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EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

VOLUME 2

CHANGES TO THIS DOCUMENT REQUIRE PREPARATION AND APPROVAL OF A CHANGE REQUEST IN ACCORDANCE WITH PROJECT AP-3.3Q

UNITED STATES DEPARTMENT OF ENERGY
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT OFFICE

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

EXPLORATORY STUDIES FACILITY

DESIGN REQUIREMENTS DOCUMENT

REVISION 0

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VOLUME 2

Prepared by

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APPENDIX A.1

POTENTIAL REPOSITORY/EXPLORATORY STUDIES FACILITY INTERFACE CONSTRAINTS

Constraints imposed upon the Exploratory Studies Facility (ESF) by the repository shall be as follows:

A.1-1. The reference Repository/ESF configuration in the ESF Title I Design Summary Report, Revision 1 shall form the basis for the final ESF configuration to be developed during Title II design.
[SD&TRD 3.2.7.A, 3.2.7.1.B.1, 3.7.B.1][10 CFR 60.111(b)(1)][CRD 3.3.1.A]

A.1-2. Design and construction of the ESF main test level shall not preclude construction of the repository emplacement level at the highest elevation possible compatible with the contact between the Topopah Spring welded unit 1 (TSw1) and Topopah Spring welded unit 2 (TSw2).
[SD&TRD 3.2.7.A, 3.2.7.1.B.1, 3.7.B.1][10 CFR 60.111(b)(1)][CRD 3.3.1.A]

A.1-3. Design and construction of the ESF main test level shall not preclude design and construction of the repository so that waste emplacement drifts do not cross major faults, such as the Ghost Dance Fault.
[SD&TRD 3.2.7.A, 3.2.7.1.B.1, 3.7.B.1][10 CFR 60.111(b)(1)][CRD 3.3.1.A]

A.1-4. Refer also to Yucca Mountain Site Characterization Project Repository Design Requirements (YMP/92-32) for additional constraints.
[SD&TRD 3.2.7.A, 3.2.7.1.B.1, 3.7.B.1][10 CFR 60.111(b)(1)][CRD 3.3.1.A]

LIST OF ACRONYMS

ESF	Exploratory Studies Facility
MGDS	Mined Geologic Disposal System
RDR	Repository Design Requirements
TSw1	Topopah Spring Welded Unit 1
TSw2	Topopah Spring Welded Unit 2
YMP	Yucca Mountain Site Characterization Project

APPENDIX A.2

EXPLORATORY STUDIES FACILITY - POTENTIAL REPOSITORY INTERFACE DRAWINGS

APPENDIX A.2

EXPLORATORY STUDIES FACILITY - POTENTIAL REPOSITORY INTERFACE DRAWINGS

The information referenced in this Appendix consists of drawings illustrating spatial relationships between ESF and potential repository drifts. The drawings show how ESF drifts will be incorporated into the layout of the potential repository. The layouts are based on the reference ESF/potential repository configuration (referenced in Appendix A.1, ESF/Potential Repository Interface Constraints). The drawings are preliminary. As the ESF and potential repository designs evolve, the interface drawings will be revised to reflect changes in concept and include greater detail.

The referenced drawings are in the ESF Technical Baseline, YMP/CM-0016 (Part 2).

Drawing No.	Title
MND-A201-100	Repository General Layout and Plan
MND-A201-101	TS North Ramp/Main Drift Plan & Section
MND-A201-102	TS South Ramp/Main Drift Plan & Section
MND-A201-103	Repository Main Drifts & TS East/West Drifts - Plan View
MND-A201-104	Repository Main Drifts & TS East/West Drifts - Cross Sections
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[TBD]

APPENDIX A.4

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[TBD]

APPENDIX A.5

SEISMIC DESIGN BASIS LOADS FOR THE EXPLORATORY STUDIES FACILITY

[TBV]

APPENDIX A.5

SEISMIC DESIGN BASIS LOADS FOR THE EXPLORATORY STUDIES FACILITY

DEFINITION OF SURFACE AND SUBSURFACE

The delineation between surface and subsurface construction is the mountain side of the portal (or collar) interface. Subsurface construction is comprised of those areas where the excavation penetratesthis interface and extends into the mountain: surface construction is comprised of those areas not penetrating this interface.

(ESFDR 3.2.2.2.2.L)

ESF SEISMIC DESIGN BASIS

	SURFACE	**SUBSURFACE
ESF (Temporary)	UBC (Zone 4)	0.3g
ESF (Permanent)	*	*
Repository	0.75g [TBV]	0.4g [TBV]

*ESF permanent items will be designed to the corresponding surface or subsurface Repository value. In some cases, ESF permanent items will be designed to a lesser criteria if the item can be upgraded (modified and/or supplemented) or replaced. In these cases the design basis will be the value for ESF temporary items.

**The surface seismic design basis will be applied to the subsurface items which are less than [TBD] ft. below the surface.

All ESF items which are intended to be incorporated into the potential repository are considered permanent. Permanent ESF items will be designed, constructed and maintained consistent with the quality controls and record keeping requirements expected for permanent items that are part of a potential repository.

[SD&TRD 3.7.B.1][10 CFR 60.131(b)(1)]

APPENDIX B

FACILITY DESIGN REQUIREMENTS FOR EXPLORATORY STUDIES FACILITY TESTING

APPENDIX B

FACILITY DESIGN REQUIREMENTS FOR EXPLORATORY STUDIES FACILITY TESTING

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APPENDIX B

FACILITY DESIGN REQUIREMENTS FOR EXPLORATORY STUDIES FACILITY TESTING

B.1 INTRODUCTION

B.1.1 PURPOSE

This Appendix presents test requirements which reflect Exploratory Studies Facility (ESF) configuration, mechanical excavation methods, and exploratory drifting and testing in the nonwelded Calico Hills unit.

B.1.2 OVERVIEW

The Underground Testing Program covered in this appendix is a flowdown of activities identified in the Site Characterization Plan (SCP) and defined in Preliminary Exploratory Studies Facility Test Planning Package 91-5. The testing information, as provided, is deemed adequate to initiate Exploratory Studies Facility (ESF) Title II Design. Underground testing requirements for facility design were previously incorporated into the ESF Design Requirements (ESFDR) Rev. 7/2/92 as Appendix B.

Table B-1 lists the tests performed in the ESF, and provides a cross-reference between the tests in this Appendix and the source in the Site Design and Test Requirements Document (SD&TRD).

B.1.3 SCOPE

The testing requirements will be revised by Los Alamos National Laboratory, as necessary to support design development and test planning, using inputs from the Test Organizations and Principal Investigators (PIs). Revisions will be based on prioritized needs to support Title II Design phases as identified by the Regulatory and Site Evaluation Division and the Engineering and Development Division, and will provide changes consistent with the SCP and with selected facility configuration and construction methods. As developed, test-related design requirement inputs will be submitted for inclusion in formal revisions of the ESFDR, and as supplemental criteria and constraints in formal test planning packages. These revisions will include results of integration studies to define common and specific testing program schedules and networks, manpower requirements, storage/lab space requirements, utility and communication requirements, and common sampling requirements for the ESF Test Program.

Table B-1 Tests Performed in the ESF

TITLE	SD&TRD SECTION REFERENCE	LEAD ORGANIZATION	APPENDIX B PARAGRAPH
Chloride & Chlorine-36 Measurements of Percolation at Yucca Mountain	3.2.1.2.B.2.a	LANL	B.2.1
Matrix Hydrologic Properties Testing	3.2.1.2.B.3.a	USGS	B.2.2
Intact-Fracture Test in the ESF	3.2.1.2.B.4.a	USGS	B.2.3
Percolation Tests in the ESF	3.2.1.2.B.4.b	USGS	B.2.4
Bulk Permeability Test in the ESF	3.2.1.2.B.4.c	USGS	B.2.5
Radial Borehole Tests in the ESF	3.2.1.2.B.4.d	USGS	B.2.6
Excavation Effects Test in the ESF	3.2.1.2.B.4.e	USGS	B.2.7
RESERVED			B.2.8
Perched-Water Testing in the ESF	3.2.1.2.B.4.g	USGS	B.2.9
Hydrochemistry Tests in the ESF	3.2.1.2.B.4.h	USGS	B.2.10
RESERVED			B.2.11
Hydrologic Properties of Major Faults Encountered in the ESF	3.2.1.2.B.4.j	USGS	B.2.12
Diffusion Tests in the ESF	3.2.1.2.B.5.a	LANL	B.2.13
Petrologic Stratigraphy of the Topopah Spring Member	3.2.1.3.B.1.a	LANL	B.2.14
Mineral Distributions between Host Rock and Accessible Environment	3.2.1.3.B.1.b	LANL	B.2.15
Fracture Mineralogy	3.2.1.3.B.1.c	LANL	B.2.16
History of Mineralogic and Geochemical Alteration of Yucca Mountain	3.2.1.3.B.2.a	LANL	B.2.17
Biological Sorption and Transport	3.2.1.3.D.2	LANL	B.2.18
Field-Scale Experiments to Study Radionuclide Transport at Yucca Mountain	3.2.1.3.G.2.b	LANL	B.2.19
Underground Geologic Mapping	3.2.1.4.B.2.d	USGS	B.2.20
Seismic Tomography/Vertical Seismic Profiling at the ESF	3.2.1.4.B.2.e	USGS	B.2.21
Laboratory Tests (Thermal & Mechanical) Using Samples Obtained from the ESF	3.2.1.15.A	SNL	B.2.22

Table B-1 Tests Performed in the ESF (Continued)

TITLE	SD&TRD SECTION REFERENCE	LEAD ORGANIZATION	APPENDIX B PARAGRAPH
Access Convergence Measurements	3.2.1.15.A.5.a	SNL	B.2.23
Demonstration Breakout Room	3.2.1.15.A.5.b	SNL	B.2.24
Sequential Drift Mining	3.2.1.15.A.5.c	SNL	B.2.25
Heater Experiment in TSw1	3.2.1.15.A.6.a	SNL	B.2.26
Canister-Scale Heater Experiment	3.2.1.15.A.6.b	SNL	B.2.27
Heated Block Experiment	3.2.1.15.A.6.c	SNL	B.2.28
Thermal Stress Test	3.2.1.15.A.6.d	SNL	B.2.29
Heated Room Experiment	3.2.1.15.A.6.e	SNL	B.2.30
Plate Loading Tests	3.2.1.15.A.7.a	SNL	B.2.31
Rock-Mass Response Test	3.2.1.15.A.7.b	SNL	B.2.32
Evaluation of Mining Methods	3.2.1.15.A.8.a	SNL	B.2.33
Monitoring of Ground Support Systems	3.2.1.15.A.8.b	SNL	B.2.34
Monitoring Drift Stability	3.2.1.15.A.8.c	SNL	B.2.35
Air Quality and Ventilation Experiment	3.2.1.15.A.8.d	SNL	B.2.36
Overcore Stress Experiments in the ESF	3.2.1.15.B.1.b	USGS	B.2.37
Development and Demonstration of Required Equipment	3.2.2.1.A	SNL	B.2.38
In Situ Testing of Seal Components	3.2.3.2.A.1.a	SNL	B.2.39
Geomechanical Attributes of the Waste Package Environment	3.2.4.2.A.3	LLNL	B.2.40
Repository Horizon Near-Field Hydrologic Properties	3.2.4.2.A.4.a	LLNL	B.2.41
Repository Horizon Rock-Water Interaction	3.2.4.2.A.4.b	LLNL	B.2.42

B.2 FACILITY DESIGN REQUIREMENTS FOR EXPLORATORY STUDIES FACILITY TESTING

B.2.1 CHLORIDE AND CHLORINE-36 MEASUREMENTS OF PERCOLATION AT YUCCA MOUNTAIN (SCP 8.3.1.2.2.2.1)

B.2.1.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.2.B.2.a) is to determine the residence time of water in the unsaturated zone tuffs based on the chlorine-36/chloride ratio of meteoric chloride by measuring chlorine-36, chloride, and bromide at various locations. Bulk samples from various locations throughout the ESF will be collected, packaged, and labelled for laboratory analysis. Because of the requirement to extract sufficient meteoric chloride to analyze each sample for chlorine-36 and to provide for the potential to replicate analyses of a given sample, large samples will be needed from each sampling location. In the event that perched water is encountered, perched-water samples will also be collected as part of this activity.

B.2.1.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform this activity.

B.2.1.3 PERFORMANCE CRITERIA

A. Collect samples of about 100kg (220.5 pounds) quantity from each sampling location. [SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

B. Access any given sample location for resampling, if judged necessary. [SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

C. Collect samples concurrently with construction 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). [SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

D. Collect samples from each geologic unit encountered in the north and south ramps and in drifts in the Calico Hills and Topopah Spring units. [SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

E. Collect samples from selected fracture zones, fault and breccia zones, lithologic contacts, and wet zones. [SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

F. Collect samples by conducting dry coring if coring is required. Any use of tracer must be approved by the PI prior to use.
[SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

G. Collect samples ensuring that the depth of the core shall be sufficient to ensure pristine samples and 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.
[SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

H. Standard ESF utilities, including power, lighting, water, compressed air, communications, and ventilation are required.
[SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

B.2.1.4 CONSTRAINTS

A. Sampling from documented locations will follow completion of geologic mapping activities.
[SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

B. Timing 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 to avoid interference with the construction schedule. However, wet zones and perched water require immediate sampling to protect the integrity of these samples.
[SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

C. Sampling of wet zones and occurrences of perched water must be coordinated with the Perched-Water Test.
[SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

D. No water shall be used in the immediate vicinity of any sampling location (zone of potential interference to be determined).
[SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

E. No tracer shall be used in the vicinity of any sampling location without approval of the PI (zone of potential interference to be determined).
[SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

F. Any drilling necessary to obtain samples shall be done dry. [SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

B.2.1.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.2.B.2.a][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

B.2.1.6 ASSUMPTIONS

A common integrated sampling program is available for the ESF. Components of this program include provisions for locating, collecting, and storing samples following criteria supplied by the PI; coordination of efforts to sample wet zones and occurrences of perched water; the potential for co-utilization of dry-drilled core holes; and short-term storage facility for samples.

B.2.2 MATRIX HYDROLOGIC PROPERTIES TESTING (SCP 8.3.1.2.2.3.1)

B.2.2.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.2.B.3.a) is to develop a comprehensive data base on matrix flux properties in the unsaturated zone tuffs at Yucca Mountain. This activity involves collecting bulk and/or core samples from the ESF. Bulk samples may be collected from exposed areas in the ESF or from rubble created during drill-and-blast mining operations. Core samples may be obtained either from boreholes drilled for other tests (drilled for other PIs) or from boreholes drilled specifically for the collection of core samples for matrix properties testing. The bulk samples and core samples will be packaged, labeled, and sent to a laboratory for various analyses.

B.2.2.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the sample collection.

B.2.2.3 PERFORMANCE CRITERIA

A. Samples will be required from all lithologic units penetrated by the ESF; those samples adjacent to lithologic contacts and from bedded intervals are particularly important. 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 PI boreholes), provided that dry-drilling techniques are employed. Additional borehole or block samples may be required to provide samples from all the lithologic units penetrated by the ESF.
[SD&TRD 3.2.1.2.B.3.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(i), .4-2-1(b)(5)(iii), .4-2-1(d)]

B. Boreholes cored specifically for this test should be HQ3-sized boreholes, deep enough to retrieve natural-state samples, oriented approximately horizontal and drilled dry (air as the circulating fluid).
[SD&TRD 3.2.1.2.B.3.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(i), .4-2-1(b)(5)(iii), .4-2-1(d)]

C. 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.
[SD&TRD 3.2.1.2.B.3.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(i), .4-2-1(b)(5)(iii), .4-2-1(d)]

D. 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 determined by the type of units being sampled.
[SD&TRD 3.2.1.2.B.3.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(i), .4-2-1(b)(5)(iii), .4-2-1(d)]

E. Standard ESF utilities are required for this test.
[SD&TRD 3.2.1.2.B.3.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(i), .4-2-1(b)(5)(iii), .4-2-1(d)]

F. Ramp and drift walls may need to be sampled as soon as they are excavated. The samples, preferably taken by the United States Geological Survey (USGS) or designated representatives, may be block samples or small core plugs. Long-term access (from six months to years) to drill boreholes and sample ramp and drift walls may be required.
[SD&TRD 3.2.1.2.B.3.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(i), .4-2-1(b)(5)(iii), .4-2-1(d)]

B.2.2.4 CONSTRAINTS

A. This test provides data on in situ hydrologic conditions to other PIs, providing background information for boreholes that are 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.
[SD&TRD 3.2.1.2.B.3.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(i), .4-2-1(b)(5)(iii), .4-2-1(d)]

B. Where practical, core samples for this test shall be collected from boreholes drilled for other ESF tests, provided that the boreholes are drilled dry.
[SD&TRD 3.2.1.2.B.3.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(i), .4-2-1(b)(5)(iii), .4-2-1(d)]

C. No Integrated Data System (IDS) requirements are foreseen at this time.
[SD&TRD 3.2.1.2.B.3.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(i), .4-2-1(b)(5)(iii), .4-2-1(d)]

D. The PI or his designated representative will determine from which location the in situ samples should be collected to minimize the impact caused by wet-drilling operations; this will ensure uncontaminated samples. No interference envelope is required.
[SD&TRD 3.2.1.2.B.3.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(i), .4-2-1(b)(5)(iii), .4-2-1(d)]

E. Dry drilling is required for this test, although minimal water may be used in drilling the blast holes. Block samples, created by drill-and-blast methods, should be collected prior to significant use of water for dust control.
[SD&TRD 3.2.1.2.B.3.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(i), .4-2-1(b)(5)(iii), .4-2-1(d)]

B.2.2.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.2.B.3.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(i), .4-2-1(b)(5)(iii), .4-2-1(d)]

B.2.2.6 ASSUMPTIONS

A. Samples will be collected as part of the bulk sampling described in the Common Sampling Design Requirements (B.3.6). The USGS or designated representative will do all the sampling in the ESF.

B. Core samples will be processed according to the PI's sample-handling procedures.

C. Facilities for handling samples collected from the ESF by the PI will be provided by or through the Sample Management Facility (SMF).

B.2.3 INTACT-FRACTURE TEST IN THE EXPLORATORY STUDIES FACILITY (SCP 8.3.1.2.2.4.1)

B.2.3.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.2.B.4.a) is to enhance the understanding of the physics of fluid flow and for flow modeling by evaluating fluid-flow and chemical transport properties and mechanisms in relatively undisturbed and variably-stressed fractures.

B.2.3.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the test.

B.2.3.3 PERFORMANCE CRITERIA

A. Sample locations will be chosen by the PI using detailed mapping information, if available. Numerous core samples will be collected from various locations in the following hydrogeologic units:

- Tiva Canyon welded (the North and/or South ramp)
- Paintbrush nonwelded (the North and/or South ramp)
- Topopah Spring welded (Main Test Level (MTL))
- Vitric Calico Hills nonwelded
- Zeolitized Calico Hills nonwelded

[SD&TRD 3.2.1.2.B.4.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

B. An alcove may be needed if the core samples are collected in an area where a drill rig and dust collector may block through traffic. The PI will work with the ESF designer to identify and specify design requirements related to potential interferences with traffic in the ramps and/or drifts.
[SD&TRD 3.2.1.2.B.4.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

C. Drilling and overcoring will be dry.
[SD&TRD 3.2.1.2.B.4.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

D. Fractures of two orientations (radial and axial) will be collected from various locations using dry drilling techniques. Both types of core will be collected a short distance (probably 620 to 1240 millimeters (24 to 49 inches)) from the mined surface, depending on the type of excavation methods used. The preferred orientation shall be parallel to the excavated floor (i.e., on a rib); however, samples may be collected from the floor (invert) or roof of the excavation. The two orientations are explained below.

1. Radial fractures are oriented approximately perpendicular to the core axis. A 19 millimeter (0.75 inch) outside diameter (OD) pilot hole is drilled beyond the fracture plane; anchors and a rock bolt are used to secure the fracture plane; the

pilot hole is overcored; and a 254 millimeter (10 inches) OD, 610 millimeter (24 inches) long core is withdrawn.

2. Axial fractures are oriented parallel to the core axis. The fracture plane is overcored; a 254 millimeter (10 inches) OD, 610 millimeter (24 inches) long core is banded; and the core is withdrawn.
[SD&TRD 3.2.1.2.B.4.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

E. Standard ESF power, lighting, ventilation, compressed air, and communications are adequate to conduct this test.
[SD&TRD 3.2.1.2.B.4.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

B.2.3.4 CONSTRAINTS

A. The core samples do not have to be collected immediately following construction. However, these cores shall be collected as soon as possible so the lengthy laboratory tests can begin. This test should be performed, or sample locations marked, before any lining material is installed in the ESF.
[SD&TRD 3.2.1.2.B.4.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

B. If other tests are conducted in the vicinity of collection sites which may introduce thermal, mechanical, or chemical changes near these sites, the core samples shall be collected before the area is disturbed.
[SD&TRD 3.2.1.2.B.4.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

C. The zone of influence due to mechanical effects is [TBD] meters.
[SD&TRD 3.2.1.2.B.4.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

B.2.3.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.2.B.4.a][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

B.2.3.6 ASSUMPTIONS

None.

B.2.4 PERCOLATION TESTS IN THE EXPLORATORY STUDIES FACILITY (SCP 8.3.1.2.2.4.2)

B.2.4.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.2.B.4.b) is to observe fluid flow and solute transport processes through variably saturated, fractured, welded and nonwelded tuff under controlled, relatively undisturbed conditions. The test plan is to use isolated blocks of rock that measure about 2 meters (6.6 feet) per side and that have been excavated either within or at the contacts between selected hydrostratigraphic units. The blocks will be instrumented with thermocouple psychrometers, tensiometer-transducer systems and electrical resistivity probes to monitor fluid flow and tracer transport under fluid flow conditions that can be controlled and systematically varied. Tracer-tagged water will be introduced from a trickle system/sand bed on the surface of the block and effluent from the block will be collected and analyzed to determine transport behavior.

B.2.4.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operation flexibility to perform the Percolation Tests.

B.2.4.3 PERFORMANCE CRITERIA

A. Two locations in the Tiva Canyon welded unit (TCw)-Paintbrush Tuff nonwelded unit (PTn) and PTn-Topopah Spring Welded Unit 1 (TSw1) geologic contacts of the North Ramp, two locations in the MTL Core Test Area (CTA), and two locations (north and south) in Calico Hills must be provided to perform percolation testing.
[SD&TRD 3.2.1.2.B.4.b][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d), .5-2-10(c)]

B. At each site, two parallel drifts, approximately 4 meters wide by 4 meters high by 7 meters deep (13 feet by 13 feet by 23 feet), will be excavated as the test alcove. The final test geometry and dimensions are [TBD].
[SD&TRD 3.2.1.2.B.4.b][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d), .5-2-10(c)]

C. A support system consisting of plates and long bolts is required to clamp the test block together. Jacks and a steel framework are required to support the block. Details and design of these support components are [TBD].
[SD&TRD 3.2.1.2.B.4.b][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d), .5-2-10(c)]

D. Tapered slabs will be cut with a diamond wire saw by drilling holes through the pillar at the intersections of the horizontal and vertical faces of the slabs.
[SD&TRD 3.2.1.2.B.4.b][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d), .5-2-10(c)]

E. Flexibility in locating the block to be excavated is required because of the need for dense fracture spacing or stratigraphic contacts.
[SD&TRD 3.2.1.2.B.4.b][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d), .5-2-10(c)]

F. A minimum 1 meter (3.3 feet) air gap is required on the top and bottom of each block and a minimum 2 meter (6.6 feet) air gap is required on the four vertical sides of each block.
[SD&TRD 3.2.1.2.B.4.b][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d), .5-2-10(c)]

G. The bottom face will be exposed first, and a block support system must be installed before the pillar is excavated.
[SD&TRD 3.2.1.2.B.4.b][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d), .5-2-10(c)]

B.2.4.4 CONSTRAINTS

A. Alcove construction methods must prevent induced fractures in the test block.
[SD&TRD 3.2.1.2.B.4.b][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d), .5-2-10(c)]

B. Fractures on each of the six exposed block faces must be mapped prior to block instrumentation.
[SD&TRD 3.2.1.2.B.4.b][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d), .5-2-10(c)]

C. Provision for data collection and IDS connection must be available prior to beginning this test.
[SD&TRD 3.2.1.2.B.4.b][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d), .5-2-10(c)]

D. The test blocks will be cut by a wire saw using tagged water (tracer TBD) to cool the wire and control the dust.
[SD&TRD 3.2.1.2.B.4.b][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d), .5-2-10(c)]

E. The zone of influence due to mechanical effects is [TBD] meters.
[SD&TRD 3.2.1.2.B.4.b][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d), .5-2-10(c)]

F. The zone of influence due to hydrologic effects is [TBD] meters.
[SD&TRD 3.2.1.2.B.4.b][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d), .5-2-10(c)]

B.2.4.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section 3.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements

Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.2.B.4.b][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(iv), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d), .5-2-10(c)]

B.2.4.6 ASSUMPTIONS

A. A ram can be used to push the tapered slabs (cut from the pillar) into an alcove and jack hammers will be adequate to break the slabs for removal.

B. A fluid effluent collection system designed and implemented by the USGS will be installed beneath the block prior to placement of the block-support system.

C. The USGS will drill the approximately 25.4 millimeters (1 inch) diameter boreholes used for instrument emplacement within the block.

B.2.5 BULK PERMEABILITY TEST IN THE EXPLORATORY STUDIES FACILITY (SCP 8.3.1.2.2.4.3)

B.2.5.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.2.B.4.c) is to examine the effects of measurement scale on calculated permeability and to characterize media heterogeneity with respect to bulk permeability utilizing single- and cross-hole air and, possibly, water injection. Tracer testing, using gaseous (and possibly liquid) tracers, will help characterize media transport properties. Testing will be conducted at 5 locations within the Topopah Spring MTL and will require up to four 60 meters (197 feet) deep HQ coreholes at each location.

B.2.5.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform this test.

B.2.5.3 PERFORMANCE CRITERIA

A. Three test locations must be distributed along MTL North-South main and East-West drifts; and two additional test locations must be provided in the MTL CTA. [SD&TRD 3.2.1.2.B.4.c][10 CFR 60.113(a)(2), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

B. The alcoves at each site must be of sufficient size to allow drilling three 60 meters (197 feet) deep HQ coreholes arranged in a frustum configuration, and a fourth corehole, drilled approximately three months later, in the center of the three-hole frustum. The initial three holes will be drilled in an alcove, at a minimum of one drift diameter off the drift, and at the corners of an equilateral triangle with 2 meters (6.6 feet) sides. The holes will be drilled at a 25 degree angle away from the centerline passing perpendicular through the center of the triangle; the fourth hole will be drilled on this centerline.

   The holes will be a maximum of 60 meters (197 feet) deep. All holes will be dry-drilled and the core will be packaged for use in other tests. The preferred orientation of the holes is near horizontal and perpendicular to the drift. [SD&TRD 3.2.1.2.B.4.c][10 CFR 60.113(a)(2), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

C. The USGS will provide all equipment used in the bulk permeability testing including the data acquisition equipment. No IDS connection or equipment is required. [SD&TRD 3.2.1.2.B.4.c][10 CFR 60.113(a)(2), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

D. The precise locations of the test sites are presently undefined, and will not be selected until after the initial geologic fracture mapping is completed. [SD&TRD 3.2.1.2.B.4.c][10 CFR 60.113(a)(2), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

E. Standard power, lighting, and communications is an adequate environment in which to conduct the test.
[SD&TRD 3.2.1.2.B.4.c][10 CFR 60.113(a)(2), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

F. Testing will require that the alcove be of adequate size for two persons to work installing and removing packer systems during normal work hours. Testing is expected to require up to five months per site.
[SD&TRD 3.2.1.2.B.4.c][10 CFR 60.113(a)(2), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

B.2.5.4 CONSTRAINTS

A. Test site locations will be chosen utilizing information from the geologic fracture mapping.
[SD&TRD 3.2.1.2.B.4.c][10 CFR 60.113(a)(2), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

B. This test can be postponed for up to one year after drift construction, provided the alcove and coreholes are not constructed. Because of rock drying, testing must begin as soon as possible after corehole drilling.
[SD&TRD 3.2.1.2.B.4.c][10 CFR 60.113(a)(2), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

C. Since this test is designed to assess the undisturbed hydrologic characteristics of the Topopah Spring Unit, it is critical that no other tests alter these characteristics. Tests that might change the rock permeability, water content or temperature must be examined closely and may be restricted. Since air and water will be injected into the formation, other nearby tests might be adversely affected.
[SD&TRD 3.2.1.2.B.4.c][10 CFR 60.113(a)(2), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

D. This test requires borehole geophysical and downhole TV logging information before testing can begin.
[SD&TRD 3.2.1.2.B.4.c][10 CFR 60.113(a)(2), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

E. The zone of influence due to mechanical effects is [TBD] meters.
[SD&TRD 3.2.1.2.B.4.c][10 CFR 60.113(a)(2), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

F. The zone of influence due to hydrologic effects is [TBD] meters.
[SD&TRD 3.2.1.2.B.4.c][10 CFR 60.113(a)(2), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

B.2.5.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.2.B.4.c][10 CFR 60.113(a)(2), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5)(iv), .4-2-1(d)]

B.2.5.6 ASSUMPTIONS

The alcove space required for drilling will also be sufficient for assembly and installation of the packer systems.

B.2.6 RADIAL BOREHOLE TESTS IN THE EXPLORATORY STUDIES FACILITY (SCP 8.3.1.2.2.4.4)

B.2.6.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.2.B.4.d) is to investigate vertical and lateral movement of gas, water, and vapor within the individual hydrogeologic units and across the hydrogeologic units' contacts. These tests consist of three test programs:

A. Anisotropy testing of the hydrogeologic units using a three-hole arrangement

B. Contact testing at the hydrogeologic units using a four-hole arrangement

C. Long-term monitoring at the contact test sites.

B.2.6.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operation flexibility to perform the Radial Borehole Tests.

B.2.6.3 PERFORMANCE CRITERIA

A. Locations must be provided as follows:

1. Anisotropy Test Sites

North Ramp

Alcove in upper TCw
Alcove in lower TCw
Alcove in middle PTn
Alcove in TSw1

Calico Ramp off North Ramp

Alcove in Topopah Spring Welded Unit 2 (TSw2)

South Ramp

Alcove in upper TCw
Alcove in lower TCw
Alcove in PTn
Alcove in TSw1
Alcove in TSw2

Calico Ramp off South Ramp

Alcove in Topopah Spring Welded Unit 3 (TSw3)

Calico Hills Test Level

Three Alcoves in Calico Hills nonwelded unit (CHn) (distributed along drifts)

2. Contact Test Sites

North Ramp

Alcove at TCw-PTn contact
Alcove at PTn-TSw1 contact

Calico Ramp off North Ramp

Alcove at TSw2-TSw3 contact

South Ramp

Alcove at TCw-PTn contact
Alcove at PTn-TSw1 contact

Calico Ramp off South Ramp

Alcove at TSw3-CHn contact

Calico Hills Level

Three Alcoves at Vitric-Zeolitic contacts along CH drifts
Alcove at TSw3-CHn contact

[SD&TRD 3.2.1.2.B.4.d][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5), .4-2-1(d)]

B. Alcoves

1. Anisotropy Test Sites

The alcoves must be large enough to allow HQ drilling of three 30 meters (98.4 feet) coreholes. The coreholes will be horizontal, perpendicular to the ramp, parallel to each other and configured in an equilateral triangle with 3 meters (10 feet) sides. In addition, the holes must be a minimum of one ramp diameter off the ramp, be dry drilled, and the core boxed and transported to the SMF.

2. Contact Test Sites

The alcoves must be large enough to allow HQ drilling of four 30 meters (98.4 feet) coreholes parallel to the contact, perpendicular to the ramp and parallel to each other. These coreholes must be in a rectangular configuration with two located a maximum of 2 meters (6.6 feet) above the contact, separated by up to

3 meters (10 feet) and two located below the contact, separated by up to 3 meters (10 feet). In addition, the coreholes must be drilled a minimum of one ramp diameter off the ramp, be dry drilled, and the core boxed and transported to the SMF.

3. Long-term Monitoring

Following completion of contact testing, the long-term monitoring program will utilize the contact test-site coreholes with no additional modifications. The long-term monitoring program may last up to five years.
[SD&TRD 3.2.1.2.B.4.d][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5), .4-2-1(d)]

C. The USGS supplies all equipment used in this test including the data acquisition equipment. Data storage for the anisotropy and contact tests is self-contained. However, the long-term monitoring requires an RS-232 connection from the IDS to the USGS data collection PC.
[SD&TRD 3.2.1.2.B.4.d][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5), .4-2-1(d)]

D. The exact anisotropy test sites are located only after the preliminary geologic mapping in the drifts have been conducted; the exact contact test sites are found only when the ramp has intersected the contact. Ramp construction may present geologic information that necessitates the addition of one or more test sites. Due to the many unknowns, it is imperative that a great deal of flexibility be maintained in the test site selection and development.
[SD&TRD 3.2.1.2.B.4.d][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5), .4-2-1(d)]

E. Standard power, lighting, and communications will be adequate. Testing will require compressed air at 1000slpm and 1035kPa at the anisotropy and contact test sites during testing. After completion of long-term monitoring, the contact test sites will require water for water-injection testing. It is estimated the water-injection tests will take up to 3 months and require water at 100 liters per minute at 100kPa gauge pressure.
[SD&TRD 3.2.1.2.B.4.d][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5), .4-2-1(d)]

F. Anisotropy Test Sites

Testing will require that the alcove be of adequate size for three persons to work installing and removing packer systems during normal work hours. Testing is expected to take up to three months per site.
[SD&TRD 3.2.1.2.B.4.d][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5), .4-2-1(d)]

G. Contact Test Sites

Testing will require that the alcove be of adequate size for two persons to work removing and installing packers during normal work hours. Testing is expected to take up to three months per site.
[SD&TRD 3.2.1.2.B.4.d][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5), .4-2-1(d)]

H. Long-term Monitoring

This program will require weekly access for maintenance and equipment checks; repair technicians will also require access in cases of equipment failure. Long-term monitoring may last up to five years. Upon completion of monitoring, a two-person crew will require daily access during normal work hours to conduct water-injection tests. The water-injection tests may require up to three months.
[SD&TRD 3.2.1.2.B.4.d][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5), .4-2-1(d)]

B.2.6.4 CONSTRAINTS

A. This test requires borehole geophysical and downhole TV logging information before testing can begin.
[SD&TRD 3.2.1.2.B.4.d][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5), .4-2-1(d)]

B. The anisotropy sites can be postponed up to one year after ramp construction, assuming that the alcoves and coreholes are not constructed. Construction of the alcoves and coreholes cause changes in the rock water content, most notably in the nonwelded units, and therefore it is very important to begin testing as soon as possible after corehole construction.

The contact test sites have a long-term monitoring component; it is, therefore, important to get these tests started as soon as possible. It is necessary to get the early baseline data before changes due to ramp construction affect the contact test sites.
[SD&TRD 3.2.1.2.B.4.d][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5), .4-2-1(d)]

C. An (Integrated Data Acquisition System) IDAS RS-232 connection to the USGS data collection PC must be present at the start of monitoring at all sites.
[SD&TRD 3.2.1.2.B.4.d][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5), .4-2-1(d)]

D. Because this test measures the undisturbed (or minimally disturbed) characteristics of the rock, it is critical that no other tests alter the rock characteristics. Tests that might change the rock permeability, water content, or temperature must be examined closely and will probably be restricted.
[SD&TRD 3.2.1.2.B.4.d][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5), .4-2-1(d)]

E. The zone of influence due to hydrologic effects is [TBD] meters.
[SD&TRD 3.2.1.2.B.4.d][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5), .4-2-1(d)]

B.2.6.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.2.B.4.d][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iii), .122(b)(8)(iv), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(5), .4-2-1(d)]

B.2.6.6 ASSUMPTIONS

A. The USGS data acquisition and test control equipment will occupy a space that is approximately 1 meter (3.3 feet) wide, 1 meter (3.3 feet) deep, and 2 meters (6.6 feet) in height, and can remain in the alcoves for long-term testing.

B. The alcove space required for drilling HQ coreholes should be sufficient for assembly and installation of packer systems.

C. Large air pressure fluctuations in the ramp and alcove could adversely influence testing.

D. Fluctuations in the compressed-air supply or pressure could adversely influence testing.

E. Air pressure fronts or water from other tests flowing into the test areas zone of influence could adversely affect testing.

B.2.7 EXCAVATION EFFECTS TEST IN THE EXPLORATORY STUDIES FACILITY (SCP 8.3.1.2.2.4.5)

B.2.7.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.2.B.4.e) is to measure permeability changes that result from stress redistribution around the underground excavations. The test is conducted in the Topopah Spring horizon to provide design information for the potential repository.

B.2.7.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform this test.

B.2.7.3 PERFORMANCE CRITERIA

A. Locations must be provided at the CH ramp takeoff from the North Ramp, and at the MTL intersection of the North-South main and East-West drift, to perform the tests. [SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

B. There must be enough space to accommodate a drilling rig used to drill several holes up to 33 meters (108.3 feet) long, house data acquisition systems and packer strings, and keep them off main traffic routes. [SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

C. The general geometry of the instrumentation holes is [TBD]. [SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

D. Approximately 26 horizontal boreholes (up to 33 meters (108.3 feet) long, 96 millimeters OR 76 millimeters (3.8 OR 3.0 inches) in diameter) that are dry-drilled will be needed. [SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

E. All instrument leads shall be protected from damage. [SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

F. Alcove dimensions must be adequate to support an overcore stress test, performed prior to initiating the excavation effects test. [SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

G. An organizational data collection area (or alcove) and an IDS connection must be provided near the instrumented face. [SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

H. Standard ESF electric power, lighting, ventilation, compressed air, and communications are adequate to perform this test.
[SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

I. Nitrogen gas and associated tubing is required to pressurize packers and test permeability.
[SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

B.2.7.4 CONSTRAINTS

A. Overcore stress testing must be conducted in the alcove prior to initiating this test.
[SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

B. The instrumentation holes must be completed before the tested opening is excavated more than 1 meter (3.3 feet) beyond the instrumentation face.
[SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

C. Testing must be conducted during excavation of tested opening. No deferral is allowed.
[SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

D. At least 30 meters (98.4 feet) of excavated opening is required to obtain sufficient data.
[SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

E. No other drilling activities will be allowed in the alcove or in the tested opening during this test.
[SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

F. All instrumentation holes are drilled using air as a drilling fluid.
[SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

G. Provision for data collection and IDS connection must be available prior to the beginning of this test.
[SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

H. Long-term permeability, temperature, and moisture are measured from the test holes. Access to the instrumentation face must be maintained.
[SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

B.2.7.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.2.B.4.e][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(5), .131(a), .131(b)(7); .133(f)]

B.2.7.6 ASSUMPTIONS

Logging, surveying, and packer installation in the holes can be accommodated within the alcove provided.

B.2.8 RESERVED

B.2.9 PERCHED-WATER TESTING IN THE EXPLORATORY STUDIES FACILITY (SCP 8.3.1.2.2.4.7)

B.2.9.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.2.B.4.g) is to detect the occurrence of, and delineate the lateral and vertical extent of, perched-water zones (if encountered) during excavation of the ESF, to identify perching mechanisms, and to sample the perched-water for chemical analyses. Because there is significant uncertainty regarding the likelihood of encountering perched-water, the perched-water test is categorized as a "contingency test." The form and duration of the testing depends upon the nature of any encountered perched water.

If perched water is encountered during excavation, one or more small-diameter borehole(s) will be drilled to enhance drainage, facilitate collection of water samples, and allow flow and/or pressure measurements to be made. The borehole(s) may be instrumented for long-term testing and monitoring to obtain data on hydraulic pressure over time. Periodic water sampling may be required from perched-water boreholes.

B.2.9.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and the operational flexibility to perform perched-water sample collection.

B.2.9.3 PERFORMANCE CRITERIA

A. 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 (1 meter by 1 meter by 0.5 meter (3.3 feet by 3.3 feet by 1.6 feet). 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.
[SD&TRD 3.2.1.2.B.4.g][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(c)(23), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

B. 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 (using air as the circulating fluid).
[SD&TRD 3.2.1.2.B.4.g][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(c)(23), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

C. 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.
[SD&TRD 3.2.1.2.B.4.g][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(c)(23), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

D. The locations of perched-water tests are 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 are controlled by the nature of the perched-water zone.
[SD&TRD 3.2.1.2.B.4.g][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(c)(23), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

E. Boreholes are drilled in the ESF to concentrate and collect perched-water samples for laboratory testing. The boreholes are instrumented to test and monitor perched-water zones. Small flow perched-water zones may only require that water samples be collected with an estimate of the flow rate and total volume of water produced.
[SD&TRD 3.2.1.2.B.4.g][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(c)(23), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

F. Standard ESF utilities are required for this test.
[SD&TRD 3.2.1.2.B.4.g][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(c)(23), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

G. 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 of the extent of the perched-water zone is made. Based on this information, decide 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.
[SD&TRD 3.2.1.2.B.4.g][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(c)(23), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

B.2.9.4 CONSTRAINTS

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 are provided for the matrix hydrologic properties test if necessary.
[SD&TRD 3.2.1.2.B.4.g][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(c)(23), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

B. No IDS requirements are foreseen at this time. Perched-water data collected on data loggers may be transmitted and stored on the IDS system.
[SD&TRD 3.2.1.2.B.4.g][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(c)(23), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

C. This test will be conducted wherever perched water is encountered in the ESF. No interference envelope is required.
[SD&TRD 3.2.1.2.B.4.g][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(c)(23), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

D. If boreholes are needed, dry drilling is required for this test. If grouting 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. [SD&TRD 3.2.1.2.B.4.g][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(c)(23), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

B.2.9.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.2.B.4.g][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(c)(23), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d)]

B.2.9.6 ASSUMPTIONS

A. The PI or his designated representative determines what methods are needed to characterize the perched water each time it is encountered.

B. The USGS will provide all sampling, testing, and monitoring equipment.

C. Criteria will be developed by the USGS to define what constitutes evidence of perched water.

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

B.2.10 HYDROCHEMISTRY TESTS IN THE EXPLORATORY STUDIES FACILITY (SCP 8.3.1.2.2.4.8)

B.2.10.1 DEFINITION OF TEST

The purpose of these tests (discussed in SD&TRD 3.2.1.2.B.4.h) is to determine the chemical composition, reactive mechanisms, and age of water and gas in pores, fractures, and perched-water zones within the unsaturated tuffs accessible from the ESF and/or affiliated coreholes. The ESF will provide access for the collection of gas, rock, and fracture-water samples.

B.2.10.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform this test.

B.2.10.3 PERFORMANCE CRITERIA

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

1. All Radial Borehole Test holes

2. Many of the Bulk Permeability Test holes

3. Many of the Major Faults Test holes

4. Additional coreholes drilled specifically for the 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, 2 additional locations in the Topopah Spring hydrogeologic unit, the zeolitic and vitric faces of Calico Hills nonwelded hydrogeologic units, and the bedded tuff of the Paintbrush hydrogeologic unit. This also may include wet areas, 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 61 millimeters (2.4 inches) in diameter (HQ), and dry drilled to a depth of about 30 meters (98.4 feet).
   [SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

B. Long-term gas sampling will occur twice per year for at least three years. [SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

C. Gas samples will be provided from short-term boreholes drilled from the drift in a minimum of two locations in each hydrogeologic unit as soon as possible after excavation. In addition, it may be necessary to provide short-term boreholes from alcoves at each of the locations listed in 1, 2, 3, and 4, above. Information obtained

from the short-term boreholes drilled from the drift helps determine the necessity for, and depth of, the alcove short-term boreholes.
[SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

D. Alcoves may be required at each gas sampling location as necessary to provide at least 1.8 meter (6 feet) by 2.4 meter (8 feet) space out of the traffic area for gas sampling equipment.
[SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

E. Standard 110V power, lighting, and communications will be adequate to conduct this test. Testing requires that compressed air (345kPa) be available to inflate the packers.
[SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

F. Samples of all traced water used at the ESF shall be provided for chemical analysis from all water system taps using procedures [TBD].
[SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

G. Access must be provided to the test location collar on a continuing periodic basis for gas sample collection.
[SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

H. A location must be provided for short-term core storage. The location should be at least 3 meters by 3 meters by 2.4 meters (10 feet by 10 feet by 8 feet), out of traffic areas, and the temperature and humidity should not fluctuate by more than 11 degrees Celsius or 20% relative humidity.
[SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

I. Presently, the precise test site locations 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.
[SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

J. During the long-term gas sampling, no other hydrologic testing should be done within about 15 meters (49.2 feet) of the sampling intervals.
[SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

B.2.10.4 CONSTRAINTS

A. Chemically trace all water used at the ESF.
[SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

B. Chemically trace all gas used for drilling or testing in the ESF.
[SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

C. Collect samples from all concrete, grout, and other liquid construction materials as required by the ESF Fluid/Material/Tracer System Plan.
[SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

D. Long-term monitoring sites can be postponed up to one-half year after excavation as long as alcoves and coreholes are not constructed.
[SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

E. Short-term boreholes must be drilled within four to five days after excavation of a drift or alcove.
[SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

B.2.10.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements

Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.2.B.4.h][10 CFR 60.113(a)(2), .122(b)(1), .122(b)(7), .122(b)(8)(i), .122(c)(7), .122(c)(9), .122(c)(20), .122(c)(24), .131(a), .131(b)(7); 10 CFR 960.4-2-1(d), .4-2-2(c)(1), .4-2-2(c)(3), .5-2-9(c)(2), .5-2-10(c)]

B.2.10.6 ASSUMPTIONS

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

B. Design, procurement, and operation of the air and water tracer systems will be conducted by the Yucca Mountain Site Characterization Project (YMP) support organizations.

C. Tracer chemical specifications are the responsibility of the test organization, but requirements from all tests, Resource Conservation and Recovery Act, and other permitting requirements must be taken into account.

D. The Universal water tracer is sodium bromide.

E. Long term gas sampling occurs over a two to four week period and is performed every six months for three years at each gas sampling location.

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

G. The short-term borehole construction and pumping will include hammer drilling, insertion of a metal sleeve and grout, one hour of prepumping, and about one day of pumping.

H. The packer system is inserted by the investigators.

I. The sampling system (packers, pumps, and sampling vessels) is transported to the sampling location, and core samples are transported to the drift portal, by YMP contract personnel.

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

K. Cores are sealed by YMP contract personnel according to procedures to be determined by the test organization.

B.2.11 RESERVED

B.2.12 HYDROLOGIC PROPERTIES OF MAJOR FAULTS ENCOUNTERED IN THE EXPLORATORY STUDIES FACILITY (SCP 8.3.1.2.2.4.10)

B.2.12.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.2.B.4.j) is to provide hydrologic information in conjunction with a portion of SD&TRD Activity 3.2.1.4.B.2.d (Geologic Mapping of the Exploratory Studies Facility). All faults encountered in the ESF will be characterized geologically under the geologic mapping activity; hydraulic properties of major faults encountered in the ESF will also be determined. The major faults or fault zones expected to be tested are:

- Bow Ridge,
- Boundary Ridge,
- Imbricate fault zone,
- Ghost Dance,
- a suspected fault in Drill Hole Wash,
- Solitario Canyon,
- the fault along Yucca Crest,
- and any major faults not previously identified, especially if fluid flow is observed.

A hydrologic testing program will be implemented based on the major faults identified by the geologic mapping activity. This program will consist primarily of tests conducted in boreholes drilled through or parallel to fault zones, and tests on core collected from the boreholes. The first activity will be the drilling and testing of a geothermal borehole; sensitive temperature measurements made in the borehole will indicate water movement in the fault zone. Air permeability tests will be conducted between other boreholes to determine the fault zone's permeability to air. Some boreholes will be instrumented to determine in situ conditions of the rock mass and monitored for any changes in these conditions over time. Other sets of boreholes will be used for cross-hole water-injection tests. All water used for injection will be tagged with a tracer. Core recovered from the boreholes will be tested to provide a water-content profile across the fault zone. This profile may provide information regarding recent moisture changes in the fault zone.

B.2.12.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operation flexibility to perform this test.

B.2.12.3 PERFORMANCE CRITERIA

A. Special L-shaped alcoves are required at each fault testing location. The maximum dimensions for an alcove shall be 15 meters (49.2 feet) by 18 meters (59 feet). The dimensions will vary depending on excavation effects.

The major faults or fault zones expected to be tested are:

- Bow Ridge,
- Boundary Ridge,
- Imbricate fault zone,
- Ghost Dance,

- a suspected fault in Drill Hole Wash,
- Solitario Canyon,
- 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 cannot be determined at this time. Each ramp or drift intersection with a major fault or fault zone will be tested. [SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

B. A geothermal borehole will be dry drilled, approximately horizontal, in 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 60 meters (197 feet) deep.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

C. 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.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

D. The planned IDS may be utilized for long-term monitoring requirements.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

E. Access to the geothermal boreholes is required for the entire duration of site characterization.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

F. 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, and they will be approximately 15 meters (49.2 feet) long.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

G. The facility design and operations shall allow access to these boreholes to replace faulty packers, repair and calibrate instrumentation, handle the nitrogen gas bottles and associated hardware for trouble-shooting, test the instrumentation, and to test the data collection and IDS equipment.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

H. Each location will require a space for organizational data collection and IDS equipment.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

I. Access to the hydrologic boreholes is required for the entire duration of site characterization.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

J. Standard ESF power, lighting, water, compressed air, ventilation, and communications are adequate to conduct these tests.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

B.2.12.4 CONSTRAINTS

A. The alcoves or hydrologic boreholes shall not be started until the PI determines that the effects of ventilation in the drift have been detected in the geothermal borehole. After this has occurred, alcove construction and borehole drilling can proceed.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

B. These boreholes will not be drilled until the PI determines that the effects of ventilation in the ESF have been detected in geothermal borehole.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

C. The IDS will be used for data acquisition and storage from the long-term monitoring operations.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

D. The interference envelope for air permeability testing is uncertain. The effects of excavation on 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. Bypassing effects of drifts near the fault-testing location may pose a serious problem. It is desirable to locate fault testing areas 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.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

E. Dry drilling will be required using a tracer gas, and boreholes will not be drilled in an alcove until preliminary mapping of the structural geologic features is complete.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

F. The zone of influence due to mechanical effects is [TBD] meters.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

G. The zone of influence due to hydrologic effects is [TBD] meters.
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

B.2.12.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.2.B.4.j][10 CFR 60.113(a)(2), .122(b)(7), .122(b)(8)(i), .122(b)(8)(iv), .122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-1(b)(3), .4-2-1(b)(5)(iv), .4-2-1(c)(3), .4-2-1(d), .5-2-9(c)(2), .5-2-9(c)(5), .5-2-10(c)]

B.2.12.6 ASSUMPTIONS

None.

B.2.13 DIFFUSION TESTS IN THE EXPLORATORY STUDIES FACILITY (SCP 8.3.1.2.2.5.1)

B.2.13.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.2.B.5.a) is to determine, in situ, the extent to which tracers diffuse into Yucca Mountain tuffs penetrated by the ESF. The diffusion tests in the ESF will be conducted in the bedded tuff between the Tiva Canyon and the Topopah Spring Member and the Topopah Spring Member and the Calico Hills unit. Tracers will be introduced into boreholes in the tuffs and permitted to diffuse. The emplacement locations will be overcored and tracer concentrations will be measured as a function of the distance from emplacement. The tracer concentration data will be used to obtain the effective diffusion coefficients of the tracers in the tuffs.

B.2.13.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform diffusion tests in the ESF.

B.2.13.3 PERFORMANCE CRITERIA

A. The following alcoves must be provided for the diffusion tests: one in the nonwelded bedded Paintbrush tuff unit below the Tiva; two in the CTA of the main test level (Topopah Spring); and four in the Calico Hills component of the ESF (two in the zeolitic units and two in the vitric units).
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

B. Alcoves must be able to accommodate the equipment required to conduct the diffusion tests (e.g., dry-drilling equipment to emplace boreholes vertically or subhorizontally, sample injection apparatus, and dry-overcoring equipment).
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

C. Dry-drilling boreholes and dry-overcoring are required for the success of the diffusion tests.
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

D. Test parameters such as temperature, humidity, atmospheric pressure and packer performance must be collected by the IDS.
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

E. Flexibility is required to find suitable locations for the diffusion tests to avoid highly fractured zones.
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

F. Two boreholes (drilled vertically or subhorizontally) are required in each alcove to perform two diffusion tests of different time duration. Each borehole will be approximately 10 centimeters (4 inches) in diameter for the upper 10 meters (33 feet) and about 4 centimeters (1.6 inches) in diameter for the bottom 45 centimeters (17.7 inches). The 4 centimeter (1.6 inches) diameter hole must be centered with respect to the 10 centimeter (4 inches) diameter hole.
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

G. Standard utilities are required for power, lighting, water, ventilation, compressed air, and communications.
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

H. Access to the alcoves is required during diffusion tests, to allow accessibility to the test locations for overcoring equipment and personnel.
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

B.2.13.4 CONSTRAINTS

A. The diffusion tests must be initiated four years prior to the completion of milestone R537, entitled "Significant Physical Processes Affecting Transport," being conducted under the Retardation Sensitivity Study (WBS 1.2.3.4.1.5.1).
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

B. The IDS must be in place before initiation of the diffusion tests.
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

C. No other activities may be conducted in the alcoves after the initiation of the diffusion tests; simulations will be utilized to specify standoff distances.
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

D. Dry-drilling of boreholes and dry-overcoring are required for the success of the diffusion tests; the introduction of substances that can interfere with the diffusion tests must be minimized during construction and drilling.
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

E. Location of diffusion tests must be surveyed and geologic mapping must be completed prior to test initiation.
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

F. The zone of influence due to chemical effects is [TBD] meters.
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

B.2.13.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.2.B.5.a][10 CFR 60.113(a)(2), .122(b)(7), .122(c)(24), .131(a), .131(b)(7)]

B.2.13.6 ASSUMPTIONS

None.

B.2.14 PETROLOGIC STRATIGRAPHY OF THE TOPOPAH SPRING MEMBER (SCP 8.3.1.3.2.1.1)

B.2.14.1 DEFINITION OF TEST

The purpose of this activity (discussed in 3.2.1.3.B.1.a) is to determine the petrologic variability within the devitrified Topopah Spring Member at Yucca Mountain, and to define the stratigraphic and lateral distribution of this variability using samples taken from locations throughout the Topopah Spring member in the ESF. Studies of the distribution of phenocryst and rock matrix textures in this member have proven useful for defining stratigraphic position. Mineralogic analysis will be conducted with X-ray diffraction. Chemical analyses will also be used to determine variability.

B.2.14.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility necessary to perform sampling for studies of petrologic Stratigraphy of the devitrified Topopah Spring Member.

B.2.14.3 PERFORMANCE CRITERIA

A. Samples will be collected from the rock exposures created by underground workings. [SD&TRD 3.2.1.3.B.1.a][10 CFR 60.122(c)(7), .122(c)(8), .122(c)(9), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

B. It may be necessary to revisit and resample mapped workings after completion of excavation and construction. [SD&TRD 3.2.1.3.B.1.a][10 CFR 60.122(c)(7), .122(c)(8), .122(c)(9), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

C. Any drilled sample will require hand-held drills only. [SD&TRD 3.2.1.3.B.1.a][10 CFR 60.122(c)(7), .122(c)(8), .122(c)(9), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

D. Oriented samples may be required. [SD&TRD 3.2.1.3.B.1.a][10 CFR 60.122(c)(7), .122(c)(8), .122(c)(9), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

E. Standard ESF power, lighting, water, ventilation, compressed air, and communications provide an adequate environment in which to conduct this test. [SD&TRD 3.2.1.3.B.1.a][10 CFR 60.122(c)(7), .122(c)(8), .122(c)(9), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

B.2.14.4 CONSTRAINTS

A. Geologic mapping should be completed prior to sample collection, or sample collection may be done concurrently with geologic mapping. [SD&TRD 3.2.1.3.B.1.a][10 CFR 60.122(c)(7), .122(c)(8), .122(c)(9), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

B. Because of the small sampling scale, this activity can proceed without impacting construction.
[SD&TRD 3.2.1.3.B.1.a][10 CFR 60.122(c)(7), .122(c)(8), .122(c)(9), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

B.2.14.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.3.B.1.a][10 CFR 60.122(c)(7), .122(c)(8), .122(c)(9), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

B.2.14.6 ASSUMPTIONS

A. Sample collection from exposures will normally be accomplished by mapping geologists during geologic mapping.

B. Mapped workings may need to be revisited and resampled.

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

B.2.15 MINERAL DISTRIBUTIONS BETWEEN HOST ROCK AND ACCESSIBLE ENVIRONMENT (SCP 8.3.1.3.2.1.2)

B.2.15.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.3.B.1.b) is to provide a three-dimensional description of the distribution and abundance of minerals along potential flow paths between a potential repository and the accessible environment. Statistical evaluation of the three-dimensional distribution models will be part of this activity, to estimate natural variability and sample density requirements. Data collected are quantitative X-ray diffraction determinations of mineral abundance, X-ray fluorescence and/or other chemical methods to determine major and trace element abundance in bulk rock, and microbeam analysis of samples. Sampling density is dependent on statistical considerations, but is also dependent on needs of other studies such as sorption (SD&TRD 3.2.1.3.D), and results of studies such as History of Mineralogic and Geochemical Alteration of Yucca Mountain (SD&TRD 3.2.1.3.B.2).

B.2.15.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility necessary to perform sampling for studies of mineral distributions between the host rock and the accessible environment.

B.2.15.3 PERFORMANCE CRITERIA

A. Samples will be collected from the rock exposures created by underground workings.
[SD&TRD 3.2.1.3.B.1.b][10 CFR 60.122(c)(8), .131(a), .131(b)(7);
10 CFR 960.4-2-2(b)(3), .4-2-2(c)(1), .4-2-2(c)(2), .5-2-9(c)(4)]

B. It may be necessary to revisit and resample mapped workings after completion of excavation and construction.
[SD&TRD 3.2.1.3.B.1.b][10 CFR 60.122(c)(8), .131(a), .131(b)(7);
10 CFR 960.4-2-2(b)(3), .4-2-2(c)(1), .4-2-2(c)(2), .5-2-9(c)(4)]

C. Any drilled sample will require hand-held drills only.
[SD&TRD 3.2.1.3.B.1.b][10 CFR 60.122(c)(8), .131(a), .131(b)(7);
10 CFR 960.4-2-2(b)(3), .4-2-2(c)(1), .4-2-2(c)(2), .5-2-9(c)(4)]

D. Oriented samples may be required.
[SD&TRD 3.2.1.3.B.1.b][10 CFR 60.122(c)(8), .131(a), .131(b)(7);
10 CFR 960.4-2-2(b)(3), .4-2-2(c)(1), .4-2-2(c)(2), .5-2-9(c)(4)]

E. Standard ESF power, lighting, water, ventilation, compressed air, and communications provide an adequate environment in which to conduct this test.
[SD&TRD 3.2.1.3.B.1.b][10 CFR 60.122(c)(8), .131(a), .131(b)(7);
10 CFR 960.4-2-2(b)(3), .4-2-2(c)(1), .4-2-2(c)(2), .5-2-9(c)(4)]

B.2.15.4 CONSTRAINTS

A. Geologic mapping should be completed prior to sample collection, or sample collection may be done concurrently with geologic mapping.
[SD&TRD 3.2.1.3.B.1.b][10 CFR 60.122(c)(8), .131(a), .131(b)(7);
10 CFR 960.4-2-2(b)(3), .4-2-2(c)(1), .4-2-2(c)(2), .5-2-9(c)(4)]

B. Because of the small sampling scale, this activity can proceed without impacting construction.
[SD&TRD 3.2.1.3.B.1.b][10 CFR 60.122(c)(8), .131(a), .131(b)(7);
10 CFR 960.4-2-2(b)(3), .4-2-2(c)(1), .4-2-2(c)(2), .5-2-9(c)(4)]

B.2.15.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.3.B.1.b][10 CFR 60.122(c)(8), .131(a), .131(b)(7);
10 CFR 960.4-2-2(b)(3), .4-2-2(c)(1), .4-2-2(c)(2), .5-2-9(c)(4)]

B.2.15.6 ASSUMPTIONS

A. Sample collection from exposures will normally be accomplished by mapping geologists during geologic mapping.

B. Mapped workings may need to be revisited and resampled.

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

B.2.16 FRACTURE MINERALOGY (SCP 8.3.1.3.2.1.3)

B.2.16.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.3.B.1.c) is to determine the mineralogic variability in fractures and faults throughout the ESF. Coatings in fractures and faults will be examined using a binocular microscope, petrographic microscope, scanning electron microscope, x-ray diffraction, and electron microprobe. Other techniques such as neutron activation analysis and cathodoluminescence may be employed. Information obtained will be used in determining mineralogy along potential transport pathways for both sorption and hydrologic calculations to assess health hazard potential of fibrous zeolites, and to establish limits on the time and condition of fracture mineral deposition.

B.2.16.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility necessary to perform this study.

B.2.16.3 PERFORMANCE CRITERIA

A. Hand samples approximately 5 by 10 to 15 centimeters (2 inches by 4 to 6 inches) and cores of up to 30 centimeters (12 inches) in length will be required along selected fractures and fault zones throughout the ESF (accesses, drifts, and available alcoves). [SD&TRD 3.2.1.3.B.1.c][10 CFR 60.122(b)(1), .122(c)(8), .122(c)(22), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(2), .4-2-4(c)(1), .5-2-9(c)(4)]

B. Oriented samples may be required. [SD&TRD 3.2.1.3.B.1.c][10 CFR 60.122(b)(1), .122(c)(8), .122(c)(22), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(2), .4-2-4(c)(1), .5-2-9(c)(4)]

C. 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. [SD&TRD 3.2.1.3.B.1.c][10 CFR 60.122(b)(1), .122(c)(8), .122(c)(22), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(2), .4-2-4(c)(1), .5-2-9(c)(4)]

D. Standard ESF power, lighting, water, ventilation, compressed air, and communications will be adequate to perform sampling. [SD&TRD 3.2.1.3.B.1.c][10 CFR 60.122(b)(1), .122(c)(8), .122(c)(22), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(2), .4-2-4(c)(1), .5-2-9(c)(4)]

B.2.16.4 CONSTRAINTS

A. Sampling will be done during or after geologic mapping. [SD&TRD 3.2.1.3.B.1.c][10 CFR 60.122(b)(1), .122(c)(8), .122(c)(22), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(2), .4-2-4(c)(1), .5-2-9(c)(4)]

B. Samples must be free of hydrochloric acid. Exposure of fracture to other materials that could be deposited on fracture surface should be minimized. [SD&TRD 3.2.1.3.B.1.c][10 CFR 60.122(b)(1), .122(c)(8), .122(c)(22), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(2), .4-2-4(c)(1), .5-2-9(c)(4)]

C. Sampling should not impact construction activities. [SD&TRD 3.2.1.3.B.1.c][10 CFR 60.122(b)(1), .122(c)(8), .122(c)(22), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(2), .4-2-4(c)(1), .5-2-9(c)(4)]

B.2.16.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.3.B.1.c][10 CFR 60.122(b)(1), .122(c)(8), .122(c)(22), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(2), .4-2-4(c)(1), .5-2-9(c)(4)]

B.2.16.6 ASSUMPTIONS

A. Sample collection from walls and roof (where required) will normally be accomplished by mapping geologists during geologic mapping of the accesses, drifts and alcoves.

B. There is an ability to revisit selected features after (possibly one to two years after) mapping and to collect samples (either hand samples or short core) tied to the survey and mapping.

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

B.2.17 HISTORY OF MINERALOGIC AND GEOCHEMICAL ALTERATION OF YUCCA MOUNTAIN (SCP 8.3.1.3.2.2.1)

B.2.17.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.3.B.2.a) is to determine the history of mineralogic and geochemical alterations of the site. This activity will include petrologic analysis of natural alteration features in the ESF wall rock. Mineralogic alteration products will be studied by petrographic microscope, scanning electron microscope, x-ray diffraction, electron microprobe, and other techniques. Ages of alteration events will be estimated by textural study, potassium-argon dating of clays and zeolites, electron spin resonance dating of quartz and calcite, or other techniques. Any alteration features encountered in the ESF wall rock may be sampled and studied as part of this activity. Natural gels (semiliquids) found in the ESF will also be sampled.

B.2.17.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility necessary to perform sampling for this test.

B.2.17.3 PERFORMANCE CRITERIA

A. Wall-rock samples will be collected by the Alteration History PI (or designee) from the north and south ramps, the Topopah Spring MTL, 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.
[SD&TRD 3.2.1.3.B.2.a][10 CFR 60.122(b)(4), .122(c)(7), .122(c)(8), .122(c)(9), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(15), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

B. Small-scale hand drilling may be required to collect samples; no other drilling will be required.
[SD&TRD 3.2.1.3.B.2.a][10 CFR 60.122(b)(4), .122(c)(7), .122(c)(8), .122(c)(9), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(15), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

C. 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.
[SD&TRD 3.2.1.3.B.2.a][10 CFR 60.122(b)(4), .122(c)(7), .122(c)(8), .122(c)(9), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(15), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

D. Standard requirements for power, lighting, water, ventilation, compressed air, and communications provide an adequate environment in which to conduct this test. [SD&TRD 3.2.1.3.B.2.a][10 CFR 60.122(b)(4), .122(c)(7), .122(c)(8), .122(c)(9), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(15), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

B.2.17.4 CONSTRAINTS

A. Sample collection for this test will generally follow the geologic mapping test. [SD&TRD 3.2.1.3.B.2.a][10 CFR 60.122(b)(4), .122(c)(7), .122(c)(8), .122(c)(9), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(15), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

B. There are no standoff requirements expected 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. [SD&TRD 3.2.1.3.B.2.a][10 CFR 60.122(b)(4), .122(c)(7), .122(c)(8), .122(c)(9), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(15), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

C. Procedures for sample collection and control will be developed by the PI in consultation with the constructor and the geologic-mapping activity personnel. [SD&TRD 3.2.1.3.B.2.a][10 CFR 60.122(b)(4), .122(c)(7), .122(c)(8), .122(c)(9), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(15), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

D. The gel-collection part of this test requires integration with the perched-water test and the geologic-mapping test. [SD&TRD 3.2.1.3.B.2.a][10 CFR 60.122(b)(4), .122(c)(7), .122(c)(8), .122(c)(9), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(15), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

E. Sampling should not be done in locations where chemicals have already been deliberately or accidentally applied to rock surfaces during other tests. [SD&TRD 3.2.1.3.B.2.a][10 CFR 60.122(b)(4), .122(c)(7), .122(c)(8), .122(c)(9), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(15), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

F. Samples will generally be 1 kilogram (2.2 lbs) to 5 kilograms (11 lbs) and will be separated from the excavation walls by hammer and chisel if possible. [SD&TRD 3.2.1.3.B.2.a][10 CFR 60.122(b)(4), .122(c)(7), .122(c)(8), .122(c)(9), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(15), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

B.2.17.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements

Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.3.B.2.a][10 CFR 60.122(b)(4), .122(c)(7), .122(c)(8), .122(c)(9), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(15), .131(a), .131(b)(7); 10 CFR 960.4-2-2(c)(1), .4-2-2(c)(2), .4-2-2(c)(3)]

B.2.17.6 ASSUMPTIONS

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

B. 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.

C. Geologic mapping test will establish a sample location coordinate system for use by Alteration History test.

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

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

F. 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.

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

H. 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.

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

B.2.18 BIOLOGICAL SORPTION AND TRANSPORT (SCP 8.3.1.3.4.2)

B.2.18.1 DEFINITION OF TEST

This activity (discussed in SD&TRD 3.2.1.3.D.2) involves determining the effects of microorganisms on the transport (either positive or negative) of radionuclides to the accessible environment. This study will determine the numbers, types, and metabolic activities of microorganisms present in Yucca Mountain. Samples from various locations throughout the ESF will be collected, packaged, and labelled for laboratory analysis.

B.2.18.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the biological sorption and transport test.

B.2.18.3 PERFORMANCE CRITERIA

A. Must have the ability to collect a minimum of 1 kilogram (2.2 lbs) of pristine sample aseptically.
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

B. 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.
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

C. Must have the ability to collect samples throughout the facility within all units and at contacts.
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

D. If coring is required to collect samples, coring must be conducted dry.
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

E. 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.
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

F. Standard ESF power, lighting, water, compressed air, communication, and ventilation provide an adequate environment in which to conduct the test.
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

G. 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.
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

H. Long-term accessibility will be required.
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

B.2.18.4 CONSTRAINTS

A. Sampling from documented locations follows completion of geologic mapping.
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

B. Sampling can be conducted during facility construction (when mapping follows the TBM) without impacting construction activities.
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

C. No water is used in the immediate vicinity of sampling locations.
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

D. Any drilling to obtain samples will be done dry.
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

E. All samples will be taken either by the PI or by a personnel trained by the PI.
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

F. No IDS interface is required.
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

B.2.18.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.3.D.2][10 CFR 60.122(b)(3), .131(a), .131(b)(7)]

B.2.18.6 ASSUMPTIONS

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

B.2.19 FIELD-SCALE EXPERIMENTS TO STUDY RADIONUCLIDE TRANSPORT AT YUCCA MOUNTAIN (SCP 8.3.1.3.7.2.2)

B.2.19.1 DEFINITION OF TEST

The purpose of this study (discussed in SD&TRD 3.2.1.3.G.2.b) is to provide data to validate laboratory estimated parameters and models for radionuclide transport calculations at Yucca Mountain. The tests will be conducted in the Calico Hills unit, where dual breakout rooms will be required for these tests. Sampling instruments and equipment used to apply water and tracers to the test block will be located in the upper room. Access to this room needs to be maintained to service equipment and make measurements. The lower alcove will provide information on the nature of the water and tracer breakthrough relative to the total area of the alcove, and serve as a sump to collect water for removal from the ESF. During room excavation, samples will be collected from the alcove area for laboratory characterization of hydrologic and chemical properties.

B.2.19.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the field scale experiments to study radionuclide transport in the ESF.

B.2.19.3 PERFORMANCE CRITERIA

A. A total of eight sites will be selected for tests. Two tests will be conducted in each of the following geologic units: Calico Hills zeolitic units, Calico Hills vitric units, vitric/zeolitic interfaces in Calico Hills, and Topopah Spring/Calico Hills contact.

1. Each test location will have the following configuration. There will be two alcoves designated upper and lower and separated by the test block. The upper alcove will be constructed off the ESF drift at a location designated by the principal investigator.

2. Preliminary dimensions for the plan view of the upper alcove are 10 meter by 10 meter (33 feet by 33 feet); these dimensions are based on the experimental plan.

3. The height for the upper alcove must be as small as possible for environmental control but should be sufficient to allow use of drilling equipment.

4. Access to the upper alcove should be as small as possible to allow for a controlled environment, but sufficient access must be maintained for drilling equipment.

5. The lower alcove will be approximately 10 meters (33 feet) beneath the upper alcove. The plan view dimensions of the lower alcove will be the same as the dimensions used for the upper alcove.

6. The lower alcove will be constructed after the upper alcove. Possible construction timing for the lower alcove is one to ten years after the test at that location has been initiated.

7. The lower alcove will not have a controlled environment. Access to the lower alcove should permit equipment required to support the roof of the lower alcove and that may be needed to mine the test block between the upper and lower alcoves.

8. All drilling will be conducted and all sampling equipment, water and tracer distribution system, and instrumentation will be placed in the upper alcove.
[SD&TRD 3.2.1.3.G.2.b][10 CFR 60.131(a), .131(b)(7)]

B. All drilling will be vertically downward through the floor of the upper alcove; dry drilling is required. The approximate borehole diameter is 5 to 7.5 centimeters (2 to 3 inches) (all holes must be cored).
[SD&TRD 3.2.1.3.G.2.b][10 CFR 60.131(a), .131(b)(7)]

C. An IDS interface is required and should be located so as to minimize access to the upper alcove during its servicing.
[SD&TRD 3.2.1.3.G.2.b][10 CFR 60.131(a), .131(b)(7)]

D. The upper alcove for those tests conducted at the contacts between the Topopah Spring/Calico Hills units and the vitric/zeolitic Calico Hills units is to be located 5 meters (16.4 feet) above the contact, and the lower alcove will be located below the contact. There are no flexibility requirements for those tests located in the vitric and zeolitic Calico Hills units.
[SD&TRD 3.2.1.3.G.2.b][10 CFR 60.131(a), .131(b)(7)]

E. Standard ESF utilities for power, lighting, water, compressed air and communications provide an adequate environment in which to conduct the test.
[SD&TRD 3.2.1.3.G.2.b][10 CFR 60.131(a), .131(b)(7)]

F. Once tests are initiated, continuous access to the upper alcove must be assured. If lower alcove is deferred, access to the lower alcove must be provided during construction.
[SD&TRD 3.2.1.3.G.2.b][10 CFR 60.131(a), .131(b)(7)]

B.2.19.4 CONSTRAINTS

A. Samples will be collected from the upper alcove for hydrologic and chemical characterization. Geologic mapping of the floor of the upper alcove is required.
[SD&TRD 3.2.1.3.G.2.b][10 CFR 60.131(a), .131(b)(7)]

B. Each test is expected to last from one to ten years, and because they support the resolution of Issue 1.1, they should be initiated whenever construction permits.
[SD&TRD 3.2.1.3.G.2.b][10 CFR 60.131(a), .131(b)(7)]

C. The IDS and IDS interface must be available prior to test initiation.
[SD&TRD 3.2.1.3.G.2.b][10 CFR 60.131(a), .131(b)(7)]

D. These tests will introduce water; therefore, locations should be off the potential repository block.

1. Alcoves should be located a sufficient distance away from ramps/shafts to avoid excavation effects on the test block.

2. A distance of 10 meters (33 feet) is proposed (this estimate will be refined by calculations and this requirement updated) as a preliminary standoff for locating other tests in relation to this test.

3. Once the test has been initiated no other activities will be permitted in the upper alcove.

4. There are no additional requirements for the lower alcove.
[SD&TRD 3.2.1.3.G.2.b][10 CFR 60.131(a), .131(b)(7)]

E. All drilling and excavation should be conducted dry.

1. Efforts are needed to minimize the introduction of fluids and materials during construction.

2. Rock bolts will not be used for roof support of the lower alcove.
[SD&TRD 3.2.1.3.G.2.b][10 CFR 60.131(a), .131(b)(7)]

F. The zone of influence due to mechanical effects is [TBD] meters.
[SD&TRD 3.2.1.3.G.2.b][10 CFR 60.131(a), .131(b)(7)]

G. The zone of influence due to hydrologic effects is [TBD] meters.
[SD&TRD 3.2.1.3.G.2.b][10 CFR 60.131(a), .131(b)(7)]

B.2.19.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.3.G.2.b][10 CFR 60.131(a), .131(b)(7)]

B.2.19.6 ASSUMPTIONS

There will be no organizational computer, the IDS will provide primary data collection.

B.2.20 UNDERGROUND GEOLOGIC MAPPING (SCP 8.3.1.4.2.2.4)

B.2.20.1 DEFINITION OF TEST

The objectives of this test (discussed in SD&TRD 3.2.1.4.B.2.d) are to document (using mapping and photogrammetry) lithologic and fracture variability to the vertical and horizontal extent of the underground excavations, to investigate structural features, and to provide siting data to confirm (or modify) planned test locations within the underground excavations. Geologists will take stereo photographs of exposed rock surfaces of all openings in the ESF. These photographs will be analyzed off site using a computer-driven analytical plotter. Detail line surveys will be performed continuously along one wall of each drift or ramp (or at 2 meter (6.6 feet) intervals if in a shaft).

B.2.20.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform this test.

B.2.20.3 PERFORMANCE CRITERIA

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 meters (246 feet) 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.

   1. 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.

   2. 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 a platform designed for mapping (machine excavation). In both cases, the walls must be mapped prior to any wire mesh, shotcrete, or permanent utilities are installed.
   [SD&TRD 3.2.1.4.B.2.d][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(22); 10 CFR 960.4-2-1(b)(3), .4-2-1(c)(1), .4-2-1(c)(3), .4-2-3(b)(1), .4-2-3(c)(1), .5-2-9(a)(1), .5-2-9(b)(1), .5-2-9(c)(1), .5-2-9(c)(2), .5-2-9(c)(5)]

B. Survey accuracy for the underground geologic mapping test shall be ±1 centimeter (±0.3937 inch) for the benchmarks. The ability should be retained to resurvey and upgrade the initial mapping survey and reference points.
[SD&TRD 3.2.1.4.B.2.d][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(22); 10 CFR 960.4-2-1(b)(3), .4-2-1(c)(1), .4-2-1(c)(3), .4-2-3(b)(1), .4-2-3(c)(1), .5-2-9(a)(1), .5-2-9(b)(1), .5-2-9(c)(1), .5-2-9(c)(2), .5-2-9(c)(5)]

C. A securable, underground space of about 5 meters (16.4 feet) by 6 meters (19.7 feet) with a height at least 2.5 meters (8.2 feet), is required for storage of mapping equipment. If the north and south ramps are developed separately, a storage room is required in each one.
[SD&TRD 3.2.1.4.B.2.d][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(22); 10 CFR 960.4-2-1(b)(3), .4-2-1(c)(1), .4-2-1(c)(3), .4-2-3(b)(1), .4-2-3(c)(1), .5-2-9(a)(1), .5-2-9(b)(1), .5-2-9(c)(1), .5-2-9(c)(2), .5-2-9(c)(5)]

D. A geological storage and staging trailer or building of at least 18 square meters (200 square feet) of 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.
[SD&TRD 3.2.1.4.B.2.d][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(22); 10 CFR 960.4-2-1(b)(3), .4-2-1(c)(1), .4-2-1(c)(3), .4-2-3(b)(1), .4-2-3(c)(1), .5-2-9(a)(1), .5-2-9(b)(1), .5-2-9(c)(1), .5-2-9(c)(2), .5-2-9(c)(5)]

E. If the optional shaft is required, the shaft sinking galloway must be provided with equipment to ensure a stable platform for photography. In drifts other than those excavated by a full-face TBM, a collapsible platform must be provided to allow geologists access to all surfaces of the excavations.
[SD&TRD 3.2.1.4.B.2.d][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(22); 10 CFR 960.4-2-1(b)(3), .4-2-1(c)(1), .4-2-1(c)(3), .4-2-3(b)(1), .4-2-3(c)(1), .5-2-9(a)(1), .5-2-9(b)(1), .5-2-9(c)(1), .5-2-9(c)(2), .5-2-9(c)(5)]

F. The construction contractor will clean the walls using compressed air/water following procedures developed during prototype testing.
[SD&TRD 3.2.1.4.B.2.d][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(22); 10 CFR 960.4-2-1(b)(3), .4-2-1(c)(1), .4-2-1(c)(3), .4-2-3(b)(1), .4-2-3(c)(1), .5-2-9(a)(1), .5-2-9(b)(1), .5-2-9(c)(1), .5-2-9(c)(2), .5-2-9(c)(5)]

G. A light-tight photography laboratory (in a trailer or building) approximately 2.5 meters by 4 meters (8-feet by 13-feet), with a minimum of 9.3 square meters (100 square feet) 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; a sink with hot and cold running water; two 110V, 20A circuits; and one 220V, 30A circuit.
[SD&TRD 3.2.1.4.B.2.d][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(22); 10 CFR 960.4-2-1(b)(3), .4-2-1(c)(1), .4-2-1(c)(3), .4-2-3(b)(1), .4-2-3(c)(1), .5-2-9(a)(1), .5-2-9(b)(1), .5-2-9(c)(1), .5-2-9(c)(2), .5-2-9(c)(5)]

B.2.20.4 CONSTRAINTS

A. In TBM drifts and ramps, a distance of at least 75 meters (246 feet) 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.
[SD&TRD 3.2.1.4.B.2.d][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(22); 10 CFR 960.4-2-1(b)(3), .4-2-1(c)(1), .4-2-1(c)(3), .4-2-3(b)(1), .4-2-3(c)(1), .5-2-9(a)(1), .5-2-9(b)(1), .5-2-9(c)(1), .5-2-9(c)(2), .5-2-9(c)(5)]

B. In roadheader/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 progress.
[SD&TRD 3.2.1.4.B.2.d][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(22); 10 CFR 960.4-2-1(b)(3), .4-2-1(c)(1), .4-2-1(c)(3), .4-2-3(b)(1), .4-2-3(c)(1), .5-2-9(a)(1), .5-2-9(b)(1), .5-2-9(c)(1), .5-2-9(c)(2), .5-2-9(c)(5)]

C. Ground support in the form of rock bolts and anchors may be installed as near the working face as necessary without impairing mapping. The installation of chain-link fabric, wire mesh, or the application of shotcrete may not take place until mapping is completed.
[SD&TRD 3.2.1.4.B.2.d][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(22); 10 CFR 960.4-2-1(b)(3), .4-2-1(c)(1), .4-2-1(c)(3), .4-2-3(b)(1), .4-2-3(c)(1), .5-2-9(a)(1), .5-2-9(b)(1), .5-2-9(c)(1), .5-2-9(c)(2), .5-2-9(c)(5)]

D. 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.

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

2. During drift wall mapping, all unnecessary equipment will be removed from that section of the drift being mapped.
[SD&TRD 3.2.1.4.B.2.d][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(22); 10 CFR 960.4-2-1(b)(3), .4-2-1(c)(1), .4-2-1(c)(3), .4-2-3(b)(1), .4-2-3(c)(1), .5-2-9(a)(1), .5-2-9(b)(1), .5-2-9(c)(1), .5-2-9(c)(2), .5-2-9(c)(5)]

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 depend on the excavation method (machine vs. drill-blast).
[SD&TRD 3.2.1.4.B.2.d][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(22); 10 CFR 960.4-2-1(b)(3), .4-2-1(c)(1), .4-2-1(c)(3), .4-2-3(b)(1), .4-2-3(c)(1), .5-2-9(a)(1), .5-2-9(b)(1), .5-2-9(c)(1), .5-2-9(c)(2), .5-2-9(c)(5)]

B.2.20.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System

If required, the shaft sinking equipment must accommodate the shaft mapping equipment. [SD&TRD 3.2.1.4.B.2.d][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14), .122(c)(22); 10 CFR 960.4-2-1(b)(3), .4-2-1(c)(1), .4-2-1(c)(3), .4-2-3(b)(1), .4-2-3(c)(1), .5-2-9(a)(1), .5-2-9(b)(1), .5-2-9(c)(1), .5-2-9(c)(2), .5-2-9(c)(5)]

B.2.20.6 ASSUMPTIONS

A. 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.

B. 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.

C. Shaft and drift mapping will be sequenced with construction to minimize interference with construction progress. In the TBM ramps, where advance rates may approach 75 meters (246 feet) per day, it is expected that mapping may require 2 shifts on a daily basis to keep up with excavation. This arrangement will require mapping and mining concurrently.

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

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

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

B.2.21 SEISMIC TOMOGRAPHY/VERTICAL SEISMIC PROFILING AT THE EXPLORATORY STUDIES FACILITY (SCP 8.3.1.4.2.2.5)

B.2.21.1 DEFINITION OF TEST

One purpose of these tests (discussed in SD&TRD 3.2.1.4.B.2.e) is to apply seismic imaging methods (cross hole, cross drift, cross ramp, surface to subsurface, and Vertical Seismic Profiling (VSP)) to provide a means for detecting and characterizing the subsurface fault and fracture patterns, lithologic features, and zones of perched water in regions between and ahead of tunnels, drifts, ramps, boreholes, and between the surface and subsurface workings. Another purpose is to characterize and quantify the damage associated with tunneling activities as a function of space and time through high-resolution seismic imaging. Thirdly, passive seismic monitoring will be used to provide data to predict ground motion and its effects on repository integrity from near-seismic events that may cause severe ground motion.

The results of this work will be used to calibrate and relate the seismic characteristics of the host rock to the fracture patterns and lithology observed directly in the underground workings; and to select and define structural, lithologic, and fracture domains with similar properties within the ESF for future application over the entire potential repository. Successful seismic results will provide constraints for the 3-D rock properties models of the potential repository volume at a variety of scales. This work will also provide baseline measurements for performance confirmation and postclosure studies. The tests will be performed in a staged manner to assess their applicability and functionality for the stated purpose.

B.2.21.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform this test.

B.2.21.3 PERFORMANCE CRITERIA

A. There are no alcoves or dedicated rooms required for these tests. The work will be performed in and from the presently available underground workings on a non-interference basis with the other work. The exception will be space required for the strong motion monitors. These can be located in any out of the way area near the designated zone of monitoring. Approximately 1 cubic meter (35.3 cubic feet) of space will be necessary for each strong motion instrument (a maximum of ten are envisioned for the entire ESF).
[SD&TRD 3.2.1.4.B.2.e][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(8), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14); 10 CFR 960.4-2-1(c)(3), .5-2-9(a)(1), .5-2-9(c)(5)]

B. Two shallow, parallel, 85 millimeter (3.3 inches) to 90 millimeter (3.5 inches) diameter drill holes (5 meters (16.4 feet) deep, 2 meters (6.6 feet) apart) with a three degree dip will be required for the damage zone. These can be either air or water drilled (water is the preferred method, but air drilling is acceptable). Ideally, boreholes will be filled with fluid during the survey, but dry boreholes can also be used. Other drill holes may be necessary in zones of loose rock to emplace a sensor, but these can be hand drilled using a hand-held drill. Open boreholes drilled for other

tests can also be used for this activity, dedicated boreholes are not necessary. For the larger scale borehole to borehole, or drift to borehole work, any horizontal or near horizontal borehole can be used as long as it is at least 85 millimeters (3.3 inches) in diameter. It may be necessary to drill horizontal holes to map fracture or fault zones of interest identified by the cross drift, the surface to drift seismic or VSP surveys. [SD&TRD 3.2.1.4.B.2.e][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(8), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14); 10 CFR 960.4-2-1(c)(3), .5-2-9(a)(1), .5-2-9(c)(5)]

C. The investigator's office responsible for this test will supply all data collection equipment for this work. All equipment is temporary and will not need IDS. The exception is that the strong motion recorders will be connected to IDS. [SD&TRD 3.2.1.4.B.2.e][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(8), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14); 10 CFR 960.4-2-1(c)(3), .5-2-9(a)(1), .5-2-9(c)(5)]

D. Seismic imaging tests will be used at several different scales, meter size, 10's of meters, and 100's of meters. The meter size tests will be used to infer the damage zone associated with the tunneling and mining activities. These tests will be performed at various locations along the ramps where perched-water zones, significant fracturing, and lithologic changes are encountered; therefore they will not be at equal spacing. The number and location of tests will be dictated to a large degree by the geology and structure encountered in the subsurface workings.

   Other tests will be run between relatively larger spaced boreholes (and tunnel to borehole, tunnel to tunnel, surface to tunnel, etc.) than for the damage zone studies. The spacing of the boreholes will depend upon the feature being mapped, but typical spacing will most likely be 50 (164 feet) meters to 100 meters (328 feet) apart. The 100's of meter scale tests will be carried out between the drifts to map the location and characteristics of the features in and around the emplacement drifts that may affect potential repository integrity and groundwater travel time from the surface all the way to the Calico Hills workings.
   [SD&TRD 3.2.1.4.B.2.e][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(8), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14); 10 CFR 960.4-2-1(c)(3), .5-2-9(a)(1), .5-2-9(c)(5)]

E. The general test configuration will place a seismic source in one location and recording the seismic energy from this source at another location. This may be in a borehole to borehole, mine working to borehole, surface to borehole, surface to mine working, or mine working to mine working, or any combination thereof. [SD&TRD 3.2.1.4.B.2.e][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(8), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14); 10 CFR 960.4-2-1(c)(3), .5-2-9(a)(1), .5-2-9(c)(5)]

F. No special utility requirements beyond the already planned power, air, and water services will be needed for this test.
   [SD&TRD 3.2.1.4.B.2.e][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(8), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14); 10 CFR 960.4-2-1(c)(3), .5-2-9(a)(1), .5-2-9(c)(5)]

G. Access will be needed in the drifts and tunnels to emplace the instrumentation, but once in place access is not needed to the sensors. The source will be moving every few minutes (or less) in boreholes or the tunnels. In all of the subsurface activities (all activities are considered primarily subsurface except VSP and the surface to tunnel imaging) space is required along the tunnel walls to attach a seismic sensor (0.5 square meter (5.4 square feet)) at the above specified scales, and room enough for the associated cabling running to a portable central recording system. This system can be located in a small alcove on a table top of a few square meters. The seismic source will be moved along the tunnels and ramps and only access to the tunnel floor or wall is necessary at 5 or 10 meter (16.4 or 33 feet) intervals. Only the strong motion recording devices are permanent, all other equipment will be removed after each survey. Approximately 1 cubic meter (35.3 cubic feet) of space is needed for each strong motion accelerometer and associated electronics. Once installed, access is required only to replace faulty equipment.
[SD&TRD 3.2.1.4.B.2.e][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(8), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14); 10 CFR 960.4-2-1(c)(3), .5-2-9(a)(1), .5-2-9(c)(5)]

B.2.21.4 CONSTRAINTS

A. The sequence of the tests will largely depend upon the sequence of the tunneling activities, but the overall sequence is to carry out the VSP work before tunneling begins to map large scale features, obtain data for designing future seismic tests, and to provide input relating to variations in the general rock properties at Yucca Mountain for the site scale modeling activities.

The next tests will be the damage zone studies which will be carried out as soon as there is access to the tunnel walls. These tests will be repeated periodically to examine damage zone growth as a function of time. The cross hole, surface to ramp, ramp to ramp, etc., class of studies will be carried out as boreholes become available and as the need to map critical features away from the workings are encountered as the excavation activities proceed. The schedule will also be driven by the success of the technique and its ability to provide input to the 3-D rock characteristics models.
[SD&TRD 3.2.1.4.B.2.e][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(8), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14); 10 CFR 960.4-2-1(c)(3), .5-2-9(a)(1), .5-2-9(c)(5)]

B. The only permanent cable will be a twisted pair from each strong motion device to the surface recording (it is assumed IDS will provide this capability). The strong motion devices will only record data when a strong earthquake or underground nuclear explosion occurs. No other IDS requirements are identified.
[SD&TRD 3.2.1.4.B.2.e][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(8), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14); 10 CFR 960.4-2-1(c)(3), .5-2-9(a)(1), .5-2-9(c)(5)]

C. These tests are not anticipated to interfere with other activities. The drill holes used for this work should be in competent rock.
[SD&TRD 3.2.1.4.B.2.e][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(8), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14); 10 CFR 960.4-2-1(c)(3), .5-2-9(a)(1), .5-2-9(c)(5)]

D. The only significant constraint is that the best seismic data are collected in conditions where there is small vibration noise. In most cases this will not be a problem because the frequency band of interest will not be in the cultural noise band. However, in the cases where this is not true, the work can be scheduled during quiet times at night, off shift, or during down time for other experiments when mining activities are low. The survey setup can be done at any time.
[SD&TRD 3.2.1.4.B.2.e][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(8), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14); 10 CFR 960.4-2-1(c)(3), .5-2-9(a)(1), .5-2-9(c)(5)]

B.2.21.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.4.B.2.e][10 CFR 60.113(a)(2), .122(c)(4), .122(c)(5), .122(c)(8), .122(c)(11), .122(c)(12), .122(c)(13), .122(c)(14); 10 CFR 960.4-2-1(c)(3), .5-2-9(a)(1), .5-2-9(c)(5)]

B.2.21.6 ASSUMPTIONS

A. Geophones, analog cables, connections, energy source, and recording and storing equipment will be furnished by the office of the scientist in charge.

B. It is anticipated that the geophone installation for each of the tests will require 2 shifts (probably 2 days).

C. Each measurement will take approximately 30 seconds after the source, receivers, and recorder are in place. Depending upon signal-to-noise ratio, there could be as many as 50 measurements taken in succession at each source site.

D. Once the geophones are installed in a tunnel or drift, it is anticipated that a 5- to 10-hour time period will be required to collect data.

E. Storage space will not be required at the ESF. The minimal office and storage space needed for these tests will be provided by the Underground Geologic Mapping Group.

F. Geophones will be clamped into the holes during the periods of seismic measurement. In the drifts, geophones will be attached to the walls directly by clamping to plates installed at 5 meter (16.4 feet) intervals (±0.3 meter (±0.9 feet)).

G. Geophones will be secured (without grout) by the seismic-test team in such a way that signals from each phone can be transmitted separately to the recording equipment over an instrumentation link via an analog cable. The analog cable will be installed after completion of geophone installation. The instrumentation cable will connect all geophones so that the signals from all phones can be recorded simultaneously. This cable is connected to the geophone cables via "takeouts."

H. At the completion of data collection from each test, all geophones and portable recording equipment will be removed.

I. The IDS will not be used in these tests. The seismic data will be recorded on an industry standard (SEFY or SEGB) recording device.

J. Water is not required for these tests, but a small amount of traced water used in each hole will aid in tamping material to secure the geophone.

K. Compressed air may be required to blow out the holes prior to the installation of geophones.

L. The in-tunnel cable will be "Seiscord" brand or equivalent. This cord has 128 pairs of wire in a cable 21.5 millimeters (0.845 inch) diameter and a weight of 357#/MFT.

M. Where geophones attach to the in-tunnel cable, the diameter of the junction will expand the cable diameter to about 50.8 millimeters (2 inches) for a length of about 0.61 meters (2 feet). If the cable is placed in a conduit, access for junctions must be provided at each measurement station.

N. This test is a short duration test, and the PI suggests that the cable may be better accessed if it is not placed in a conduit. The cable can be removed after the test is complete (reference assumption H., above).

B.2.22 LABORATORY TESTS (THERMAL & MECHANICAL) USING SAMPLES OBTAINED FROM THE EXPLORATORY STUDIES FACILITY (SCP 8.3.1.15.1)

B.2.22.1 DEFINITION OF TEST

The laboratory geoengineering properties test (discussed in SD&TRD 3.2.1.15.A) will provide bulk, thermal, and mechanical properties data for evaluations of opening stability and related design and performance studies and/or modeling. Data from the laboratory test will also support analyses of the geomechanical and thermomechanical field tests planned in the ESF. For this test, the ESF activities consist of the collection, packaging, and labeling of the selected bulk samples or core taken from the ramps, drifts, or shafts. The laboratory test activities are described individually in SD&TRD 3.2.1.15.A.

B.2.22.2 FUNCTIONAL REQUIREMENTS

Provide the operational flexibility to perform sample collection.

B.2.22.3 PERFORMANCE CRITERIA

A. No special room or alcove is required. These tests entail sampling (throughout the ESF) in each of the thermomechanical units encountered, with an emphasis in the TSw2.
[SD&TRD 3.2.1.15.A][10 CFR 60.131(a), .131(b)(7); 10 CFR 960.4-2-3(b)(2)]

B. No IDS data collection requirement has been identified.
[SD&TRD 3.2.1.15.A][10 CFR 60.131(a), .131(b)(7); 10 CFR 960.4-2-3(b)(2)]

C. No flexibility requirements for test location or orientation have been identified.
[SD&TRD 3.2.1.15.A][10 CFR 60.131(a), .131(b)(7); 10 CFR 960.4-2-3(b)(2)]

D. Standard underground facilities for water, air, and electricity for drilling will be used for this test. The capability should exist to extract cores of various sizes (up to 381 millimeters (15 inches) in diameter), collect samples, and to transport them to the surface for shipment to laboratories.
[SD&TRD 3.2.1.15.A][10 CFR 60.131(a), .131(b)(7); 10 CFR 960.4-2-3(b)(2)]

E. Access to locations throughout the ESF will be required to take samples.
[SD&TRD 3.2.1.15.A][10 CFR 60.131(a), .131(b)(7); 10 CFR 960.4-2-3(b)(2)]

B.2.22.4 CONSTRAINTS

A. This test can be scheduled independently of the other tests.
[SD&TRD 3.2.1.15.A][10 CFR 60.131(a), .131(b)(7); 10 CFR 960.4-2-3(b)(2)]

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 will preferably coincide with scheduled TBM shutdown. Slowdown

of excavation progress will be avoided. Impact on construction progress (far behind face) will be limited to minor interference with support forces (maintenance crews, ramp transportation vehicles, priority testing support, etc.).
[SD&TRD 3.2.1.15.A][10 CFR 60.131(a), .131(b)(7); 10 CFR 960.4-2-3(b)(2)]

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.
[SD&TRD 3.2.1.15.A][10 CFR 60.131(a), .131(b)(7); 10 CFR 960.4-2-3(b)(2)]

D. No other constraints or controls have been identified for this test.
[SD&TRD 3.2.1.15.A][10 CFR 60.131(a), .131(b)(7); 10 CFR 960.4-2-3(b)(2)]

B.2.22.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System

Detailed interface requirements will be identified and documented through the normal change control process.
[SD&TRD 3.2.1.15.A][10 CFR 60.131(a), .131(b)(7); 10 CFR 960.4-2-3(b)(2)]

B.2.22.6 ASSUMPTIONS

Samples collected as described in the mineralogy and petrology sampling tests (Sections B.2.14 through B.2.17) will be divided at the SMF to supply samples for this testing.

B.2.23 ACCESS CONVERGENCE MEASUREMENTS (SCP 8.3.1.15.1.5.1)

B.2.23.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.15.A.5.a) is to monitor rock-mass deformation around the accesses and measure in situ stress at the stations where convergence is being measured.

Rock-mass deformation around the access will be monitored at measurement stations using multiple-point borehole extensometers (MPBXs) placed at 120-degree intervals around the opening. The MPBXs primarily consist of anchors installed at predesigned depths. Movement in the rock mass is recorded as the anchors move. Deformations will be measured across the ramp diameter and as a function of distance from the access portal at multiple locations in the access using rod extensometers. Extensometer measurements will be made along diameters in the same plane as the MPBXs at 60-degrees from the MPBX heads. Stress meters will be used at stations located near faults.

If a liner is used at the portals, the portal stations will also include hydraulic pressure cells in the liner to measure radial and hoop stress changes over time as construction continues beyond the test location.

B.2.23.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform this test.

B.2.23.3 PERFORMANCE CRITERIA

A. No special room or alcove is needed.

The tests will be located in each thermomechanical unit encountered (one in each unit), preferably more than 100 meters (328 feet) from major thermomechanical contacts and faults. Additional stations may be installed near major structural features. The tests will be performed in both ramps, to investigate the different faults encountered and to study the effect of spatial separation. Stress meters will be installed about the encountered faults. 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 to validate that the openings will remain stable throughout the testing period in that region.
[SD&TRD 3.2.1.15.A.5.a][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B. The test will require drilling holes approximately 15 meters (49.2 feet) long, of sufficient diameter to install the MPBXs, and shallow holes to install anchors for the extensometer measurements.
[SD&TRD 3.2.1.15.A.5.a][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

C. It is preferable that the tests be more than 400 meters (1312.3 feet) from major thermomechanical contacts and faults. Additional stations may be installed near major structural features. Stress meters will be installed near encountered faults.
[SD&TRD 3.2.1.15.A.5.a][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

D. Each access convergence measurement station will consist of two sets of instruments installed in adjacent planes, separated by approximately 1 meter (3.3 feet).
[SD&TRD 3.2.1.15.A.5.a][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

E. 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 uninterruptible power supply (UPS) is required for the IDS.
[SD&TRD 3.2.1.15.A.5.a][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

F. Access to the measurement stations is needed during the test period. It is necessary to maintain access to the monitoring stations over a period of years.
[SD&TRD 3.2.1.15.A.5.a][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.23.4 CONSTRAINTS

A. This test can be scheduled independently of other tests.
[SD&TRD 3.2.1.15.A.5.a][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B. The very early time access convergence occurring immediately after excavation is not measured. Instead, the long term opening stability is 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) is based on scheduled availability and will preferably coincide with scheduled TBM shutdown. Slowdown of excavation progress will be avoided. Construction impact is limited to minor interference with support forces (maintenance crews, ramp transportation vehicles, priority testing, etc.).
[SD&TRD 3.2.1.15.A.5.a][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

C. Provision for IDS data collection must exist prior to the beginning of the test.
[SD&TRD 3.2.1.15.A.5.a][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

D. The tests will sense rock mass displacements on a line approximately 15 meters (49.2 feet) from and perpendicular to the drift wall, floor, and ceiling. Other tests that affect the thermomechanical response in this region in any way should be avoided.
[SD&TRD 3.2.1.15.A.5.a][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

E. This test imposes no constraint on construction. The purpose of the test is to obtain deformation, in situ stress, and the stress change due to excavation activities. No drilling is allowed near the MPBX and the pressure cell stations. [SD&TRD 3.2.1.15.A.5.a][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

F. The zone of influence due to mechanical effects is [TBD] meters. [SD&TRD 3.2.1.15.A.5.a][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.23.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.A.5.a][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.23.6 ASSUMPTIONS

None.

B.2.24 DEMONSTRATION BREAKOUT ROOM (SCP 8.3.1.15.1.5.2)

B.2.24.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.15.A.5.b) is to demonstrate constructability and stability of underground openings in the high lithophysal zone of the Topopah Spring Member. A lower demonstration breakout room in TSw2 on the MTL is not necessary because of the experience gained in building the ESF.

B.2.24.2 FUNCTIONAL REQUIREMENT

Provide the facility design and operational flexibility to perform the Upper Demonstration Breakout Room (UDBR) test.

B.2.24.3 PERFORMANCE CRITERIA

A. The test itself includes excavating a separate room off the main access. The size and cross-section of the UDBR opening will be consistent with the maximum width planned for potential repository openings. The excavation techniques for the UDBR should be similar to the excavation techniques for potential repository openings. This test evaluates excavation techniques and rock support requirements. Rock mass response will also be measured in the UDBR excavations by using extensometers and convergence measurements.
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B. The test will be located in the high lithophysal zone of the TSw1 encountered in the North Ramp. The exact location and orientation will be determined when the test is initiated.
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

C. The test requires drilling holes 15 meters (49.2 feet) deep and of sufficient diameter to accommodate the MPBXs, and shallow holes to accommodate the anchors for the extensometer measurements.
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

D. The instrument heads (MPBX and convergence anchors) will be placed in a recess at the walls of the excavation.
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

E. Flexibility in the orientation of the room is required to ensure that desired alignment relative to local geological features, such as the prevailing joint structure, is achieved.
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

F. The layout and dimensions of the demonstration breakout room are [TBD].
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

G. Standard underground facilities for water, air, and electricity for drilling will be used for this test. A UPS is required for the IDS.
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

H. It will be necessary to access the UDBR during construction.
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.24.4 CONSTRAINTS

A. The heater experiment in TSw1 (SD&TRD 3.2.1.15.A.6.a) will take place in the UDBR. Therefore, the UDBR must be constructed before the heater experiment in TSw1 can be performed.
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B. The excavation of the UDBR should be conducted before non-TBM excavations are performed on the MTL. This test is a prototype for non-TBM excavations.
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

C. The test instruments and anchors must be installed as close to the working face as practical. It is preferable that these be installed within 1 meter (3.3 feet) of the face, and that time be allotted for these anchors to be set before excavation continues.
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

D. Provision for IDS data collection must exist prior to the beginning of the test.
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

E. The test will sense rock mass displacements on a line approximately 15 meter (49.2 feet) from and perpendicular to the drift wall, floor, and ceiling. Tests which in any way affect the thermomechanical response in this region should be avoided until baseline data are gathered.
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

F. No other excavation should be performed (while the test is in progress) within a distance of approximately 15 meters (49.2 feet) from the deepest multi-point borehole extensometer installed in the walls of the opening.
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

G. The zone of influence due to mechanical effects is [TBD] meters.
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.24.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.A.5.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.24.6 ASSUMPTIONS

A. The UDBR will be used for the heater experiment in TSw1.

B. The UDBR will be used to carry out other testing; it will therefore not be put to other facility uses (e.g., storage).

B.2.25 SEQUENTIAL DRIFT MINING (SCP 8.3.1.15.1.5.3)

B.2.25.1 DEFINITION OF TEST

The purpose of this activity (discussed in SD&TRD 3.2.1.15.A.5.c) is to measure the deformational response of a repository size opening as it is being excavated. This is accomplished by installing instruments from adjacent drifts into a rock mass and subsequently excavating the instrumented rock mass.

Instruments installed in boreholes will monitor stress change caused by excavation. Tests of bulk permeability changes will be conducted and deformation will be measured. To measure rock mass response to excavation, data will be obtained before excavation of the center parallel drift. Air and water permeability in boreholes adjacent to the new drift opening will be measured after excavation.

B.2.25.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to conduct this test.

B.2.25.3 PERFORMANCE CRITERIA

A. Two parallel drifts approximately 4.3 meters (14 feet) high, 4.9 meters (16 feet) wide and 55 meters (180.4 feet) long are required to install the instruments. Center-to-center distance between the two drifts should be 34 meters (111.5 feet). After the instruments have been installed, a central drift 55 meters (180.4 feet) long with the same cross-sectional dimensions as those expected for potential repository emplacement drifts, will be excavated using the same technique that is expected to excavate the potential repository. The test will be performed in the CTA of the Topopah Spring MTL.
[SD&TRD 3.2.1.15.A.5.c][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B. The test requires drilling holes for MPBXs, borehole deflectometers, borehole permeability measurements, borehole stressmeters, and anchors for the extensometer measurements. The longest hole will be approximately 15 meters (49.2 feet).
[SD&TRD 3.2.1.15.A.5.c][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

C. A 3 meter by 4.6 meter (10 feet by 15 feet) alcove, located off one of the instrumented drifts, should be provided for the IDS. The center pillar between the instrument drifts must not be affected by this alcove.
[SD&TRD 3.2.1.15.A.5.c][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

D. The orientation of the rooms is to be decided. Flexibility regarding drift orientation is needed so that the room orientation will match the orientation used in the potential repository. The decision on orientation will be based upon early test data.
[SD&TRD 3.2.1.15.A.5.c][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

E. The cross-sections, dimensions, and test layout are [TBD].
[SD&TRD 3.2.1.15.A.5.c][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

F. Standard underground facilities for water, air, and electricity for drilling will be used for this test. A UPS is required for the IDS.
[SD&TRD 3.2.1.15.A.5.c][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

G. Test instrumentation must be accessible during the test.
[SD&TRD 3.2.1.15.A.5.c][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.25.4 CONSTRAINTS

A. It is expected that the heated room test will also be conducted in these drifts. Therefore, early construction is required to assure that the heated room test can be started early enough to allow data collection for the License Application. It is estimated that one year will elapse between the sequential drift mining test and the beginning of the heated room test.
[SD&TRD 3.2.1.15.A.5.c][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B. This is the first major test that should be performed in the core test area of the MTL to minimize effects of rock disturbance from unrelated excavations. The test should be performed as soon as two means of egress exist. This test will take place about the time the exploratory drift is mined to the Imbricate Faults. It is anticipated that instrumentation holes in the outer drifts will be drilled behind the excavation machine as soon as practical.
[SD&TRD 3.2.1.15.A.5.c][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

C. The IDS must be available when the test begins.
[SD&TRD 3.2.1.15.A.5.c][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

D. No excavation, except of the central drift, should be allowed within 15 meters (49.2 feet) of any MPBX anchor until MPBX measurements are no longer being taken. Since MPBX anchors can be 15 meters (49.2 feet) from the central drift rib, this effectively excludes a region 30 meters (98.4 feet) from the central drift ribs. No other drifts should be mined within two drift diameters of the outside ribs of the instrumentation drifts.
[SD&TRD 3.2.1.15.A.5.c][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

E. The zone of influence due to mechanical effects is [TBD] meters.
[SD&TRD 3.2.1.15.A.5.c][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.25.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.A.5.c][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.25.6 ASSUMPTIONS

The test alcove and the test instruments installed from the adjacent drifts from the sequential drift mining experiment will also be used for the heated room test (SD&TRD 3.2.1.15.A.6.e).

B.2.26 HEATER EXPERIMENT IN TSW1 (SCP 8.3.1.15.1.6.1)

B.2.26.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.15.A.6.a) is to monitor thermomechanical and hydrothermal response in the potential repository host rock for design and performance modeling, for assessment of retrievability, and for monitoring radon emanation as a function of heating. During the tests, heat fluxes will be increased so that the temperatures near the heater will exceed design limits, to aid in determining limits on waste-emplacement borehole stability.

In the UDBR, a vertical heater hole and parallel small-diameter instrumentation holes will be drilled. A small instrumentation decline will be constructed to provide radial access to the heater. Baseline moisture data in neutron probe holes, will be recorded. A heater and instrumentation (thermocouples, multi-point borehole extensometers, borehole deformation gages, and radon monitors) will be installed. Finally, heating will be initiated in incremented steps; and thermal, thermomechanical, and hydrothermal phenomena, and radon release rates, will be monitored at increasing heat loads.

B.2.26.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to conduct this test.

B.2.26.3 PERFORMANCE CRITERIA

A. The test will be conducted in the TSw1 unit within the UDBR, away from contacts and faults.
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B. The test will require drilling a vertical hole for the heater canister and horizontal and vertical holes for test instrumentation (thermocouples, MPBXs, borehole deformation gages, neutron probes, moisture sensing gages, and radon monitoring gages). The drilled holes may be as long as 15 meters (49.2 feet), to install the MPBXs. The radon monitoring holes will have the largest diameter of the instrument holes, at this time estimated to be 160 millimeters (6.3 inches); the canister heater hole will be approximately 740 millimeters (29 inches) in diameter.
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

C. Provision for the IDS must be available prior to the test.
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

D. The instrument heads will be placed in a recess at the walls of the excavation.
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

E. A small decline, approximately 10 meters (33 feet) from the heater hole, will be required to install instruments on a radial line from the heater.
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

F. Flexibility is required to ensure that the test is located away from contacts and faults. The exact test location will be based, in part, on the results of mapping and other observations after the UDBR has been constructed.
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

G. Layout, dimensions, and configuration of test instrumentation are [TBD].
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

H. Standard underground facilities for water, air, and electricity for drilling provide a sufficient environment in which to conduct this test. A UPS is required for the heater and the IDS.
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

I. Accessibility to the test is required during its duration.
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B.2.26.4 CONSTRAINTS

A. This test can only be performed after the UDBR is constructed (SD&TRD 3.2.1.15.A.5.b).
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B. The test helps assess the viability of storing waste in, or in the vicinity of, the high lithophysal zones of the Topopah Spring Member. The test should begin 36 months before license application; except for this condition, the test can be scheduled as convenient.
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

C. Provision for IDS data collection must exist before this test can begin.
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

D. To limit the influence of drift openings on the stresses near the heater and on the temperatures produced in the rock mass, the heater should be located 10 meters (33 feet) from other drifts or alcoves. The zone of influence of this test was calculated to extend 15 meters (49.2 feet) radially and 20 meters (65.6 feet) axially from the heater. However, the above constraints and zones of influence are being re-evaluated because of Nuclear Regulatory Commission (NRC) comments related to the

duration of the test. It is expected that the zone of influence may increase substantially as a result of the new analyses.
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

E. The experiment needs to be located in a low traffic area. Water usage and spillage must be controlled within a 14 meter (46 feet) radial distance from the test centerline. These controls will be determined by performance assessment analyses of the quantity of water that can be used and not appreciably change the state of saturation in the 14 meter (46 feet) radial vicinity of the test.
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B.2.26.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.A.6.a, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B.2.26.6 ASSUMPTIONS

A. Test instruments and IDS computer linkages from the UDBR test will be available for this test.

B. Interference zones calculated for this test will change if heater output or the duration of heating for this test is changed.

B.2.27 CANISTER-SCALE HEATER EXPERIMENT (SCP 8.3.1.15.1.6.2)

B.2.27.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.15.A.6.b) is to monitor thermomechanical and hydrothermal response in the potential repository host rock for design and performance modeling, for assessment of retrievability, and for monitoring radon emanation as a function of heating. During the tests, heat fluxes will be increased so that the temperatures near the heater will exceed design limits to aid in determining limits on waste-emplacement borehole stability.

At a location within the CTA of the main test level, a vertical heater hole and parallel small-diameter instrumentation holes will be drilled. A small instrumentation decline will also be constructed to provide radial access to the heater. Baseline moisture data in neutron probe holes will be recorded. A heater and instrumentation (thermocouples, MPBXs, borehole deformation gages, and radon monitors) will be installed. Finally, heating will be initiated in incremented steps; and thermal, thermomechanical, and hydrothermal phenomena, and radon release rates, will be monitored at increasing heat loads.

B.2.27.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the canister scale heater experiment.

B.2.27.3 PERFORMANCE CRITERIA

A. The test will be conducted in the TSw2 unit in a separate room within the core test area of the MTL, away from contacts and faults.
[SD&TRD 3.2.1.15.A.6.b, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B. The test will require drilling a vertical hole for the heater canister and vertical and horizontal holes for test instrumentation (thermocouples, MPBXs, borehole deformation gages, neutron probes, moisture sensing gages, and radon monitoring gages). The drilled holes may be as long as 15 meters (49.2 feet) to install the MPBXs. The radon monitoring holes will have the largest diameter of the instrument holes, at this time estimated to be 160 millimeters (6.3 inches); the heater hole will be approximately 740 millimeters (29 inches) in diameter.
[SD&TRD 3.2.1.15.A.6.b, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

C. The instrument heads will be placed in a recess at the walls of the excavation. A small decline, approximately 10 meters (33 feet) from the heater hole, is required to install instruments on a radial line from the heater.
[SD&TRD 3.2.1.15.A.6.b, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

D. Flexibility is required to ensure that the test is located away from contacts and faults.
[SD&TRD 3.2.1.15.A.6.b, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i);
10 CFR 960.5-2-9(c)(3)]

E. Layout, dimensions, and test instrument configuration are [TBD].
[SD&TRD 3.2.1.15.A.6.b, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i);
10 CFR 960.5-2-9(c)(3)]

F. Standard underground facilities for water, air, and electricity for drilling provide sufficient environment to conduct this test. A UPS is required for the heater and the IDS.
[SD&TRD 3.2.1.15.A.6.b, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i);
10 CFR 960.5-2-9(c)(3)]

G. Accessibility to the test is required during its duration.
[SD&TRD 3.2.1.15.A.6.b, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i);
10 CFR 960.5-2-9(c)(3)]

B.2.27.4 CONSTRAINTS

A. This test can be scheduled independently of other tests.
[SD&TRD 3.2.1.15.A.6.b, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i);
10 CFR 960.5-2-9(c)(3)]

B. The test will help assess the viability of storing waste in the welded fractured tuff of the TSw2 thermomechanical unit. The test should begin 36 months before license application; except for this condition, the test can be scheduled as convenient for all involved.
[SD&TRD 3.2.1.15.A.6.b, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i);
10 CFR 960.5-2-9(c)(3)]

C. IDS support for this test must be operational and provision for IDS data collection must be available before this test can begin.
[SD&TRD 3.2.1.15.A.6.b, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i);
10 CFR 960.5-2-9(c)(3)]

D. To limit the influence of drift openings on the stresses near the heater and on the temperatures produced in the rock mass, the heater should be located 10 meters (33 feet) from other drifts or alcoves. The zone of influence of this test was calculated to extend 15 meters (49.2 feet) radially and 20 meters (65.6 feet) axially from the heater. However, the above constraints and zones of influence are being re-evaluated because of NRC comments related to the duration of the test. It is expected that the zone of influence may increase substantially as a result of the new analyses.
[SD&TRD 3.2.1.15.A.6.b, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i);
10 CFR 960.5-2-9(c)(3)]

E. The experiment needs to be located in a low traffic area because surface temperatures may reach 200 degrees C and may pose a hazard to personnel in the area. Water usage and spillage must be controlled within a 14 meters (46 feet) radial distance from the test centerline. These controls will be determined by Performance Assessment analyses of the quantity of water that can be used and not appreciably change the state of saturation in the 14 meters (46 feet) radial vicinity of the test.
[SD&TRD 3.2.1.15.A.6.b, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i);
10 CFR 960.5-2-9(c)(3)]

B.2.27.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.A.6.b, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i);
10 CFR 960.5-2-9(c)(3)]

B.2.27.6 ASSUMPTIONS

The interference zone for this test will change if the heater output or the duration of heating used for this test is changed.

B.2.28 HEATED BLOCK EXPERIMENT (SCP 8.3.1.15.1.6.3)

B.2.28.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.15.A.6.c) is to provide intermediate scale field measurements of three-dimensional deformation and temperature changes in a rock mass. Results of this test are used to validate models as well as to determine rock mass response under a variety of loading conditions.

In an alcove of the CTA of the main test level, a 2 meter by 2 meter (6.6 feet by 6.6 feet) area of rock will be defined. Reference survey pins will be established, and crosshole ultrasonic measurements will be made. Slots will be cut on each side of the block, approximately 2 meters (6.6 feet) deep, and flatjacks will be inserted. An array of heaters will be installed in holes on opposite sides of the block. Additional holes will be drilled and instrumented with thermocouples, MPBXs, and deformation gages. Cyclic thermal and mechanical tests will be conducted using the flatjacks and the heaters. The rock responses will be monitored under the induced loads.

B.2.28.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform this test.

B.2.28.3 PERFORMANCE CRITERIA

A. An experimental alcove with nominal dimensions of 9 meters by 9 meters (29.5 feet by 29.5 feet) and a height of 4.3 meters (14 feet) is required in the core test area of the MTL in TSw2.
[SD&TRD 3.2.1.15.A.6.c, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B. The test requires drilling holes for test instrumentation (MPBXs, surface extensometers, stressmeters, permeability gages, thermocouples, neutron probes) and for heaters. The largest drilled hole is estimated to be 4 meters (13 feet) long and 76 millimeters (3 inches) in diameter.
[SD&TRD 3.2.1.15.A.6.c, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

C. Flexibility in test alcove location is required to ensure that the block contains a joint spacing and orientation that is reasonably representative of the potential repository horizon.
[SD&TRD 3.2.1.15.A.6.c, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

D. Test layout, dimensions, and instrument configuration are [TBD].
[SD&TRD 3.2.1.15.A.6.c, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

E. Standard underground facilities for water, air, and electricity for drilling provide a suitable environment for this test. A UPS is required for the heaters and the IDS. [SD&TRD 3.2.1.15.A.6.c, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

F. Access to the test area is required while the test is underway. [SD&TRD 3.2.1.15.A.6.c, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B.2.28.4 CONSTRAINTS

A. This test can be scheduled independently of the other tests. [SD&TRD 3.2.1.15.A.6.c, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B. The test should be scheduled to begin 24 months before license application and 1 year before the heated room experiment begins (SD&TRD 3.2.1.15.A.6.e). Otherwise, the test can be conducted at any time after the test alcove has been constructed. [SD&TRD 3.2.1.15.A.6.c, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

C. Provision for IDS data collection must exist prior to this test. [SD&TRD 3.2.1.15.A.6.c, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

D. The test should be 10 meters (33 feet) from the nearest test which altered the thermomechanical properties of the rock. As a result of this test, a hydrologically and chemically altered region may extend as much as 11 meters (36 feet) from the line of heaters. [SD&TRD 3.2.1.15.A.6.c, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

E. The experiment should be located in a low traffic area so that dust and vibrations from other construction and testing do not interfere with sensitive displacement measurements being made as the block is loaded. [SD&TRD 3.2.1.15.A.6.c, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B.2.28.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements

Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.A.6.c, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B.2.28.6 ASSUMPTIONS

A. The test organization will provide the chain saw for slot cutting.

B. The interference zone for this test will change if the power output of the heaters or the duration of heating changes.

B.2.29 THERMAL STRESS TEST (SCP 8.3.1.15.1.6.4)

B.2.29.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.15.A.6.d) is to measure thermal stresses in a relatively large volume of jointed rock and relate the stress changes to thermomechanical displacement for numerical modeling. This test will also be used to establish criteria for rock mass failure. The test will be conducted at one or two locations on the MTL. The primary location will be in an alcove that was planned for the Lower Demonstration Breakout Room (LDBR). All other activities planned for the LDBR in the old configuration are currently planned for other locations in the MTL, eliminating the need for a separate LDBR.

B.2.29.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform this test.

B.2.29.3 PERFORMANCE CRITERIA

A. The test will be in a separate room of the CTA of the main test level. Additional space should be reserved on the MTL for a second test, if required. The cross-section of the room should be similar to that of a potential repository emplacement drift; however, the room does not need to be full-scale, and can be excavated by any method.
[SD&TRD 3.2.1.15.A.6.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.4-2-3(c)(2), .5-2-9(c)(3), .5-2-9(c)(4)]

B. Drilling is required for instrumentation holes (thermocouples, stress gages, MPBXs, extensometers) and for heater holes. The largest drilled hole is estimated to be 12 meters (39.4 feet) long and 76 millimeters (3 inches) in diameter.
[SD&TRD 3.2.1.15.A.6.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.4-2-3(c)(2), .5-2-9(c)(3), .5-2-9(c)(4)]

C. Test room location flexibility is required to ensure that the joint spacing and orientation is reasonably representative of the potential repository horizon. The test location will be selected after observing rock conditions and joint orientation.
[SD&TRD 3.2.1.15.A.6.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.4-2-3(c)(2), .5-2-9(c)(3), .5-2-9(c)(4)]

D. Test layout, dimensions, and instrumentation configuration are [TBD].
[SD&TRD 3.2.1.15.A.6.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.4-2-3(c)(2), .5-2-9(c)(3), .5-2-9(c)(4)]

E. Standard underground facilities for water, air, and electricity for drilling provide sufficient environment for these tests. A UPS is required for the heaters and the IDS.
[SD&TRD 3.2.1.15.A.6.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.4-2-3(c)(2), .5-2-9(c)(3), .5-2-9(c)(4)]

F. The test room should be accessible during testing.
[SD&TRD 3.2.1.15.A.6.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.4-2-3(c)(2), .5-2-9(c)(3), .5-2-9(c)(4)]

B.2.29.4 CONSTRAINTS

A. It will be necessary to complete this test before heating for the Heated Room Experiment (SD&TRD 3.2.1.15.A.6.e).
[SD&TRD 3.2.1.15.A.6.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.4-2-3(c)(2), .5-2-9(c)(3), .5-2-9(c)(4)]

B. The tests should be performed in a timely manner so that the results can be used in assessing the failure and stability criteria for potential repository drifts.
[SD&TRD 3.2.1.15.A.6.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.4-2-3(c)(2), .5-2-9(c)(3), .5-2-9(c)(4)]

C. Provision for IDS data collection must exist prior to this test.
[SD&TRD 3.2.1.15.A.6.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.4-2-3(c)(2), .5-2-9(c)(3), .5-2-9(c)(4)]

D. No excavation should be conducted within a two drift diameter standoff region until the test is completed. The test should be conducted in a drift that can be isolated from normal mine traffic. The zone of influence of this test was calculated to be less than the standoff region; however, the above constraints and zones of influence are being re-evaluated because of NRC comments related to the duration of the test. It is expected that the zone of influence may increase substantially as a result of the new analyses. Rock falls in the test room are likely during the test.
[SD&TRD 3.2.1.15.A.6.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.4-2-3(c)(2), .5-2-9(c)(3), .5-2-9(c)(4)]

B.2.29.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.A.6.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.4-2-3(c)(2), .5-2-9(c)(3), .5-2-9(c)(4)]

B.2.29.6 ASSUMPTIONS

The test interference zone will change if the heater output or heating duration changes.

B.2.30 HEATED ROOM EXPERIMENT (SCP 8.3.1.15.1.6.5)

B.2.30.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.15.A.6.e) is to measure thermomechanical responses in fractured welded tuff at a drift size scale. The sequential drift mining experiment (SD&TRD 3.2.1.15.A.5.c) heats the rock around the central drift to temperatures representative of those expected in the potential repository. The measurements help to acquire data for evaluating preclosure and postclosure design, and support the validation phase of empirical and numerical design methods. The two flanking drifts will be access for installation of heaters and instrumentation. Instrumentation installed for the sequential drift mining experiment will remain in use during at least part of the heated room test.

B.2.30.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform this heated room test.

B.2.30.3 PERFORMANCE CRITERIA

A. The test will be located in the drifts mined during the sequential drift mining experiment. Upon completion of the sequential drift mining experiment in the core test area of the MTL, the rock around the central drift will be heated to temperatures representative of those expected in the repository.
[SD&TRD 3.2.1.15.A.6.e, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B. Drilling will be required to install the heaters used in this experiment. Current dimensions for these holes are 160 millimeters (6.3 inches) in diameter and 11 meters (36 feet) long.
[SD&TRD 3.2.1.15.A.6.e, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

C. The IDS alcove used previously for the sequential drift mining experiment will be reused for this test.
[SD&TRD 3.2.1.15.A.6.e, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

D. The orientation of the rooms is to be decided. Flexibility regarding room orientation is needed so that the geologic conditions are representative of those expected in the potential repository. The decision on orientation will be based on early test data (taken before the sequential drift mining experiment).
[SD&TRD 3.2.1.15.A.6.e, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

E. Test layout and instrument configuration are [TBD].
[SD&TRD 3.2.1.15.A.6.e, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

F. Standard underground facilities for water, air, and electricity for drilling provide a sufficient environment for these tests. A UPS is required for the heaters and the IDS. [SD&TRD 3.2.1.15.A.6.e, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

G. Accessibility to test instrumentation is required during the test. [SD&TRD 3.2.1.15.A.6.e, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B.2.30.4 CONSTRAINTS

A. The experiment will be conducted following the sequential drift mining experiment and the thermal stress test (SD&TRD 3.2.1.15.A.6.d). [SD&TRD 3.2.1.15.A.6.e, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B. Heating will begin during the site characterization phase and will continue into the confirmation period. The test will need to begin approximately three years before license application to collect data for the application. The test should begin within a year after the sequential drift mining experiment has ended; outside of these considerations, the test can be scheduled as convenient. [SD&TRD 3.2.1.15.A.6.e, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

C. Provision for IDS data collection must be available prior to beginning the test. [SD&TRD 3.2.1.15.A.6.e, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

D. Mining, except to excavate the central room, should not be allowed within 15 meters (49.2 feet) of any MBPX anchor until MPBX measurements are no longer being taken. Since MPBX anchors can be 15 meters (49.2 feet) from the central room rib, this effectively excludes a region 30 meters (98.4 feet) from the central room ribs. Based on consideration of the zone of influence of this test, a standoff distance of 46 meters (151 feet) laterally from the centerline of the center drift and 15 meters (49.2 feet) longitudinally beyond the ends of the center drift, is needed. However, the zone of influence is being re-evaluated because of NRC comments related to the duration of this test. The zone of influence may increase substantially as a result of the new analyses. [SD&TRD 3.2.1.15.A.6.e, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

E. Because it will take approximately three years after heating begins before needed data is obtained, the test should begin early enough to obtain the data. Special doors and thermal barriers may be required to control the ventilation and heat flow from the area. No traffic will be allowed in the test drift during the experiment. [SD&TRD 3.2.1.15.A.6.e, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B.2.30.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.A.6.e, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(i); 10 CFR 960.5-2-9(c)(3)]

B.2.30.6 ASSUMPTIONS

A. The data collection space and facilities used for the sequential drift mining experiment will also be used for this test.

B. The zone of influence for this test is based on present plans for the heater power. If the heater power is increased to accelerate the heating rate, or if the duration of heating is increased, the standoff zone will need to be re-evaluated.

B.2.31 PLATE LOADING TESTS (SCP 8.3.1.15.1.7.1)

B.2.31.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.15.A.7.a.) is to load diametrically opposed surfaces of rock to measure deformation. Experimental results can be used to calculate rock mass modulus and interpret the depth of the disturbed zone. This test will follow International Society for Rock Mechanics and American Society of Testing and Materials standard testing procedures.

B.2.31.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform this test.

B.2.31.3 PERFORMANCE CRITERIA

A. The tests will be conducted in alcoves extending from the accesses or main drifts. The alcoves will be approximately 4.6 meters wide by 2 meters high by 18 meters long (15 feet by 6.6 feet by 59 feet). The actual cross-section of the alcoves depends on the location, excavation machinery available, and the test apparatus to be used. The height of the alcoves will most likely be the minimum that can be successfully excavated and will be determined by the PI and the Architecture and Engineer (A&E). Five or more tests may be performed in each alcove. The excavations should be mechanically excavated such that the surface damage created approximates the excavation damage expected in the potential repository.
[SD&TRD 3.2.1.15.A.7.a][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B. The tests will be conducted in each of the thermomechanical units encountered in the North and South Ramps. Testing will be performed in the South Ramp to test the unique thermomechanical units encountered there. Most tests should be away from geological contacts or structure; some locations proximal to faults will be acceptable. In the MTL and Calico Hills tests will be conducted at one or two locations, with at least one test on each of the two levels near a crossing with the Ghost Dance fault.
[SD&TRD 3.2.1.15.A.7.a][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

C. Instrumentation holes for the MPBXs, extensometer anchors and acoustic emission microphones require drilling. The largest holes will be for the MPBXs, which will be approximately 15 meters (49.2 feet) long and 76 millimeters (3 inches) in diameter.
[SD&TRD 3.2.1.15.A.7.a][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

D. Flexibility is required to ensure that the joint spacing and orientation of the test alcoves are reasonably representative of the potential repository horizon and that the cross-section of the test alcoves is consistent with the test apparatus that will be used.
[SD&TRD 3.2.1.15.A.7.a][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

E. The test layout, dimensions, and instrument configuration are [TBD].
[SD&TRD 3.2.1.15.A.7.a][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

F. Standard underground facilities for water, air, and electricity for drilling provide an environment sufficient for this test. A UPS is required for the IDS.
[SD&TRD 3.2.1.15.A.7.a][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

G. The test alcoves must be accessible during the test.
[SD&TRD 3.2.1.15.A.7.a][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.31.4 CONSTRAINTS

A. One test in the TSw2 unit should be completed before the sequential drift mining test (SD&TRD 3.2.1.15.A.5.c).
[SD&TRD 3.2.1.15.A.7.a][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B. The test should be performed in a timely manner because it provides input to facility design and other ESF tests. Otherwise, test alcoves can be built at any time and will be scheduled as convenient for all involved. The tests will be performed as soon as the alcoves are finished.
[SD&TRD 3.2.1.15.A.7.a][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

C. Provision for IDS data collection is required prior to beginning this test.
[SD&TRD 3.2.1.15.A.7.a][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

D. The test should be a minimum of 10 meters (33 feet) from the nearest test which altered the thermomechanical properties of the rock. Only a small region of rock (approximately 1 to 3 cubic meters (35.3 to 106 cubic feet)) will be directly loaded and the effects of the loading will likely extend a distance of only a few times the width of the area over which the load is applied. No permanent alteration to the local hydrological, chemical, or thermal conditions will result from this test.
[SD&TRD 3.2.1.15.A.7.a][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

E. Testing impedes traffic, therefore test alcoves should be provided.
[SD&TRD 3.2.1.15.A.7.a][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.31.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements

Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.A.7.a][10 CFR 60.122(c)(21), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.31.6 ASSUMPTIONS

The alcoves used in this test may also be used for the slot tests conducted in the rock mass response test (SD&TRD 3.2.1.15.A.7.b). Tests that are in shared alcoves will share access to the IDS.

B.2.32 ROCK-MASS RESPONSE TEST (SCP 8.3.1.15.1.7.2)

B.2.32.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.15.A.7.b) is to evaluate the mechanical behavior of the rock mass. Tests will obtain information on the mechanical response of multiple jointed volumes of rock. This test is composed of three different types of activities (uniaxial compression tests, ambient block tests, and slot tests) and will be conducted in several areas that represent the range of conditions encountered in the MTL of TSw2 and in the Calico Hills. The information will be used to evaluate scale effects between laboratory and in situ conditions, provide data to evaluate empirical design criteria, and to evaluate and validate jointed-rock models.

B.2.32.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to conduct this test.

B.2.32.3 PERFORMANCE CRITERIA

A. Tests will be conducted in alcoves extending from the drifts. The alcoves will be approximately 3.7 meters wide by 3.7 meters long by 2.4 meters high (12 feet by 12 feet by 8 feet). If the exposed floor is not suitable for the test, the alcoves will need to be enlarged.
[SD&TRD 3.2.1.15.A.7.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B. Tests will be performed in alcoves at 2 or 3 selected areas in the MTL and in Calico Hills. Specifically, in situ tests for strength and deformability would be conducted in the MTL if the rock mass is fractured or heterogeneous. Alcoves cannot be located until after excavation and mapping identify appropriate rock conditions. Tests will be conducted in Calico Hills to verify the stability of the accesses for long term use.
[SD&TRD 3.2.1.15.A.7.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

C. Drilling is required for test instrumentation (MPBXs and fracture deflection gages). The holes will be 38 millimeters (1.5 inches) and 76 millimeters (3 inches) in diameter and approximately 1 to 3 meters (3.3 to 10 feet) in length.
[SD&TRD 3.2.1.15.A.7.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

D. Test alcove location flexibility in the MTL and in Calico Hills is required to ensure that the test is conducted in rock with the appropriate fracture spacings and quality. Alcoves cannot be located until after exploration and mapping identify appropriate rock conditions.
[SD&TRD 3.2.1.15.A.7.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

E. Layouts, dimensions, and instrument configurations for uniaxial, ambient block, and slot tests are [TBD].
[SD&TRD 3.2.1.15.A.7.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

F. Standard underground facilities for water, air and electricity for drilling will be used for these tests.
[SD&TRD 3.2.1.15.A.7.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

G. Access to the test alcoves is required during the tests.
[SD&TRD 3.2.1.15.A.7.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.32.4 CONSTRAINTS

A. Block tests will be conducted in the same alcoves as the compressive tests. Slot tests may be conducted in the same alcove, or in other selected locations, such as the alcoves used in the plate loading tests (SD&TRD 3.2.1.15.A.7.a).
[SD&TRD 3.2.1.15.A.7.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B. No conflict exists with facility construction. Tests will be conducted in alcoves developed after drift excavation is complete.
[SD&TRD 3.2.1.15.A.7.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

C. Provision for IDS data collection must be available prior to beginning this test.
[SD&TRD 3.2.1.15.A.7.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

D. This experiment will be conducted in alcoves along any access or drift where suitable rock conditions (in regions that have not been altered by other activities) exist. The location of the tests will be determined after the drifts are excavated.

The experiment will be similar to the plate loading test in that only a small region of rock (approximately 1 to 3 cubic meters (35.3 to 105.9 cubic feet) will be directly loaded and the effects of the loading will likely extend a distance of only a few times the width of the area over which the load is applied. The local hydrological, chemical, and thermal conditions will not be permanently altered as a result of this test. No significant zone of influence will result from the rock-mass loading imposed in this activity.
[SD&TRD 3.2.1.15.A.7.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

E. Protection will be required from the high-pressure hydraulics used in this test.
[SD&TRD 3.2.1.15.A.7.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.32.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.A.7.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.32.6 ASSUMPTIONS

A. Tests that are in shared alcoves will share access to the IDS.

B. The slots required for the compressive strength, block tests, and slot tests will be cut using the hydraulic saws provided by the test organization. Construction of the test reaction frames will be done by the test organization.

B.2.33 EVALUATION OF MINING METHODS (SCP 8.3.1.15.1.8.1)

B.2.33.1 DEFINITION OF TEST

These tests (discussed in SD&TRD 3.2.1.15.A.8.a) will monitor and evaluate excavation methods for ramp and drift openings, with an emphasis on rock responses in a variety of lithologic and structural settings that may be encountered in the ESF. This activity will be used to develop recommendations for excavation in the potential repository. Investigations will include excavation performance measurements, and examination of induced damage, as appropriate. This experiment will not monitor the machine performance (cutting heads, etc.).

B.2.33.2 FUNCTIONAL REQUIREMENTS

Provide the operational flexibility to perform the evaluation of mining methods tests.

B.2.33.3 PERFORMANCE CRITERIA

A. No special rooms or alcoves are required. The tests will be conducted in conjunction with excavation of all openings in the North Ramp, South Ramp, MTL, and in Calico Hills. Both ramps will be considered in this experiment, due to the different slopes, lithologies, and faults associated with each ramp. The experiment involves monitoring performance and is not invasive; thus, it should not cause interference with excavation when performed in both ramps.
[SD&TRD 3.2.1.15.A.8.a][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2)]

B. No drilling is required for this test.
[SD&TRD 3.2.1.15.A.8.a][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2)]

C. It is expected that data collection will be performed by the ESF constructor as part of the construction process.
[SD&TRD 3.2.1.15.A.8.a][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2)]

D. No flexibility requirements have been identified.
[SD&TRD 3.2.1.15.A.8.a][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2)]

E. Because this is a monitoring activity, no sketch of the test configuration is needed.
[SD&TRD 3.2.1.15.A.8.a][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2)]

F. Because this is a monitoring activity, no utility requirements exist.
[SD&TRD 3.2.1.15.A.8.a][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2)]

G. No accessibility requirements have been identified.
[SD&TRD 3.2.1.15.A.8.a][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2)]

B.2.33.4 CONSTRAINTS

A. This test can be scheduled independently of the scheduling of other tests.
[SD&TRD 3.2.1.15.A.8.a][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2)]

B. The test will be performed as the excavation proceeds, following the excavation equipment. The test will be performed near the face 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.
[SD&TRD 3.2.1.15.A.8.a][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2)]

C. No IDS requirement has been identified.
[SD&TRD 3.2.1.15.A.8.a][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2)]

D. No interference envelope exists; this test is observational only.
[SD&TRD 3.2.1.15.A.8.a][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2)]

B.2.33.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.A.8.a][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(2)]

B.2.33.6 ASSUMPTIONS

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

B.2.34 MONITORING OF GROUND SUPPORT SYSTEMS (SCP 8.3.1.15.1.8.2)

B.2.34.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.15.A.8.b) is to develop recommendations for ground support, in drifts in the potential repository, based on evaluations of the ground-support techniques in the underground excavations, and on experimentation with other ground-support configurations. This activity will be carried out in both ramps, in the MTL, and in Calico Hills. The selection, installation, and performance of the support systems used will be monitored. Ground support experimentation will include pull tests on rock bolts and installation of rock bolt load cells. Unsupported rock will be observed; shotcrete cores will be measured for strength; and trials will be made of ground-support systems different from those prescribed for the ESF. In the heated room experiment (SD&TRD 3.2.1.15.A.6.c), the effects of heat on ground support will be considered.

B.2.34.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to conduct this test.

B.2.34.3 PERFORMANCE CRITERIA

A. No special room or alcove is required. The tests will be conducted in all of the thermomechanical units encountered in both ramps, the MTL and Calico Hills. The observational tests will be performed in both ramps because they are non-invasive, survey type tests. By examining the different lithologies and faults encountered in each, the data basemay be increased. The tests will be performed in Calico Hills to monitor the stability of the drifts to enhance safety over the time period in which access will be needed. The pull tests are conducted in the North Ramp and the MTL only.
[SD&TRD 3.2.1.15.A.8.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(3)]

B. No required drilling has been identified for this test.
[SD&TRD 3.2.1.15.A.8.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(3)]

C. Provision for IDS data collection is required for the rock bolt load cells and the pull tests.
[SD&TRD 3.2.1.15.A.8.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(3)]

D. Location will depend on ground conditions. 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 sets will be instrumented with load cells.
[SD&TRD 3.2.1.15.A.8.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(3)]

E. Because this is a monitoring activity, no sketch is given for this test.
[SD&TRD 3.2.1.15.A.8.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(3)]

F. Standard underground facilities for water, air, and electricity for drilling provide a sufficient environment for this test. No other special experimental needs exist.
[SD&TRD 3.2.1.15.A.8.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(3)]

G. Accessibility to the rock bolts tested using pull tests is required. Accessibility to the rock bolt load cells will be needed only for repair activities.
[SD&TRD 3.2.1.15.A.8.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(3)]

B.2.34.4 CONSTRAINTS

A. This test can be scheduled independently of other tests.
[SD&TRD 3.2.1.15.A.8.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(3)]

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 will preferably coincide with scheduled TBM shutdown. Slowdown of excavation progress will be avoided. Impact on construction progress (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.
[SD&TRD 3.2.1.15.A.8.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(3)]

C. Monitoring must begin when the rock bolts are installed, and the 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 average of a day).
[SD&TRD 3.2.1.15.A.8.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(3)]

D. No interference envelope exists for this experiment; however, pull tests may temporarily block movement of vehicles in the drifts.
[SD&TRD 3.2.1.15.A.8.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(3)]

B.2.34.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements

Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.A.8.b][10 CFR 60.122(c)(20), .131(a), .131(b)(7); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(3)]

B.2.34.6 ASSUMPTIONS

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

B.2.35 MONITORING DRIFT STABILITY (SCP 8.3.1.15.1.8.3)

B.2.35.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.15.A.8.c) is to monitor drift convergence and drift maintenance activities throughout the ESF, along accesses, and in Calico Hills. Convergence measurement stations will be selected by the PI; and in the ESF drifts on the MTL, convergence measurements will be taken in a continuous manner. Rock-mass relaxation will be investigated in these drifts using MPBXs. Rock falls and maintenance activities will be documented.

B.2.35.2 FUNCTIONAL REQUIREMENTS

Provide the operational flexibility to perform this test.

B.2.35.3 PERFORMANCE CRITERIA

A. 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 MTL, especially near the Ghost Dance Fault, and in Calico Hills. Drift intersections will be monitored, and will be more heavily instrumented than the tests at other locations. The purpose of the Calico Hills tests is to monitor the long term stability of the drifts to enhance safety during the time that they are used.
[SD&TRD 3.2.1.15.A.8.c, 3.7.B.1][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7), .133(a)(2), .133(e)(2); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(2), .5-2-9(c)(3)]

B. Drilling requirements for this test include holes for MPBXs that are approximately 15 meters (49.2 feet) long and 76 millimeters (3 inches) in diameter, and shallow holes for tape extensometer anchors that are approximately 230 millimeters (9 inches) long, and 29 millimeters (1 inch) in diameter.
[SD&TRD 3.2.1.15.A.8.c, 3.7.B.1][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7), .133(a)(2), .133(e)(2); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(2), .5-2-9(c)(3)]

C. 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.
[SD&TRD 3.2.1.15.A.8.c, 3.7.B.1][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7), .133(a)(2), .133(e)(2); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(2), .5-2-9(c)(3)]

D. Layouts, dimensions, and instrument configuration are [TBD].
[SD&TRD 3.2.1.15.A.8.c, 3.7.B.1][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7), .133(a)(2), .133(e)(2); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(2), .5-2-9(c)(3)]

E. Standard underground facilities for water, air, and electricity for drilling provide a sufficient environment for this test. No other special experimental needs exist. [SD&TRD 3.2.1.15.A.8.c, 3.7.B.1][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7), .133(a)(2), .133(e)(2); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(2), .5-2-9(c)(3)]

F. Access to the monitoring stations will be required periodically during the test. [SD&TRD 3.2.1.15.A.8.c, 3.7.B.1][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7), .133(a)(2), .133(e)(2); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.35.4 CONSTRAINTS

A. This test can be scheduled independently of other tests. [SD&TRD 3.2.1.15.A.8.c, 3.7.B.1][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7), .133(a)(2), .133(e)(2); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(2), .5-2-9(c)(3)]

B. This experiment will look at early-time 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 will preferably coincide with scheduled TBM shutdown. Slowdown of excavation progress will be avoided. Impact on construction progress (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.
[SD&TRD 3.2.1.15.A.8.c, 3.7.B.1][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7), .133(a)(2), .133(e)(2); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(2), .5-2-9(c)(3)]

C. Provision for IDS data collection is required prior to beginning this test. [SD&TRD 3.2.1.15.A.8.c, 3.7.B.1][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7), .133(a)(2), .133(e)(2); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(2), .5-2-9(c)(3)]

D. No interference envelope exists for this test. [SD&TRD 3.2.1.15.A.8.c, 3.7.B.1][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7), .133(a)(2), .133(e)(2); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(2), .5-2-9(c)(3)]

E. MPBXs and extensometer anchors should be installed as close to the advancing face as possible.
[SD&TRD 3.2.1.15.A.8.c, 3.7.B.1][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7), .133(a)(2), .133(e)(2); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.35.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.A.8.c, 3.7.B.1][10 CFR 60.122(c)(20), .122(c)(21), .131(a), .131(b)(7), .133(a)(2), .133(e)(2); 10 CFR 960.4-2-3(c)(1), .5-2-9(b)(2), .5-2-9(c)(2), .5-2-9(c)(3)]

B.2.35.6 ASSUMPTIONS

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

B.2.36 AIR QUALITY AND VENTILATION EXPERIMENT (SCP 8.3.1.15.1.8.4)

B.2.36.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.15.A.8.d) is to assess the impact of site characteristics on ventilation requirements to ensure a safe working environment. This activity consists of:

- measurements of radon emanation
- surveys of airflow and pressure, temperature, and humidity
- determinations of air resistance factors
- dust characterization

The radon emanation measurements will be made in a dead-end drift that has been sealed with a bulkhead and that will be repeatedly ventilated and then allowed to return to equilibrium. Radon concentrations may also be measured in a borehole. The air quality and ventilation measurements are not expected to interfere significantly with other underground activities.

B.2.36.2 FUNCTIONAL REQUIREMENTS

Provide the operational flexibility to perform this test.

B.2.36.3 PERFORMANCE CRITERIA

A. 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.
[SD&TRD 3.2.1.15.A.8.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(g)(1)]

B. The tests will be conducted throughout the ESF after construction is completed. The end section of a drift or alcove on the MTL will be sealed with a bulkhead to allow measurement of radon gas emanation. Surveys of airflow and pressure, temperature, and humidity, determinations of air resistance factors, and dust characterization will be performed on the MTL and in the North and South Ramps.
[SD&TRD 3.2.1.15.A.8.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(g)(1)]

C. This test will require a radon measurement hole in the dead-end drift approximately 9 meters (29.5 feet) in length with a 160 millimeter (6.3 inches) diameter.
[SD&TRD 3.2.1.15.A.8.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(g)(1)]

D. No flexibility requirements for test location or orientation have been identified.
[SD&TRD 3.2.1.15.A.8.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(g)(1)]

E. No figure is supplied with this test.
[SD&TRD 3.2.1.15.A.8.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(g)(1)]

F. Standard underground facilities for water, air, and electricity for drilling provide a sufficient environment to conduct this test. No other special experimental needs exist.
[SD&TRD 3.2.1.15.A.8.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(g)(1)]

G. Accessibility to the dead-end drift will be required throughout the test period, and periodic access to locations throughout the ESF after construction is completed will also be required.
[SD&TRD 3.2.1.15.A.8.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(g)(1)]

B.2.36.4 CONSTRAINTS

A. This test can be scheduled independently of other tests.
[SD&TRD 3.2.1.15.A.8.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(g)(1)]

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 will preferably coincide with scheduled TBM shutdown. Slowdown of excavation progress will be avoided. Impact on construction progress (far behind face) will be limited to minor interference with support forces (maintenance crews, ramp transportation vehicles, priority testing support, etc.)
[SD&TRD 3.2.1.15.A.8.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(g)(1)]

C. Provision for IDS data collection should be available prior to conducting the measurement of radon emanation.
[SD&TRD 3.2.1.15.A.8.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(g)(1)]

D. To measure radon emanation, the area around the sealed test drift must not be affected by thermal or hydrologic testing. Additional analyses will be performed to define acceptable amounts of thermal and hydrologic change that will be allowed.
[SD&TRD 3.2.1.15.A.8.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(g)(1)]

E. The measurement of radon emanation will require sealing off the end of a drift. The remainder of the test requires only periodic air sampling. No special constraints are required for these activities in ESF testing, and no additional perturbation to natural conditions (stress, temperature, moisture, etc.) will result from these additional activities.
[SD&TRD 3.2.1.15.A.8.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(g)(1)]

B.2.36.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.A.8.d, 3.7.B.1][10 CFR 60.131(a), .131(b)(7), .133(g)(1)]

B.2.36.6 ASSUMPTIONS

A. 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 summer and once in winter). These measurements will be conducted throughout the ESF after construction is completed. The IDS is not required to acquire data for these surveys.

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

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

B.2.37 OVERCORE STRESS EXPERIMENTS IN THE EXPLORATORY STUDIES FACILITY (SCP 8.3.1.15.2.1.2)

B.2.37.1 DEFINITION OF TEST

The purpose of this test (discussed in SD&TRD 3.2.1.15.B.1.b) is to determine the in situ state of stress above, within, and below the potential repository horizon (in that portion of the unsaturated zone penetrated by the ESF) to determine the extent of excavation-induced stress changes, and to relate stress parameters to rock-mass heterogeneities.

B.2.37.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform this test.

B.2.37.3 PERFORMANCE CRITERIA

A. Adequate space is required to drill and core the test holes. Boreholes will be approximately 20 meters (65.6 feet) in length and up to 152 millimeters (6 inches) in diameter (cored). The test will be conducted in alcoves constructed from both ramps in the high lithophysal zone of the upper Topopah Spring welded unit, in alcoves on the main test level (one north end, one south end), and in the Calico Hills nonwelded unit at both ends of the facility. In addition, the test will be conducted in each alcove used for the Excavation Effects test to support the Excavation Effects test.
[SD&TRD 3.2.1.15.B.1.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(3)]

B. Three borehole sizes will be required, all of which will be approximately 20 meters (65.6 feet) long. The dilatometer boreholes will have a diameter of 76 millimeters (3 inches), pilot holes for the overcore holes will be 38 millimeters (1.5 inches) in diameter, and overcore boreholes will be 152 millimeters (6 inches) in diameter. Dry drilling is not required.
[SD&TRD 3.2.1.15.B.1.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(3)]

C. Test location flexibility is required because intact segments of core are required; thus the location, distribution, orientation and apertures of fractures need to be examined prior to conducting tests.
[SD&TRD 3.2.1.15.B.1.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(3)]

D. Standard utilities are expected to be adequate to conduct this test.
[SD&TRD 3.2.1.15.B.1.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(3)]

E. Access to the borehole locations must be maintained until after overcoring, then no further access will be required.
[SD&TRD 3.2.1.15.B.1.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(3)]

B.2.37.4 CONSTRAINTS

A. This test does not require any special sequencing/timing relative to the ESF construction with the exception of the tests conducted in conjunction with the Excavation Effects test which must be conducted prior to conducting the Excavation Effects test.
[SD&TRD 3.2.1.15.B.1.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(3)]

B. The test must be conducted at a distance equivalent to at least two opening diameters from any opening. The test must be located at least 15 meters (49.2 feet) from any heater test or be conducted prior to any heater test located within 15 meters (49.2 feet). If water is used in drilling/coring, any hydrologic tests should be located at least several meters away. Tests conducted in the Calico Hills nonwelded unit will include hydrofracture tests conducted with low-volume amounts of water. The Calico Hills nonwelded unit test locations should be sited so as to not impact hydrologic tests or other water-sensitive tests. An analysis will be developed at a future time to determine appropriate standoff distance for hydrologic tests.
[SD&TRD 3.2.1.15.B.1.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(3)]

B.2.37.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.1.15.B.1.b][10 CFR 60.122(c)(21), .131(a), .131(b)(7);
10 CFR 960.4-2-3(c)(1), .5-2-9(c)(3)]

B.2.37.6 ASSUMPTIONS

A. The location for the mobile laboratory will be on an auxiliary pad. The trailer will be about 12 meters (39.3 feet) long.

B. Testing equipment will be provided by the test organization.

B.2.38 DEVELOPMENT AND DEMONSTRATION OF REQUIRED EQUIPMENT (SCP 8.3.2.5.6)

B.2.38.1 DEFINITION OF TEST

This test (discussed in SD&TRD 3.2.2.1.A) includes prototype testing and development of test instrumentation for activities covered in SD&TRD 3.2.1.15.A.1.

B.2.38.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the development and demonstration testing of required equipment.

B.2.38.3 PERFORMANCE CRITERIA

A. The need for special rooms/alcoves, and the location of this test have not been decided. Locations will be chosen after the types of prototype testing and test instrumentation to be developed have been selected.
[SD&TRD 3.2.2.1.A]

B. No drilling requirements have been identified for this test.
[SD&TRD 3.2.2.1.A]

C. No data collection or space requirements have been identified.
[SD&TRD 3.2.2.1.A]

D. No flexibility requirements have been identified.
[SD&TRD 3.2.2.1.A]

E. No general test configuration or arrangement has been developed for this test.
[SD&TRD 3.2.2.1.A]

F. Standard underground facilities for water, air, and electricity for drilling will be used for this test. No other special experimental needs are currently identified.
[SD&TRD 3.2.2.1.A]

G. No accessibility requirements have been identified.
[SD&TRD 3.2.2.1.A]

B.2.38.4 CONSTRAINTS

A. This test will be performed before the activity that it prototypes. When the type of prototype testing and test instrumentation demonstrated are identified, test sequencing can be determined.
[SD&TRD 3.2.2.1.A]

B. No conflict with facility construction has currently been identified.
[SD&TRD 3.2.2.1.A]

C. Requirement for the IDS is [TBD].

[SD&TRD 3.2.2.1.A]

D. The interference envelope for this test is [TBD].

[SD&TRD 3.2.2.1.A]

B.2.38.5 INTERFACE REQUIREMENTS

[TBD]

[SD&TRD 3.2.2.1.A]

B.2.38.6 ASSUMPTIONS

[TBD]

B.2.39 IN SITU TESTING OF SEAL COMPONENTS (SCP 8.3.3.2.2.1.1)

B.2.39.1 DEFINITION OF TEST

The objectives of this test (discussed in SD&TRD 3.2.3.2.A.1.a) are to characterize water and air flow and evaluate sealing concepts and components. There are two categories of testing required in the sealing program:

Category A - Conduct an intrinsic permeability characterization of discrete, geologic features to evaluate water inflow and air outflow.

Category B - Evaluate specific sealing concepts and sealing components. Hydrologically assess selected rock-mass locations to drain water. Characterize the modified permeability zone in main ramps and in drifts parallel to the main ramp.

If a test area involves only the conductivity (hydraulic and air) characterization of a discrete geologic feature and does not involve a Category B test, it is not considered a sealing test but is considered necessary to support the sealing program. It is anticipated that other organizations will be interested in this geohydrologic information and may have proposed similar tests.

Category B tests are considered the in situ sealing components tests and are the primary focus of the sealing program. There are a variety of sealing tests conducted in the ESF. These tests are:

- small-scale in situ seal tests
- intermediate-scale borehole seal tests
- large-scale shaft seal tests
- fracture grouting tests
- a filter/single embankment test
- engineered drainage-enhancement tests
- full-scale backfill tests in the Calico Hills unit
- bulkhead tests in the Calico Hills unit
- drift-scale backfill tests at the surface

The tests indicated above are intended to reduce the uncertainties associated with the performance of sealing components. A broad range of testing is proposed to accommodate the potential broad range of conditions that may be encountered in the underground workings. The types and numbers of sealing tests are ultimately dependent on the geology, hydrology, and design of the underground facility.

B.2.39.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform intrinsic permeability characterization and seal component in situ testing.

B.2.39.3 PERFORMANCE CRITERIA

A. Category A tests require alcoves or adequate space for core drilling two horizontal holes with depths of approximately 20 meters (65.6 feet). The first hole will be drilled perpendicular to the discrete, geologic feature and the second hole will be drilled to intercept the feature at a currently unspecified angle.

Tentative locations for Category A tests include:

1. In the North Ramp - Bow Ridge Fault, a characteristic fault or fracture zone beneath alluvium downgrade from the Bow Ridge fault, a characteristic fault or fracture zone downgrade from the alluvial area, and 2 characteristic faults or fracture zones in the Topopah Spring Member.

2. In the South Ramp - A characteristic fault or fracture zone from the surface through the Tiva Canyon to the ramp; a characteristic fault or fracture zone from the alluvial area, through the Tiva Canyon, the nonwelded Paintbrush tuff, and the Topopah Spring tuff, to the ramp; a characteristic fault or fracture zone near the repository boundary; and the Ghost Dance fault.

3. Within the Topopah Spring and Calico Hills horizons, representative Category A testing of discrete, geologic features will be the same as the testing proposed by the USGS.

[SD&TRD 3.2.3.2.A.1.a, 3.7.B.1][10 CFR 60.122(c)(7), .134(b), .142(d)]

B. The Category B tests at the North Ramp TCw and nonwelded PTn locations should be developed consistent with the development of the main repository level, if possible. At each location approximately 300 meters (984 feet) of drifting will be required, the drifts will be 3.66 meters (12 feet) in height and width. Each location will include two drifts coming off of the main ramp.

1. The drift further to the east will incline at a 10% grade. Two drifts will come off of this drift and connect at the far end, and both will have an upgrade of 6%.

2. The second drift will be approximately 70 meters (229.6 feet) from the first, with a downgrade of 20%. Two drifts will come off of this drift and both will be connected at the far end, and will have a downgrade of 6%.

3. The minimum separation of the two levels is 15 meters (49 feet).

4. Two 31 centimeter (12.2 inches) intermediate boreholes will be drilled between the two levels.

5. Within the lower drifts the following boreholes will be developed:

   (a) two 0.9 meter (3 feet) diameter by 2.7 meters (9 feet) long;

   (b) two 0.9 meter (3 feet) diameter by 1.8 meters (6 feet) long;

   (c) three 0.46 meter (1.5 feet) diameter by 1.2 meters (4 feet) long;

(d) and three 0.46 meter (1.5 feet) diameter by 0.6 meter (2 feet) long.

6. Flexibility must be provided to construct two shafts (between the drifts furthest from the main ramp), sized and lined consistent with designs for the repository.

7. A uniform compressed air supply is required at both locations.

8. Air conductivity at the drift scale will be measured at both locations. This will require the pressurization of a segment of the drift and injection of a tracer. Because of the scale of this test, a larger compressed-air supply will be necessary. The air supply size requirement depends on the quality of the rock being evaluated.

9. Large-scale testing of the drifts will require construction of temporary bulkheads, (possibly constructed of cinder blocks and sealed with Gunite).
[SD&TRD 3.2.3.2.A.1.a, 3.7.B.1][10 CFR 60.122(c)(7), .134(b), .142(d)]

C. The Category B Calico Hills Test south of and parallel to the southern Ghost Dance Fault drift, requires a drift perpendicular to the main drift, approximately 30 meters (98.4 feet) long; and of the same design as the remainder of drifting in the Calico Hills unit.

1. Associated with this drift are three alcoves:

(a) The first and second alcoves should be approximately 4 meters by 4 meters (13 feet by 13 feet), house the instrumentation for the experiment, and be located off of the drift that penetrates the Ghost Dance fault furthest to the south.

(b) The third drift should be approximately 6 meters by 6 meters (19.6 feet by 19.6 feet) and should be used for storage of rockfill for the backfilling operation.

2. Some drilling will be required to core into the backfill as emplaced, and excavation of the backfill may be performed to extract samples.
[SD&TRD 3.2.3.2.A.1.a, 3.7.B.1][10 CFR 60.122(c)(7), .134(b), .142(d)]

D. The Category B Calico Hills Test at the north or south end of the CHn main drift (dependent on hydrologic conditions of the access ramps) requires a drift having the same design as the others in the Calico Hills unit.

1. The drift should be approximately 25 meters (82 feet) in length. Testing will involve the construction of a large-scale seal and subsequent testing behind the seal.

2. Coring of the seal may be performed to obtain strength and hydrologic properties, and flexibility must be maintained to allow seal coring.
[SD&TRD 3.2.3.2.A.1.a, 3.7.B.1][10 CFR 60.122(c)(7), .134(b), .142(d)]

E. The MTL core test area Category B test (coupled heated block/grout test) will utilize the heated block test alcove, if possible. If the existing heated-block test area is not a suitable area to conduct the heated block/grout test, then a drift of approximately 10 meters (33 feet) long by 4.9 meters (16 feet) wide by 4.9 meters (16 feet) high will have to be developed. This drift will be constructed in the same manner as that containing the heated-block test.
[SD&TRD 3.2.3.2.A.1.a, 3.7.B.1][10 CFR 60.122(c)(7), .134(b), .142(d)]

F. The MTL core test area Category B test (engineered drainage-enhancement tests) requires development of a drift approximately 25 meters (82 feet) long located in the MTL CTA. Because testing will involve the emplacement of rockfill, a storage area of adequate capacity will be required; otherwise, there are no specific requirements for this area.
[SD&TRD 3.2.3.2.A.1.a, 3.7.B.1][10 CFR 60.122(c)(7), .134(b), .142(d)]

G. A location must be provided at the surface (within the defined disturbance area) for simulation of rockfill placement, the testing of the rockfill, and the placement of instrumentation in the rockfill. A culvert-like facility is proposed which may be 4 meters (13 feet) in diameter and 20 meters (65.6 feet) long; instrumentation ports will be placed throughout the culvert to gain remote access to the rockfill. Drilling of boreholes will be required for the rockfill instrumentation.
[SD&TRD 3.2.3.2.A.1.a, 3.7.B.1][10 CFR 60.122(c)(7), .134(b), .142(d)]

H. Data acquisition systems and IDS connections must be provided at all test locations.
[SD&TRD 3.2.3.2.A.1.a, 3.7.B.1][10 CFR 60.122(c)(7), .134(b), .142(d)]

I. At all test locations (Category A and B), standard facility support for water, power, lighting, ventilation, and communications will be required.
[SD&TRD 3.2.3.2.A.1.a, 3.7.B.1][10 CFR 60.122(c)(7), .134(b), .142(d)]

B.2.39.4 CONSTRAINTS

[TBD] including constraints for the rock support system.
[SD&TRD 3.2.3.2.A.1.a, 3.7.B.1][10 CFR 60.122(c)(7), .134(b), .142(d)]

B.2.39.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements

Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.3.2.A.1.a, 3.7.B.1][10 CFR 60.122(c)(7), .134(b), .142(d)]

B.2.39.6 ASSUMPTIONS

None.

B.2.40 GEOMECHANICAL ATTRIBUTES OF THE WASTE PACKAGE ENVIRONMENT

B.2.40.1 DEFINITION OF TEST

The objective of this test (discussed in SD&TRD 3.2.4.2.A.3) is to characterize the geomechanical response of the rock in the near-field environment, to changing environment conditions expected to occur over the lifetime of the potential repository.

Initial heater tests are planned in the North Ramp, the results of which will be used to help design tests in the MTL. Multiple tests located in the North Ramp and the main test level are needed to provide information for studying the homogeneity of the potential repository horizon. Some tests will study the effect of a heating/cooling cycle on the stability of rock blocks formed by excavation of the emplacement hole. Other tests will assess the potential for spalling or other types of borehole breakout that may occur due to the heating/cooling cycle, and the associated changes in rock/fracture properties. For some tests, temperatures and/or stresses above those expected in the potential repository may be imposed on rock blocks to accelerate geomechanical mechanisms. Flat jacks may be used to induce elevated stress on a rock block.

B.2.40.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform these tests.

B.2.40.3 PERFORMANCE CRITERIA

A. Each test (North Ramp and CTA of the MTL) requires an alcove room of at least 1.2 meters (4 feet) long, 6.1 (20 feet) meters wide and 4.6 meters (15 feet) high; in addition, two alcoves, each with a floor area of at least 3.7 meters by 3.7 meters (12 feet by 12 feet) is required by each test. One of the alcoves will be used for an instrumentation room, therefore, it has to be air-conditioned; the other alcove will be used as storage. These two alcoves should be adjacent to the test area.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

B. The test areas in the North Ramp and the MTL should be at least 9.1 meters (30 feet) from other activities and 6.1 meters (20 feet) from other openings. This separation will be evaluated as design progresses.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

C. Instrumentation borehole sizes to 7.62 centimeter (3 inches) in diameter and emplacement borehole sizes to 76.2 centimeter (30 inches) in diameter, will be required. The boreholes will be dry drilled vertically from the invert of the testing alcove.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

D. Data will be collected by the Lawrence Livermore National Laboratory (LLNL) data acquisition system. The IDS will be connected to the LLNL data acquisition system.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

E. Flexibility to adjust the test location to avoid fracture zones should be provided.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

F. Normal utility supplies (power, ventilation, water, and compressed air) in the ramps and MTL, will be required. Additional requirements of power and compressed air are listed below.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

G. Power is needed for heating (208V, 3-phase, 45A, voltage regulated), and for instrumentation (120V, 30A UPS).
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

H. Compressed air will be needed for mechanical loading of the rocks.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

I. Capability of slotting the perimeter of a 3.1 meters cubed block of rock, with an aperture of 1.27 centimeters (0.5 inches) to 2.54 centimeters (1 inch), is required.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

J. Test area access should be maintained for LLNL personnel during the duration of the tests. Test area access control is required.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

B.2.40.4 CONSTRAINTS

A. The North Ramp test should start as soon as possible so that input to the MTL test design can be provided, and MTL tests must be initiated as soon as possible to provide adequate information to support the license application date.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

B. Provision for data collection by LLNL and connection to the IDS must be available prior to the beginning of these tests.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

C. Once a test has begun, no excavation is allowed that could affect the stress state near the heater.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

D. Site characterization analysis objectives requiring standoff zones dependent on test duration are [TBD] and will be addressed during Title II Design.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

E. The zone of influence due to mechanical effects is [TBD] meters.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

F. The zone of influence due to thermal effects is [TBD] meters.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

G. The zone of influence due to hydrologic effects is [TBD] meters.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

H. The zone of influence due to chemical effects is [TBD] meters.
[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

B.2.40.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System

[SD&TRD 3.2.4.2.A.3][10 CFR 60.135(a)(1), .135(a)(2)]

B.2.40.6 ASSUMPTIONS

A. Office space will be provided at the ESF, and space will be assigned in Area 25. Office space should provide enough space and a change house for at least three persons, and two computer stations.

B. LLNL will not provide any equipment for the construction of the ramps, drifts, and alcoves.

C. There is no other activity in the vicinity whose thermal load and/or mechanical load will affect the tests, and vice versa.

D. A trailer pad sufficient for a 3.7 meter by 18.3 meter (12 feet by 60 feet) machine shop trailer will be provided at the surface of the test area. LLNL will bring the trailer on site. Parking space will be provided at the trailer pad for at least one pickup truck. The trailer pad will have water, sewer, and 120/208V, 3-phase power hookups.

NOTE: These design requirements are for the Site Characterization Plan-Conceptual Design Report emplacement configuration; review and/or revision of this test would be required if alternate configurations were proposed.

B.2.41 REPOSITORY HORIZON NEAR-FIELD HYDROLOGIC PROPERTIES (SCP 8.3.4.2.4.4.1)

B.2.41.1 DEFINITION OF TEST

The objectives of these tests (discussed in SD&TRD 3.2.4.2.A.4.a) are to investigate moisture movement and saturation conditions in the host rock during heating and cooling periods of waste storage, and to investigate the scale effects of the heater hole on the measured parameters. A series of heater and infiltration tests are planned in the North Ramp (initial tests) and in the core test area of the ESF MTL. The MTL tests will be conducted following the initial tests performed in the North Ramp Access. The results of the North Ramp test will be used to help design the test on the MTL. The tests in the North Ramp and the MTL will provide information for studying the homogeneity of the potential repository horizon. Some tests will measure the parameters during the thermal cycle using ambient moisture as the initial condition, and other tests will include simulated percolation events to examine the effect of water percolating or diffusion through the rock mass.

B.2.41.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to these tests.

B.2.41.3 PERFORMANCE CRITERIA

A. Provide drift systems for tests in the North Ramp and the main test level CTA; for each test, the emplacement drift and instrumentation drift are required. The emplacement drift should have enough space for several heater test groups (each heater test group consists of heater holes and instrumentation holes). The emplacement drift system should be designed so that the rock within each heater test group can be studied in three dimensions. The instrumentation drift should be at a lower level than the emplacement drift. An invert to invert vertical separation of about 13.7 meters (50 feet) is required between the emplacement drift and the instrumentation drift.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

B. For each heater test group, the emplacement drift includes a 76.2 centimeters (30 inches) diameter by approximately 12.2 meters (40 feet) deep, emplacement hole, of which the lower 6.1 meters (20 feet) will be occupied by the heater. The heater emplacement hole will be drilled vertically into the invert of the emplacement drift. The instrumentation drift will allow horizontal accesses above and below the heated region.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

C. Instrumentation alcoves with at least 3.7 meters by 3.7 meters (12 by 12 feet) of floor space each, should be provided; depending on layout, 2 to 3 alcoves may be needed. The instrumentation alcoves should be within 15 meters (49.2 feet) of the active test areas, and should be air-conditioned.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

D. At least two (2) storage alcoves, with a miniumum of 3.7 meters by 3.7 meters (12 by 12 feet) of floor space each, should be provided.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

E. The separation (in a drift) of each heater test group should be such that a minimum of 7.6 meters (25 feet) of rock in all directions around each heater, will be undisturbed by other tests or activities. Enough drift should be provided for at least five heater tests. At least one of the tests should be continued as performance confirmation testing.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

F. The emplacement drift width will provide an array of vertical boreholes drilled into the invert that extends 3 meters (10 feet), radially, from the center of the heater.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

G. The instrumentation drift height will be sufficient to allow drilling of an array of almost horizontal boreholes that extend 9.1 meters (30 feet) vertically.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

H. Horizontal and vertical clearances opposite the collars of all instrumentation holes, must be sufficient to allow the use of downhole logging tools up to 4.6 meters (15 feet) in length. Horizontal and vertical clearances opposite the heater collars, must be sufficient to allow 6.2 meter (20.3 feet) long heater assemblies to be used.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

I. Instrumentation borehole sizes to 7.62 centimeters (3 inches) and emplacement hole sizes to 76.2 centimeters (30 inches) in diameter, will be drilled in each of the heater test groups. The depth of these boreholes will range from about 6.2 meters (20.3 feet) to about 18.3 meters (60 feet). The boreholes will be either vertical or almost horizontal. Dry drilling and coring of these boreholes are required.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

J. LLNL will have its own data acquisition system (DAS). This DAS will be connected to the IDS.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

K. Flexibility is required to adjust the test locations to avoid fracture systems deemed adverse to the test (such as shear zones or faults that would perturb the overall hydrologic response of the system). Sufficient drift length to allow test locations to be moved by 15.2 meters (50 feet) in either direction from the proposed location is considered adequate flexibility.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

L. Standard utility supply for the ramps and MTL (power, water, compressed air, ventilation, communication) will be needed. Other requirements are:

1. Electrical power required for the heater and instruments:

(a) For the heater, five 208V, 3-phase, 45A circuits connected to a standby, voltage regulated source are needed.

(b) For instrumentation, eighteen 120V, 30A circuits connected to UPS will be needed.

2. A minimum length of 15.2 meters (50 feet) of illuminated drift is required for each test location. The ability to monitor all power consumed by the lighting near the test area is required.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

M. Water will be needed for infiltration studies. [TBD]
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

N. Access to the test area should be maintained during the test. Ability to control access to the test areas is required.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

B.2.41.4 CONSTRAINTS

A. The tests in the North Ramp should start early enough so that their results can be used as input to the design of the tests in the MTL. Provision for data collection by LLNL and connection to the IDS must be available before these tests.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

B. The tests in the MTL must be initiated as early as possible to provide adequate information to support the license application date.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

C. Minimum vertical separation of at least 13.7 meters (45 feet) (from invert to invert) between the emplacement drift and instrumentation drifts will be required.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

D. No metallic rock bolts shall be located within the test region (defined by the rock mass penetrated by the instrumentation boreholes, plus 1.5 meters (5 feet)).
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

E. Once a test has begun, no excavation may begin that could affect the stress state near the heater.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

F. Site characterization analysis objectives requiring standoff zones dependent on test duration are [TBD] and will be addressed during Title II Design.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

G. The zone of influence due to mechanical effects is [TBD] meters.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

H. The zone of influence due to thermal effects is [TBD] meters.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

I. The zone of influence due to hydrologic effects is [TBD] meters.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

J. The zone of influence due to chemical effects is [TBD] meters.
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

B.2.41.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.4.2.A.4.a][10 CFR 60.135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1)]

B.2.41.6 ASSUMPTIONS

A. Office space will be provided at the ESF, and some space will be assigned in Area 25. Office space should provide enough space and a change house for at least 8 persons, and two computer workstations.

B. LLNL will not provide any equipment to be used in the construction of the ramps, drifts, and alcoves.

C. There is no other activity in the vicinity whose thermal load and/or mechanical load will affect the tests, and vice versa.

D. A trailer pad of sufficient size for a 3.7 meters (12 feet) by 18.3 meters (60 feet) machine shop trailer will be provided at the surface of the test area. LLNL will bring the trailer on site. Parking space at the trailer pad for at least one pickup truck will be provided. The trailer pad will have water, sewer, and 120/208V, 3-phase power hookups.

NOTE: These design requirements are for the SCP Conceptual Design Report emplacement configuration; review and/or revision of this test would be required if alternate configurations were proposed.

B.2.42 REPOSITORY HORIZON ROCK-WATER INTERACTION (SCP 8.3.4.2.4.4.2)

B.2.42.1 DEFINITION OF TEST

The objective of this activity (discussed in SD&TRD 3.2.4.2.A.4.b) is to obtain samples for laboratory testing of rock-water interactions at high temperatures. The samples needed are 15.24 centimeters (6 inches) to 20.32 centimeters (8 inches) diameter cores, or blocks of rock a of minimum 20.32 centimeters (8 inches) to 30.48 centimeters (12 inches) on a side. In situ gas and water samples are also needed. These samples may be collected by LLNL or provided by other organizations (e.g. hydrochemistry, perched water). The rock types to be studied include the lithophysal Topopah Spring tuff at the contact between the Tiva Canyon and Topopah Spring units, the welded Topopah Spring, the Basal Vitrophyre of Topopah Spring, and the top of the zeolitic tuff in the Calico Hills unit.

B.2.42.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to collect samples for this test.

B.2.42.3 PERFORMANCE CRITERIA

A. There is no space requirement and no alcove is needed. The locations of the sampling include the North and South Ramps and the MTL; 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. [SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

B. A sampling hole up to 20.32 centimeters (8 inches) in diameter, may be dry drilled a few meters deep. 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. [SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

C. All data will be collected in laboratory by LLNL personnel. [SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

D. The timing of sample collection is flexible, they can be taken after excavation and construction phases of ramps, drifts, or alcoves. [SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

E. Standard power, compressed air, lighting, water, and ventilation will be adequate except as specifically requested for drilling. [SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

F. No special access is needed after initial sampling.
[SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2);
10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

B.2.42.4 CONSTRAINTS

A. There is no particular sequential constraint for this test.
[SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2);
10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

B. The tests should be started as early as possible so that adequate information can be provided for the license application date.
[SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2);
10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

C. No IDS or data collection is required.
[SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2);
10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

D. There will be no interference with other activities.
[SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2);
10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

E. Dry drilling is required to obtain samples.
[SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2);
10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

F. Sample locations will be approved by the responsible PI prior to sampling activity.
[SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2);
10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

G. The zone of influence due to mechanical effects is [TBD] meters.
[SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2);
10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

H. The zone of influence due to thermal effects is [TBD] meters.
[SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2);
10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

I. The zone of influence due to hydrologic effects is [TBD] meters.
[SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2);
10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

J. The zone of influence due to chemical effects is [TBD] meters.
[SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2);
10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

B.2.42.5 INTERFACE REQUIREMENTS

Interface requirements are discussed in the appropriate integration studies (listed below).

Section B.3.1 Scientific Manpower/Schedule Information
Section B.3.2 Laboratory/Office/Storage Space Requirements
Section B.3.3 Electrical Power Requirements
Section B.3.4 Water System Requirements
Section B.3.5 Compressed Air System Requirements
Section B.3.6 Common Sampling Design Requirements
Section B.3.7 Communications System Requirements
Section B.4.0 Integrated Data System
[SD&TRD 3.2.4.2.A.4.b][10 CFR 60.122(c)(7), .135(a)(1), .135(a)(2); 10 CFR 960.4-2-1(c)(1), .4-2-2(c)(1)]

B.2.42.6 ASSUMPTIONS

A. Some office space at the ESF will be assigned in Area 25.

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

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

B.3 INTEGRATION STUDIES FOR ESF TESTING

B.3.1 SCIENTIFIC MANPOWER REQUIREMENTS FOR EXPLORATORY STUDIES FACILITY TESTING

B.3.1.1 DEFINITION OF STUDY

The objective of this study is to define the recommended planning and design assumptions for on-site scientific manpower requirements to support ESF testing. Initial estimates provided here were developed in 1988 (Los Alamos letter ESD-WX4-7/88-7) and will be refined as a part of the manpower integration study. This integration study will be completed during Title II design.

B.3.1.2 FUNCTIONAL REQUIREMENTS

Provide the system design and operational flexibility to conduct this test.

B.3.1.3 PERFORMANCE CRITERIA

A. The ESF should be designed to accommodate a nominal scientific work force of 100 persons.

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B. Peak scientific manpower, during day shift in the first few months after MTL CTA test locations first become available, is estimated to be 120 people.

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B.3.1.4 CONSTRAINTS

TBD

B.3.1.5 ASSUMPTIONS

A. Initial analysis is based on a network of 670 resource-loaded test activities which contained input from 19 PIs. The judgments and assumptions are discussed in a Los Alamos letter dated July 12, 1988 (ESD-WX4-7/88-7). Subsequent revision by the PIs allowed the recommended peak scientific manpower to be reduced to 120 people. Manpower estimates will be refined as test planning proceeds.

B. Manpower estimates do not include:

1. Drilling crews
2. Cable plant installation
3. Construction activities
4. Official visitors

B.3.2 LABORATORY/OFFICE/STORAGE SPACE REQUIREMENTS

B.3.2.1 DEFINITION OF STUDY

The objective of this study is to determine the specific surface and underground spatial requirements for ESF testing. The ESFDR, Section 3.2.2.3.2, "Test Support Facilities," presents functional requirements and performance criteria for common test support assembly, checkout, and repair facilities; that information is not duplicated in this section. Testing requirements for laboratory, office, and storage areas depend on test planning and design activities and will be developed and incorporated in this section as Title II design and test planning proceed.

B.3.2.2 FUNCTIONAL REQUIREMENTS

Provide the design and operational flexibility for provision of adequate laboratory, office, and storage space to support the ESF testing activities.

B.3.2.3 PERFORMANCE CRITERIA

All support facilities must be located so that support can be provided to testing activities at all ESF access portals and underground test locations; if necessary, this may require some facility replication. If facilities are not replicated on each pad site, then readily accessible, unimpeded transportation between sites must be provided.

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B.3.2.4 CONSTRAINTS

TBD

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B.3.2.5 ASSUMPTIONS

TBD

B.3.3 ELECTRICAL POWER REQUIREMENTS FOR EXPLORATORY STUDIES FACILITY TESTING

B.3.3.1 DEFINITION OF TEST

The objective of this test is to provide electrical power requirements for each ESF test and the IDS. If requirements are expected to exceed the designed standard power available at each underground test location (accesses and drifts), then specific power design requirements for lighting, instrumentation and heaters, data collection, or other test support are provided as performance criteria in each test subsection. No consideration of construction-related or drilling electrical power requirements is included.

If no special power requirements are anticipated for a specific test, a statement of adequacy for standard power supply is included. These statements are considered preliminary until the ESF designer provides initial ESF electrical power availability and distribution information.

As ESF Title II design test planning proceeds, this section will be used to summarize electrical power requirements for ESF testing support at all locations in the facility.

B.3.3.2 FUNCTIONAL REQUIREMENTS

Provide the system design and operational flexibility to ensure adequate provision of electrical power to support all ESF test activities.

B.3.3.3 PERFORMANCE CRITERIA

TBD

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B.3.3.4 CONSTRAINTS

TBD

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B.3.3.5 ASSUMPTIONS

Unless specifically defined in Sections B.2 and B.4, normal lighting values from design handbooks for laboratories and offices are acceptable in testing alcoves.

B.3.4 WATER SYSTEM DESIGN REQUIREMENTS FOR EXPLORATORY STUDIES FACILITY TESTING

B.3.4.1 DEFINITION OF TEST

The objective of this test is to define the water system requirements to support ESF testing. Results will be provided in this section as ESF Title II design and test planning proceed.

B.3.4.2 FUNCTIONAL REQUIREMENT

Provide the system design and operational flexibility to accommodate ESF testing water requirements.

B.3.4.3 PERFORMANCE CRITERIA

A. Each test location will have water provided. Unless specifically considered in Section B.2, standard ESF water system capacity, to be determined by the ESF designer, is adequate. Supply lines capable of providing an intermittent flow rate of 38 lpm to each test area is minimally required.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B. The water supply for each test shall be provided to access a coupling and an isolation valve near each test location.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

C. All water will be tagged with a suitable tracer [TBD] and documented.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

D. All water used in or around the ESF for each activity will be monitored, and appropriate quantity records will be maintained by the ESF Test Coordination Office. Methods of monitoring and recording water usage will be developed by the ESF designer and are [TBD].
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B.3.4.4 CONSTRAINTS

A. Water system leakage must be minimized and shall be contained to the maximum extent possible.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B. A performance evaluation of all water sources used in underground construction must be performed prior to use. The analysis must assess potential impacts to characterization testing and waste isolation.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B.3.4.5 ASSUMPTIONS

A. The test organizations will be responsible for the distribution system downstream from the isolation valve.

B. Each organization will be responsible for adding test-specific tracers to its respective test (if needed) subject to tracer limitations necessitated by other tests.

C. Standards for water meter accuracy conforming to American Water Works Association standard C700-77 will be adequate.

D. Water metering will be required, as a minimum, at each tracer injection location.

E. Water usage location and quantity records will be collected and handled using procedures developed or approved by the Project Office. It is anticipated that a "best effort" criterion will be adequate.

B.3.5 COMPRESSED AIR SYSTEM DESIGN REQUIREMENTS FOR EXPLORATORY STUDIES FACILITY TESTING

B.3.5.1 DEFINITION OF STUDY

The objective of this study is to define the compressed air system requirements to support ESF testing. Results will be provided in this section as ESF Title II design and test planning proceed.

B.3.5.2 FUNCTIONAL REQUIREMENTS

Provide the design and operational flexibility in the compressed air system to accommodate ESF testing requirements.

B.3.5.3 PERFORMANCE CRITERIA

A. Compressed air will be provided at each test location. Unless specifically considered in Section B.2, standard ESF compressed air system capacity, [TBD] by the ESF designer, is considered adequate.

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B. The compressed air supply for each test shall be provided to an access coupling and an isolation valve near each test location.

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

C. All compressed air will be tagged with SF6 (or other approved) tracer at a concentration [TBD].

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B.3.5.4 CONSTRAINTS

A. Provision will be made to prevent the introduction of liquid water from the compressed air supply into tests that are sensitive to water, such as Diffusion, Bulk Permeability, Repository Horizon Near-Field Hydrologic Properties, and Radial Boreholes.

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B. A performance evaluation of all gas tracers proposed for use in the ESF must be performed prior to their acceptance. The analysis must assess potential impacts to characterization testing and waste isolation.

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B.3.5.5 ASSUMPTIONS

The test organizations will be responsible for the distribution downstream from the isolation valve.

B.3.6 COMMON SAMPLING DESIGN REQUIREMENTS FOR EXPLORATORY STUDIES FACILITY TESTING

B.3.6.1 DEFINITION OF STUDY

The objective of this study is to determine requirements that provide performance criteria or constraints related to ESF design and operation. Sample collection requirements occur whenever cores, bulk, or other samples of rock, water, or gas are required to support ESF testing. Control and collection procedures will be developed by the PIs, with coordination and custodial documentation provided by the sample management facility staff.

B.3.6.2 FUNCTIONAL REQUIREMENTS

Provide system design and construction specifications with sufficient flexibility to accommodate ESF sample collection requirements.

B.3.6.3 PERFORMANCE CRITERIA

A. Sample collection will be required to satisfy the Performance Criteria of various ESF tests as identified in Section B.2. The facility design must be capable of variously accommodating sample collection as specified in Section B.2.

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B. ESF design considerations for the underground geologic mapping test (B.2.20) shall incorporate flexibility to accommodate sampling support for short drilling, coring, and bulk sample collection to support identified ESF test activities.

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B.3.6.4 CONSTRAINTS

TBD

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B.3.6.5 ASSUMPTIONS

None identified.

B.3.7 COMMUNICATIONS SYSTEM DESIGN REQUIREMENTS FOR EXPLORATORY STUDIES FACILITY TESTING

B.3.7.1 DEFINITION OF STUDY

The objective of this study is to define the communication system requirements to support ESF testing. Results will be provided in this section (as ESF design requirements) as test planning and Title II design proceed.

B.3.7.2 FUNCTIONAL REQUIREMENTS

Provide sufficient design and operational flexibility to ensure intercom and telephone service to all ESF test locations, alcoves, and test support facilities.

B.3.7.3 PERFORMANCE CRITERIA

Permanent intercom or telephone stations must be provided in each of the major ESF test locations and IDS equipment enclosures. This includes the IDS surface-based test facility (SBTF) and the MTL IDS shop. Unless specifically considered in Section B.2, standard ESF communication system provisions, [TBD] by the ESF designer, is considered adequate.

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B.3.7.4 CONSTRAINTS

A. The intercom and telephone systems cabling and equipment must be designed such that no detectable electromagnetic signals are induced into the IDS data acquisition equipment or any associated sensor.

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B. No data to be used for site characterization will be transmitted over the telephone or intercom systems.

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

C. Telephone and intercom systems will be powered from a UPS.

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

D. The intercom system will be designed and constructed to prevent radio frequency interference that could affect electromagnetic measurements being made.

[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

B.3.7.5 ASSUMPTIONS

The type of cabling or other media used to support the intercom and telephone systems is left to the designer.