be investigated using borehole pressure cells, in addition to MPBXs.

1h. Use of tracers, fluids, and materials by the testing organization in conduct of this test shall be recorded and reported as described in the applicable job package.
Ii. Immediately after MPBX installation, cable runs and equipment will be installed by the constructor in the right rib to support transmission of data from MPBXs to a data storage system provided by SNL.

8A8.2 CONSTRAINTS

A. This test can be scheduled independently of the scheduling of the other tests.

B. The experiment will look at both early time response and long term response. Test preparation should be initiated as soon as practical after the test location is exposed. The test instruments must be installed before the installation of permanent utilities, and permanent access to measurement heads will be required. The use of underground resources, (men and equipment) will be based on scheduled availability and preferably coincide with scheduled TBM shut down. Slow down of excavation progress will be avoided. Construction progress impact (far behind face) will be limited to minor interference with support forces (maintenance crews, ramp transportation vehicles, priority testing support, etc.). Monitoring of cross-drift convergence and borehole extensometers will continue beyond site characterization to help predict long-term stability.

C. Provision for data collection by the Integrated Data system is required prior to beginning this test.

   i. The initial phases of monitoring may utilize a data logger or manual readings if the IDCS is unavailable.

D. No interference envelope exists for this test.

E. MPBXs and extensometer anchors should be installed as close to the advancing face as possible.

   i. MPBXs and convergence pin anchors should be installed as close to the advancing face as possible.

8A8.3 INTERFACE REQUIREMENTS
1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.

Section 2.3.1 Scientific Manpower/Schedule Information
Section 2.3.2 Laboratory/Office/Storage Space Requirements
Section 2.3.3 Electrical Power Requirements
Section 2.3.4 Water System Requirements
Section 2.3.5 Compressed Air System Requirements
Section 2.3.6 Common Sampling Design Requirements
Section 2.3.7 Communications System Requirements
Section 3.0 Integrated Data System

8A8.4 ASSUMPTIONS

1. No test-specific assumptions have yet been identified for this test.

8A9. SUPPLEMENTAL PLANNING INFORMATION FOR AIR QUALITY AND VENTILATION TESTS IN THE ESF (B-2.2.36)

The Air Quality and Ventilation test is described in Study Plan 8.3.1.15.1.8, In Situ Design Verification

8A9.1 SUPPLEMENTAL PERFORMANCE CRITERIA

1a. A dead-end drift that can be sealed with a bulkhead is required for measurements of radon emanation. The sealed drift will be repeatedly ventilated and then allowed to reach equilibrium.

The tests will be conducted throughout the ESF after construction is completed. The end section of a drift or alcove on the Main Test Level will be sealed with a bulkhead to allow measurement of radon gas emanation. Surveys of air-flow and pressure, temperature, and humidity, determinations of air resistance factors, and dust characterization will be performed on the Main Test Level and in the North and South Ramps.
1b. This test will require a radon measurement hole in the dead-end drift approximately 9m in length with a 160mm diameter.

1c. No flexibility requirements for test location or orientation have yet been identified.

1d. No figure is supplied with this test.

1e. Standard underground facilities for water, air, and electricity for drilling will be used for this test. No other special experimental needs exist.

1f. Accessibility to the dead-end drift will be required throughout the test period. Periodic access to locations throughout the ESF after construction is completed is needed for this test.

1g. As an interim part of this test, samples of mined rock may be collected from the TBM conveyor. Samples of mined rock may be collected in 19 liter to 208 liter (5-gallon to 55-gallon) drums that need to be transported out of the tunnel.

1h. Air quality information is required from the Construction Contractor. Alternatively, access will be required to collect air quality information.

   (i) Access to the entry and exit points for the exhaust ventilation line for periodic sampling or instrumentation is required.

   (ii) Design flexibility to install ports for sampling by SNL at selected locations along the vent line is required.

1i. Drilling of some monitoring holes may be required, however, where possible, holes drilled for other testing will be utilized.

8A9.2 CONSTRAINTS

A. This test can be scheduled independently of the scheduling of the other tests.
i. Where possible, radon measurements in boreholes will be coordinated with other ESF test activities.

B. Test preparation shall be initiated within one month after the test location is exposed. The use of underground resources (men and equipment) will be based on scheduled availability and preferably coincide with scheduled TBM shut down. Slow down of excavation progress will be avoided. Construction progress impact (far behind face) will be limited to minor interference with support forces (maintenance crews, ramp transportation vehicles, priority testing support, etc.)

C. Provision for data collection by the Integrated Data System should be available prior to conducting the measurement of radon emanation.

i. Data may be monitored manually with a data logger if the IDCS is not available.

D. For the measurement of radon emanation part of the test, the area around the sealed test drift must not be affected by thermal or hydrological testing. Additional analyses will be performed to define acceptable amounts of thermal and hydrological change that will be allowed.

E. The measurement of radon emanation will require the sealing off the end of a drift. The remainder of the test requires only periodic air sampling, and no special constraints are required for these activities in the ESF testing, and no additional perturbation to natural conditions (stress, temperature, moisture, etc.) will result from these additional activities.

8A9.3 INTERFACE REQUIREMENTS

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.

Section 2.3.1 Scientific Manpower/Schedule Information
Section 2.3.2 Laboratory/Office/Storage Space Requirements
Section 2.3.3 Electrical Power Requirements
Section 2.3.4 Water System Requirements
Section 2.3.5 Compressed Air System Requirements
8A9.4 ASSUMPTIONS

1. The survey of pressures and air flows will be conducted once, over a period of a few days. Heat balances will be conducted twice (once in the summer and once in the winter). These measurements will be conducted throughout the ESF after construction is completed. Data acquisition by the IDS is not required for these surveys.

2. In the radon emanation test, continuous measurement of radon and radon daughter concentrations, temperature, humidity, barometric pressure, and air flow will be made.

3. Independent control of the ventilation air flow rate at the end of the dead-end drift will be required.

8A10. SUPPLEMENTAL PLANNING INFORMATION FOR CONSOLIDATED SAMPLING IN THE EXPLORATORY STUDIES FACILITY

SCP activities corresponding to the Consolidated Sampling Test include:

- Chloride & Chlorine-36 Measurements of Percolation at YM (8.3.1.2.2.2.1)
- Matrix Hydrologic Properties Testing (8.3.1.2.2.3.1)
- Petrologic Stratigraphy of the Topopah Spring Member (8.3.1.3.2.1.1)
- Mineral Distributions Between Host Rock And Accessible Environment (8.3.1.3.2.1.2)
- Fracture Mineralogy (8.3.1.3.2.1.3)
• History of Mineralogic and Geochemical Alteration of YM (8.3.1.3.2.2.1)

• Biological Sorption and Transport (8.3.1.3.4.2)

• Studies of Calcite and Opaline Silica Vein Deposits 8.3.1.5.2.1.5

• Geochemical Assessment of Yucca Mountain in Relation to the Potential for Mineralization (8.3.1.9.2.1.1)

• Repository Horizon Rock-Water Interaction (8.3.4.2.4.4.2)

• In-Situ Design Verification (8.3.1.15.1.8.4)

• Laboratory Thermal Properties (8.3.1.15.1.1)

• Laboratory Thermal Expansion Testing (8.3.1.15.1.2)

• Laboratory Determination of Mechanical Properties of Intact Rock (8.3.1.15.1.3)

• Laboratory Determination of Mechanical Properties of Fractures (8.3.1.15.1.4)

The purpose of the tests are to collect samples in the ESF for a variety of hydrologic, and geologic, mechanical, and chemical tests.

8A10.1 GENERAL PERFORMANCE CRITERIA

1a. Ability to collect bulk rock samples; short (less than 1-meter) core; and samples of tracers, fluids, and materials from all ramps, drifts, and alcoves.

1b. Ability to access any given sample location for resampling, if judged necessary, must be maintained.

1c. Ability to access Standard ESF utilities, including power, lighting, water, compressed air, communications, and ventilation.
A. Each bulk rock and short (less than 1-meter) core sample location shall be surveyed and photographed.

B. Sampling from documented locations will generally follow completion of geologic mapping activities.

C. Sampling will be coordinated with other testing and construction activities and generally can be conducted during facility construction without impact to construction activities.

D. No water shall be used in the immediate vicinity of any sampling location (zone of potential interference to be determined) without approval of the PI.

   i. Exempted from this requirement is misted water in compressed air used to clean tunnel surfaces prior to geologic mapping and chemically tagged water used for construction purposes.

E. No tracer shall be used in the vicinity of any sampling location without approval of the PI.

   i. Exempted from this requirement is tracer use in construction water. For water applied underground in dust suppression; blasthole drilling; in grout, mortar, concrete and shotcrete; wall washing (blowdown) prior to mapping; and other construction applications, addition of a universal tracer is required. Lithium bromide shall be the only tracer (universal) required and acceptable from the standpoint of ESF testing. The concentration of lithium bromide tracer in construction water should be 20 ppm (as bromide) with an acceptable tolerance of + 10% and a maximum range of 10 ppm to 30 ppm. Tracer system verification should include an automated volumetric analyzer (electrode) and periodic sampling for laboratory analysis.

   ii. Use of tracers, fluids, and materials in constructions, especially in proximity to sample locations
shall be documented and samples will be provided to PIs upon request.

F. Any drilling necessary to obtain samples shall be done dry unless otherwise indicated by the PI for a specific test.

G. Sample orientation should be described and recorded and, unless doing so would potentially alter sample analyses, orientation should be marked on the sample.

8A10.3 CHLORIDE & CHLORINE-36 MEASUREMENTS OF PERCOLATION AT YUCCA MOUNTAIN (B-2.2.1)

Performance Criteria

1a. Ability to collect samples of about 100 kg quantity from each sampling location must be provided.

i. Collection of paired samples ranging from approximately 20-40 kg (45-90 lb) quantities from approximately each 15m (50 ft) of excavation should be provided.

ii. Each sample location should be surveyed and photographed.

iii. Samples should not be taken in close proximity to spills.

1b. Ability to access any given sample location for resampling, if judged necessary, must be maintained.

1c. Provide the ability to take samples concurrently with construction, either by core, as rubble from drill and blast, or as chips from mechanical excavators. Individual fragments of any given sample must be chip size or larger, (i.e.), not rock flour.

1d. Provide the ability to collect several samples from each geologic unit encountered in both the North and South Ramps and in drifts in the Calico Hills and Topopah Spring units.

i. At selected lithologic contacts, a minimum of two samples should be collected, and an additional
sample collected from within 5 cm (2 in) of each side of the contact.

ii. In each alcove, a minimum of one sample per 10 m (33 ft) of excavation should be collected. Samples should be collected from dry drilled boreholes or other dry sampling techniques from the rock matrix adjacent to the fault zone within 2 m (7 ft).

le. Provide the ability to collect samples from selected fracture zones, fault and breccia zones, lithologic contacts, and wet zones.

i. In major fracture and fault zones that are less than one meter in thickness, samples should be collected centered on the fracture as close as possible from the unfractured matrix, and within two meters of the fracture zone.

ii. In major fracture and fault zones that are more than 1 m (3 ft) in thickness, samples should be collected every 2 m (7 ft) within the fault zone, more or less equally spaced, with a minimum of two samples collected. Additional samples should be collected within 2 m (7 ft) from the unfractured matrix on either side of the fault zone.

lf. If coring is required to collect samples, coring must be conducted dry. Any use of tracer must be approved by the principal investigator prior to use.

i. Exempted from this requirement is lithium bromide used to chemically tag underground water use.

lg. If coring is required to collect samples, the depth of the core should be sufficient to ensure pristine samples and to avoid interference from contaminants which may be introduced by excavation or other activities. Contaminants of concern include water, chloride, and bromide or materials containing any of these constituents.

i Core samples will be drilled dry to minimize contamination and use of chloride, bromide, and water will be controlled in coring operations.
1h. Standard ESF utilities, including power, lighting, water, compressed air, communications, and ventilation are required.

CONSTRAINTS

A. Sampling from documented locations will follow completion of geologic mapping activities.

B. The timing of this test will vary according to the construction method used in the ESF. In general, sampling can be conducted during facility construction without impact to construction activities. In some instances, samples may have to be deferred until completion of some construction activities in order to avoid interference with the construction schedule. However, wet zones and perched water require immediate sampling in order to protect the integrity of these samples.

C. Sampling of wet zones and occurrences of perched water must be coordinated with the Perched Water Test.

D. No water shall be used in the immediate vicinity of any sampling location (zone of potential interference to be determined).

   i. Exempted from this requirement is misted water in compressed air used to clean tunnel surfaces prior to geologic mapping and chemically tagged water used for construction purposes.

E. No tracer shall be used in the vicinity of any sampling location without approval from the principal investigator of this activity (zone of potential interference to be determined).

   i. Tracer use in construction water. For water applied underground in dust suppression; blasthole drilling; in grout, mortar, concrete and shotcrete; wall washing (blowdown) prior to mapping; and other construction applications, addition of a universal tracer is required. Lithium bromide shall be the only tracer (universal) required and acceptable from the standpoint of ESF testing. The concentration of lithium
bromide tracer in construction water should be 20 ppm (as bromide) with an acceptable tolerance of +10% and a maximum range of 10 ppm to 30 ppm. Tracer system verification should include an automated volumetric analyzer (electrode) and periodic sampling for laboratory analysis.

ii. Use of tracers, fluids, and materials in proximity to sample locations shall be recorded and submitted as described in applicable JPs.

F. Any drilling necessary to obtain samples shall be done dry.

8A10.4 MATRIX HYDROLOGIC PROPERTIES TESTING (B-2.2.2)

PERFORMANCE CRITERIA

1a. Samples will be required from all lithologic units penetrated by the ESF. Samples adjacent to lithologic contacts and from bedded intervals are of particular importance. Small alcoves, large enough for a core rig, may be required if boreholes are drilled specifically to collect samples for this test. If possible, core samples will be collected from boreholes drilled for other testing purposes (other PIs boreholes), provided that dry-drilling techniques are employed. Additional sampling may be required, either boreholes or block samples, to provide samples from all the lithologic units penetrated by the ESF.

1b. Boreholes cored specifically for this test should be HQ3-sized boreholes, deep enough to retrieve natural-state samples, oriented approximately horizontal (this is not critical), and drilled dry (air as the circulating fluid).

1c. There are currently no plans to instrument boreholes drilled specifically to collect samples for this test. No data collection equipment will be needed in the ESF.

1d. The placement of matrix hydrologic properties boreholes is flexible where thick, homogeneous units are being sampled. At lithologic contacts and in bedded units, there may be less sample flexibility. Orientation of the boreholes is
flexible, to be determined by the type of units being sampled.

1e. Standard ESF utilities are required for this test.

1f. Ramp and drift walls may need to be sampled as soon as they are excavated. The samples would be block samples or small core plugs, preferably taken by the USGS or designated representatives. Long-term access to drill boreholes and sample ramp and drift walls from 6 months to possibly years may be required.

CONSTRAINTS

A. The matrix hydrologic properties testing will provide data on in situ hydrologic conditions to other PIs; providing background information for boreholes that are to be instrumented for monitoring changes in the rock surrounding the ESF. In some cases, the data provided from this test will be needed before instruments are placed in the monitoring boreholes.

B. Where practicable, core samples for this test shall be collected from boreholes drilled for other ESF tests, provided that the boreholes are drilled dry.

C. No IDS requirements are foreseen at this time.

D. This test requires in situ samples. The PI or his designated representative will determine where the samples should be collected from to minimize the impact caused by any wet-drilling operation. This will ensure uncontaminated samples. No interference envelope is required.

E. Dry drilling is required for this test. Block samples, created by drill-and-blast methods, should be collected prior to significant use of water for dust control. Minimal water may be used in drilling the blast holes.

INTERFACE REQUIREMENTS

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.
ASSUMPTIONS

1. The samples will be collected as part of the bulk sampling described in the Common Sampling Design Requirements (2.3.6). The USGS or designated representative will do all the sampling in the ESF.

2. Core samples will be processed according to the PIs sample-handling procedures.

3. Facilities for handling samples collected from the ESF by the Principal Investigator will be provided by or through the Sample Management Facility.

8A10.5  MINERAL DISTRIBUTIONS BETWEEN HOST ROCK AND ACCESSIBLE ENVIRONMENT (B-2.2.15)

PERFORMANCE CRITERIA

1a. Samples will be collected from the rock exposures created by underground workings.

1b. It may be necessary to revisit and resample mapped workings after completion of excavation and construction.

1c. Any drilled sample will require hand-held drills only.

1d. Oriented samples may be required.

1e. Standard ESF power, lighting, water, ventilation, compressed air, and communications are adequate.

CONSTRAINTS
A. Geologic mapping should be completed prior to sample collection, or sample collection may be done concurrently with geologic mapping.

B. Because of the small scale of sampling, this activity can proceed without impacting construction.

**INTERFACE REQUIREMENTS**

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.

   Section 2.3.1  Scientific Manpower/Schedule Information
   Section 2.3.2  Laboratory/Office/Storage Space Requirements
   Section 2.3.3  Electrical Power Requirements
   Section 2.3.4  Water System Requirements
   Section 2.3.5  Compressed Air System Requirements
   Section 2.3.6  Common Sampling Design Requirements
   Section 2.3.7  Communications System Requirements
   Section 3.0    Integrated Data System

**ASSUMPTIONS**

1. Sample collection from exposures will normally be accomplished by mapping geologists during the same time period as geologic mapping is performed.

2. Ability to revisit and resample mapped workings is assumed.

3. A common sampling and sample shipping program will be developed to accommodate the sampling needs of related activities.

**8A10.6  FRACTURE MINERALOGY (B-2.2.16)**

**PERFORMANCE CRITERIA**

1a. Hand samples approximately 5x10-15cm and cores of up to 30cm length will be required along selected fractures and fault zones throughout the ESF (accesses, drifts, and available alcoves).
i. Hand samples with fracture surface areas totaling approximately 10-15 cm² (4 to 6 inches²) will be required along selected fractures and fault zones throughout the ESF north ramp and north ramp alcoves. Cores of up to 30 cm (12 inches) in length may be required in fault zones.

ii. Each sample location shall be surveyed and photographed.

b. Oriented samples may be required.

i. Sample orientation should be provided with an arrow indicating the "up" direction. Additional sample description information shall include fracture orientation, fracture roughness, fracture aperture (to the nearest mm) and offset, if any.

lc. Additional sampling (hand samples and/or short cores) of fractures or faults exposed in the walls or roof of accesses, drifts and alcoves may be required after construction and mapping are completed. This may be some years after completion of excavation and may require temporary removal of small areas of mesh.

ld. Standard ESF power, lighting, water, ventilation, compressed air, and communications will be adequate to perform sampling.

CONSTRAINTS

A. Sampling will be done during or after geologic mapping.

B. Samples must be free of hydrochloric acid (HCl). Exposure of fracture to other materials that could be deposited on fracture surface should be minimized.

C. Sampling should not impact construction activities.

INTERFACE REQUIREMENTS

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.

Section 2.3.1 Scientific Manpower/Schedule Information
ASSUMPTIONS

1. Sample collection from walls and roof (where required) will normally be accomplished by mapping geologists during the same time period as geologic mapping of the accesses, drifts and alcoves is performed.

2. Ability to revisit selected features after (possibly 1-2 years after) mapping and to collect samples (either hand samples or short core) tied to the survey and mapping is assumed.

3. A common sampling program and shipping procedure will be developed.

8A10.7 HISTORY OF MINERALOGICAL AND GEOCHEMICAL ALTERATION OF YUCCA MOUNTAIN (B-2.2.17)

PERFORMANCE CRITERIA

1a. Wall-rock samples will be collected by the Alteration History PI (or designee) from the north and south ramps, from the Main Topopah Spring Test Level (MTL), from the drifts in the tuff of Calico Hills, and from any other drifts. A safe method of collecting and transporting samples to the surface will be provided.

i. Each sample collected should be surveyed and photographed.

ii. Sample orientation shall be provided with an arrow indicating the "up" direction, or more complete documentation along with sample photograph information shall be provided by the sample collector, (this does not include gel samples).
iii. In addition to the samples collected by the PI, approximately 15 to 25 samples per 60 m (197 ft) of excavated tunnel should be collected throughout the ESF.

1b. Small-scale hand drilling may be required to collect samples. No other drilling will be required.

1c. For the most part, this test can be conducted during facility construction without impact to construction activities. The activity will be conducted in two phases. An early phase of sampling and spot-detail mapping during construction will be followed by more sampling as needed. Accessibility for sampling on a long-term basis is desired. Gels must be sampled as soon as possible after exposure by excavation. If fault zones or other features requiring surface treatment for stabilization (e.g., shotcrete) are encountered during excavation, then the ability to examine them before they are covered is desired, provided that safety considerations permit.

1d. Standard requirements for power, lighting, water, ventilation, compressed air, and communications are adequate.

CONSTRAINTS

A. Sample collection for this test will generally follow the geologic mapping test.

B. There are no expected standoff requirements for this test because wall-rock sampling can be accomplished before most other tests begin. Sampling activities for this test are not expected to interfere with other tests.

C. Procedures for sample collection and control will be developed by the PI with consultation from the constructor and the geologic-mapping activity personnel.

D. The gel-collection part of this test requires integration with the perched-water test and the geologic mapping test.

i. If gel samples must be collected promptly, the PI for this activity must be notified as soon as
possible once the samples are collected prior to sample distribution.

E. Sampling should not be done in locations where chemicals have already been deliberately or accidentally applied to rock surfaces during other tests.

i. Exempted from this requirement is lithium bromide used to chemically tag underground water use.

F. Samples will generally be 1 to 5kg (2.2-11 lbs) and will be separated from the excavation walls by hammer and chisel if possible.

i. If an alternative sampling method (such as a hydraulic splitter) is utilized, the method should be identified in the sample description in case the sample might become altered.

INTERFACE REQUIREMENTS

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.

Section 2.3.1 Scientific Manpower/Schedule Information
Section 2.3.2 Laboratory/Office/Storage Space Requirements
Section 2.3.3 Electrical Power Requirements
Section 2.3.4 Water System Requirements
Section 2.3.5 Compressed Air System Requirements
Section 2.3.6 Common Sampling Design Requirements
Section 2.3.7 Communications System Requirements
Section 3.0 Integrated Data System

ASSUMPTIONS

1. Geologic mapping test will provide copies of wall maps/photos, adequate to function as general guide to mapped units, to PI of Alteration History activity in a timely manner.

2. Alteration History wall-rock sampling will not be part of a common sampling program, but will share some procedures with the common sampling program and may participate on a special-case basis, as for gel collection.
3. Geologic mapping test will establish a sample location coordinate system for use by Alteration History test.

4. On-site storage facility for rock samples and a means to transport rock samples from the underground to the surface will be available.

5. Locations where chemicals have been deliberately or accidentally applied to wall-rock surfaces will be tagged, labelled, and recorded to prevent inadvertent sampling.

6. Prior notification will be given regarding experiments that will involve introduction of chemicals into the wall-rock so that any necessary sampling can be completed before the experiments begin.

7. Apparatus for access to upper walls and ceiling of excavations will be available on a part-time basis.

8. Small portions of the excavation that have been covered with shotcrete or wire mesh may be re-exposed if this study requires examination or sampling of important features.

9. Apparatus for measuring sampling orientation will be available on a part-time basis.

8A10.8 PETROLOGIC STRATIGRAPHY OF THE TOPOPAH SPRING MEMBER (B-2.2.14)

Performance Criteria

1a. Samples will be collected from the rock exposures created by underground workings.

1b. It may be necessary to revisit and resample mapped workings after completion of excavation and construction.

1c. Any drilled sample will require hand-held drills only.

1d. Oriented samples may be required.
1. Standard ESF power, lighting, water, ventilation, compressed air, and communications are adequate.

Constraints

A. Geologic mapping should be completed prior to sample collection, or sample collection may be done concurrently with geologic mapping.

B. Because of the small scale of sampling, this activity can proceed without impacting construction.

Interface Requirements

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.

Section 2.3.1 Scientific Manpower/Schedule Information
Section 2.3.2 Laboratory/Office/Storage Space Requirements
Section 2.3.3 Electrical Power Requirements
Section 2.3.4 Water System Requirements
Section 2.3.5 Compressed Air System Requirements
Section 2.3.6 Common Sampling Design Requirements
Section 2.3.7 Communications System Requirements
Section 3.0 Integrated Data System

Assumptions

1. Sample collection from exposures will normally be accomplished by mapping geologists during the same time period as geologic mapping is performed.

2. Ability to revisit and resample mapped workings is assumed.

3. A common sampling and sample shipping program will be developed to accommodate the sampling needs of related activities.

8A10.9 BIOLOGICAL SORPTION AND TRANSPORT (B-2.2.19)
Performance Criteria

1a. Must have the ability to collect aseptically a minimum of 1.0 kg of pristine sample.

1b. Must have the ability to collect samples in line with construction, either by core, as rubble from drill and blast, or small scale hand drilling.

1c. Must have the ability to collect samples throughout the facility within all units and at contacts.

1d. If coring is required to collect samples, coring must be conducted dry.

1e. If coring is required to collect samples, the depth of the core shall be sufficient to ensure pristine samples, and to avoid interference from contaminants which may be introduced by excavation or other activities. Contaminants of concern include water and drilling fluids.

1f. Provision of standard ESF utilities (power, lighting, water, compressed air, communication, ventilation, etc.) will be adequate.

1g. Because sample integrity is the utmost requirement, samples will be collected immediately following the tunnel boring machine (TBM). Sample collection will not impact the progress of the TBM.

   i. Samples should be collected as soon as practicable from the area on or around the mapping gantry station.

1h. Long-term accessibility will be required.

1i. Samples should be collected from an area beyond the zone of TBM-induced mechanical alteration.

Constraints

A. Sampling from documented locations will follow completion of geologic mapping activities.
B. Sampling can be conducted during facility construction (during the time that mapping is following the TBM) without impact to construction activities.

i. Samples will be collected under the supervision of the PI or designee and a split of all samples will be hand carried offsite by the PI or designee for immediate processing.

C. No water will be used in the immediate vicinity of any sampling location.

i. Exempted from this requirement is water used for dust control and for cleaning of rock surfaces prior to geologic mapping.

D. Any drilling used to obtain samples will be done dry.

E. All samples will be taken either by the principal investigator (PI) or by a personnel trained by the PI.

F. No IDS interface is required.

Interface Requirements

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.

Section 2.3.1 Scientific Manpower/Schedule Information
Section 2.3.2 Laboratory/Office/Storage Space Requirements
Section 2.3.3 Electrical Power Requirements
Section 2.3.4 Water System Requirements
Section 2.3.5 Compressed Air System Requirements
Section 2.3.6 Common Sampling Design Requirements
Section 2.3.7 Communications System Requirements
Section 3.0 Integrated Data System

Assumptions

1. A common sampling program for the ESF will be available. Components of this program will include provisions for locations of samples following criteria supplied by the
principal investigator, sample labeling, the potential for co-utilization of samples, and short-term storage facility for samples.

8A10.10 REPOSITORY HORIZON ROCK-WATER INTERACTION (B-2.2.42)

Performance Criteria

1a. There is no space requirement; no alcove is needed. The locations of the sampling include the North and South Ramps and the Main Test Level; access from the lithophysal zone of Topopah Spring Tuff at the contact of Tiva Canyon and Topopah Spring, Basal Vitrophyre of Topopah Spring, and the top of the zeolitic tuff of the Calico Hill unit.

1b. Sampling hole up to 20 cm (8") in diameter, may be drilled a few meters deep. Dry drilling is required. Block sampling may be obtained by mechanical means from drift surfaces although slotting or line drilling to obtain samples away from the immediate drift surface may be required.

1c. All data will be collected in the laboratory by LLNL personnel.

   i. All ESF samples will be collected by LLNL personnel.

1d. The timing of sample collection is flexible. They can be taken after excavation and construction phases of ramps, drifts, or alcoves.

1e. Normal power, compressed air, lighting, water, and ventilation for the Ramps and the Main Test Level will be adequate except as specifically requested for drilling.

1f. No special access is needed after initial sampling.

Constraints

A. There is no particular sequential constraint on testing.
B. The tests should be started as early as possible so that adequate information can be provided for the license application date.

C. No IDS or data collection are required.

D. No interference with other activities.

E. Dry drilling is required to obtain samples.*

F. Sample locations must be approved by the responsible PI or designee prior to the sampling activity.

Interface Requirements

1. Interface requirements to other systems, if applicable, are discussed in the appropriate integration studies.

Section 2.3.1 Scientific Manpower/Schedule Information
Section 2.3.2 Laboratory/Office/Storage Space Requirements
Section 2.3.3 Electrical Power Requirements
Section 2.3.4 Water System Requirements
Section 2.3.5 Compressed Air System Requirements
Section 2.3.6 Common Sampling Design Requirements
Section 2.3.7 Communications System Requirements
Section 3.0 Integrated Data System

Assumptions

1. Office space at the ESF and some space will be assigned in Area 25.

2. Office space at the ESF should provide enough space and change house for at least 2 persons.

3. There will be a common sampling program developed. LLNL will evaluate the sampling requirement when that program is developed.
Performance Criteria

1a. Ability to collect bulk samples of construction materials used in the ESF, along with bulk samples (and possibly short cores) of ramp and drift walls at selected locations to examine the effects of construction materials on natural conditions.

1b. Ability to emplace artificial materials at PI-selected locations and later retrieve these materials for laboratory analyses.

1c. Standard ESF utilities are required for this test.

1d. Key data to be collected are wall rock samples (and possibly short core samples) and samples of construction materials for laboratory analyses.

Constraints

A. Long-term access for periodic resampling of ramp and drift walls on a yearly or bi-yearly basis may be required.

B. No IDS requirements are foreseen at this time.

C. The PI or designated representative will select sample collection and emplacement locations.

D. For any cored samples, dry drilling will required.

8A10.12 STUDIES OF CALCITE AND OPALINE SILICA VEIN DEPOSITS

Performance Criteria

1a. Hand samples approximately 15 x 15 x 15 cm (6 x 6 x 6 in) in size (or large enough to include much of the thicker portions of the secondary mineralization) will be required along selected fractures and fault zones throughout the ESF (accesses, drifts, and available alcoves).

1b. Samples orientation should be described and recorded.
1c. Standard ESF power, lighting, water, ventilation, compressed air, and communications will be adequate to perform sampling.

1d. Key data to be obtained are samples of secondary mineralization containing calcite or opaline silica in faults and fractures, along with adjacent wall rock.

Constraints

A. Sampling will be done during or after geologic mapping.

B. No IDS requirements are foreseen at this time.

8A10.13 GEOCHEMICAL ASSESSMENT OF YUCCA MOUNTAIN IN RELATION TO THE POTENTIAL FOR MINERALIZATION

Performance Criteria

1a. Hand samples will be required along selected fractures and fault zones throughout the ESF (accesses, drifts, and available alcoves).

1b. Samples orientation should be described and recorded.

1c. Standard ESF power, lighting, water, ventilation, compressed air, and communications will be adequate to perform sampling.

1d. Key data to be obtained are samples of potential natural resources, especially compounds concentrated by primary magmatic processes, secondary weathering, or hydrothermal alteration. There is special interest in precious metals and pathfinder elements, including gold, silver, copper, lead, zinc, mercury, thorium, uranium, antimony, fluorine, barium, arsenic, and yttrium.

Constraints

A. Sampling will be done during or after geologic mapping.
B. No IDS requirements are foreseen at this time.

C. This test requires in situ samples. The PI or his designated representative will determine where the samples should be collected from to minimize the impact caused by construction or other tests. No interference envelope is required.
8A10.14  TESTS (THERMAL & MECHANICAL) USING SAMPLES OBTAINED
FROM THE EXPLORATORY STUDIES FACILITY (B-2.2.22)

Performance Criteria

1a. No special room or alcove is required. The tests entail
sampling throughout the ESF, in each of the thermomechanical
units encountered, with an emphasis in the TSw2.

1b. No need for data collection by the Integrated Data system
has been identified.

1c. No flexibility requirements for test location or orientation
have yet been identified.

1d. Standard underground facilities for water, air, and
electricity for drilling will be used for this test.

   i. Capability should exist to collect bulk samples of
      various sizes (up to 25 by 25 by 25 cm [10 by 10
      by 10 in]) and to transport them to the surface
      for shipment to laboratories.

1e. Access to locations throughout the ESF will be required in
order to take samples.

Constraints

A. This test can be scheduled independently of the scheduling
of the other tests.

B. Test preparation can be performed at any time after the test
location is exposed. The use of underground resources (men
and equipment) will be based on scheduled availability and
preferably coincide with scheduled TBM shut down. Slow down
of excavation progress will be avoided. Construction
progress impact (far behind face) will be limited to minor
interference with support forces (maintenance crews, ramp
transportation vehicles, priority testing support, etc.)

C. No interference envelope exists. Samples should be taken
from rock that has not been disturbed by excavation or other
testing. Dry coring may be required in some cases.
D. No other constraints or controls have been yet identified for this test.