B.3 CONSOLIDATED SAMPLING

B.3.1 DEFINITION OF TEST

This test consolidates requirements for those SCP Activities that involve the collection of samples from the ESF. Each of the incorporated SCP Activities is described below. Subsequent sections present general criteria for all sampling activities and requirements that are specific to each test.

A. Chloride and Chlorine-36 Measurement of Percolation at Yucca Mountain, is discussed in Section 8.3.1.2.2.2.1 of the SCP. This activity involves measurements of chlorine-36, chloride, and bromide made at various locations to determine the residence time of water in the unsaturated-zone tuffs based on the Chlorine-36/chlorine ratio of meteoric chloride. Large bulk samples from various locations throughout the ESF will be collected, packaged, and labeled 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 for 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. The purpose of Matrix Hydrologic Properties Testing, discussed in Section 8.3.1.2.2.3.1 of the SCP, is to develop a comprehensive database on matrix flux properties in the unsaturated-zone tuffs at Yucca Mountain. This activity includes 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.

C. The Intact Fracture Test in the ESF is discussed in Section 8.3.1.2.2.4.1 of the SCP. The Intact Fracture Test will be used to evaluate fluid-flow and chemical transport properties and mechanisms in relatively undisturbed and variably-stressed fractures to enhance the understanding of the physics of fluid flow and for flow modeling. Intact Fracture analyses will be performed in an off-site laboratory.

   Minimally disturbed core samples containing fractures will be collected from different rock types, locations, and orientations in the facility to provide samples that represent natural, rough-walled fractures in the unsaturated zone. Two coring methods are being considered for fracture sampling: a bolting and overcoring technique, and a clamp-core technique.

   The first technique is used when radial fractures are oriented approximately perpendicular to the core axis. A pilot hole is drilled beyond the fracture plane, anchors and a rock bolt (or threaded rod) are used to secure the fracture plane, the pilot hole is overcored, and a long core is withdrawn.

The second technique may be used when axial fractures are oriented parallel to the core axis. The fracture plane is overcored, a 254mm (10 in) OD, 610mm (24 in) long core is banded, and the core is withdrawn.

Samples will be collected from the following five hydrogeologic units:

- Tiva Canyon welded tuff (the North and/or South ramp),
- Paintbrush Nonwelded tuff (the North and/or South ramp),
- Topopah Spring welded tuff (Main Drift and North Ramp Extension),
- Vitric Calico Hills Nonwelded tuff, and
- Zeolitized Calico Hills Nonwelded tuff.

Sample locations will be chosen by the PI.

D. Studies of the petrologic stratigraphy of the Topopah Spring Member are discussed in Section 8.3.1.3.2.1.1 of the SCP. The goal of this activity 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 been shown to be useful for defining stratigraphic position. Mineralogic analysis will be conducted with X-ray diffraction. Chemical analyses will also be used to determine variability.

E. Studies of mineral distributions between the host rock and the accessible environment are discussed in Section 8.3.1.3.2.1.2 of the SCP. This activity will 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 by this activity 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 also dependent on needs of other studies such as sorption (SCP 8.3.1.3.4) and results of studies such as History of Mineralogic and Geochemical Alteration of Yucca Mountain (SCP Section 8.3.1.3.2.2).

F. Fracture Mineralogy studies of the ESF are discussed in Section 8.3.1.3.2.1.3 of the SCP. The fracture mineralogy studies will be conducted 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.

G. History of Mineralogic and Geochemical Alteration of Yucca Mountain studies in the ESF are discussed in Section 8.3.1.3.2.2.1 of the SCP. 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.

H. Biological Sorption and Transport is discussed in Section 8.3.1.3.4.2 of the SCP. This activity involves determining the effects of micro-organisms on the transport (either positive or negative) of radionuclides to the accessible environment. This study will determine the numbers, types, and metabolic activities of micro-organisms present in Yucca Mountain. Samples from various locations through the ESF will be collected, packaged, and labeled for laboratory analysis.

I. Laboratory tests (thermal and mechanical) using samples obtained from the ESF are discussed in Section 8.3.1.15.1 of the SCP. The laboratory geoengineering properties test 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 SCP Section 8.3.1.15.1.

J. Studies of Introduced Materials using samples from the ESF are discussed in Section 8.3.1.19.5 of the SCP.

K. Studies of Calcite and Opaline Silica Vein Deposits using samples from the ESF are discussed in Section 8.3.1.5.2.1.5 of the SCP.

L. Geochemical Assessment of Yucca Mountain in relation to the Potential for Mineralization using samples from the ESF is discussed in Section 8.3.1.9.2.1.1 of the SCP.

M. The Repository Horizon Rock-Water Interaction Tests are discussed in Section 8.3.4.2.4.4.2 of the SCP. This activity obtains samples for laboratory testing of rock-water interactions at high temperatures. The samples needed are 15.24 cm (6 in) to 20.32 cm (8 in) diameter cores or blocks of rock of minimum 20.32 cm (8 in) to 30.48 cm (12 in) on a side. In situ gas and water samples are also needed. These samples may be collected by Lawrence Livermore National Laboratory or provided by other organizations (e.g., Hydrochemistry, Perched-Water Programs). 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 the Topopah Spring, and the top of the zeolitic Tuff in the Calico Hills unit.

The sampling locations include the North and South Ramps, the Main Drift, and the North Ramp Extension, the lithophysal zone of the Topopah Spring Tuff, the contact of the Paintbrush Tuff non-welded unit and the Topopah Spring, Basal Vitrophyre of Topopah Spring, and the top of the zeolitic tuff of the Calico Hills unit.

B.3.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform Consolidated Sampling in the ESF.

B.3.3 COMMON DESIGN REQUIREMENTS

A. Provide the capability to access, recover and transport samples to the surface. Samples may need to be taken from the invert, walls, and back of any excavation in the ESF.

[DERIVED]

B. The capability to access any given sample location to collect additional samples, if judged necessary, shall be maintained.

[DERIVED]

C. Standard ESF utilities, including power, lighting, water, compressed air, communications, and ventilation are required (see Table B-2).

[DERIVED]

B.3.4 ADDITIONAL DESIGN REQUIREMENTS FOR CHLORIDE AND CHLORINE-36 SAMPLING

A. Provide the capability to recover and transport to the surface chloride and chlorine-36 samples of up to 50 kg (110 lbs) total weight. Samples may need to be taken from the invert, walls, and back of any excavation in the ESF.

[DERIVED]

B. The timing of this test may vary; however, wet zones and perched-water require immediate sampling in order to protect the integrity of the sample. This capability shall be provided.

[DERIVED]

C. As required by the ESF TCO, the Contractor shall provide access for sampling prior to placing grout, fibercrete, or other cementitious materials.

[DERIVED]

D. Provide the capability to take chloride and chlorine-36 samples concurrently with construction, either by core, as rubble from drill and blast, or as chips from mechanical excavators.

[DERIVED]

B.3.5 ADDITIONAL DESIGN REQUIREMENTS FOR MATRIX HYDROLOGIC PROPERTIES TESTING

A. Provide the capability to collect matrix hydrologic properties samples from all lithologic units penetrated by the ESF.

[DERIVED]

B. Ramp and drift walls may need to be sampled as soon as they are excavated. Long-term access to boreholes and sample locations in the ramp and drift walls, from six months to possibly years may be required.

[DERIVED]

B.3.6 ADDITIONAL DESIGN REQUIREMENTS FOR THE INTACT FRACTURE TEST

A. Provide the capability to collect core samples from various locations in the ESF. Sampling shall be permitted prior to the installation of any lining material or the sample locations marked before any lining material is installed.

[DERIVED]

B. An alcove may be needed if the core samples are collected where a drill rig and dust collector may block traffic. The ESF TCO will work with the ESF A/E to identify and specify design requirements related to potential interference with traffic in the ramps and/or drifts.

[DERIVED]

B.3.7 ADDITIONAL DESIGN REQUIREMENTS FOR PETROLOGIC STRATIGRAPHY OF THE TOPOPAH SPRING MEMBER

None Identified.

B.3.8 ADDITIONAL DESIGN REQUIREMENTS FOR MINERAL DISTRIBUTIONS BETWEEN THE HOST ROCK AND THE ACCESSIBLE ENVIRONMENT

None Identified.

B.3.9 ADDITIONAL DESIGN REQUIREMENTS FOR FRACTURE MINERALOGY

A. Provide the capability to collect hand samples and cores along selected fractures and fault zones throughout the ESF (accesses, drifts, and available alcoves).

[DERIVED]

B. Provide the capability to revisit selected features after (possibly one to two years) mapping to collect samples (either hand samples or short core). This may be some years after completion of excavation and may require temporary removal of small areas of mesh.

[DERIVED]

C. Samples shall be free of hydrochloric acid. Exposure of fracture to other materials that could be deposited on fracture surface should be minimized.

[DERIVED]

B.3.10 ADDITIONAL DESIGN REQUIREMENTS FOR HISTORY OF MINERALOGIC AND GEOCHEMICAL ALTERATION OF YUCCA MOUNTAIN

A. Access for sample collection shall be provided as needed. Access shall also be provided for sampling on a long-term basis. 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 required, provided that safety considerations permit.

[DERIVED]

B. Prior notice shall be given regarding construction activities that will involve introduction of chemicals into the wall-rock so that any necessary sampling can be completed before the potentially contaminating activity(s) begins.

[DERIVED]

B.3.11 ADDITIONAL DESIGN REQUIREMENTS FOR BIOLOGICAL SORPTION AND TRANSPORT

A. Provide the capability to collect, aseptically, a minimum of 1.0 kg (2 lbs) of pristine sample at each sampling location.

[DERIVED]

B. Provide the capability to collect samples in line with construction, from locations in the sidewall of the main and access drifts and test alcoves.

(1) Provide access to the sampling location as soon as possible following excavation.

(2) Up to 1 m (3 ft) of rock will need to be removed over a 1 m (3 ft) square area, at the sampling location, to expose the sampling horizon.

[DERIVED]

C. Provide the capability to collect samples throughout the facility within all units and at contacts.

[DERIVED]

D. Sampling can be conducted during facility construction (during the time that mapping is following the Tunnel Boring Machine (TBM)).

[DERIVED]

E. Whenever possible, the Contractor shall provide access for sampling prior to placing grout, fibercrete, or other cementitious materials.

[DERIVED]

B.3.12 ADDITIONAL DESIGN REQUIREMENTS FOR LABORATORY TESTS USING SAMPLES OBTAINED FROM THE ESF

Capability should be provided to transport core of various sizes (up to 38 cm [15 in] in diameter) and samples to the surface for shipment to laboratories.

[DERIVED]

B.3.13 ADDITIONAL DESIGN REQUIREMENTS FOR INTRODUCED MATERIALS, SAMPLES FROM THE ESF

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

[DERIVED]

B. Provide the capability to emplace artificial materials at selected locations and later retrieve these materials for laboratory analyses.

[DERIVED]

B.3.14 ADDITIONAL DESIGN REQUIREMENTS FOR STUDIES OF CALCITE AND OPALINE SILICA VEIN DEPOSITS, USING SAMPLES FROM THE ESF

Provide the capability to collect hand samples approximately 15 x 15 x 15 cm (6 x 6 x 6 in) in size (or large enough to include much of the thicker portions of the secondary mineralization) along selected fractures and fault zones throughout the ESF (accesses, drifts, and available alcoves).

[DERIVED]

B.3.15 ADDITIONAL DESIGN REQUIREMENTS FOR GEOCHEMICAL ASSESSMENT OF YUCCA MOUNTAIN

Provide the capability to collect hand samples along selected fractures and fault zones throughout the ESF (accesses, drifts, and available alcoves).

[DERIVED]

B.3.16 ADDITIONAL DESIGN REQUIREMENTS FOR REPOSITORY HORIZON ROCK-WATER INTERACTION TESTS

Dry drilling of sampling boreholes is required. Block sampling may be accomplished using mechanical means from drift surfaces. However, the capability for slotting or line drilling to obtain samples away from the immediate drift surface shall also be provided.

[DERIVED]

B.4 PERCOLATION TESTS IN THE ESF

B.4.1 DEFINITION OF TEST

The Percolation Tests in the ESF activity is discussed in Section 8.3.1.2.2.4.2 of the SCP. These tests will be used to observe fluid flow and solute transport processes through variably saturated, fractured, welded, and nonwelded tuff under controlled, relatively undisturbed conditions. The tests will use large, isolated blocks of rock of about 2 m (6 ft) on a side 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 irrigation system/sand bed on the surface of the block and effluent from the block collected and analyzed to determine transport behavior.

B.4.2 FUNCTIONAL REQUIREMENTS

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

B.4.3 DESIGN REQUIREMENTS

A. Two locations shall be provided at the Tiva Canyon Welded Unit (TCw)-Paint Brush Tuff Nonwelded Unit (PTn) and PTn-Topopah Spring Welded Unit 1 (TSw1) geologic contacts in the North Ramp, two locations in the Main Drift and/or North Ramp Extension, and two locations (north and south) in the Calico Hills for performance of percolation testing.

[DERIVED]

B. The current test configuration requires the construction of two parallel drifts/alcoves. However, alternative methods of test block excavation and isolation, that avoid the use of multiple drifts/alcoves, are being evaluated. Any changes to the test geometry and the selected test layout and dimensions will be developed and provided by the ESF TCO to the ESF A/E.

[DERIVED]

C. Construction methods shall not induce fractures in the test block.

[DERIVED]

D. Flexibility in locating the block to be excavated is required because of the need for dense fracture spacing or stratigraphic contacts.

[DERIVED]

E. Standard ESF power (with uninterruptible power supply (UPS) backup), lighting, ventilation, compressed air, and communications are adequate to conduct this test (see Table B-2).

[DERIVED]

B.5 BULK PERMEABILITY TEST IN THE ESF

B.5.1 DEFINITION OF TEST

The Bulk Permeability Test activity is discussed in Section 8.3.1.2.2.4.3 of the SCP. The tests will utilize single- and cross-hole air, and possibly water, injection to examine the effects of measurement scale on calculated permeability and to characterize media heterogeneity with respect to bulk permeability. Tracer testing using gaseous and possibly liquid tracers will help characterize media transport properties. Testing will be conducted in Alcoves at five locations within the Topopah Spring (units TSw1 and Topopah Spring Welded Unit 2 (TSw2)) and Calico Hills.

The alcoves at each site will need to be of sufficient size to allow drilling of three 60 m (200 ft) long HQ coreholes arranged in a frustum configuration, followed by a fourth HQ corehole drilled in the center of the three-hole frustum. Drilling of the fourth hole will follow the initial three holes by approximately three months. The initial three holes will be drilled from the end of an alcove, located a minimum of one drift diameter from the access drift. Holes will be collared at the corners of an equilateral triangle with 2 m (6 ft) sides. The holes will be drilled at a 25-degree angle away from a centerline passing perpendicular through the centroid of the triangle. The fourth hole will be drilled on this center line. The holes will be a maximum of 60 m (200 ft) in length. All holes will be dry-drilled and the core will be packaged for use in other tests. The preferred orientation of the holes is as noted above, but flexibility exists in orienting the holes.

B.5.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the Bulk Permeability Tests.

B.5.3 DESIGN REQUIREMENTS

A. Provide three test alcoves at locations along the North, South, and Main drifts, and two alcoves at additional locations in the North Ramp Extension. The precise alcove locations will be selected after initial geologic mapping in the access drift(s) has been completed.

[DERIVED]

B. Each alcove shall be sized to provide for personnel access, installation of standard utilities, and to allow operation of drilling and drilling support equipment. Detailed requirements will be provided to the ESF A/E by the ESF TCO.

[DERIVED]

C. Standard power, lighting, and communications will be adequate (see Table B-2).

[DERIVED]

B.6 RADIAL BOREHOLE TESTS IN THE ESF

B.6.1 DEFINITION OF TEST

The Radial Borehole Tests (RBT) in the ESF are discussed in Section 8.3.1.2.2.4.4 of the SCP. These tests will investigate vertical and lateral movement of gas, water, and vapor within the individual hydrogeologic units and across the hydrogeologic unit contacts. The RBTs consist of three test programs:

- Anisotropy testing of the hydrogeologic units;
- Contact testing at the hydrogeologic units contacts; and
- Long-term monitoring at the contact test sites.

Planned test locations are as follows:

ESF TEST LOCATION	ALCOVE LOCATION
Anisotropy Test Sites	
North Ramp	Upper TCw Lower TCw Middle PTn TSw1
Calico Ramp off North Ramp	TSw2
South Ramp	Upper TCw Lower TCw PTn TSw1 TSw2
Calico Ramp off South Ramp	TSw3
Calico Hills Test Level	CHn, distributed along drifts

ESF TEST LOCATION	ALCOVE LOCATION
Contact Test Sites	
North Ramp	TCw-PTn contact PTn-TSw1 contact
Calico Ramp off North Ramp	TSw2-TSw3 contact
South Ramp	TCw-PTn contact PTn-TSw1 contact
Calico Ramp off South Ramp	TSw3-CHn contact
Calico Hills Test Level	Vitric-Zeolitic contacts along CHn drifts TSw3-CHn contact

B.6.2 FUNCTIONAL REQUIREMENTS

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

B.6.3 DESIGN REQUIREMENTS

A. The exact location of RBT alcoves cannot be determined at this time. Design and construction flexibility is required to allow final location and configuration of alcoves based on data obtained during ramp construction.

(1) Locations will initially be determined during implementation of the Underground Geologic Mapping Test.

(2) Actual alcove locations shall be selected based on written criteria to be provided by the ESF TCO.

[DERIVED]

B. Each alcove shall be sized to provide for personnel access, installation of standard utilities, and to allow operation of drilling and drilling support equipment. Detailed requirements will be provided to the ESF A/E by the ESF TCO.

[DERIVED]

C. Standard power with UPS backup, lighting, and communications will be adequate (see Table B-2).

[DERIVED]

D. The anisotropy alcoves can be postponed up to one year after ramp construction.
[DERIVED]

E. The contact test sites have a long-term monitoring component. It is therefore important to begin these tests as soon as possible after contact exposure.
[DERIVED]

B.7 EXCAVATION EFFECTS TEST IN THE ESF

B.7.1 DEFINITION OF TEST

The Excavation Effects Test in the ESF is discussed in Section 8.3.1.2.2.4.5 of the SCP. This test is designed to measure permeability changes that result from stress redistribution around the underground excavations. The test will be conducted in the Topopah Spring horizon to provide design information for the potential repository. It will monitor changes to both the stress state and fractured rock permeability caused by excavation.

B.7.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the Excavation Effects Test.

B.7.3 DESIGN REQUIREMENTS

A. Test locations shall be provided at the Calico Hills ramp takeoff from the North Ramp, and at the intersections of the Main Drift and North and South Ramps, for performance of the tests.

[DERIVED]

B. Enough space shall be provided to accommodate a drilling rig that will be used to drill several holes up to 33 m (100 ft) long, and house data acquisition systems and packer strings and keep them off main traffic routes. The final test geometry and dimensions will be provided by the ESF TCO.

[DERIVED]

C. Alcove dimensions shall be adequate to support an overcore stress test that will be performed prior to initiating the Excavation Effects Test.

[DERIVED]

D. This test shall be conducted during excavation of the tested opening. No deferral is allowed.

[DERIVED]

E. The instrumentation holes shall be completed before the tested opening is excavated more than 1 m (3 ft) beyond the instrumentation face.

[DERIVED]

F. At least 30 m (100 ft) of excavated opening is required to obtain sufficient data.

[DERIVED]

G. An organizational data collection area (or alcove) shall be provided near the instrumentation face.

[DERIVED]

H. Standard ESF electric power with UPS backup, lighting, ventilation, compressed air, and communications are adequate to perform this test (see Table B-2).

[DERIVED]

I. Long-term permeability, temperature, and moisture measurements will be performed from the test holes. Access to the instrumentation shall be maintained.

[DERIVED]

B.8 PERCHED-WATER TESTING IN THE ESF

B.8.1 DEFINITION OF TEST

The Perched Water Testing in the ESF activity is discussed in Section 8.3.1.2.2.4.7 of the SCP.

The purpose of the Perched Water Test is to detect the occurrence, and delineate the lateral and vertical extent, of perched-water zones (if encountered) during excavation of the ESF. The test will also provide the means to identify perching mechanism(s), 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 is dependent upon the nature of any encountered perched-water.

If perched-water is encountered during excavation, small-diameter borehole(s) may 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.8.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and the operational flexibility to perform perched-water testing in the ESF.

B.8.3 DESIGN REQUIREMENTS

A. Perched water zones in the ramps and drifts shall be sampled and examined as soon as they are encountered.

[DERIVED]

(1) This activity may require that the TBM cutter head be pulled back or driven forward to provide access to the perched water, whichever is faster. This capability shall be provided. After initial sampling, a determination as to the extent of the perched water zone shall be made. A decision will then be made by the PI, with concurrence from the ESF TCO, whether to suspend excavation operations to allow for more complete testing and sampling or to allow excavation operations to continue.

[DERIVED]

(2) Because of the nature of perched water, the location of its occurrence cannot be predicted. Any suspected occurrences shall be immediately reported to ESF TCO field personnel.

[DERIVED]

(3) Provisions shall be made to permit long-term sampling and monitoring of perched water zones, either in boreholes or along ESF surfaces. Sampling and monitoring will continue until the nature of a perched water zone is determined.

[DERIVED]

B. The space required for conducting this test will depend upon the nature of the perched water zone encountered.

[DERIVED]

(1) 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.

[DERIVED]

(2) 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 shall be provided to move the drilling operations out of heavy traffic areas in the ESF.

[DERIVED]

C. Standard ESF utilities are required for this test (See Table B-2).

[DERIVED]

B.9 HYDROCHEMISTRY TESTS IN THE ESF

B.9.1 DEFINITION OF TEST

The Hydrochemistry Tests are discussed in Section 8.3.1.2.2.4.8 of the SCP. The Hydrochemistry tests will 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.9.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the Hydrochemistry Test.

B.9.3 DESIGN REQUIREMENTS

A. Provide access to collect core and gas samples from:

- All RBT holes;
- Bulk Permeability Test holes;
- Hydrologic Properties of Major Faults Test holes; and
- Additional coreholes drilled specifically for the Hydrochemistry test to provide gas and core samples from locations not satisfied by the above test locations.

[DERIVED]

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

[DERIVED]

(2) Clear access to alcoves shall be maintained at all times.

[DERIVED]

(3) The constructor shall coordinate with the ESF TCO prior to application of fibercrete in Hydrologic Properties of Major Faults, RBT, or other permeability testing alcoves; the ESF TCO may preclude application in areas if required by PIs.

[DERIVED]

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

[DERIVED]

B. The time interval between completion of alcove construction and initiation of drilling for test boreholes should be minimized to counter the effects of drying. Time intervals will be established for each alcove by the USGS, ESF TCO, and construction manager prior to alcove construction.

[DERIVED]

C. Standard 110V power, lighting, and communications will be adequate (see Table B-2). Testing will require that compressed air (345 kPa, [50 psi]) be available to inflate the packers.

[DERIVED]

D. Access shall be provided to the test location on a continuing periodic basis for gas sample collection.

[DERIVED]

E. Upon request of the ESF TCO, the constructor shall provide samples of materials, including water, used in alcove or starter tunnel construction for chemical analysis by the hydrochemistry PI.

[DERIVED]

B.10 HYDROLOGIC PROPERTIES OF MAJOR FAULTS

B.10.1 DEFINITION OF TEST

The Hydrologic Properties of Major Faults Encountered in the ESF test is discussed in Section 8.3.1.2.2.4.10 of the SCP.

This activity is designed to provide hydrologic information in conjunction with a portion of Activity 8.3.1.4.2.2.4 (Geologic Mapping of the Exploratory Shaft and Drifts). All faults encountered in the ESF will be characterized geologically under the geologic mapping activity. The major faults or fault zones expected to be tested are the Bow Ridge fault, the Boundary Ridge fault, the Imbricate fault zone, the Ghost Dance fault, a suspected fault in Drill Hole Wash, Solitario Canyon fault, 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 typically begin with 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 permeability to air of the fault zones. Some boreholes will be instrumented to determine in situ conditions of the rock mass and will be 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.10.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operation flexibility to perform the Hydrologic Properties of Major Faults Test.

B.10.3 DESIGN REQUIREMENTS

A. An HQ3-sized geothermal borehole may be drilled from the access drift at each test location. Access shall be provided to this borehole as soon as possible after drilling and at intervals of from two days initially to weekly thereafter.

[DERIVED]

B. Alcoves are required at each fault testing location as identified by the PI. Final alcove depth, orientation, and configuration will be determined in the field based on geologic information and written criteria provided by the USGS.

[DERIVED]

(1) Two alcoves will typically be required at each fault intercept.

[DERIVED]

(2) Unless otherwise specified for a specific alcove, the test location shall be large enough to allow dry drilling of up to 30 m (98 ft) boreholes.

[DERIVED]

(3) Final written criteria specifying the drilling configuration will be provided by the USGS during the test planning process. Any associated design or construction requirements to prepare the test location will be defined in test-related job packages.

[DERIVED]

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

[DERIVED]

D. Access to the alcoves and test boreholes is required for the entire duration of site characterization.

[DERIVED]

E. Standard ESF power with UPS backup, lighting, water, compressed air, ventilation, and communications (see Table B-2) are adequate to conduct these tests.

[DERIVED]

B.11 DIFFUSION TESTS IN THE ESF

B.11.1 DEFINITION OF TEST

The Diffusion Tests in the ESF are discussed in Section 8.3.1.2.2.5.1 of the SCP. The diffusion tests in the ESF will be conducted in the bedded tuff between the Tiva Canyon and the Topopah Spring Member, the Topopah Spring Member, and the Calico Hills unit. These tests will determine in situ the extent to which tracers diffuse into the Yucca Mountain tuffs penetrated by the ESF. Tracers will be introduced into boreholes in the tuffs and permitted to diffuse. After approximately three months, 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. Longer duration (approximately one year) tests will be performed once experimental techniques, developed during the three-month test, have been refined.

B.11.2 FUNCTIONAL REQUIREMENTS

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

B.11.3 DESIGN REQUIREMENTS

A. Alcoves shall be provided at the following locations for the diffusion tests:

- An alcove in the nonwelded bedded Paintbrush tuff unit below the Tiva,
- Two alcoves in the Main Drift and/or North Ramp Extension (Topopah Spring unit), and
- Four alcoves in the Calico Hills component of the ESF (two in the zeolitic units and two in the vitric units).

[DERIVED]

B. Alcoves shall be able to accommodate the equipment required to conduct the diffusion tests, such as dry-drilling equipment to emplace boreholes vertically or sub-horizontally, sample injection apparatus, and dry-overcoring equipment. Alcove depth, orientation, and configuration will be determined in the field based on geologic information and written criteria provided by the USGS.

[DERIVED]

C. Standard utilities shall be provided including power, lighting, water, ventilation, compressed air, and communications (see Table B-2).

[DERIVED]

D. Access to the alcoves throughout the duration of the diffusion tests is required for overcoring equipment and personnel.

[DERIVED]

B.12 FIELD-SCALE EXPERIMENTS TO STUDY RADIONUCLIDE TRANSPORT AT YUCCA MOUNTAIN

B.12.1 DEFINITION OF TEST

The Field-Scale Experiments to Study Radionuclide Transport at Yucca Mountain are discussed in Section 8.3.1.3.7.2.2 of the SCP.

This study will 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. Dual breakout rooms will be required for these tests. The upper room is where sampling instruments and equipment to apply water and tracers to the test block will be located. Access will need to be maintained to this room 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.12.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the Field Scale Experiments to Study Radionuclide Transport in the ESF.

B.12.3 DESIGN REQUIREMENTS

A. A total of eight sites will be selected for tests. Two tests will be conducted in each of the following geologic units:

- Zeolitic unit of the Calico Hills,
- Vitric unit of the Calico Hills,
- Vitric/zeolitic interface in the Calico Hills, and
- The Topopah Spring/Calico Hills contact.

(1) Two alcoves, separated vertically by a test block, shall be provided at each test location. The upper alcove will be constructed off the ESF drift at a location designated by the ESF TCO.

[DERIVED]

(2) Alcoves shall be able to accommodate the equipment required to conduct the Field-Scale Experiments to Study Radionuclide Transport at Yucca Mountain. The required depth, spatial separation, orientation, and configuration of each alcove shall be provided by the ESF TCO to the ESF A/E.

[DERIVED]

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

[DERIVED]

C. Standard ESF utilities including power, lighting, water, compressed air and communications are adequate (see Table B-2).

[DERIVED]

D. Once tests are initiated, continuous access to the upper alcove shall be ensured. If the lower alcove is deferred, access to the lower alcove shall be provided during construction.

[DERIVED]

E. Rock bolts shall not be used for roof support of the lower alcove.

[DERIVED]

B.13 UNDERGROUND GEOLOGIC MAPPING IN THE ESF

B.13.1 DEFINITION OF TEST

Geologic Mapping of the Exploratory Shaft and Drifts Test is discussed in Section 8.3.1.4.2.2.4 of the SCP. Geologic mapping and photogrammetry will be used to document lithologic and fracture variability throughout 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. 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 about 2 m [6 ft] intervals if in a shaft).

The test organization will map all ESF excavations, on a daily basis, usually mapping the extent of daily progress, up to an expected maximum of 75 m (250 ft) in TBM drifts. Mapping will generally be done prior to installation of any chain-link, mesh, or shotcrete. Where ground conditions require fabric or shotcrete, the excavation and mapping sequence will need to be modified to permit mapping near the heading.

In roadheader and/or mobile miner excavations, mapping will be done as near the heading as possible.

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 the purpose of mapping (machine excavation). In both cases, the walls will be mapped prior to installing any wire mesh, shotcrete, or permanent utilities.

B.13.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the Underground Geologic Mapping Test.

B.13.3 DESIGN REQUIREMENTS

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

[DERIVED]

B. In TBM drifts and ramps, a distance of at least 75 m (250 ft) shall 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.

[DERIVED]

C. In drifts other than those excavated by a full-face tunnel boring machine, a collapsible platform shall be provided to allow geologists access to all surfaces of the excavation.

[DERIVED]

(1) Utilities (including permanent fan line) shall not be installed until an area has been mapped and photographed. Generally, mapping will keep up with the daily excavation process.

[DERIVED]

(2) During drift wall mapping, all unnecessary equipment shall be removed from the section of the drift being mapped.

[DERIVED]

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

The shaft sinking galloway shall be provided with equipment to ensure a stable platform for photography.

[DERIVED]

E. Ground conditions encountered during tunnel excavation may impose safety-related limitations on access to, or exposures for, mapping activities. For normal mapping operations, nothing more than pattern bolting and approximately 15.2 cm (6 inch) or greater wire mesh should be present. If, due to ground conditions, additional ground control is necessary (such as steel rings, lagging, mesh less than 15.2 cm [6-inches], or shotcrete), construction management shall advise the ESF TCO and USGS mapping PI, and shall assist in identification of alternatives to collect geologic data.

[DERIVED]

F. The Construction Contractor shall clean the walls using compressed air/water following procedures approved by the ESF TCO and USGS PI.

[DERIVED]

G. The excavation contractor shall provide a support person for cleaning of the excavation walls, operating the mapping platform, hooking up utilities, and assistance in sample acquisition and handling.

[DERIVED]

H. Survey accuracy for mapping and sampling shall be $\pm$ 2 cm (0.79 in) (horizontally and vertically from the benchmark). Survey laser alignment shall be at least third order class II quality. The ability should be retained to re-survey and upgrade the initial mapping survey and reference points.

[DERIVED]

I. Re-mapping, or more detailed mapping, of excavation surfaces may be required to support the site characterization program. The capability to revisit previously mapped areas shall be maintained whenever possible.

[DERIVED]

J. Standard ESF utilities including power, lighting, water, compressed air and communications are adequate (see Table B-2).

[DERIVED]

K. Small alcoves may be required for secure storage of underground mapping equipment. The size and location of required alcoves will be developed by the ESF TCO in consultation with the ESF A/E.

[DERIVED]

B.14 SEISMIC TOMOGRAPHY/VERTICAL SEISMIC PROFILING AT THE ESF

B.14.1 DEFINITION OF TEST

The Seismic Tomography/Vertical Seismic Profiling tests are discussed in Section 8.3.1.4.2.2.5 of the SCP. The purpose of these tests is to apply seismic imaging methods (cross hole, cross drift, cross ramp, surface to subsurface, and Vertical Seismic Profiling) 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. In addition, passive seismic monitoring will be used to provide data to predict ground motion and its effects on potential repository integrity from nearby seismic events that may cause strong 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.

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. An exception will be the 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 one cubic meter (one cubic yard) of space will be necessary for each strong motion instrument. A maximum of ten are envisioned for the entire ESF.

B.14.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the Seismic Tomography/Vertical Seismic Profiling tests.

B.14.3 DESIGN REQUIREMENTS

A. Provide access to the drift and tunnel walls to drill test boreholes and to emplace instrumentation.

[DERIVED]

(1) Two shallow, parallel, drillholes will be required for the damage zone evaluation. These can be either air or water drilled; water is the preferred method but air drilling will be acceptable. Other drill holes may be necessary to map fracture or fault zones of interest that have been identified by the cross drift, the surface to drift seismic, or Vertical Seismic Profiling surveys.

[DERIVED]

(2) Space is required along the tunnel walls to attach seismic sensors (0.5 sq m [5 sq ft]) and to provide room for the associated cabling running to a portable central

recording system. The central recording 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 five or ten meter (16 or 33 feet) intervals. Only the strong motion recording devices are permanent, all other equipment will be removed after each survey. Approximately one cubic meter (35 cubic feet) of space is needed for each strong motion accelerometer and associated electronics. Once installed, access will be as required to replace faulty equipment.

[DERIVED]

B. Standard ESF utilities including power, lighting, water, compressed air, and communications are adequate (see Table B-2).

[DERIVED]

B.15 ACCESS CONVERGENCE MEASUREMENTS

B.15.1 DEFINITION OF TEST

The Access Convergence Measurements test is discussed in Section 8.3.1.15.1.5.1 of the SCP.

Access convergence tests are required to monitor rock-mass deformation around the accesses and to measure in situ stress at the stations where convergence is being measured.

Rock-mass deformation around the access ramp or drift will be monitored at measurement stations using multiple-point borehole extensometers (MPBXs) placed at the crown and springline of the opening. The MPBXs primarily consist of anchors installed at pre-designed depths. Movement in the rock mass is recorded as the rock moves. Deformations will be measured across the ramp diameter and at multiple locations in the access using rod or tape extensometers. Extensometer measurements will be made along diameters in the same plane as the MPBXs. Stress measurements will be made at stations located near faults.

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 m (300 ft) from major thermomechanical contacts and faults. Additional stations may be installed near major structural features. The tests will be performed in both ramps and in the optional ESF shaft if it is constructed. Stress meters will be installed about the faults that are encountered. As a minimum, the tests will 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.

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.15.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the Access Convergence Test.

B.15.3 DESIGN REQUIREMENTS

A. No special rooms or alcoves are required. The tests will be conducted in conjunction with excavation of all openings in the ESF.

   (1) Provide the capability to drill instrumentation boreholes (for accelerometers, MPBXs, tape extensometer anchors) from locations on the TBM, and from other locations in the North and South Ramps, Main Drift, North Ramp Extension and selected alcoves. Required locations for drilling support will be specified by the ESF TCO and PI.

[DERIVED]

(2) Provide the ability to install convergence pin anchors (at selected locations) as close to the TBM cutter head as possible. In some instances, access shall be provided ahead of the mapping platform to install extensometer anchors and MPBXs. Locations will be jointly determined by Sandia National Laboratories (SNL), the ESF TCO, ESF design, and the construction manager.

[DERIVED]

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

[DERIVED]

B. PI access to all instrumentation is required for the duration of the test:

[DERIVED]

(1) Tape extensometers and MPBX heads shall be maintained free of shotcrete.

[DERIVED]

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) shall accommodate these measurements.

[DERIVED]

D. Immediately after instrument installation, cable runs and equipment shall be installed by SNL to support transmission of data from instrumentation to a junction box on the right rib supplied by SNL.

[DERIVED]

E. Standard underground utilities and facilities for drilling shall be provided for this test Table B-2).

[DERIVED]

B.16 DEMONSTRATION BREAKOUT ROOM

B.16.1 DEFINITION OF TEST

This test has been deferred as access to the ESF is via ramps. However, the test may be implemented if the optional ESF shaft is constructed.

The Upper Demonstration Breakout Room test is discussed in Section 8.3.1.15.1.5.2 of the SCP.

This test will be used to demonstrate constructability and stability of underground openings in the high lithophysal zone of the Topopah Spring Member. A lower demonstration breakout room in welded fractured tuff (TSw2) is not necessary because of the experience that will be gained in building the ESF.

B.16.2 FUNCTIONAL REQUIREMENT

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

B.17 SEQUENTIAL DRIFT MINING

B.17.1 DEFINITION OF TEST

The Sequential Drift Mining test is discussed in Section 8.3.1.15.1.5.3 of the SCP. The purpose of this activity is to measure the deformational response of a potential repository size opening as the opening is being excavated. This is accomplished by installing instruments from adjacent drifts into a rock mass and subsequently excavating the instrumented rock mass.

The Sequential Drift Mining test will precede the Emplacement Drift Thermal Test and will be conducted in the same openings excavated for that test. The test arrangement includes an instrumentation access drift mined parallel to and on one side of the test drift. The access drift will be excavated first so that instrumentation can be installed to monitor changes in rock displacements, permeability, and stresses as the test drift is excavated. After the instruments have been installed, the test drift, having the same cross-sectional dimensions as those expected for potential repository emplacement drifts, shall be excavated using the same techniques that are expected to be used to excavate the potential repository.

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 parallel test drift. Air and water permeability in boreholes adjacent to the new drift opening will be measured before and after excavation.

B.17.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the Sequential Drift Mining Test.

B.17.3 DESIGN REQUIREMENTS

A. An access and instrumentation drift and a parallel, adjacent, repository-sized drift shall be provided. The orientation and location of the rooms are to be decided. Flexibility regarding drift orientation and location is needed so that the room orientation will match the orientation to be used in the actual repository. The required depth, spatial separation, orientation, and configuration of each alcove shall be provided by the ESF TCO to the ESF A/E.

[DERIVED]

B. No excavation, except to excavate the test drift, should be allowed within 15 m (50 ft) of any MPBX anchor until MPBX measurements are no longer being taken. No other drifts should be mined within three drift diameters of the outside ribs of the instrumentation drifts without the consent of the ESF TCO.

[DERIVED]

C. Standard underground utilities and facilities for drilling shall be provided for this test (see Table B-2).

[DERIVED]

D. Access to test instrumentation shall be provided for the duration of the test.

[DERIVED]

B.18 SINGLE ELEMENT HEATER TEST (FIRST ESF THERMAL TEST SHAKEDOWN PHASE)

B.18.1 DEFINITION OF TEST

The Single Element Heater Test (also referred to as the Shakedown Phase of the First ESF Thermal Test) discussed in the *In Situ Thermal Testing Program Strategy* (DOE/YMSCO-003, 1995), is similar to the Canister Scale Heater Test described in Section 8.3.1.15.1.6.2 of the SCP. This test is part of the thermal testing strategy associated with the current program and is not explicitly covered in the SCP.

The objectives of this activity are to provide measurement of rock mass thermal and thermomechanical properties and to investigate coupled thermal-mechanical response at several locations representative of potential repository conditions. The test will provide some data for input to the Technical Site Suitability determination and therefore requires early access to the potential repository horizon.

The test will be installed in a sidewall parallel to another drift or near a corner so that instrumentation can be installed parallel and perpendicular to the heater axis. A heater hole, parallel small-diameter instrumentation holes, and perpendicular MPBX holes will be drilled at each test location. A borehole jack will be used to measure rock mass modulus. Baseline moisture data in neutron probe holes will be recorded. Rock mass permeability measurements will be made before and after the test. A heater and instrumentation (thermocouples, MPBXs, and borehole deformation gages) will be installed. Finally, heating in incremental steps will be initiated, and thermal, thermomechanical phenomena will be monitored at increasing heat loads.

This test will raise the temperature of the rock mass above 200°C and must therefore be isolated from other ESF activities.

B.18.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the Single Element Heater Test.

B.18.3 DESIGN REQUIREMENTS

A. An alcove shall be provided in the TSw2 unit away from contacts and faults.

[DERIVED]

(1) The test shall be located in a low traffic area.

[DERIVED]

(2) The test shall be located to permit instrumentation to be installed in boreholes both parallel and perpendicular to the axis of the heater borehole.

[DERIVED]

(3) Test location, layout, dimensions, and configuration of the alcove, heater and test instrumentation will be supplied by the ESF TCO as design and test-related information for design package(s).

[DERIVED]

B. The heater shall be installed sufficiently remote from other mined openings to limit the influence of the openings on the stresses near the heater and on the temperatures produced in the rock mass. Required stand-off distances shall be determined by the PI and provided to the ESF A/E by the ESF TCO.

[DERIVED]

C. Provide the capability to drill boreholes for the heater and instrumentation (thermocouples, MPBXs, borehole deformation gages, neutron probes, and moisture sensing gages).

[DERIVED]

D. Enhanced underground utilities and facilities for drilling shall be provided for this test (see Table B-2).

[DERIVED]

B.19 EMPLACEMENT DRIFT THERMAL TEST (FIRST ESF THERMAL TEST)

B.19.1 DEFINITION OF TEST

The Emplacement Drift Thermal Test (also referred to as the First ESF Thermal Test) is based on an integration of the test objectives and strategies for the Heated Room and Thermal Stress Tests described in Section 8.3.1.15.1.6 of the SCP, the Mechanical Attributes of the Waste Package Environment study described in Section 8.3.4.2.4.3 of the SCP, and one phase of the Engineered Barrier field test described in Section 8.3.4.2.4.4 of the SCP.

The test is designed to address specific phenomenonological issues associated with the waste package environment and preclosure issues related to ground support and opening stability.

The test arrangement includes an instrumentation access drift mined parallel to and on one side of the test drift. The access drift will be excavated first so that instrumentation can be installed to monitor changes in rock displacements, permeability, and stresses as the test drift is excavated. The Sequential Drift Mining Test described in Section 8.3.1.15.1.5 of the SCP, and in Section B.17 of this document, will be conducted during the construction of the test drift. Instruments will be installed, primarily within boreholes, and the test drift will then be excavated. Heaters and additional instrumentation will then be installed in boreholes drilled from within the test drift and a series of mockup multi-purpose canister heaters (about three to five) will be installed in the drift. One section of the heated drift may include backfill over the heater element and a provision to add water to the top of the backfill. The heated drift will be sealed during the experiment.

Instrumentation will consist of thermocouples, thermal flux gages, pressure sensors, MPBXs, displacement gages, and neutron probes installed in boreholes. Observation boreholes will be used to monitor fluid movement and air samples will be taken from the heated drift. Air permeability measurements will be made in boreholes within and around the thermally perturbed zone. Stress changes and ground support reactions will also be monitored as the drift is heated. Mineralogic changes will be monitored using core samples obtained before and after testing.

A Plate Load Thermal Test will also be conducted inside the test drift. This test is a derivative of several test concepts, including the canister scale heater test and the heated block test discussed in Section 8.3.1.15.1.6 of the SCP, and the plate loading test described in Section 8.3.1.15.7 of the SCP. The objective of this test is to investigate thermal-mechanical properties such as thermal expansion and rock mass modulus on an intermediate scale.

The test utilizes the emplacement drift guard heaters as a heat source, and incorporates instrumented boreholes installed adjacent to a slot or small alcove excavated in the emplacement test drift sidewall, just outside of the sealed area. The small alcove will permit installation of the plate loading apparatus used to measure the rock mass modulus under both nominal and elevated temperature conditions.

These tests will raise the temperature of the rock mass above 200°C and must therefore be isolated from other ESF activities.

B.19.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the Emplacement Drift Thermal and Plate Load Thermal tests.

B.19.3 DESIGN REQUIREMENTS

A. A test location shall be provided in the TSw2 unit away from contacts and faults.
[DERIVED]

B. The Construction Contractor shall excavate, support, and prepare the test areas, drill instrumentation boreholes, and assist with the installation of test equipment under the direction of the ESF TCO.
[DERIVED]

C. The test shall be installed sufficiently remote from other mined openings to limit the influence of the openings on the stresses and temperatures produced in the rock mass. Required stand-off distances and other criteria for locating this test shall be determined by the PI and provided to the ESF A/E by the ESF TCO.
[DERIVED]

D. The required layout of instrumentation and heaters in the access and test drifts, and the required dimensions of the alcove/slot will be provided by the ESF TCO in Test Planning documentation for this test.
[DERIVED]

E. Careful construction of the access and test drifts is required to avoid excessive damage to the near-field rock. Controlled drill-and-blast excavation methods may be used if it can be demonstrated that they meet blast damage criteria. These criteria and the acceptability of the excavation method will be developed by the ESF TCO and the ESF A/E.
[DERIVED]

F. Provide the capability to mine the alcove/slot that will house the plate loading apparatus using excavation methods that minimize disturbance of the rock mass.
[DERIVED]

G. This test will require major upgrading of the power component of the standard ESF utility package along with other standard utilities and facilities for drilling (see Table B-2). Special provisions may also need to be made in routing power to this test and within the test area due to the very high anticipated thermal loads.
[DERIVED]

H. Access to the test area may be required while the test is underway. However, rock fall and thermal hazards will exist in the vicinity of this test requiring that access be controlled to prevent entry by unauthorized personnel.
[DERIVED]

I. Special doors and thermal barriers may be required to control the ventilation and heat flow from the test drift and from the overall test area. No traffic shall be allowed in the test drift during the experiment.

[DERIVED]

J. Provide the capability to drill boreholes for the heater and instrumentation (thermocouples, MPBXs, borehole deformation gages, neutron probes, moisture sensing gages, thermocouples, thermal flux gages, etc.).

[DERIVED]

B.20 ENGINEERED BARRIER SYSTEM FIELD TESTS (LARGE SCALE, LONG DURATION THERMAL TEST)

B.20.1 DEFINITION OF TEST

The Engineered Barrier System Field Test, also referred to as the Large Scale, Long Duration Thermal Test, is discussed in Section 8.3.4.2.4 of the SCP. The purpose, objectives, and rationale for the test are described in Study Plans 8.3.4.2.4.3, Characterization of the Geomechanical Attributes of the Waste Package Environment; and 8.3.4.2.4.4, Engineered Barrier System Field Tests. The test description contained in the SCP and the design requirements contained in the previous ESFDR were for the SCP-CD borehole emplacement configuration that has been changed. The new emplacement configuration includes multi-purpose canisters placed in drifts.

The ESF tests currently included to study the coupled thermal-mechanical-hydrological-chemical processes within the integrated thermal testing strategy are the first ESF Thermal Test (Shakedown and Main Phases) and the Large Scale, Long Duration Thermal Test. Descriptions of the two phases of the first tests are in Sections B.18 and B.19 of this appendix.

The first ESF Thermal Test will be conducted in a region near the bottom of the North Ramp, in the TSw2 unit.

The Large Scale, Long Duration Thermal Test will be conducted after the first ESF Thermal Test in an adjacent area. Details of the test layout and configuration are currently unavailable, but are expected to include multiple heater drifts and multiple instrumentation drifts at elevations above and below the heater elevation. Details will be included in future revisions to this appendix when they become available.

B.20.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to conduct the Engineered Barrier System Field Tests.

B.20.3 DESIGN REQUIREMENTS

A. Three or more adjacent drifts shall be provided in the TSw2 unit in the vicinity of the Drift Scale Thermal Test.

[DERIVED]

(1) The Construction Contractor shall excavate, support, and prepare the test areas, drill instrumentation boreholes, and assist with the installation of test equipment under the direction of the ESF TCO.

[DERIVED]

(2) The test shall be installed sufficiently remote from other mined openings to limit the influence of the openings on the stresses and temperatures produced in the rock mass. Required stand-off distances and other criteria for locating this test shall be determined by the PI and provided to the ESF A/E by the ESF TCO.

[DERIVED]

(3) Provide the capability to drill boreholes for and install the heaters and instrumentation to be used in this experiment. The required layout of instrumentation and heaters in each drift will be provided by the ESF TCO in Test Planning documentation for this test.

[DERIVED]

(4) Alternative locations and drift configurations, potentially required for this test, shall be communicated by the ESF TCO to the ESF A/E.

[DERIVED]

B. Careful construction of the access and test drifts is required to avoid excessive damage to the near-field rock. Controlled drill-and-blast excavation methods may be used if it can be demonstrated that they meet blast damage criteria. These criteria and the acceptability of the excavation method will be developed by the ESF TCO and the ESF A/E.

[DERIVED]

C. This test will require major upgrading of the power component of the standard ESF utility package along with other standard utilities and facilities for drilling (see Table B-2). Special provisions may also need to be made in routing power to this test and within the test area due to the very high anticipated thermal loads.

[DERIVED]

D. Access to the test area may be required while the test is underway. However, rock fall and thermal hazards may exist in the vicinity of this test requiring that access be controlled to prevent entry by unauthorized personnel.

[DERIVED]

E. No metallic rock bolts shall be located within the test region, defined by the rock mass that is penetrated by the instrumentation boreholes, plus 1.5 m (5 ft). If metallic wire mesh is used for support, it should be electrically isolated from the drift.

[DERIVED]

F. Once a test has begun, no excavation that could affect the stress state near the heaters may begin.

[DERIVED]

G. 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.

[DERIVED]

H. The Large Scale, Long Duration Thermal Test will require heater and instrumentation drifts at multiple elevations.

[DERIVED]

B.21 PLATE LOADING TESTS

B.21.1 DEFINITION OF TEST

The Plate Loading Test is discussed in Section 8.3.1.15.1.7.1 of the SCP.

The plate loading test loads diametrically opposed surfaces of rock for the purpose of deformation measurements. 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.

Plate loading experiments will be performed at numerous (10-20) locations in the ESF. Horizontal and vertical measurements will be made in each of the thermomechanical units encountered in the North and South Ramps. Testing will be performed in the South Ramp in order 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 Main Drift and in the 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.

Instruments that will be installed in and around this test include MPBXs, rod extensometers, rock bolt load cells, and acoustic monitoring sensors.

B.21.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the Plate Loading Tests.

B.21.3 DESIGN REQUIREMENTS

A. Provide alcoves, constructed off the North Ramp, South Ramp, or North Ramp Extension, for conducting the Plate Loading tests.

[DERIVED]

(1) Provide the capability to drill boreholes for and install the instrumentation (MPBXs, extensometer anchors, and acoustic emission microphones) to be used in this experiment.

[DERIVED]

(2) The required location and dimensions for each alcove will be provided by the ESF TCO to the ESF A/E.

[DERIVED]

(3) The required layout of instrumentation in each alcove will be provided by the ESF TCO in test planning documentation for this test.

[DERIVED]

(4) Flexibility in locating each test alcove shall be provided to ensure that the joint spacing and orientation at the location are reasonably representative of the potential repository horizon.

[DERIVED]

B. Standard underground utilities and facilities for drilling shall be provided for this test (see Table B-2).

[DERIVED]

C. Access to the test alcoves shall be maintained while the test is underway.

[DERIVED]

B.22 ROCK-MASS STRENGTH EXPERIMENT

B.22.1 DEFINITION OF TEST

The Rock-Mass Strength Experiment is discussed in Section 8.3.1.15.1.7.2 of the SCP.

This activity evaluates the mechanical behavior of the rock-mass. Tests will obtain information on the mechanical response of rock containing multiple joint sets. Tests will be conducted in drifts at the Topopah Spring Level (units TSw1 and TSw2), and areas will be selected to be representative of the range of geologic conditions expected in the potential repository. Joint shear response will be measured on individual joints using International Society for Rock Mechanics suggested methods. Rock Mass uniaxial strength will be measured on large blocks (1 m to 2 m, [3 to 6 ft]) that include multiple joints. Blocks of rock will be cut using hydraulic chain saws and compressive loads will be applied using flatjacks. The information will be used to evaluate scale effects between laboratory and in situ conditions, provide data to evaluate empirical design criteria, and provide data to evaluate and validate jointed-rock models.

Instruments and test equipment that will be installed in and around this test include: flatjack(s), rod extensometer, fracture deflection gage(s), MPBXs, long-gage surface extensometers.

B.22.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the Rock-mass Response Test.

B.22.3 DESIGN REQUIREMENTS

A. Provide alcoves, constructed off the North Ramp, South Ramp, North Ramp Extension, and Calico Hills Drift for conducting the Rock-Mass Strength Experiment.

[DERIVED]

(1) Flexibility in location of the test alcoves is required to ensure that the test is conducted in rock with the appropriate fracture spacing and quality. Alcoves cannot be located until after exploration and mapping identify appropriate rock conditions.

[DERIVED]

(2) The required location and dimensions for each alcove will be provided by the ESF TCO to the ESF A/E.

[DERIVED]

(3) The required layout of instrumentation in each alcove will be provided by the ESF TCO in test planning documentation for this test.

[DERIVED]

(4) Provide the capability to drill instrumentation boreholes (for MPBXs and fracture deflection gages).

[DERIVED]

B. Standard underground utilities and facilities for drilling shall be provided for this test (see Table B-2).

[DERIVED]

C. Access to the test alcoves is needed while the tests are underway.

[DERIVED]

B.23 EVALUATION OF MINING METHODS

B.23.1 DEFINITION OF TEST

The Evaluation of Mining Methods Test is discussed in Section 8.3.1.15.1.8.1 of the SCP.

These tests 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 methods 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.).

The test will be performed as the excavation proceeds, following the excavation equipment. The test will be performed near the face, in order to record the performance 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.

B.23.2 FUNCTIONAL REQUIREMENTS

Provide the operational flexibility to perform the Evaluation of Mining Methods tests.

B.23.3 DESIGN REQUIREMENTS

A. No special rooms or alcoves are required. The tests will be conducted in conjunction with excavation of all openings in the ESF. Both ramps will be considered in this experiment, because of the different slopes, lithologies, and faults associated with each ramp.

[DERIVED]

B. Provide the capability to drill, grout and re-drill holes for inspection of the blast damaged zone.

[DERIVED]

C. Provisions shall be made for certain data to be collected by the Construction Contractor. Requirements will be provided in test planning documentation for this test.

[DERIVED]

D. Standard underground utilities will be required for this test (see Table B-2).

[DERIVED]

B.24 MONITORING OF GROUND SUPPORT SYSTEMS

B.24.1 DEFINITION OF TEST

The monitoring of ground support systems, discussed in Section 8.3.1.15.1.8.2 of the SCP, will develop recommendations for ground support in drifts in the potential repository, based on evaluations of the ground support techniques used in the underground excavations, and on experimentation with other ground support configurations. This activity will be carried out in both ramps, in the Main Drift, the North Ramp Extension, and in the Calico Hills. The selection, installation, and performance of the support systems used will be monitored. Experimentation with ground supports will include pull tests on rock bolts and installation of rock bolt load cells. Observation will be made of unsupported rock, strength measurements will be made on shotcrete cores, and trials of ground support systems different from those prescribed for the ESF may be made.

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

B.24.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to permit Monitoring of Ground Support Systems.

B.24.3 DESIGN REQUIREMENTS

A. No special rooms or alcoves are required. The tests will be conducted in conjunction with excavation of all openings in the ESF.

[DERIVED]

(1) Provide the capability to drill instrumentation boreholes (for MPBXs).

[DERIVED]

(2) Access to selected rock bolts shall be provided for installation of load cells.

[DERIVED]

(3) Provide the capability to install extra rock bolts, in addition to those required for safety, for this test.

[DERIVED]

(4) Provide the personnel and equipment to perform pull tests on installed rock bolts as required by the PI.

[DERIVED]

(5) Where shotcrete is used, provide the capability to take cores for laboratory testing of strength and bonding to the rock.

[DERIVED]

(6) For each location where steel sets are used, provide the capability to instrument two with load cells. Provide the capability to weld or otherwise attach instruments to the steel sets before the sets are installed.

[DERIVED]

B. Access to instrumented ground support elements and the MPBXs shall be provided for the duration of the test.

[DERIVED]

C. Standard underground utilities shall be provided for this test (see Table B-2).

[DERIVED]

B.25 MONITORING DRIFT STABILITY

B.25.1 DEFINITION OF TEST

The Monitoring Drift Stability test is discussed in Section 8.3.1.15.1.8.3 of the SCP.

These tests will monitor drift convergence and drift maintenance activities throughout the ESF, along accesses, and in the Calico Hills. Convergence measurement stations will be selected by the PI. Where possible, convergence measurements will be taken in a continuous manner. Rock mass relaxation will be investigated using MPBXs. Rock falls and maintenance activities will be documented.

No special room or alcove is required. The tests will be conducted at drift closure monitoring stations in the North and South Ramps, in the Main Drift, especially near the Ghost Dance Fault, and in the Calico Hills. Drift intersections will be monitored, and will be more heavily instrumented than the tests at locations away from drift intersections.

B.25.2 FUNCTIONAL REQUIREMENTS

Provide the operational flexibility to Monitor Drift Stability.

B.25.3 DESIGN REQUIREMENTS

A. No special rooms or alcoves are required. The tests will be conducted in conjunction with excavation of all openings in the ESF.

(1) Provide the capability to drill instrumentation boreholes (for accelerometers, MPBXs, tape extensometer anchors) from locations on the TBM, and from other locations in the North and South Ramps, Main Drift, North Ramp Extension and selected alcoves. Required locations for drilling support will be specified by the ESF TCO and PI.

[DERIVED

(2) Provide the ability to install convergence pin anchors (at selected locations) as close to the TBM cutter head as possible. In some instances, access shall be provided ahead of the mapping platform to install extensometer anchors and MPBXs. Locations will be jointly determined by SNL, the ESF TCO, ESF design, and the Construction Manager.

[DERIVED]

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

[DERIVED]

B. PI access to all instrumentation is required for the duration of the test:

[DERIVED]

(1) Tape extensometers and MPBX heads shall be maintained free of shotcrete.

[DERIVED]

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) shall accommodate these measurements.

[DERIVED]

D. Standard underground utilities and facilities for drilling shall be provided for this test (see Table B-2).

[DERIVED]

B.26 AIR QUALITY AND VENTILATION EXPERIMENT

B.26.1 DEFINITION OF TEST

The purpose of the Air Quality and Ventilation test, discussed in Section 8.3.1.15.1.8.4 of the SCP, 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 air-flow velocity and pressure, temperature, and humidity;
- Determinations of air resistance factors; and
- 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.

The sealed drift test will be conducted after construction is completed. The end section of a drift or alcove in the Main Drift or North Ramp Extension will need to be sealed with a bulkhead to allow measurement of radon gas emanation.

B.26.2 FUNCTIONAL REQUIREMENTS

Provide the operational flexibility to perform the Air Quality and Ventilation Experiment.

B.26.3 DESIGN REQUIREMENTS

A. Provide a dead-end drift in the North Ramp or North Ramp Extension that can be sealed with a bulkhead for measurements of radon emanation. The sealed drift will be repeatedly ventilated and then allowed to reach equilibrium. Independent control of the ventilation system and air flow rate shall be provided.

[DERIVED]

(1) Test preparation shall be initiated within one month after the test location is exposed.

[DERIVED]

(2) Provide the capability to drill a radon measurement hole in the dead-end drift. Drilling of some additional monitoring holes may be also be required; however, where possible, holes drilled for other testing will be utilized.

[DERIVED]

(3) Final layouts, dimensions, and instrument configurations will be determined based on field conditions and communicated to the ESF A/E by the ESF TCO.

[DERIVED]

B. Access to the dead-end drift shall be provided throughout the test period. Periodic access to locations throughout the ESF after construction is completed is also needed for this test.

[DERIVED]

C. Provide the capability to perform surveys of air-flow and pressure, temperature, and humidity, determinations of air resistance factors, and dust characterization in the North and South Ramps, and Main Drift.

[DERIVED]

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

(1) Access to the entry and exit points for the exhaust ventilation line for periodic sampling or instrumentation shall be provided.

[DERIVED]

(2) Design flexibility to install ports for sampling by SNL at selected locations along the vent line shall be provided.

[DERIVED]

E. As an interim part of this test, samples of mined rock may be collected from the TBM conveyor. Provide the capability to sample and transport mined rock in 19 liter to 208 liter (5-gallon to 55-gallon) drums from the heading to the surface facilities located on the portal pad.

[DERIVED]

F. Standard underground utilities and facilities for drilling shall be provided for this test (see Table B-2).

[DERIVED]

B.27 OVERCORE STRESS EXPERIMENTS IN THE ESF

B.27.1 DEFINITION OF TEST

The Overcore Stress Experiments in the ESF are discussed in Section 8.3.1.15.2.1.2 of the SCP.

The overcore stress experiments will be performed 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. Initially, 25 m (82 ft) long, NX-size holes will be cored to examine fracture characteristics at the test location. The overcoring experiment will involve drilling a small diameter (EX-size) pilot hole that will be instrumented and then overcored using a 152 mm (6 in) diameter core barrel.

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 Drift and North Ramp Extension, 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.

B.27.2 FUNCTIONAL REQUIREMENTS

Provide the facility design and operational flexibility to perform the Overcore Stress Experiments.

B.27.3 DESIGN REQUIREMENTS

A. This test will be conducted in alcoves constructed for the Excavation Effects Test.
[DERIVED]

B. Provide adequate space to drill and core the instrumentation holes.
[DERIVED]

C. Flexibility in location of the tests 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.
[DERIVED]

D. Final layouts, dimensions, and instrument configurations will be determined based on field conditions and communicated to the ESF A/E by the ESF TCO.
[DERIVED]

E. Access shall be maintained to the borehole locations until after overcoring is complete. No further access will be required after overcoring is complete.
[DERIVED]

F. Standard underground utilities and facilities for drilling shall be provided for this test (see Table B-2).
[DERIVED]

B.28 DEVELOPMENT AND DEMONSTRATION OF REQUIRED EQUIPMENT

B.28.1 DEFINITION OF TEST

The development and demonstration of required equipment activity is discussed in Section 8.3.2.5.6 of the SCP.

The ESF test provides the capability for the in situ demonstration of equipment developed for the program. The types of equipment that may be demonstrated include:

- Mining (e.g., mechanical excavation equipment),
- Horizontal and vertical borehole construction,
- Remote systems for emplacing and retrieving waste.

This test also includes prototype testing and the development of test instrumentation for activities covered in SCP 8.3.1.15.1.

B.28.2 FUNCTIONAL REQUIREMENTS

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

B.28.3 DESIGN REQUIREMENTS

Provide the capability to monitor and instrument the performance of prototype equipment in the ESF. Explicit needs will be developed by the ESF A/E and ESF TCO and provided by the ESF TCO.

[DERIVED]

B.29 IN SITU TESTING OF SEAL COMPONENTS

B.29.1 DEFINITION OF TEST

The In Situ Testing of Seal Components activity is discussed in Section 8.3.3.2.2.3 of the SCP.

There are two categories of testing required in the sealing program:

A. Category A: Intrinsic permeability characterization of discrete, geologic features to evaluate water inflow and air outflow. 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 two 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 potential 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.

B. Category B: Evaluation of specific sealing concepts and sealing components including a hydrologic assessment of selected, rock mass locations to drain water and characterization of the modified permeability zone (MPZ) in the Main Ramps and in the drifts parallel to the Main Ramp. Category B Tests are planned for:

   (1) The North Ramp in the TCw and nonwelded PTn.

   (2) The Calico Hills unit south of and parallel to the southern Ghost Dance fault drift.

   (3) The Calico Hills unit at the north or south end of the CHn Main Drift (dependent on hydrologic conditions of the access ramps).

   (4) The North Ramp Extension (coupled heated block/grout test, and the engineered drainage-enhancement 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 to be 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,
- 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.29.2 FUNCTIONAL REQUIREMENTS

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

B.29.3 DESIGN REQUIREMENTS

A. Category A tests will require alcoves or adequate space for core drilling two horizontal holes.

[DERIVED]

(1) Provide adequate space to drill and core the instrumentation holes.

[DERIVED]

(2) Final layouts, dimensions, and instrument configurations will be determined based on field conditions and communicated to the ESF A/E by the ESF TCO.

[DERIVED]

B. The Category B tests currently require extensive construction support.

(1) Tests at the North Ramp TCw and nonwelded PTn locations shall be developed consistent with the development of the main potential repository level, if possible. At each location approximately 300 m (1,000 ft) of drifting and two 15 m (50 ft) deep shafts shall be provided.

[DERIVED]

(2) A drift perpendicular to the Main Drift, approximately 30 m (100 ft) long, and up to three alcoves shall be provided for the Calico Hills Test. The drift shall be constructed south of and parallel to the southern Ghost Dance fault drift and shall utilize the same design as the remainder of drifting in the Calico Hills unit.

[DERIVED]

(3) A 30 m (100 ft) long drift shall be provided for the Calico Hills Test at the north or south end of the CHn Main Drift.

[DERIVED]

(4) The North Ramp Extension coupled heated block/grout test shall utilize the Heated Block test alcove, if possible.

[DERIVED]

(5) A drift approximately 25 m (75 ft) long shall be provided for the North Ramp Extension engineered drainage-enhancement tests.

[DERIVED]

C. The required location and dimensions for each test arrangement will be provided by the ESF TCO to the ESF A/E.

[DERIVED]

D. Standard underground utilities and facilities for drilling shall be provided for both Category A and Category B tests (see Table B-2).

[DERIVED]

B.30 ACRONYMS AND ABBREVIATIONS

A/E	Architect/Engineer
CHn	Calico Hills Nonwelded Unit
DAS	Data Acquisition System
ESF	Exploratory Studies Facility (includes accesses and drifts)
ESFDR	ESF Design Requirements Document
MPBX	Multiple-Point Borehole Extensometer
PI	Principal Investigator, Experimentalist
PTn	Paintbrush Tuff Nonwelded (bedded) Unit
RBT	Radial Borehole Tests
SCP	Site Characterization Plan
SNL	Sandia National Laboratories
TBM	Tunnel Boring Machine
TCO	Test Coordination Office
TCw	Tiva Canyon Welded Unit
TSw1	Topopah Spring Welded Unit 1
TSw2	Topopah Spring Welded Unit 2
TSw3	Topopah Spring Welded Unit 3
UPS	Uninterruptible Power Supply
USGS	United States Geological Survey

INTENTIONALLY LEFT BLANK

APPENDIX C

RESERVED

INTENTIONALLY LEFT BLANK

APPENDIX D

SITE DESIGN AND TEST REQUIREMENTS DOCUMENT TRACEABILITY MATRIX

INTENTIONALLY LEFT BLANK

APPENDIX D

SITE DESIGN AND TEST REQUIREMENTS DOCUMENT TRACEABILITY MATRIX

SD&TRD SECTION	ESFDR SECTION
I.3.2.1.1.1.A	3.2.1.1.2.6.A
I.3.2.1.1.1.A	3.4.2.1.2.H
I.3.2.1.1.1.B	3.8.2.10.1.B
I.3.2.1.1.1.B	3.8.2.10.1.C
I.3.2.1.1.2.A	3.4.2.1.2.A
I.3.2.1.1.2.A	3.4.2.5.1.H
I.3.2.1.1.2.A	3.4.2.6.1.I
I.3.2.1.1.2.A	3.4.5.1.2.A
I.3.2.1.1.2.A	3.8.2.5.1.F
I.3.2.1.1.2.B	3.8.2.11.1.E
I.3.2.1.1.2.D	3.8.2.5.1.J
I.3.2.1.1.2.D	3.8.2.5.1.L
I.3.2.1.1.2.D	3.8.2.11.1.E
I.3.2.1.1.3.A	3.4.2.1.2.A
I.3.2.1.1.3.A	3.8.2.4.1.A
I.3.2.1.1.3.A	3.8.2.4.1.B
I.3.2.1.1.3.A	3.8.2.4.1.E
I.3.2.2.1.A	3.2.1.1.2.2.A
I.3.2.2.1.A	3.4.5.2.1.AC
I.3.2.2.1.A	3.4.5.3.1.U
I.3.2.2.1.A	3.4.5.5.1.N
I.3.2.2.1.A	3.4.5.6.1.H
I.3.2.2.1.A	3.4.5.7.1.F
I.3.2.2.1.A	3.4.6.3.1.H
I.3.2.2.1.A	3.6.2.1.Q
I.3.2.2.1.A	3.8.2.2.1.Q
I.3.2.2.1.A	3.8.2.3.1.M
I.3.2.2.1.A	3.8.2.4.1.G
I.3.2.2.1.A	3.8.2.5.1.Q
I.3.2.2.1.A	3.8.2.6.1.G
I.3.2.2.1.A	3.8.2.7.1.N
I.3.2.2.1.A	3.8.2.8.1.E
I.3.2.2.1.A	3.8.2.9.1.E
I.3.2.2.1.A	3.8.2.11.1.F
I.3.2.2.1.B	3.2.1.1.2.2.B

SD&TRD SECTION	ESFDR SECTION
I.3.2.2.2.A	3.2.1.1.2.1.C
I.3.2.2.2.A	3.2.1.1.2.1.C.1
I.3.2.2.2.A	3.2.1.1.2.1.C.2
I.3.2.2.2.A	3.2.1.1.2.1.C.3
I.3.2.2.2.B	3.2.1.1.2.1.A
I.3.2.2.2.B	3.2.1.1.2.1.B
I.3.2.2.2.B	3.2.1.1.2.3.A
I.3.2.2.3.A	3.2.1.1.2.3.B.4
I.3.2.2.3.B	3.2.1.1.3.1.B
I.3.2.2.3.C.1.a	3.2.1.1.2.3.B.1
I.3.2.2.3.C.1.a	3.8.2.1.2.B
I.3.2.2.3.C.1.a	3.8.2.1.2.C
I.3.2.2.3.C.1.b	3.2.1.1.2.3.B.2
I.3.2.2.3.C.1.b	3.8.2.1.2.B
I.3.2.2.3.C.1.b	3.8.2.1.2.C
I.3.2.2.3.C.1.b	3.8.2.7.1.I
I.3.2.2.3.C.1.c	3.2.1.1.2.3.B.3
I.3.2.2.3.C.1.c	3.8.2.1.2.B
I.3.2.2.3.C.1.c	3.8.2.1.2.C
I.3.2.2.3.C.1.d	3.2.1.1.2.3.B.4
I.3.2.2.3.C.1.d	3.8.2.1.2.B
I.3.2.2.3.C.1.d	3.8.2.1.2.C
I.3.2.2.3.C.1.e	3.2.1.1.2.3.B.5
I.3.2.2.3.C.1.f	3.2.1.1.2.3.B.6
I.3.2.2.3.D	3.2.1.1.2.3.C
I.3.2.2.3.D.1	3.2.1.1.3.2.C
I.3.2.2.3.E.1	3.2.1.1.2.3.B.3
I.3.2.2.3.E.1	3.2.1.1.2.3.B.4
I.3.2.2.3.E.2	3.2.1.1.3.1.C
I.3.2.2.4.A	3.2.1.2.2.A
I.3.2.2.4.B	3.2.1.2.2.B
I.3.2.3.1.A	3.2.1.2.1.1.A
I.3.2.3.1.A	3.2.1.2.1.1.D
I.3.2.3.1.A	3.2.1.2.1.1.H
I.3.2.3.1.A	3.2.1.2.1.1.J
I.3.2.3.1.A	3.2.1.2.1.2.A
I.3.2.3.1.A	3.2.1.2.1.2.B
I.3.2.3.1.A	3.2.1.2.1.2.D
I.3.2.3.1.A	3.4.5.2.1.X

SD&TRD SECTION	ESFDR SECTION
I.3.2.3.1.A	3.8.2.7.1.H
I.3.2.3.1.B	3.2.1.2.1.1.G
I.3.2.3.1.C	3.2.1.2.1.1.C
I.3.2.3.1.D	3.2.1.2.4.A
I.3.2.3.1.E	3.2.1.2.1.1.B
I.3.2.3.1.F	3.2.1.2.1.1.I
I.3.2.3.1.F	3.4.5.7.1.E
I.3.2.3.1.F	3.5.1.2.B
I.3.2.3.1.G.1	3.3.1.Z
I.3.2.3.1.G.1	3.4.3.1.C
I.3.2.3.1.G.1	3.4.4.1.J
I.3.2.3.1.G.1	3.5.2.1.F
I.3.2.3.1.G.1	3.5.4.1.E
I.3.2.3.1.G.1	3.5.6.1.C
I.3.2.3.1.G.1	3.5.10.1.D
I.3.2.3.1.G.2	3.3.1.Z
I.3.2.3.1.G.2	3.4.4.1.J
I.3.2.3.1.G.2	3.5.2.1.F
I.3.2.3.1.G.2	3.5.4.1.E
I.3.2.3.1.G.2	3.5.6.1.C
I.3.2.3.1.G.2	3.5.10.1.D
I.3.2.3.1.G.2	3.7.2.2.1.B
I.3.2.3.1.G.2	3.7.2.6.1.A
I.3.2.3.1.I	3.2.1.2.1.1.F
I.3.2.3.1.I	3.2.1.2.1.2.C
I.3.2.3.1.J	3.2.1.2.1.1.E
I.3.2.3.1.J	3.2.1.2.1.1.G
I.3.2.3.2.1.A	3.4.2.1.2.B
I.3.2.3.2.1.B	3.4.5.3.1.N
I.3.2.3.2.1.B	3.8.2.6.1.F
I.3.2.3.2.1.B	3.8.2.9.1.B
I.3.2.3.2.1.B	3.8.2.9.1.D
I.3.2.3.2.3	3.6.4.2.1.D
I.3.2.5	3.4.2.1.1.C
I.3.2.5	3.4.2.1.2.J
I.3.2.5	3.4.2.7.1.R
I.3.2.6	3.2.1.1.2.7.A
I.3.2.7.1	3.4.1.1.A
I.3.2.7.1	3.4.1.1.D

SD&TRD SECTION	ESFDR SECTION
I.3.2.7.2	3.4.1.1.E
I.3.2.7.3	3.4.2.9.1.A
I.3.3.1.A	3.4.4.1.M
I.3.3.1.A	3.5.2.1.H
I.3.3.1.A	3.7.2.1.1.D
I.3.3.1.B	3.4.4.1.M
I.3.3.1.B	3.5.2.1.H
I.3.3.1.B	3.7.2.1.1.D
I.3.3.2.A	3.4.5.2.1.D
I.3.3.2.A	3.4.5.5.1.D
I.3.3.2.A	3.6.2.1.P
I.3.3.2.A	3.8.2.2.1.B
I.3.3.2.B	3.4.5.5.1.D
I.3.3.3.A	3.2.1.1.2.8.A
I.3.3.3.B	3.2.1.1.2.8.A
I.3.3.3.C	3.2.1.1.2.8.A
I.3.3.3.D	3.2.1.1.2.8.A
I.3.3.3.E	3.2.1.1.2.8.A
I.3.3.3.F	3.2.1.1.2.8.A
I.3.3.5	3.2.1.1.2.3.G
I.3.3.6.1.A	3.2.1.1.2.4.A
I.3.3.6.1.A	3.4.5.2.1.R
I.3.3.6.1.A	3.4.5.2.1.S
I.3.3.6.1.A	3.5.4.1.C
I.3.3.6.1.A	3.7.2.3.1.B
I.3.3.6.1.A	3.7.2.3.1.C
I.3.3.6.1.A	3.7.2.4.1.H
I.3.3.6.1.A	3.8.4.1.2.A
I.3.3.6.1.A	3.8.4.4.1.C
I.3.3.6.1.B	3.2.1.1.2.4.G
I.3.3.6.1.B	3.4.5.5.1.L
I.3.3.6.1.B	3.4.6.3.1.B
I.3.3.6.1.B	3.7.2.3.1.A
I.3.3.6.1.B	3.8.2.3.1.A
I.3.3.6.1.B	3.8.2.3.1.F
I.3.3.6.1.B	3.8.2.3.1.G
I.3.3.6.1.B	3.8.2.11.1.E
I.3.3.6.2.A	3.2.1.1.2.4.B.1
I.3.3.6.2.B	3.2.1.1.2.4.B.2

SD&TRD SECTION	ESFDR SECTION
I.3.3.6.2.C	3.2.1.1.2.4.B.3
I.3.3.6.2.D	3.2.1.1.2.4.B.4
I.3.3.6.2.E.1	3.2.1.1.2.4.H
I.3.3.6.2.E.2	3.2.1.1.2.4.I
I.3.3.6.2.E.2	3.7.2.3.1.A
I.3.3.6.2.E.2	3.8.2.4.1.C
I.3.3.6.2.E.2	3.8.4.2.1.C
I.3.3.6.2.E.3	3.2.1.1.2.4.H
I.3.3.6.3.A	3.4.2.3.1.B
I.3.3.6.3.A.2	3.7.2.6.1.C
I.3.3.6.3.B	3.2.1.1.2.4.H
I.3.3.6.3.C	3.4.2.5.1.A
I.3.3.6.3.C	3.4.2.6.1.B
I.3.3.6.3.D	3.4.5.2.1.V
I.3.3.6.3.D	3.4.5.2.1.W
I.3.3.6.3.D	3.5.7.1.D
I.3.3.6.4.A	3.4.2.7.1.A
I.3.3.6.4.C	3.4.2.7.1.F
I.3.3.6.5.A	3.2.1.1.2.4.C
I.3.3.6.5.A	3.6.4.2.1.G
I.3.3.6.5.B	3.2.1.1.2.4.C
I.3.3.6.5.B	3.4.2.1.2.E
I.3.3.6.5.B	3.4.2.1.2.F
I.3.3.6.5.B	3.4.5.3.1.B
I.3.3.6.5.B	3.4.5.3.1.C
I.3.3.6.5.C	3.2.1.1.2.4.C
I.3.3.6.5.C	3.2.1.1.2.4.D
I.3.3.6.6.B	3.8.2.4.1.D
I.3.3.6.6.C	3.4.2.1.2.L
I.3.3.6.6.C	3.8.2.4.1.C
I.3.3.6.7.B	3.2.1.1.2.4.E
I.3.3.6.7.E	3.4.2.5.1.B
I.3.3.6.7.F	3.2.1.1.2.4.F
I.3.3.6.9.A	3.4.5.2.1.L
I.3.3.6.9.B	3.4.5.2.1.N
I.3.3.6.9.B	3.4.5.2.1.P
I.3.3.6.9.B	3.8.2.12.1.C
I.3.3.7.1	3.2.1.1.2.5.A
I.3.3.7.2	3.2.1.1.2.5.B

SD&TRD SECTION	ESFDR SECTION
I.3.3.7.3	3.2.1.1.2.5.C
I.3.3.7.4	3.2.1.1.2.5.D
I.3.3.7.5.A	3.2.1.1.2.5.E
I.3.3.7.5.B	3.2.1.1.2.5.F
I.3.3.7.7	3.2.1.1.2.8.A
I.3.3.7.8	3.2.1.1.2.5.C
I.3.3.7.9	3.2.1.1.2.5.C
I.3.3.7.10	3.2.1.1.2.5.C
I.3.3.7.11	3.4.5.5.1.F
I.3.3.7.11	3.4.5.5.1.I
I.3.3.7.11	3.4.6.3.1.D
I.3.3.7.11	3.4.6.3.1.E
I.3.3.7.11	3.4.6.3.1.G
I.3.3.7.12	3.4.5.5.1.B
I.3.3.7.12	3.4.5.5.1.C
I.3.3.7.12	3.4.5.5.1.E
I.3.3.7.12	3.4.5.5.1.H
I.3.3.7.12	3.4.5.5.1.J
I.3.3.7.13	3.4.2.1.2.H
I.3.3.8.1.D	3.2.1.1.2.3.G
I.3.3.8.1.D	3.4.5.5.1.A
I.3.3.8.2	3.2.1.1.3.2.D
I.3.3.9	3.2.1.1.3.2.B
I.3.3.9	3.4.2.4.1.A
I.3.3.9	3.4.5.2.1.I
I.3.3.10.A	3.4.2.7.1.B
I.3.3.10.B	3.2.1.1.1.D
I.3.3.11.A.c	3.3.1.Y
I.3.3.11.A.c	3.4.3.1.E
I.3.3.11.A.c	3.4.4.1.H
I.3.3.11.A.c	3.4.5.2.1.Y
I.3.3.11.A.c	3.4.5.3.1.Q
I.3.3.11.A.c	3.4.5.4.1.G
I.3.3.11.A.c	3.4.5.6.1.E
I.3.3.11.A.c	3.5.2.1.D
I.3.3.11.A.c	3.5.3.1.C
I.3.3.11.A.d	3.3.1.W
I.3.3.11.A.d	3.4.3.1.H
I.3.3.11.A.d	3.4.4.1.K

SD&TRD SECTION	ESFDR SECTION
I.3.3.11.A.d	3.4.5.2.1.AB
I.3.3.11.A.d	3.4.5.3.1.S
I.3.3.11.A.d	3.4.5.4.1.L
I.3.3.11.A.d	3.4.5.6.1.G
I.3.3.11.A.d	3.5.2.1.G
I.3.3.11.A.d	3.5.3.1.F
I.3.3.11.A.e	3.3.1.AA
I.3.3.11.A.e	3.4.3.1.G
I.3.3.11.A.e	3.4.5.2.1.AA
I.3.3.11.A.e	3.4.5.4.1.H
I.3.3.11.A.e	3.4.5.4.1.I
I.3.3.11.A.e	3.4.5.6.1.F
I.3.3.11.A.e	3.5.3.1.E
I.3.3.11.A.f	3.5.6.1.D
I.3.3.11.A.g	3.4.5.3.1.R
I.3.3.11.A.g	3.4.5.4.1.J
I.3.3.11.A.g	3.5.9.1.I
I.3.3.11.A.h	3.4.5.3.1.T
I.3.3.11.A.k	3.3.1.X
I.3.3.11.A.k	3.4.2.3.1.G
I.3.3.11.A.k	3.4.3.1.F
I.3.3.11.A.k	3.4.4.1.I
I.3.3.11.A.k	3.4.5.2.1.Z
I.3.3.11.A.k	3.5.2.1.E
I.3.3.11.A.k	3.5.3.1.D
I.3.3.11.A.k	3.5.4.1.D
I.3.3.11.A.k	3.5.6.1.B
I.3.3.11.A.k	3.5.10.1.C
I.3.3.11.A.k	3.8.2.11.1.E
I.3.3.11.A.k	3.8.4.2.1.K
I.3.3.11.A.k	3.8.4.2.1.L
I.3.3.11.A.p	3.4.5.3.1.T
I.3.3.11.A.s	3.3.1.Y
I.3.3.11.A.s	3.4.3.1.E
I.3.3.11.A.s	3.4.4.1.H
I.3.3.11.A.s	3.4.5.2.1.Y
I.3.3.11.A.s	3.4.5.3.1.Q
I.3.3.11.A.s	3.4.5.4.1.G
I.3.3.11.A.s	3.4.5.6.1.E

SD&TRD SECTION	ESFDR SECTION
I.3.3.11.A.s	3.5.2.1.D
I.3.3.11.A.s	3.5.3.1.C
I.3.3.11.A.u	3.3.1.Z
I.3.3.11.A.u	3.4.4.1.J
I.3.3.11.A.u	3.5.2.1.F
I.3.3.11.A.u	3.5.4.1.E
I.3.3.11.A.u	3.5.6.1.C
I.3.3.11.A.u	3.5.10.1.D
I.3.3.11.A.v	3.4.5.4.1.H
I.3.3.11.A.v	3.4.5.4.1.K
I.3.3.11.A.w	3.3.1.AA
I.3.3.11.A.w	3.4.3.1.G
I.3.3.11.A.w	3.4.5.2.1.AA
I.3.3.11.A.w	3.4.5.4.1.H
I.3.3.11.A.w	3.4.5.4.1.I
I.3.3.11.A.w	3.4.5.6.1.F
I.3.3.11.A.w	3.5.3.1.E
I.3.3.11.A.x	3.4.5.3.1.R
I.3.3.11.B	3.4.6.3.1.F
I.3.3.11.B	3.8.2.5.1.O
I.3.3.11.B	3.8.2.8.1.D
I.3.3.12	3.2.1.1.1.C.2
I.3.3.12	3.2.1.1.2.4.A
I.3.3.12	3.2.1.1.2.4.G
I.3.3.12	3.2.1.1.2.4.H
I.3.3.12	3.2.1.1.2.4.I
I.3.3.12	3.2.1.2.1.1.B
I.3.3.12	3.4.2.5.1.B
I.3.3.12	3.4.5.2.1.X
I.3.3.12	3.7.2.2.1.A
I.3.3.12	3.7.2.3.1.A
I.3.3.12	3.7.2.3.1.B
I.3.3.12	3.7.2.3.1.C
I.3.3.12	3.7.2.4.1.D
I.3.3.12	3.7.2.6.1.C
I.3.3.12.c	3.8.2.2.1.M
I.3.3.12.c	3.8.4.4.1.C
I.3.3.12.d	3.8.2.2.1.M
I.3.3.12.j	3.7.2.4.1.H

SD&TRD SECTION	ESFDR SECTION
I.3.3.12.j	3.8.2.3.1.C
I.3.3.12.j	3.8.2.3.1.D
I.3.3.12.j	3.8.2.3.1.F
I.3.3.12.j	3.8.2.3.1.G
I.3.3.12.j	3.8.4.1.2.A
I.3.3.12.j	3.8.4.3.1.C
I.3.3.12.k	3.4.5.4.1.H
I.3.3.12.l	3.4.5.2.1.Z
I.3.3.12.l	3.8.4.2.1.L
I.3.3.12.m	3.8.2.5.1.O
I.3.3.12.o	3.4.5.3.1.R
I.3.3.12.o	3.4.5.4.1.J
I.3.3.12.o	3.5.9.1.I
I.3.3.12.p	3.4.5.3.1.R
I.3.3.12.p	3.4.5.4.1.J
I.3.3.12.p	3.5.9.1.I
I.3.3.12.ab	3.2.1.1.3.1.D
I.3.3.12.ab	3.2.1.1.3.4.A
I.3.3.12.ad	3.8.2.10.1.B
I.3.3.12.ad	3.8.2.10.1.C
I.3.3.12.ae	3.2.1.2.4.D
I.3.3.12.af	3.2.1.2.4.C
I.3.3.12.af	3.4.5.5.1.L
I.3.3.12.af	3.8.2.1.2.B
I.3.3.12.af	3.8.2.1.2.C
I.3.3.12.af	3.8.2.1.2.D
I.3.3.12.af	3.8.2.2.1.A
I.3.3.12.af	3.8.2.2.1.B
I.3.3.12.af	3.8.2.2.1.C
I.3.3.12.af	3.8.2.2.1.D
I.3.3.12.af	3.8.2.2.1.E
I.3.3.12.af	3.8.2.2.1.F
I.3.3.12.af	3.8.2.2.1.G
I.3.3.12.af	3.8.2.2.1.H
I.3.3.12.af	3.8.2.2.1.I
I.3.3.12.af	3.8.2.2.1.J
I.3.3.12.af	3.8.2.2.1.K
I.3.3.12.af	3.8.2.2.1.L
I.3.3.12.af	3.8.2.2.1.M

SD&TRD SECTION	ESFDR SECTION
I.3.3.12.af	3.8.2.2.1.N
I.3.3.12.af	3.8.2.2.1.O
I.3.3.12.af	3.8.2.2.1.P
I.3.3.12.af	3.8.2.4.1.C
I.3.3.12.af	3.8.2.6.1.F
I.3.3.12.al	3.5.6.1.D
I.3.3.12.ap	3.4.5.2.1.N
I.3.3.12.ap	3.4.5.2.1.P
I.3.3.12.ap	3.8.2.12.1.C
I.3.3.12.ar	3.2.1.2.4.B
I.3.3.12.at	3.2.1.2.1.1.E
I.3.3.12.at	3.2.1.2.1.1.G
I.3.4.1.A	3.2.1.1.3.3.C
I.3.4.2	3.4.5.3.1.M
I.3.4.3	3.2.1.1.3.3.A
I.3.4.3	3.2.1.1.3.3.B
I.3.4.5	3.7.2.1.2.C
I.3.4.6.A	3.7.2.1.2.C
I.3.5.1.A	3.2.1.1.3.1.A
I.3.5.1.A	3.8.2.12.1.A
I.3.5.1.A.1.a	3.2.1.1.2.3.D
I.3.5.1.A.1.b	3.2.1.1.2.3.E
I.3.5.1.A.1.c	3.2.1.1.2.3.F
I.3.5.1.A.1.d	3.2.1.1.3.1.D
I.3.5.1.A.2	3.4.1.1.B
I.3.5.1.1	3.2.1.1.3.2.A
I.3.5.1.2.A	3.2.1.1.2.3.H
I.3.5.2	3.2.1.1.3.2.A
I.3.5.3.1	3.4.2.6.1.D
I.3.5.3.1	3.4.2.6.1.G
I.3.5.3.1	3.4.2.6.1.K
I.3.5.3.2.A	3.4.2.6.1.L
I.3.5.3.2.B	3.4.2.6.1.M
I.3.5.3.2.C	3.4.2.6.1.C
I.3.5.3.2.C	3.4.2.6.1.E
I.3.5.3.2.C	3.4.2.6.1.J
I.3.5.4	3.4.2.6.1.F
I.3.6.2.1.A	3.2.1.1.3.4.A
I.3.6.2.1.B	3.2.1.1.3.4.A

SD&TRD SECTION	ESFDR SECTION
I.3.6.2.1.C	3.2.1.1.3.4.A
I.3.7.2.1.B.1.2.A	3.3.1.A
I.3.7.2.1.B.1.3.A	3.3.1.B
I.3.7.2.1.B.2.1.A	3.3.1.C
I.3.7.2.1.B.2.4.A	3.3.1.D
I.3.7.2.1.C.1.A	3.2.1.2.3.G
I.3.7.2.1.C.1.A	3.2.1.2.3.H
I.3.7.2.1.C.1.B	3.2.1.2.3.A
I.3.7.2.1.C.1.B	3.2.1.2.3.C
I.3.7.2.1.C.1.B	3.2.1.2.3.D
I.3.7.2.1.C.1.B	3.2.1.2.3.E
I.3.7.2.1.C.1.B	3.2.1.2.3.I
I.3.7.2.1.C.1.B	3.3.1.F
I.3.7.2.1.C.1.C	3.2.1.2.3.F
I.3.7.2.1.C.1.C	3.3.1.G
I.3.7.2.1.D.1.A	3.3.1.H
I.3.7.2.1.D.1.A	3.3.1.I
I.3.7.2.1.D.1.A	3.3.1.M
I.3.7.2.1.D.1.A	3.3.1.N
I.3.7.2.1.D.1.B	3.3.1.O
I.3.7.2.1.D.1.B	3.3.1.P
I.3.7.2.1.D.1.C	3.3.1.Q
I.3.7.2.1.D.1.C	3.3.1.R
I.3.7.2.1.D.1.D	3.3.1.X
I.3.7.2.1.D.1.E	3.2.1.1.1.C.4
I.3.7.2.1.D.1.E	3.3.1.J
I.3.7.2.1.D.1.F	3.3.1.E
I.3.7.2.1.D.1.G	3.3.1.K
I.3.7.2.1.D.1.G	3.3.1.L
I.3.7.2.1.D.1.H	3.3.1.S
I.3.7.2.1.D.2.A	3.3.1.AD
I.3.7.2.1.D.2.B	3.3.1.AC
I.3.7.2.1.D.2.C	3.3.1.T
I.3.7.2.1.D.2.D	3.3.1.U
I.3.7.2.1.D.3.A	3.3.1.AE
I.3.7.2.1.D.3.B	3.3.1.AB
I.3.7.2.1.D.3.C	3.3.1.V
I.3.7.2.2.B.1.3.A	3.4.5.1.1.B
I.3.7.2.2.B.1.3.B	3.4.4.1.C

SD&TRD SECTION	ESFDR SECTION
I.3.7.2.2.B.1.3.B	3.4.4.1.L
I.3.7.2.2.B.1.4.A	3.4.2.1.1.A
I.3.7.2.2.B.1.4.A	3.4.2.4.1.B
I.3.7.2.2.B.1.4.A	3.4.2.5.1.C
I.3.7.2.2.B.1.4.A	3.4.2.5.1.D
I.3.7.2.2.B.1.4.A	3.4.2.8.1.A
I.3.7.2.2.B.1.4.A	3.4.2.8.1.C
I.3.7.2.2.B.1.4.A	3.4.5.1.2.E
I.3.7.2.2.B.1.4.A	3.4.5.2.1.B
I.3.7.2.2.B.1.4.A	3.4.5.2.1.G
I.3.7.2.2.B.1.4.A	3.4.5.5.1.K
I.3.7.2.2.B.1.4.A	3.4.5.7.1.A
I.3.7.2.2.B.1.4.A	3.4.5.7.1.C
I.3.7.2.2.B.1.4.A	3.6.2.1.A.1
I.3.7.2.2.B.1.4.A	3.6.2.1.A.2
I.3.7.2.2.B.1.4.B	3.4.2.2.1.A
I.3.7.2.2.B.1.4.B	3.4.5.2.1.O
I.3.7.2.2.B.1.4.B	3.4.6.2.1.A
I.3.7.2.2.B.1.4.B	3.4.6.3.1.A
I.3.7.2.2.B.1.5.A	3.4.1.1.C
I.3.7.2.2.B.1.5.A	3.4.2.4.1.C
I.3.7.2.2.B.1.5.A	3.4.5.4.1.D
I.3.7.2.2.B.1.5.B	3.4.2.7.1.I
I.3.7.2.2.B.1.5.B	3.4.2.7.1.J
I.3.7.2.2.B.1.5.B	3.4.2.7.1.K
I.3.7.2.2.B.1.5.B	3.4.2.7.1.L
I.3.7.2.2.B.1.5.B	3.4.2.7.1.M
I.3.7.2.2.B.1.5.B	3.4.2.7.1.N
I.3.7.2.2.B.1.5.B	3.4.2.7.1.O
I.3.7.2.2.B.1.6.A	3.4.2.2.1.A
I.3.7.2.2.B.1.6.A	3.4.2.7.1.A
I.3.7.2.2.B.1.6.A	3.4.2.7.1.C
I.3.7.2.2.B.1.6.A	3.4.2.7.1.D
I.3.7.2.2.B.1.6.A	3.4.5.1.1.A
I.3.7.2.2.B.1.6.A	3.4.5.1.2.C
I.3.7.2.2.B.1.6.A	3.4.5.2.1.A
I.3.7.2.2.B.1.6.A	3.4.5.2.1.C
I.3.7.2.2.B.1.6.A	3.4.5.2.1.F
I.3.7.2.2.B.1.6.A	3.4.5.2.1.H

SD&TRD SECTION	ESFDR SECTION
I.3.7.2.2.B.1.6.A	3.4.5.2.1.J
I.3.7.2.2.B.1.6.A	3.4.5.2.1.M
I.3.7.2.2.B.1.6.A	3.4.5.2.1.Q
I.3.7.2.2.B.1.6.A	3.4.5.2.1.T
I.3.7.2.2.B.1.6.A	3.4.5.2.1.U
I.3.7.2.2.B.1.6.A	3.4.5.3.1.I
I.3.7.2.2.B.1.6.A	3.4.5.3.1.L
I.3.7.2.2.B.1.6.A	3.4.5.3.1.N
I.3.7.2.2.B.1.6.A	3.4.5.5.1.F
I.3.7.2.2.B.1.6.A	3.4.5.7.1.B
I.3.7.2.2.B.1.6.A	3.4.5.7.1.D
I.3.7.2.2.B.1.6.A	3.8.2.8.1.A
I.3.7.2.2.B.1.6.B	3.4.5.6.1.A
I.3.7.2.2.B.1.6.B	3.4.5.6.1.B
I.3.7.2.2.B.1.6.B	3.4.5.6.1.C
I.3.7.2.2.B.1.6.B	3.8.2.7.1.A
I.3.7.2.2.B.1.6.C	3.4.2.3.1.F
I.3.7.2.2.B.1.6.C	3.4.2.7.1.G
I.3.7.2.2.B.1.6.C	3.4.2.7.1.H
I.3.7.2.2.B.1.6.C	3.4.2.7.1.P
I.3.7.2.2.B.1.6.C	3.4.2.7.1.Q
I.3.7.2.2.B.1.6.C	3.4.6.3.1.C
I.3.7.2.2.B.2.1.A	3.4.2.1.1.A
I.3.7.2.2.B.2.1.A	3.4.2.1.1.B
I.3.7.2.2.B.2.1.A	3.4.2.1.2.I
I.3.7.2.2.B.2.1.A	3.4.5.1.1.A
I.3.7.2.2.B.2.1.A	3.4.5.1.2.D
I.3.7.2.2.C.1.A	3.2.1.2.3.G
I.3.7.2.2.C.1.A	3.2.1.2.3.H
I.3.7.2.2.C.1.A	3.4.4.1.A
I.3.7.2.2.C.1.B	3.2.1.2.3.A
I.3.7.2.2.C.1.B	3.2.1.2.3.C
I.3.7.2.2.C.1.B	3.2.1.2.3.D
I.3.7.2.2.C.1.B	3.2.1.2.3.E
I.3.7.2.2.C.1.B	3.2.1.2.3.I
I.3.7.2.2.C.1.B	3.4.2.5.1.I
I.3.7.2.2.C.1.B	3.4.3.1.B
I.3.7.2.2.C.1.B	3.4.5.3.1.E
I.3.7.2.2.C.1.B	3.4.5.3.1.F

SD&TRD SECTION	ESFDR SECTION
I.3.7.2.2.C.1.B	3.4.5.3.1.G
I.3.7.2.2.C.1.B	3.4.5.3.1.H
I.3.7.2.2.C.1.B	3.4.5.3.1.P
I.3.7.2.2.C.1.B	3.4.5.3.1.V
I.3.7.2.2.C.1.B	3.4.5.4.1.A
I.3.7.2.2.C.1.B	3.4.5.4.1.B
I.3.7.2.2.C.1.B	3.4.5.4.1.C
I.3.7.2.2.C.1.B	3.4.5.6.1.I
I.3.7.2.2.C.1.C	3.2.1.2.3.F
I.3.7.2.2.D.1.A	3.4.2.6.1.A
I.3.7.2.2.D.1.B	3.2.1.1.1.C.1
I.3.7.2.2.D.1.C	3.4.2.3.1.E
I.3.7.2.2.D.1.C	3.4.3.1.A
I.3.7.2.2.D.1.C	3.4.3.1.D
I.3.7.2.2.D.1.C	3.4.5.3.1.A
I.3.7.2.2.D.1.D	3.4.2.3.1.A
I.3.7.2.2.D.1.D	3.4.4.1.D
I.3.7.2.2.D.1.F	3.4.2.1.1.A
I.3.7.2.2.D.1.F	3.4.2.1.1.B
I.3.7.2.2.D.1.F	3.4.2.1.2.G
I.3.7.2.2.D.1.F	3.4.2.1.2.I
I.3.7.2.2.D.1.F	3.4.2.3.1.A
I.3.7.2.2.D.1.F	3.4.2.3.1.D
I.3.7.2.2.D.1.F	3.4.2.4.1.D
I.3.7.2.2.D.1.F	3.4.2.5.1.E
I.3.7.2.2.D.1.F	3.4.2.5.1.F
I.3.7.2.2.D.1.F	3.4.2.5.1.G
I.3.7.2.2.D.1.F	3.4.2.5.1.J
I.3.7.2.2.D.1.F	3.4.2.5.1.K
I.3.7.2.2.D.1.F	3.4.2.6.1.H
I.3.7.2.2.D.1.F	3.4.2.8.1.B
I.3.7.2.2.D.1.F	3.4.2.10.1.A
I.3.7.2.2.D.1.F	3.4.2.10.1.B
I.3.7.2.2.D.1.F	3.4.4.1.E
I.3.7.2.2.D.1.F	3.4.4.1.G
I.3.7.2.2.D.1.F	3.4.5.1.1.B
I.3.7.2.2.D.1.F	3.4.5.1.2.B
I.3.7.2.2.D.1.F	3.4.5.1.2.D
I.3.7.2.2.D.1.F	3.4.5.3.1.J

SD&TRD SECTION	ESFDR SECTION
I.3.7.2.2.D.1.F	3.4.5.3.1.K
I.3.7.2.2.D.1.F	3.4.5.4.1.C
I.3.7.2.2.D.1.F	3.4.5.4.1.F
I.3.7.2.3.B.1.2.A	3.5.1.1.A
I.3.7.2.3.B.1.2.A	3.5.1.2.A
I.3.7.2.3.B.1.2.A	3.5.10.1.A
I.3.7.2.3.B.1.2.A	3.5.10.1.B
I.3.7.2.3.B.1.2.B	3.5.7.1.B
I.3.7.2.3.B.1.2.B	3.5.7.1.C
I.3.7.2.3.B.1.2.B	3.5.7.1.G
I.3.7.2.3.B.1.2.B	3.5.9.1.A
I.3.7.2.3.B.1.2.B	3.5.9.1.B
I.3.7.2.3.B.1.2.B	3.5.9.1.C
I.3.7.2.3.B.1.2.B	3.5.9.1.D
I.3.7.2.3.B.1.2.B	3.5.9.1.E
I.3.7.2.3.B.1.2.B	3.5.9.1.F
I.3.7.2.3.B.1.2.C	3.4.5.2.1.T
I.3.7.2.3.B.1.2.C	3.4.5.2.1.U
I.3.7.2.3.B.1.2.D	3.4.5.4.1.C
I.3.7.2.3.B.1.4.A	3.5.7.1.F
I.3.7.2.3.B.1.4.A	3.5.9.1.G
I.3.7.2.3.B.1.6.A	3.5.1.1.A
I.3.7.2.3.B.1.6.A	3.5.1.2.A
I.3.7.2.3.B.1.6.A	3.5.4.1.A
I.3.7.2.3.B.1.6.B	3.4.5.6.1.A
I.3.7.2.3.B.1.6.B	3.4.5.6.1.C
I.3.7.2.3.B.2.2.A	3.5.2.1.A
I.3.7.2.3.B.2.4.A	3.5.1.1.A
I.3.7.2.3.B.2.4.B	3.5.7.1.A
I.3.7.2.3.C.1.A	3.2.1.2.3.G
I.3.7.2.3.C.1.A	3.2.1.2.3.H
I.3.7.2.3.C.1.B	3.2.1.2.3.A
I.3.7.2.3.C.1.B	3.2.1.2.3.C
I.3.7.2.3.C.1.B	3.2.1.2.3.D
I.3.7.2.3.C.1.B	3.2.1.2.3.E
I.3.7.2.3.C.1.B	3.2.1.2.3.I
I.3.7.2.3.C.1.B	3.5.3.1.B
I.3.7.2.3.C.1.B	3.5.7.1.D
I.3.7.2.3.C.1.B	3.5.7.1.E

SD&TRD SECTION	ESFDR SECTION
I.3.7.2.3.C.1.B	3.5.9.1.H
I.3.7.2.3.C.1.B	3.5.9.1.J
I.3.7.2.3.C.1.C	3.2.1.2.3.F
I.3.7.2.3.D.1.A	3.5.2.1.C
I.3.7.2.3.D.1.B	3.5.4.1.B
I.3.7.2.3.D.1.C	3.5.2.1.B
I.3.7.2.3.D.1.C	3.5.6.1.A
I.3.7.2.3.D.1.C	3.5.10.1.A
I.3.7.2.3.D.1.D	3.5.1.2.B
I.3.7.2.3.D.1.D	3.5.3.1.A
I.3.7.2.3.D.1.D	3.5.3.1.B
I.3.7.2.3.D.1.E	3.2.1.1.1.C.1
I.3.7.2.3.D.1.H	3.5.9.1.I
I.3.7.2.4.B.1.2.A	3.6.2.1.B
I.3.7.2.4.B.1.2.A	3.6.2.1.C
I.3.7.2.4.B.1.2.A	3.6.2.1.D
I.3.7.2.4.B.1.3.A	3.6.2.1.B
I.3.7.2.4.B.1.5.A	3.6.2.1.G
I.3.7.2.4.B.1.5.A	3.7.2.6.1.E
I.3.7.2.4.B.1.6.A	3.6.2.1.B
I.3.7.2.4.B.1.6.A	3.6.2.1.C
I.3.7.2.4.B.1.6.A	3.6.2.1.D
I.3.7.2.4.B.1.6.A	3.8.2.11.1.A
I.3.7.2.4.B.2.1.A	3.6.2.1.K
I.3.7.2.4.B.2.2.A	3.6.2.1.G
I.3.7.2.4.C.1.A	3.2.1.2.3.C
I.3.7.2.4.C.1.A	3.2.1.2.3.D
I.3.7.2.4.C.1.A	3.2.1.2.3.E
I.3.7.2.4.C.1.A	3.2.1.2.3.I
I.3.7.2.4.C.1.A	3.6.2.1.F
I.3.7.2.4.C.1.B	3.2.1.2.3.A
I.3.7.2.4.C.1.B	3.2.1.2.3.F
I.3.7.2.4.D.1.A	3.6.2.1.J
I.3.7.2.4.D.1.A	3.6.2.1.J.1
I.3.7.2.4.D.1.A	3.6.2.1.J.2
I.3.7.2.4.D.1.A	3.6.2.1.J.3
I.3.7.2.4.D.1.A	3.6.2.1.J.4
I.3.7.2.4.D.1.B	3.6.2.1.H
I.3.7.2.4.D.1.B	3.6.2.1.H.1

SD&TRD SECTION	ESFDR SECTION
I.3.7.2.4.D.1.C	3.6.2.1.I
I.3.7.2.4.D.1.D	3.6.2.1.L
I.3.7.2.4.D.1.E	3.6.2.1.K
I.3.7.2.4.D.1.E	3.6.2.1.K.1
I.3.7.2.4.D.1.E	3.6.2.1.K.2
I.3.7.2.4.D.1.F	3.6.2.1.N
I.3.7.2.5.B.1.4.A	3.7.2.5.1.C
I.3.7.2.5.B.1.4.A	3.7.3.1.A
I.3.7.2.5.B.2.2.A	3.7.2.3.1.E
I.3.7.2.5.B.2.2.B	3.7.2.1.2.B
I.3.7.2.5.B.2.2.E	3.7.2.3.1.E
I.3.7.2.5.B.2.2.E	3.7.2.6.1.D
I.3.7.2.5.B.2.2.E	3.7.3.1.L
I.3.7.2.5.B.2.3.A	3.7.2.3.1.E
I.3.7.2.5.B.2.3.B	3.7.2.3.1.E
I.3.7.2.5.B.2.3.D	3.7.2.3.1.E
I.3.7.2.5.C.1.A	3.2.1.2.3.G
I.3.7.2.5.C.1.A	3.2.1.2.3.H
I.3.7.2.5.C.1.B	3.2.1.2.3.A
I.3.7.2.5.C.1.B	3.2.1.2.3.B
I.3.7.2.5.C.1.B	3.2.1.2.3.C
I.3.7.2.5.C.1.B	3.2.1.2.3.D
I.3.7.2.5.C.1.B	3.2.1.2.3.E
I.3.7.2.5.C.1.B	3.2.1.2.3.I
I.3.7.2.5.C.1.B	3.4.5.3.1.O
I.3.7.2.5.C.1.B	3.4.5.6.1.D
I.3.7.2.5.C.1.B	3.7.1.2.C
I.3.7.2.5.C.1.B	3.7.1.2.D
I.3.7.2.5.C.1.B	3.7.2.1.1.C.1
I.3.7.2.5.C.1.B	3.7.2.1.1.C.2
I.3.7.2.5.C.1.B	3.7.3.1.B
I.3.7.2.5.C.1.B	3.8.2.9.1.F
I.3.7.2.5.C.1.C	3.2.1.2.3.F
I.3.7.2.5.C.1.D	3.2.1.1.4.A
I.3.7.2.5.C.1.D	3.7.2.1.2.D
I.3.7.2.5.C.1.D	3.7.2.1.2.E
I.3.7.2.5.C.1.D	3.7.2.4.1.A
I.3.7.2.5.C.1.D	3.7.2.4.1.D
I.3.7.2.5.C.1.D	3.7.2.4.1.F

SD&TRD SECTION	ESFDR SECTION
I.3.7.2.5.C.1.E	3.2.1.1.4.A
I.3.7.2.5.C.2	3.2.1.1.4.B
I.3.7.2.5.C.2	3.7.2.3.1.E
I.3.7.2.5.C.3	3.7.2.3.1.E
I.3.7.2.5.D.1.3	3.7.2.3.1.E
I.3.7.2.5.D.1.7	3.2.1.1.4.C
I.3.7.2.5.D.1.7	3.7.1.2.B
I.3.7.2.5.D.1.8	3.7.2.3.1.E
I.3.7.2.5.D.1.8	3.7.2.5.1.C
I.3.7.2.5.D.1.8	3.7.3.1.J
I.3.7.2.5.D.1.10	3.2.1.1.1.C.1
I.3.7.2.5.D.1.10	3.2.1.1.1.C.3
I.3.7.2.5.D.2.1	3.7.2.3.1.E
I.3.7.2.5.D.2.1	3.7.2.5.1.C
I.3.7.2.5.D.2.2	3.2.1.2.2.B
I.3.7.2.5.D.2.3	3.7.2.3.1.E
I.3.7.2.5.D.2.5	3.7.1.2.A
I.3.7.2.5.D.2.5	3.7.2.3.1.E
I.3.7.2.5.D.2.5	3.7.3.1.I
I.3.7.2.5.D.2.6	3.2.1.2.1.2.A
I.3.7.2.5.D.2.9	3.7.3.1.E
I.3.7.2.5.D.2.11	3.7.3.1.F
I.3.7.2.5.D.2.13	3.7.2.3.1.E
I.3.7.2.5.D.2.14	3.7.2.3.1.E
I.3.7.2.5.D.2.15	3.7.2.3.1.E
I.3.7.2.5.D.2.15	3.7.3.1.K
I.3.7.2.5.D.2.16	3.2.1.2.2.B
I.3.7.2.5.D.2.16	3.7.2.3.1.E
I.3.7.2.5.D.2.17	3.7.2.3.1.E
I.3.7.2.5.D.2.18	3.2.1.2.2.B
I.3.7.2.5.D.2.18	3.7.2.3.1.E
I.3.7.2.5.D.2.19	3.7.3.1.F
I.3.7.2.5.D.2.19	3.7.3.1.G
I.3.7.2.5.D.2.20	3.7.2.1.2.F
I.3.7.2.5.D.2.21	3.7.2.4.1.D
I.3.7.2.5.D.2.22	3.7.2.1.1.B
I.3.7.2.5.D.2.22	3.7.2.2.1.A
I.3.7.2.5.D.2.22	3.7.2.6.1.C
I.3.7.2.5.D.2.23	3.7.2.3.1.E

SD&TRD SECTION	ESFDR SECTION
I.3.7.2.5.D.3.2	3.2.1.1.4.D
I.3.7.2.5.D.3.2	3.7.2.3.1.E
I.3.7.2.5.D.3.2	3.7.2.5.1.C
I.3.7.2.5.D.3.3	3.7.2.5.1.C
I.3.7.2.5.D.3.4	3.7.2.5.1.C
I.3.7.2.5.D.3.6	3.7.2.3.1.E
I.3.7.2.5.D.3.6	3.7.2.5.1.C
I.3.7.2.5.D.3.6	3.7.3.1.J
I.3.7.2.5.D.3.7	3.7.2.3.1.E
I.3.7.2.5.D.3.7	3.7.2.5.1.C
I.3.7.2.5.D.3.8	3.7.2.3.1.E
I.3.7.2.5.D.3.8	3.7.2.5.1.C
I.3.7.2.5.D.3.8	3.7.3.1.J
I.3.7.2.6.B.1.2.A	3.8.2.1.2.F
I.3.7.2.6.B.1.3.A	3.8.4.2.1.A
I.3.7.2.6.B.1.3.A	3.8.4.2.1.B
I.3.7.2.6.B.1.3.B	3.8.2.7.1.A
I.3.7.2.6.B.1.4.A	3.6.2.1.A.1
I.3.7.2.6.B.1.4.A	3.6.2.1.A.2
I.3.7.2.6.B.1.4.A	3.8.2.1.2.E
I.3.7.2.6.B.1.4.A	3.8.2.1.2.G
I.3.7.2.6.B.1.4.A	3.8.2.2.1.P
I.3.7.2.6.B.1.4.A	3.8.2.3.1.J
I.3.7.2.6.B.1.4.B	3.8.2.1.2.F
I.3.7.2.6.B.1.4.B	3.8.2.1.2.G
I.3.7.2.6.B.1.5.A	3.8.1.2.C
I.3.7.2.6.B.1.5.A	3.8.2.1.1.A
I.3.7.2.6.B.1.5.A	3.8.2.1.2.E
I.3.7.2.6.B.1.5.A	3.8.2.2.1.H
I.3.7.2.6.B.1.5.A	3.8.2.2.1.I
I.3.7.2.6.B.1.5.A	3.8.2.2.1.J
I.3.7.2.6.B.1.5.A	3.8.2.2.1.K
I.3.7.2.6.B.1.5.A	3.8.2.2.1.L
I.3.7.2.6.B.1.5.A	3.8.2.2.1.M
I.3.7.2.6.B.1.5.A	3.8.2.3.1.A
I.3.7.2.6.B.1.5.A	3.8.2.3.2.A
I.3.7.2.6.B.1.5.A	3.8.2.3.2.B
I.3.7.2.6.B.1.5.A	3.8.2.3.2.C
I.3.7.2.6.B.1.5.A	3.8.2.7.1.A

SD&TRD SECTION	ESFDR SECTION
I.3.7.2.6.B.1.5.A	3.8.2.7.1.E
I.3.7.2.6.B.1.5.A	3.8.2.7.1.H
I.3.7.2.6.B.1.5.A	3.8.2.7.1.I
I.3.7.2.6.B.1.5.A	3.8.2.7.1.J
I.3.7.2.6.B.1.5.A	3.8.2.7.1.K
I.3.7.2.6.B.1.5.A	3.8.2.7.1.L
I.3.7.2.6.B.1.5.A	3.8.2.7.1.M
I.3.7.2.6.B.1.5.A	3.8.2.7.2.A
I.3.7.2.6.B.1.5.A	3.8.2.7.2.C
I.3.7.2.6.B.1.5.A	3.8.2.8.1.B
I.3.7.2.6.B.1.5.A	3.8.2.8.1.C
I.3.7.2.6.B.1.5.A	3.8.2.8.1.D
I.3.7.2.6.B.1.5.A	3.8.2.11.1.B
I.3.7.2.6.B.1.5.A	3.8.2.11.1.C
I.3.7.2.6.B.1.5.A	3.8.2.11.1.D
I.3.7.2.6.B.1.5.A	3.8.2.11.1.E
I.3.7.2.6.B.1.5.A	3.8.2.12.1.B
I.3.7.2.6.B.1.5.A	3.8.2.12.1.D
I.3.7.2.6.B.1.5.A	3.8.4.1.2.B
I.3.7.2.6.B.1.5.A	3.8.4.1.2.C
I.3.7.2.6.B.1.5.A	3.8.4.2.1.D
I.3.7.2.6.B.1.5.A	3.8.4.2.1.E
I.3.7.2.6.B.1.5.A	3.8.4.2.1.F
I.3.7.2.6.B.1.5.A	3.8.4.2.1.G
I.3.7.2.6.B.1.5.A	3.8.4.2.1.J
I.3.7.2.6.B.1.5.A	3.8.4.3.1.D
I.3.7.2.6.B.1.5.A	3.8.4.3.1.E
I.3.7.2.6.B.1.5.A	3.8.4.3.1.F
I.3.7.2.6.B.1.5.A	3.8.4.3.1.G
I.3.7.2.6.B.1.5.A	3.8.4.4.1.B
I.3.7.2.6.C.1.A	3.2.1.2.3.G
I.3.7.2.6.C.1.A	3.2.1.2.3.H
I.3.7.2.6.C.1.B	3.2.1.2.3.A
I.3.7.2.6.C.1.B	3.2.1.2.3.C
I.3.7.2.6.C.1.B	3.2.1.2.3.D
I.3.7.2.6.C.1.B	3.2.1.2.3.E
I.3.7.2.6.C.1.B	3.2.1.2.3.I
I.3.7.2.6.C.1.B	3.8.2.6.1.A
I.3.7.2.6.C.1.B	3.8.2.6.1.B

SD&TRD SECTION	ESFDR SECTION
I.3.7.2.6.C.1.B	3.8.2.6.1.C
I.3.7.2.6.C.1.B	3.8.2.6.1.D
I.3.7.2.6.C.1.B	3.8.2.6.1.E
I.3.7.2.6.C.1.B	3.8.2.6.1.H
I.3.7.2.6.C.1.B	3.8.2.7.1.B
I.3.7.2.6.C.1.B	3.8.2.7.1.C
I.3.7.2.6.C.1.B	3.8.2.7.1.D
I.3.7.2.6.C.1.B	3.8.2.7.1.E
I.3.7.2.6.C.1.B	3.8.2.7.1.F
I.3.7.2.6.C.1.B	3.8.2.7.1.G
I.3.7.2.6.C.1.B	3.8.2.9.1.A
I.3.7.2.6.C.1.B	3.8.2.10.1.A
I.3.7.2.6.C.1.B	3.8.2.12.1.E
I.3.7.2.6.C.1.B	3.8.4.2.1.I
I.3.7.2.6.C.1.C	3.2.1.2.3.F
I.3.7.2.6.C.1.C	3.8.4.3.1.A
I.3.7.2.6.C.1.C	3.8.4.4.1.D
I.3.7.2.6.D.1.B	3.8.2.1.2.D
I.3.8.A	3.2.1.1.1.B.1
I.3.8.B	3.2.1.1.1.B.2
I.3.8.C	3.2.1.1.1.B.3
I.3.9	3.2.1.1.1.A

INTENTIONALLY LEFT BLANK

APPENDIX E

RESERVED

INTENTIONALLY LEFT BLANK

APPENDIX F

APPLICATION OF 10 CFR 60 REQUIREMENTS TO THE EXPLORATORY STUDIES FACILITY

APPENDIX F

APPLICATION OF 10 CFR 60 REQUIREMENTS TO THE EXPLORATORY STUDIES FACILITY

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

Page

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

INTENTIONALLY LEFT BLANK

APPENDIX F

APPLICATION OF 10 CFR 60 REQUIREMENTS TO THE EXPLORATORY STUDIES FACILITY

F.1 INTRODUCTION

The Site Design and Test Requirements Document (SD&TRD), YMP/CM-0021, provides a list of 10 CFR 60 requirements that are either mandatory or are to be considered in the design and construction of the Exploratory Studies Facility (ESF). This Appendix F presents the interpretation and applicability of these requirements to the statements with respect to the *Exploratory Studies Facility Design Requirements* (ESFDR) document.

This Appendix F addresses all 10 CFR 60 requirements in the U. S. Nuclear Regulatory Commission's (NRC) *Staff Technical Position on Regulatory Considerations in the Design and Construction of the Exploratory Studies Facility* (NUREG-1439). The specific requirements that address each applicable 10 CFR 60 requirement are compiled in Section 6 of this ESFDR.

F.2 DISCUSSION ON THE INTERPRETATION AND APPLICABILITY OF 10 CFR 60 REQUIREMENTS

The following are discussions of the interpretations and descriptions of the applicability of each of the 10 CFR 60 requirements identified in NUREG 1439. If determined applicable to ESF design, the form of that applicability is also described.

F.2.1 10 CFR 60.2, 10 CFR 60 Definitions

DISCUSSION

These definitions are considered in the interpretation of the 10 CFR 60 requirements but do not result in facility design requirements.

APPLICABILITY

No specific ESF design requirements.

F.2.2 10 CFR 60.4(b), Records to be legible and safeguarded against tampering and loss of records

DISCUSSION

The *Quality Assurance Requirements and Description* (QARD), DOE/RW-0333P, establishes quality assurance (QA) requirements for the Yucca Mountain Site Characterization Project (YMP). Implementing procedures have been developed by the Program and the YMP to support these requirements. The design is being documented per these procedures and therefore will meet this requirement.

APPLICABILITY

No ESF design requirement.

F.2.3 10 CFR 60. 15(b), Site characterization to include in-situ exploration and testing at the depths that wastes will be emplaced

DISCUSSION

Provide underground access to the depths that waste will be emplaced. Support in situ testing as specified by the YMP through test objectives/study plans. The coordinated set of tests and their requirements are documented in Appendix B of this ESFDR.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth. Design and build test alcoves and test support facilities as per requirements in Appendix B of this ESFDR.

F.2.4 10 CFR 60.15(c)(1), Limit adverse effects on repository

DISCUSSION

Develop applicable design requirements through analysis. Appropriate Determination of Importance Evaluations to be performed for each Configuration Item to determine potential waste isolation impacts.

APPLICABILITY

Capture applicable facility design requirements from analyses and evaluations in this ESFDR. Process and operational requirements will be transmitted to design and construction directly through the Determination of Importance Evaluations.

F.2.5 10 CFR 60.15(c)(2), Limit the number of boreholes and shafts

DISCUSSION

"Shafts" are interpreted as being either shafts and/or ramps. Main access openings will support all Repository considerations by being created consistent with the Repository depth and layout. Other openings, created by ESF that are not permanent, will be evaluated for waste isolation impacts by design analysis and coordinated with Repository design prior to being developed and constructed.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth. Other openings (non-permanent) will be designed by ESF analysis and coordinated with Repository design.

F.2.6 10 CFR 60.15(c)(3), Locate boreholes and shafts where shafts are planned and where unexcavated pillars are planned

DISCUSSION

Main access openings will be designed and constructed to support all Repository design considerations by being consistent with Repository design. Exploratory boreholes, if required, will be analyzed and coordinated with Repository design.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth. Other openings will be designed by analysis and coordinated with Repository design.

F.2.7 10 CFR 60.15(c)(4), Coordinate subsurface drilling, testing and excavation with repository design

DISCUSSION

All subsurface excavations will be designed by analysis and coordinated with Repository design.

APPLICABILITY

Subsurface excavations, testing, and drilling will be designed by analysis and coordinated with Repository design.

F.2.8 10 CFR 60.16*, SCP required before ESF construction

DISCUSSION

The YMP has developed, and the NRC has reviewed, a *Site Characterization Plan*, (SCP) DOE/RW-0199, for the YMP. The SCP was updated with the *Site Characterization Program Baseline*, YMP/CC-0011, and is now kept up to date by the SD&TRD.

APPLICABILITY

No specific ESF design requirements.

F.2.9 10 CFR 60.17*, Contents of SCP

DISCUSSION

This is a requirement for the content of the SCP.

---

* The following applies to all asterisked items in Appendix F: The use of the 10 CFR 60 requirements was the subject of discussion between the NRC and the DOE. The reasons for considering but not directly using certain requirements, are given in the February 27, 1990, letter from DOE (Appel) to the NRC (Linehan) and are repeated in this section.

APPLICABILITY

No specific ESF design requirements.

F.2.10 10 CFR 60.21(c)(1)(ii)(D), SAR to contain Engineered Barrier effectiveness analysis and an evaluation of alternative features

DISCUSSION

This is primarily a Repository License Application issue involving the safety analysis. The ESF Alternative Study (SAND91-0025) evaluated 34 options for ESF - Repository configurations. The selected configuration has been incorporated into the Repository design. To preserve the Repository design and support the development of a License Application, the main ESF access openings will be consistent with Repository design with respect to orientation, geometry, layout, and depth [also see 10 CFR 60.133(a)(1)]. Determination of Importance Evaluations controls [10 CFR 60.15(c)(1)] are being applied to design and construction. Records will be kept for all permanent items as per 10 CFR 60.72.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth.

F.2.11 10 CFR 60.21(c)(1)(ii)(E), SAR to contain an analysis of major design SSCs to identify ITS items

DISCUSSION

The ESF design looks to the *Q-List*, YMP/90-55Q, to obtain the Important to Safety (ITS) status of any ESF component. Changes or updates to the *Q-List* are performed through QAP-2-3, *Classification of Permanent Items*. This analysis is outside of the scope of ESF design and does not result in any ESF design requirements.

APPLICABILITY

No specific ESF design requirements.

F.2.12 10 CFR 60.21(c)(11), SAR to include a description of design considerations to facilitate closure and decontamination or dismantlement of surface facilities

Discussion

there are no permanent esf surface facilities and therefore this requirement does not apply to esf surface facilities. All permanent items in the esf are underground and their design will be coordinated with repository design to ensure that they are consistent with the repository's approach.

Applicability

no specific esf design requirements.

F.2.13 10 CFR 60.24(a)*, license application to be as complete as possible

DISCUSSION

Providing for updates to the License Application does not impose any design requirements on the ESF design, construction, or operations. The SCP and SD&TRD provide the test objectives that will be designed for and implemented through the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.14 10 CFR 60.72(a), DOE to maintain records of repository construction in accordance with 10 CFR 60.51(a)(2)

DISCUSSION

The QARD establishes QA requirements for the YMP. Implementing procedures have been developed to support these requirements for all Q items. The design is being documented per these procedures, which are imposed upon construction through construction specifications, and therefore will provide the Repository the necessary information to support this requirement. Records will also be kept for all non-Q items in support of this requirement.

APPLICABILITY

No specific ESF design requirements; however, facility construction specifications contain requirements for the appropriate records of those items identified as applicable from [10 CFR 60.72(b)].

F.2.15 10 CFR 60.72(b)(1), Construction records to include surveys of the facility excavations, shafts and boreholes

DISCUSSION

Surveys of underground facility excavations, shafts, and boreholes will be provided by the testing community.

APPLICABILITY

No specific ESF design requirements.

F.2.16 10 CFR 60.72(b)(2), Construction records to include a description of the encountered materials

DISCUSSION

Documentation of encountered materials will be provided by the testing community as part of site characterization activities. Construction will record information on the materials

encountered for the purpose of choosing the proper ground support. This will be recorded as part of the ground support activities but is not being performed to meet this requirement.

APPLICABILITY

No specific ESF design requirements.

F.2.17 10 CFR 60.72(b)(3), Construction records to include geologic maps and geologic cross sections

DISCUSSION

ESF design and construction will not be collecting this data. The scientific testing community will collect and document this data as part of site characterization activities. ESF will provide a mapping platform from which most of this data will be collected.

APPLICABILITY

ESF to develop and provide a platform from which mapping of the upper portions of the tunnel can be performed. The lower portion of the tunnel can be mapped without devices for elevating personnel.

F.2.18 10 CFR 60.72(b)(4), Construction records to include locations and amount of seepage

DISCUSSION

The ESF constructor will notify the testing organization when water seepage is encountered. The desire is to provide quantity, flow rate, etc., without compromising worker safety. Sealing will be determined in the field by safety and site characterization representatives.

APPLICABILITY

ESF to require the constructor to notify the testing organization of water seepage before sealing off inflow unless worker safety is an issue. Water inflow measurements are to be made provided worker safety is not compromised.

F.2.19 10 CFR 60.72(b)(5), Construction records to include details of equipment, methods, progress, and sequence of work

DISCUSSION

This will be established primarily through ESF design. The constructor will be allowed to make variations and to determine the most appropriate method of construction.

APPLICABILITY

ESF to require constructor to document equipment, methods, progress and sequence of work.

F.2.20 10 CFR 60.72(b)(6), Construction records to include construction problems

DISCUSSION

The constructor will document significant construction problems.

APPLICABILITY

ESF to require constructor to document all significant construction problems encountered, and their solutions.

F.2.21 10 CFR 60.72(b)(7), Construction records to include anomalous conditions encountered

DISCUSSION

All geologic anomalies will be reported by the testing community. All anomalous construction situations will be reported by the constructor, as per [10 CFR 60.72(b)(6)].

APPLICABILITY

ESF to require constructor to document all significant construction problems encountered and solutions [as per 10 CFR 60.72(b)(6)].

F.2.22 10 CFR 60.72(b)(8), Construction records to include instrument locations, readings, and analysis

DISCUSSION

Scientific testing will be responsible for this activity and therefore be responsible for documenting it.

APPLICABILITY

No specific ESF design requirements.

F.2.23 10 CFR 60.72(b)(9), Construction records to include location and description of structural support systems

DISCUSSION

ESF will document location of all ground support systems.

APPLICABILITY

ESF to require the locations of all ground support systems to be documented, consistent with approved QA implementing procedures.

F.2.24 10 CFR 60.72(b)(10), Construction records to include location and description of dewatering systems

DISCUSSION

ESF will document the description and location of all dewatering systems.

APPLICABILITY

ESF will document the description and location of all dewatering systems.

F.2.25 10 CFR 60.72(b)(11), Construction records to include details, methods of emplacement, and location of seals used

DISCUSSION

This function will be performed and documented by Repository design and construction.

APPLICABILITY

No specific ESF design requirements.

F.2.26 10 CFR 60.74, Perform or be able to perform tests that the Commission deems appropriate

DISCUSSION

ESF will design for all tests specified through the Test Coordination Office (TCO) and, if needed, will add and/or modify the ESF to accommodate any new or additional tests. Tests with radioactive material will require additional facility design and construction that will not be performed until such need is identified.

APPLICABILITY

No additional ESF design requirements.

F.2.27 10 CFR 60.111(a), Design GROA to maintain radiation exposures, radiation levels and releases of radioactive materials within the limits of Part 20 and EPA standards, during preclosure

DISCUSSION

This requirement imposes allowable radiation exposure limits on the Geologic Repository Operations Area (GROA) where waste will be handled during the preclosure period. No handling of radioactive materials is being planned by the ESF. The only permanent ESF items being designed and constructed are the main access opening and the ground support system, which are being designed and constructed in compliance with the applicable requirements in [10 CFR 60.130].

APPLICABILITY

No specific ESF design requirements.

F.2.28 10 CFR 60.111(b)(1), Preserve the ability to retrieve waste

DISCUSSION

ESF layout design will be consistent with Repository design for main access openings. Permanent ground support and linings are being designed for a 150 year maintainable life to cover the period up to permanent closure. This includes 100 years for waste retrieval, as per the Program Approach.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth. Design all permanent ground support for a 150 year maintainable life.

F.2.29 10 CFR 60.111(b)(3), Reasonable schedule for retrieval

DISCUSSION

Definition of a retrieval schedule is further clarification of [10 CFR 60.111(b)(1)] but does not result in a design requirement.

APPLICABILITY

No specific ESF design requirements.

F.2.30 10 CFR 60.112, Overall system performance for the geologic repository after permanent closure

DISCUSSION

Site selection is not within the scope of the ESF design. To support the Engineered Barrier System (EBS), the ESF main access opening will be designed and constructed consistent with Repository design. Design of shafts, boreholes, and their seals is the responsibility of Repository design.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth.

F.2.31 10 CFR 60.113(a)(1)(i), Design of Engineered Barrier system

DISCUSSION

ESF contribution to the EBS is achieved by designing the main access openings consistent with the Repository design, which is explicitly covered in [10 CFR 60.133(a)(1)].

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth.

F.2.32 10 CFR 60.113(a)(1)(ii)(A), Containment of HLW within waste packages

DISCUSSION

This 10 CFR 60 is directed at the waste package's role to meet [10 CFR 60.113(a)(i)]. The ESF has no impact or control over the waste package design and therefore this requirement is not applicable to the design of the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.33 10 CFR 60.113(a)(1)(ii)(B), Release rate from Engineered Barrier system

DISCUSSION

The EBS will be the responsibility of the Repository design. The main access drifts will be part of this system and therefore the ESF will design and construct the main access consistent with the Repository layout and with the Determination of Importance Evaluations controls.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth.

F.2.34 10 CFR 60.113(a)(2)*, Geologic setting

DISCUSSION

This requirement is a siting criteria applicable to the geologic setting and does not impose any direct design requirements on the ESF. The ESF design will locate the ESF main access openings consistent with the Repository design and therefore preserve the consideration to this requirement that was given during site selection and Repository layout.

APPLICABILITY

No specific ESF design requirements.

F.2.35 10 CFR 60.113(b)(2)*, Factors related to NRC specifying other release rates(nature/age of waste and design of the underground facility)

DISCUSSION

This requirement does not directly impose requirements on the ESF. This section serves to provide flexibility for the NRC to select a different criteria with respect to the numerical limits pertaining to the performance objectives for the EBS and the geologic setting as stipulated in [10 CFR 60.113(a)(2)].

APPLICABILITY

No specific ESF design requirements.

F.2.36 10 CFR 60.113(b)(3)*, Factors related to NRC specifying other release rates (geochemical characteristics)

DISCUSSION

This requirement does not directly impose requirements on the ESF. This section serves to provide flexibility for the NRC to select a different criteria with respect to the numerical limits pertaining to the performance objectives for the EBS and the geologic setting as stipulated in [10 CFR 60.113(a)(2)].

APPLICABILITY

No specific ESF design requirements.

F.2.37 10 CFR 60.113(b)(4)*, Factors related to NRC specifying other release rates (sources of uncertainty in predicting GROA performance)

DISCUSSION

This requirement does not directly impose requirements on the ESF. This section serves to provide flexibility for the NRC to select a different criteria with respect to the numerical limits pertaining to the performance objectives for the EBS and the geologic setting as stipulated in [10 CFR 60.113(a)(2)].

APPLICABILITY

No specific ESF design requirements.

F.2.38 10 CFR 60.122(a)(1)*, Siting criteria to meet 10 CFR 60.122(b)

DISCUSSION

The *Nuclear Waste Policy Amendments Act of 1987*, 42 USC 10101, Section 160(a), selected Yucca Mountain for investigation as a potential Repository. The testing objectives which

control the site characterization tests being performed and the data collected are controlled in the SCP and SD&TRD. This siting criteria is applicable to the final Repository as it will influence the design of the EBS so that together they meet the waste isolation requirements. There are no applicable design requirements for the ESF. Potentially adverse and/or favorable conditions may be discovered at the site because of the ESF activities but these will not affect the ESF design.

APPLICABILITY

No specific ESF design requirements.

F.2.39 10 CFR 60.122(a)(2)*, Repository action if an adverse condition is found during site characterization

DISCUSSION

This requirement applies to the Repository if site characterization discovers an adverse condition. The investigation for adverse conditions is controlled by the tests being performed (SCP and SD&TRD).

APPLICABILITY

No specific ESF design requirements.

F.2.40 10 CFR 60.122(b)*, Favorable conditions for site suitability

DISCUSSION

These identifications of favorable conditions are applicable to the Repository design. The ESF will only investigate those test objectives specified in the SCP and the SD&TRD.

APPLICABILITY

No specific ESF design requirements.

F.2.41 10 CFR 60.122(c)*, Potentially adverse conditions for site suitability

DISCUSSION

These identifications of adverse conditions are applicable to the Repository design. The ESF will only investigate those test objectives specified in the SCP and the SD&TRD. The potential for flooding during ESF construction and operation is covered in [10 CFR 60.133(a)(2)].

APPLICABILITY

No specific ESF design requirements.

F.2.42 10 CFR 60.122(c)(1)*, Potentially adverse conditions for site suitability - potential for flooding

DISCUSSION

As indicated in the remarks for [10 CFR 60.122(c)], the identification of adverse conditions is applicable to the Repository design. This requirement identifies flooding as a potential adverse condition to consider for Repository design. The potential for flooding requirement for ESF design is covered under [10 CFR 60.133(a)(2)].

APPLICABILITY

No specific ESF design requirements.

F.2.43 10 CFR 60.130, All design bases to be consistent with the site characterization results

DISCUSSION

All design bases of permanent items in the ESF will be consistent with site characterization data. The main access openings will be consistent with Repository design, and permanent ground support will be selected based upon the local ground conditions. The ESF design will include all site characterization results by using the site data known at the time of design and by following the appropriate implementing procedure developed in compliance with the QARD to evaluate impacts from additional data that is obtained after design. (Currently this is NLP-3-26, *Impact Reviews for Revisions of the Documents That Affect the MGDS Development Organization*).

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth. Ground support selected based upon local ground conditions.

F.2.44 10 CFR 60.131(a)*, Radiological protection

DISCUSSION

Compliance with this requirement is primarily a function of equipment design and operating procedures for radiation protection which will be provided by the Repository.

APPLICABILITY

No specific ESF design requirements.

F.2.45 10 CFR 60.131(a)(6), The GROA design to include a radiation alarm system

DISCUSSION

This requirement pertains to radiation levels in the air in restricted areas. Since no radioactive materials will be brought into the ESF, this requirement does not apply to the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.46 10 CFR 60.131(b)(1), SSCs that are ITS to withstand anticipated natural phenomena and environmental conditions so as not to interfere with safety functions

DISCUSSION

The ground support system is the only ITS item in the ESF. Being underground, the only natural phenomena will be seismic motion. The naturally occurring and man induced environmental conditions underground will be considered in the ground support design.

APPLICABILITY

Permanent ground support system will be designed for Repository seismic loads and all naturally occurring and man induced underground environmental conditions.

F.2.47 10 CFR 60.131(b)(2), SSCs that are ITS to withstand impacts from equipment failures that could lead to loss of safety functions

DISCUSSION

This requirement has been interpreted as impacts to ITS items from machinery (runaway train) or rotating equipment failures (flywheel, cutter disc, etc.). The application of this interpretation is for Repository only and not during ESF construction and/or operations; therefore, there are no ESF design requirements associated with this requirement.

APPLICABILITY

No specific ESF design requirements.

F.2.48 10 CFR 60.131(b)(3)(i), SSC ITS to perform safety functions during and after fires and explosion

DISCUSSION

The definition of credible fires and explosions in the GROA will be defined by the Repository and any permanent structures, systems, and components (SSCs) provided by the ESF will be evaluated by Repository design before relying on it to perform ITS function(s). Ground support is the only ITS item being designed and installed in the ESF. The level of ground support, installed by ESF design, will meet ESF operational requirements but not necessarily Repository requirements. The ESF ground support design and installation will be installed compliant with all Q-controls and will allow supplemental ground support to be added by Repository, if needed.

APPLICABILITY

No specific ESF design requirements.

F.2.49 10 CFR 60.131(b)(3)(ii), Repository to incorporate noncombustible and heat resistant materials

DISCUSSION

To the extent practical rather than practicable, this requirement is applicable to the ESF and will be complied with. Practical is being specified rather than practicable because risk and cost analysis will need to be performed before committing to applying this requirement everywhere possible, regardless of whether the risk warrants the expense.

APPLICABILITY

Incorporate noncombustible and/or heat resistant materials, to the extent practical.

F.2.50 10 CFR 60.131(b)(3)(iii), Explosion and fire detection alarm system; suppression system to reduce adverse effects on SSC ITS

DISCUSSION

The Repository will install alarm and suppression systems. The ESF will install a portion of the permanent ground support and if there were to be a fire the integrity of the ESF installed ground support will be evaluated before using it for Repository operations.

APPLICABILITY

No specific ESF design requirements.

F.2.51 10 CFR 60.131(b)(3)(iv), The repository to include protection against the adverse effects of the operation or failure of the fire suppression systems

DISCUSSION

The only ITS item in the ESF is the ground support system. If there were to be a fire the integrity of the ground support will be evaluated before using it for Repository operations. The ground support system is upgradeable and/or replaceable.

APPLICABILITY

No specific ESF design requirements.

F.2.52 10 CFR 60.131(b)(4)(i), SSC ITS maintain control of radioactive effluent, permit prompt termination of operations and evacuate personnel

DISCUSSION

This requirement is only applicable during Repository operations.

APPLICABILITY

No specific ESF design requirements.

F.2.53 10 CFR 60.131(b)(4)(ii)*, On-site facilities for emergency condition

DISCUSSION

This requirement is only applicable during Repository operations.

APPLICABILITY

No specific ESF design requirements.

F.2.54 10 CFR 60.131(b)(6), The structures, systems, and components important to safety to permit inspection, testing, and maintenance

DISCUSSION

This requirement applies to ESF ITS items.

APPLICABILITY

The ground support system will be designed to allow periodic inspection, testing and maintenance.

F.2.55 10 CFR 60.131(b)(8)*, Instrumentation and control systems to monitor and control systems ITS

DISCUSSION

This requirement is only applicable during Repository operations.

APPLICABILITY

No specific ESF design requirements.

F.2.56 10 CFR 60.131(b)(9), The repository design, construction and operation to include worker protection as regulated by MSHA

DISCUSSION

Protecting the people who operate ITS items is not applicable to the ESF because there will be no ITS functions taking place in the ESF. Designing, installing, and maintaining the ground support systems to Mine Safety and Health Administration (MSHA) standards is applicable to the ESF as a YMP safety requirement but not as a regulatory requirement from [10 CFR 60.131(b)(9)]. This requirement will be met due to compliance with MSHA safety standards.

APPLICABILITY

Although the ground support systems will be designed, installed and maintained to meet all applicable MSHA standards, this requirement does not specify any additional design requirements.

F.2.57 10 CFR 60.131(b)(10)*, Shaft conveyances for rad waste handling

DISCUSSION

This requirement is only applicable during Repository operations if a shaft hoist is used in Repository.

APPLICABILITY

No specific ESF design requirements.

F.2.58 10 CFR 60.133(a)(1), Orientation, geometry, layout and depth of underground facility and EB contribute to containment and isolation of radionuclides

DISCUSSION

ESF will be designed to be consistent with the Repository design. Since the Repository design will determine where the ESF main access opening will be, ESF design cannot address whether the geometry, layout, or depth contributes to isolation or containment. The ESF is not designing the EBS. The main access will be part of the Repository facility, which will be part of the EBS, and therefore will preserve any waste isolation allocation responsibilities that have been associated with the orientation, geometry, layout, and depth of the opening.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth.

F.2.59 10 CFR 60.133(a)(2), The effects of credible disruptive events do not spread through the facility

DISCUSSION

This requirement is a Repository requirement to ensure that control of the facility is not lost when nuclear materials are present. With no nuclear materials in the ESF, MSHA and Occupational Safety and Health Administration (OSHA) standards are sufficient for ESF operations. The location of the north and south portal openings and the slope of the access ramps can have an impact on the ability of the potential Repository to control flooding and therefore will be consistent with Repository design. The slope of the Main Drift, between the ramps, is specifically designed for drainage.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth.

F.2.60 10 CFR 60.133(b), The underground facility designed with flexibility to accommodate site conditions

DISCUSSION

The ESF Subsurface excavations will be consistent with the Repository design, therefore preserving the inherent Repository designed layout and orientation flexibility. The ground support design must consider all anticipated ground conditions to be able to provide the required protection for all conditions.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth. The ground support is to be designed to operate in all anticipated ground conditions.

F.2.61 10 CFR 60.133(c), The underground facility to permit retrieval of waste in accordance with 10 CFR 60.111(b)

DISCUSSION

This requirement can only be met with the Repository design. To preserve the current Repository concept, the ESF will be excavated consistent with the Repository design. The ESF main access opening and the ground support system will be designed as permanent items.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth. Main access openings and ground support systems will be designed as permanent items.

F.2.62 10 CFR 60.133(d), Control of gas and water intrusion

DISCUSSION

This requirement was written for the Repository and the control of water and gas is an important consideration when waste is emplaced or is being emplaced so as not to assist the migration of radionuclides. The application of this requirement for the ESF is restricted to those water and methane gas encounters in the underground and not those intentionally being brought into the underground facility. If (perched) water is encountered, the TCO will be consulted and, if allowed, the water will be pumped out and recorded. The ramp slope and sump pumps will provide a reasonable water control and removal capability. The underground opening has been determined to be non-gassy and therefore no controls are needed. If the underground is found to be gassy at a later date, the appropriate OSHA controls will be applied.

APPLICABILITY

Ramps and main drift slope shall be consistent with Repository design for Repository function water control.

F.2.63 10 CFR 60.133(e)(1), Design underground openings to permit safe operations and maintain retrievability

DISCUSSION

Safe operations will be ensured by complying with MSHA and OSHA standards. The retrievability option will be supported by excavating the openings consistent with the Repository design and providing a permanent ground support system.

APPLICABILITY

All underground excavations will comply with applicable portions of MSHA and OSHA standards. The main access openings will be consistent with the Repository design with respect to orientation, geometry, layout, and design. The ground support will be designed and installed as a permanent item.

F.2.64 10 CFR 60.133(e)(2), Openings in the underground facility to reduce deleterious rock movement or fracturing of overlying or surrounding rock

DISCUSSION

Deleterious rock movement was defined in the *ESF Ground Support Analysis*, BABEE0000-01717-0200-00002, Rev.00C. The analysis indicates that if a single point rock failure occurs, and the surrounding rock is not supported, an uncontrolled series of failures could occur which would lead to loss of control of the opening.

APPLICABILITY

Install ground support throughout the opening and require an effective program of inspection and maintenance to ensure that all installed ground support continues to function properly for the full duration of the maintainable design life.

F.2.65 10 CFR 60.133(f), The underground facility to incorporate excavation methods that limit the potential for creating preferential pathway for groundwater

DISCUSSION

Use excavation methods that limit the damage to the rock beyond the intended opening.

APPLICABILITY

Use mechanical excavation equipment and/or controlled drill and blast methods of excavation.

F.2.66 10 CFR 60.133(g)(1), Ventilation system to control the transport of radioactive particulates and gases from the underground in accordance with 60.111(a)

DISCUSSION

This is a Repository requirement. The ESF ventilation system is not permanent and [10 CFR 60.111(a)] has been determined as not applicable to the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.67 10 CFR 60.133(g)(2), The underground facility ventilation system is designed to assure continued function during normal operations and under accident conditions

DISCUSSION

This is a Repository requirement that does not apply to the ESF. The ESF ventilation is temporary and will not be used by the Repository and therefore will not be designed to meet this requirement.

APPLICABILITY

No specific ESF design requirements.

F.2.68 10 CFR 60.133(g)(3), Separate the excavation and waste emplacement ventilation systems

DISCUSSION

This is a Repository requirement.

APPLICABILITY

No specific ESF design requirements.

F.2.69 10 CFR 60.133(h), Design Engineered Barrier to assist the geologic setting

DISCUSSION

This is a Repository requirement for design of the waste package and backfill. The ESF will construct the main access openings with mechanical excavation equipment and controlled drill and blast to minimize the effects on the rock which is covered by [10 CFR 60.133(f)].

APPLICABILITY

No specific ESF design requirements.

F.2.70 10 CFR 60.133(i), The underground facility to account for thermal and thermomechanical response of host rock and groundwater system

DISCUSSION

Thermal loads are determined by the Repository design and the ESF will not preclude the Repository from meeting this requirement by excavating the main access openings consistent with the Repository layout.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth.

F.2.71 10 CFR 60.134(a), Seals for shafts and boreholes do not become pathways that compromise the repository from meeting its performance objective

DISCUSSION

Shafts and/or boreholes created and used by the ESF will be sealed by the Repository. Pressure grouting will not be used in any locations that it is not authorized. The location(s) of seals will not be known during the periods that the ESF will be under construction or in operation.

APPLICABILITY

No specific ESF design requirements.

F.2.72 10 CFR 60.134(b)(1), Select seal materials and placement methods to reduce the possibility of groundwater contacting the waste package

DISCUSSION

Since sealing of holes is a Repository function the selection of seal materials and placement methods will not be performed by the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.73 10 CFR 60.134(b)(2), Select seal materials and placement methods to reduce the radionuclide migration through existing pathways

DISCUSSION

Since sealing of holes is a Repository function the selection of seal materials and placement methods will not be performed by the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.74 10 CFR 60.137, The GROA designed to permit implementation of a performance confirmation program that meets the requirements of 10 CFR 60 Subpart F

DISCUSSION

Performance Confirmation tests that will be performed in the ESF during the construction and operational phase of the ESF are identified and specified by the TCO.

APPLICABILITY

Design the ESF to support the tests and corresponding facility requirements specified in Appendix B of this ESFDR.

F.2.75 10 CFR 60.140(b), Performance confirmation started during site characterization

DISCUSSION

Testing objectives are defined in the SCP and updated in the SD&TRD. The ESF provides the facility to perform the subsurface tests. All ESF testing design requirements, associated with each test, are specified through the TCO in Appendix B of this ESFDR.

APPLICABILITY

No additional design requirements.

Design the ESF to support the tests and corresponding facility requirements specified in Appendix B of this ESFDR.

F.2.76 10 CFR 60.140(c), Performance confirmation to include in situ monitoring, laboratory and field testing, etc.

DISCUSSION

The ESF will support in situ monitoring and field testing. Testing objectives are defined in the SCP and updated in the SD&TRD. The ESF provides the facility to perform the subsurface tests. All ESF performance confirmation testing and construction monitoring design requirements are specified through the TCO in Appendix B.

APPLICABILITY

No additional design requirements.

Design the ESF to support the tests and corresponding facility requirements specified in Appendix B of this ESFDR.

F.2.77 10 CFR 60.140(d)(1), The performance confirmation program not to compromise natural and engineered elements of the repository

DISCUSSION

This is a requirement on the performance confirmation testing program and not on the ESF design.

APPLICABILITY

No specific ESF design requirements.

F.2.78 10 CFR 60.141(a), During repository construction and operations, confirm geotechnical and design parameters and inform NRC of any design changes to accommodate field conditions

DISCUSSION

During ESF construction and operations test data will be collected to support this requirement. This data will be utilized by Repository design to support this requirement. The ESF main access openings will be constructed consistent with any changes in Repository design. This data will be reviewed by the ESF design team to reevaluate the bases of the permanent ground support system design and determine if a design change is warranted.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth. Design the ESF to support the tests and corresponding facility requirements specified in Appendix B of this ESFDR. Require a reevaluation of the ground support system utilizing in situ site data.

F.2.79 10 CFR 60.141(b), Monitor and evaluate subsurface conditions against design assumptions

DISCUSSION

Monitoring of the subsurface is part of the test objectives for site characterization. Similar to the support of [10 CFR 60.141(a)], the ESF main access openings will be constructed consistent with any changes in Repository design. This data will be reviewed by the ESF design team to reevaluate the bases of the permanent ground support system design and determine if a design change is warranted.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth. Design the ESF to support the tests and corresponding facility requirements specified in Appendix B of this ESFDR. Require a reevaluation of the ground support system utilizing in situ site data.

F.2.80 10 CFR 60.141(c), Measure rock and water response resulting from development operations

DISCUSSION

These data will be collected through the testing program specified in the SD&TRD. Design the ESF to accommodate the tests specified by the TCO in Appendix B of this ESFDR.

APPLICABILITY

Design the ESF to support the tests and corresponding facility requirements specified in Appendix B of this ESFDR.

F.2.81 10 CFR 60.141(d), Evaluate changes in rock parameters (10 CFR 60.141(c)) against design bases assumptions

DISCUSSION

Similar to the support of [10 CFR 60.141(a) and (c)], the ESF main access openings will be constructed consistent with any changes in Repository design. This data will be reviewed by the ESF design team to reevaluate the bases of the permanent ground support system design and determine if a design change is warranted.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth. Design the ESF to support the tests and corresponding facility requirements specified in Appendix B of this ESFDR. Require a reevaluation of the ground support system utilizing in situ site data.

F.2.82 10 CFR 60.141(e), Conduct in-situ monitoring of thermomechanical response of the underground facility until permanent closure

DISCUSSION

This is a Repository requirement which requires monitoring the thermal effects of the heat from waste packages on the Repository. The ESF will perform heater testing for the purpose of site characterization and not performance confirmation since the heat source will not be waste packages located in emplacement drifts.

APPLICABILITY

No specific ESF design requirements.

F.2.83 10 CFR 60.142(a), Conduct in-situ testing of shaft and borehole seals, backfill and thermal interaction effects of the waste packages, backfill, rock and groundwater

DISCUSSION

This is a performance confirmation requirement that will be performed by Repository design and development. The final Repository designed version cannot be tested in the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.84 10 CFR 60.142(b), Initiate tests as soon as practicable

DISCUSSION

Since [10 CFR 60.142(a)] does not apply to the ESF, this requirement also does not apply to the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.85 10 CFR 60.142(c), Backfill test section constructed

DISCUSSION

Will be performed during Repository development and will not be performed during ESF construction or operation.

APPLICABILITY

No specific ESF design requirements.

F.2.86 10 CFR 60.142(d), Borehole and shaft seal test section

DISCUSSION

Will be performed during Repository development and will not be performed during ESF construction or operation.

APPLICABILITY

No specific ESF design requirements.

F.2.87 10 CFR 60.143(a)*, Establish program at GROA to monitor conditions of waste packages,

DISCUSSION

Waste package monitoring will not be performed in the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.88 10 CFR 60.143(b)*, Waste package monitoring environment to be representative

DISCUSSION

Waste package monitoring will not be performed in the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.89 10 CFR 60.143(c)*, Duplicate waste package environment in laboratory experiments

DISCUSSION

Waste package monitoring will not be performed in the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.90 10 CFR 60.143(d)*, Continue waste package monitoring up to permanent closure

DISCUSSION

Waste package monitoring will not be performed in the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.91 10 CFR 60.151, The quality assurance program applies to all SSCs that are ITS, to design and characterization of barriers important to waste isolation and related activities

DISCUSSION

The QARD establishes QA requirements for the YMP. Procedures have been developed to implement these requirements. The ESF is being designed, developed, and constructed, and activities documented per these procedures.

APPLICABILITY

No ESF design requirement. Following the YMP's QA procedures will implement the requirements of the QARD.

F.2.92 10 CFR 60.152, DOE to implement a quality assurance program based on 10 CFR 50 Appendix B and 10 CFR 60.151

DISCUSSION

The QARD establishes QA requirements for the YMP based on [10 CFR 50, Appendix B] and other regulatory, commitment, and guidance documents.

APPLICABILITY

No ESF design requirements. Following the YMP's QA procedures will implement the requirements of the QARD.

INTENTIONALLY LEFT BLANK

CRWMS/M&O

Controlled Document Instructions

Complete only applicable items.

DATE
04/19/96

TO	COPY NO.	LOCATION
DELLIGATTI MARK	102796.0	ROCKVILLE -NRC

Description of Document(s)

TITLE	DOCUMENT IDENTIFIER	EFFECTIVE DATE	NO. OF SHEETS
YMP/CM-0019 Rev. 2 ICN 0 EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS		04/22/96	

Instructions/Remarks

Please incorporate changes required per the instructions of this CDI on the effective date noted.

REPLACE: TITLE PAGE VOLUME 1 WITH THE ATTACHED TITLE PAGE DATED 04/22/96

REPLACE: DOCUMENT CHANGE NOTICE (DCN) PAGE 4 OF 4 WITH THE ATTACHED DOCUMENT CHANGE NOTICE (DCN) PAGE 4 OF 4

INSERT: CHANGE DIRECTIVE CR 96/029 DIRECTLY BEHIND DOCUMENT CHANGE NOTICE (DCN) PAGE 4 OF 4

RETAIN: ALL EXISTING CHANGE DIRECTIVES CR 95/242, CR 95/194 CR 95/071, CR 94/412, CR 94/273, CR 94/251, CR 93/422

REPLACE: THE REMAINING PAGES OF REV 1 AND ALL APPLICABLE ICN'S PAGE II THRU J-26 WITH REV 2 PAGE II THRU F-28

Receipt Acknowledgement

NAME	SIGNATURE	DATE

Contact the Document Center staff member named below with any questions regarding these instructions.

BY	LOCATION	PHONE
DCC LAS VEGAS	TES3/423	(702) 295-5464

CRWMS/M&O

Controlled Document Instructions

Complete only applicable items.

DATE
04/19/96

TO	COPY NO.	LOCATION
DELLIGATTI MARK	102796.0	ROCKVILLE -NRC

Description of Document(s)

TITLE	DOCUMENT IDENTIFIER	EFFECTIVE DATE	NO. OF SHEETS

Instructions/Remarks

***NOTE: VOLUME 2 OF REV 1 HAS BEEN INCORPORATED INTO
NEW REV 2***

*** DESTROY SUPERSEDED MATERIAL ***

DUE BY: N/A

Receipt Acknowledgement

NAME	SIGNATURE	DATE

Contact the Document Center staff member named below with any questions regarding these instructions.

BY	LOCATION	PHONE
DCC LAS VEGAS	TES3/423	(702) 295-5464

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED: "YUCCA MOUNTAIN CHARACTERIZATION PROJECT - Selected Test Pits and Preliminary Surficial Deposits Map" "TN8 L PACKAGING"

WITHIN THIS PACKAGE

Note: B ecause of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.