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APPENDIX A.2

ESF-REPOSITORY INFERFACE DRAWINGS

[TBD]

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APPENDIX A.3

ESF SEALING REQUIREMENTS IMPOSED BY REPOSITORY SEALING PLAN

[TBD]

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APPENDIX A.4

THERMAL DESIGN BASIS LOADS FOR THE ESF

[TBD]

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APPENDIX A.5

SEISMIC DESIGN BASIS LOADS FOR THE ESF

[TBD]

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APPENDIX B

ESF TESTING REQUIREMENTS FOR FACILITY DESIGN

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APPENDIX B

Exploratory Studies Facility (ESF) Testing Requirements For Facility Design

The information provided in this Appendix is preliminary design input supporting pre-Title II Design Studies for the ESF Reference Design Concept, and is the first phase submittal of test related design information. The information is taken from Test Planning Package 91-5, "Preliminary ESF TPP for Support of Preliminary Title II ESF Design Studies -- First Phase Submittal, Planned ESF Tests - North Ramp Access." The content and format of the information is consistent with the Raytheon Services Nevada (RSN) request for Title I Design testing information (FS-YMP-5197).

Two additional ESFDR Appendix B design phased inputs will be developed for ESF testing in the Calico Hills and the Topopah Spring Main Test Level (including South Ramp Access). The purpose of these phased design inputs is to complete the design requirements for ESF testing prior to Title II Design.

Supporting requirements from the ESFDR, Rev. 0, Appendix B (Sections 2.3 through 2.9) for the above test design inputs, are provided for use in design study activities as preliminary, best available information, for development of the ESF Reference Design Concept. Information provided in TPP 91-5 is the most current and takes precedence over Sections 2.3 through 2.9 if discrepancies occur. Prior to the initiation of Title II Design, the North Ramp, Calico Hills, and the Topopah Spring Main Test Level (including South Ramp Access) test design inputs will be revised based upon prioritized needs to support Design Studies and Phased Title II Design. This will include changes which result from SCPB revisions and selected facility configuration and construction methods. These changes will be submitted as a formal revision of the ESFDR.

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APPENDIX B

TABLE OF CONTENTS

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APPENDIX B

TABLE OF CONTENTS (Cont.)

TEST PLANNING PACKAGE 91-5
PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

TPPII gal
5-06-91
[illegible]

PLANNED ACTIVITY IN ESF NORTH ACCESS	SCPB STUDY NUMBER	SCPB ACTIVITY NUMBER	SCPB ADDITION ? (2)	PONTENTIAL IMPACT ON CONSTRUCTION ?	ALCOVE NECESSARY ?	SAMPLING ONLY ?	IDS SUPPORTED ?
United States Geological Survey							
Underground Geologic Mapping	8.3.1.4.2.2	8.3.1.4.2.2.4					
Seismic Tomography / Vertical Seismic Profiling in the ESF	8.3.1.4.2.2	8.3.1.4.2.2.5		X			X
Overcore Stress Experiment in the ESF	8.3.1.15.2.1	8.3.1.15.2.1.2			X		
Matrix Hydrologic Properties Testing	8.3.1.2.2.3	8.3.1.2.2.3.1				X	
Intact Fracture Test	8.3.1.2.2.4	8.3.1.2.2.4.1					
Radial Borehole Tests in the ESF	8.3.1.2.2.4	8.3.1.2.2.4.4			X		X
Excavation Effects Test	8.3.1.2.2.4	8.3.1.2.2.4.5		X	X		X
Perched Water Testing in the ESF	8.3.1.2.2.4	8.3.1.2.2.4.7		X (3)			X
Hydrochemistry Tests in the ESF	8.3.1.2.2.4	8.3.1.2.2.4.8			X		
Hydrologic Properties of Major Faults Encountered in the ESF	8.3.1.2.2.4	8.3.1.2.2.4.10		X (3)	X		X
Lawrence Livermore National Laboratory							
Geomechanical Attributes of the Waste Package Environment	8.3.4.2.4.3	UNDEFINED	X		X		X
Repository Horizon Near-Field Hydrologic Properties	8.3.4.2.4.4	8.3.4.2.4.4.1			X		X
Repository Horizon Rock-Water Interaction	8.3.4.2.4.4	8.3.4.2.4.4.2				X	
Sandia National Laboratory							
Access Convergence Test at the ESF	8.3.1.15.1.5	8.3.1.15.1.5.1					X
Demonstration Breakout Rooms	8.3.1.15.1.5	8.3.1.15.1.5.2			X		X
Heater Experiment in TSw1	8.3.1.15.1.6	8.3.1.15.1.6.1			X		X
Plate Loading Tests	8.3.1.15.1.7	8.3.1.15.1.7.1			X		X
Evaluation of Mining Methods	8.3.1.15.1.8	8.3.1.15.1.8.1					X
Monitoring of Ground Support Systems	8.3.1.15.1.8	8.3.1.15.1.8.2					X
Monitoring Drift Stability	8.3.1.15.1.8	8.3.1.15.1.8.3					X
Air Quality and Ventilation Experiment	8.3.1.15.1.8	8.3.1.15.1.8.4					X
Laboratory Tests (Thermal & Mechnical) Using Samples ...	8.3.1.15.1.1, 2, 3, 4	(1)				X	
Development and Demonstration of Required Equipment	8.3.2.5.6	UNDEFINED	X				UNCERTAIN
In Situ Testing of Seals Components	8.3.3.2.2.3	UNDEFINED	X		X		X
Los Alamos National Laboratory							
Chloride and Chlorine-36 Measurements of Percolation at YM	8.3.1.2.2.2	8.3.1.2.2.2.1				X	
Diffusion Test in the ESF	8.3.1.2.2.5	8.3.1.2.2.5.1			X		X
History of Mineralogic and Geochemical Alteration of YM	8.3.1.3.2.2	8.3.1.3.2.2.1				X	
Fracture Mineralogy Studies of the ESF	8.3.1.3.2.1	8.3.1.3.2.1.3				X	
Petrologic Stratigraphy of the Topopah Spring Member	8.3.1.3.2.1	8.3.1.3.2.1.1				X	
Biological Sorption and Transport	8.3.1.3.4.2	UNDEFINED	X			X	

NOTES:
1. SCPB Activities under this identifier are 8.3.1.15.1.1.1, 2, 3; 8.3.1.15.1.2.1; 8.3.1.15.1.3.1, 2; 8.3.1.15.1.4.1, 2
2. Requires addition of activity description in SCPB
3. [illegible] construction impact is more attributable to the characteristics of the feature than actual [illegible] conduct

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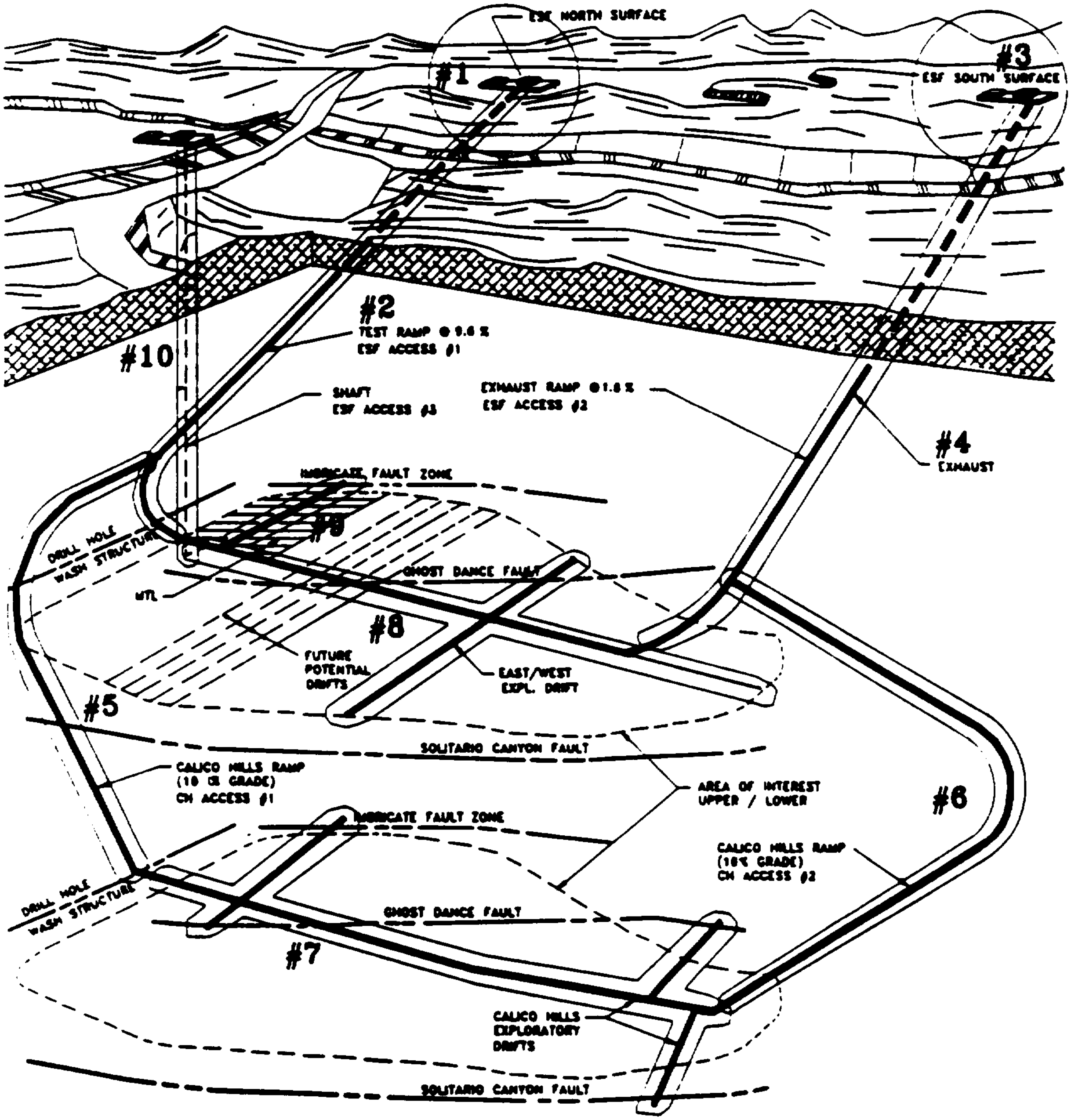

NOTE: THIS IS PICTORIAL ONLY AND NOT DRAWN TO SCALE

NOTE: DESIGN, CONSTRUCTION, AND TESTING PHASES SHOWN --- #2

Figure A.

REFERENCE DESIGN CONCEPT
FOR COMMENCING STUDY

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: UNDERGROUND GEOLOGIC MAPPING

SCPB Section 8.3.1.4.2.2.4 (Activity)

Description of Activity

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 within the underground excavations. Geologists will take stereo-photographs of exposed rock surfaces of all openings in the ESF. These photographs will be analyzed off-site using a computer-driven analytical plotter. Detail line surveys will be performed continuously along one wall of each drift or ramp (or at 2-m intervals if in a shaft). Detail line surveys consist of recording the characteristics of each fracture, geologic discontinuity, or feature which intersects a datum line. Regular sampling of the wall rock and fracture infilling will be part of the mapping process.

Location

Geologic mapping will be performed in all ESF openings where items of particular interest such as faults, special contacts, etc. are encountered, special small-scale mapping may be conducted.

Special Room/Alcove Requirements

No special rooms required. Mapping will adjust to the opening configuration.

Interference Envelope

We are trying to design the underground mapping to have minimal interference with both construction and other experimentation. Standoff distances are not applicable to this test.

Constraints/Controls

1. Mapping must be conducted before installation of chain-link or wire mesh.

2. Walls must be cleaned before photography for mapping.

3. Utilities must be confined to the lower left or right quadrants or the invert of the ramp for 250 ft behind the trailing gear of the TBM.

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4. Geologists must have access to the entire circumference for sampling and mapping.

Timing/Schedule Requirements

Mapping will begin as soon as construction starts, and will proceed with excavation progress.

ESF Design/Test Support Requirements

Generally, mapping will be done as close to the working face as possible to minimize any deterioration of the rock, or interference from ground support. While the presence of rock bolts and plates will not hinder processing of the photos, rock pans, chain link fabric, or wire mesh must not be installed until the walls have been cleaned and photographed. The walls will be cleaned of all dirt, muck smear, or any other encrusted materials by the use of a high-pressure air-water blowpipe. The air-water mixture of the blowpipe should be adjusted such that little or no free water is present on the walls during cleaning. A tracer will be added to the cleaning water to allow detection of any penetration into the wall rock.

Mapping will be preformed on as much of the exposed rock surface as possible. The location of utilities (fan lines, compressed air line, conveyor, water line, electrical cables) should be arranged in each drift and ramp such that the maximum circumference of the tunnel is visible for mapping. We recommend that the utilities be confined to the lower left or right quadrants or the invert of the ramp if possible. Adequate illumination will be required for inspection of the walls, but strobe lighting for photography will be provided by the mapping team. The strobes require 110v AC power. Mapping will also require surveying support for location of photogrammetry control targets. The accuracy of locations of geologic features depends on the accuracy of the surveyed target locations.

Provision must be made to allow mapping geologists access to all parts of the tunnel circumference. We recommend some type of mapping platform be built, which would be equipped with multiple decks and/or levels, and an apparatus for mounting and aligning the photogrammetric camera for stereophotography of the walls. This platform could also be used for placing and surveying of photogrammetry control points, and hanging of wire mesh or chain line (after completion of a section of mapping).

We expect the maximum advance rate of the TBM to be about 250 ft per day. For this reason, a 250-ft section is required behind the trailing gear in which to conduct mapping. This section must be free of chain link fabric and wire mesh, and as free of obstruction from the utilities as possible. Behind this 250-ft area, miners will be free to install additional roof support, chain link fabric, or arrange utilities however they see fit. If ground conditions require fabric, mesh, or shotcrete closer to the machine than 250 ft, steps will be taken to do mapping as close to the machine as possible.

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Collection of various samples will be done concurrent with mapping. Where possible, geologists will use pry bars and hammers to remove samples from the wall. Where smooth walls make traditional sampling difficult, the use of a small drill and hydraulic splitter may be an option. This would require the drilling of a 6-inch to 1-ft deep hole adjacent to a fracture, about 1.25-inch in diameter. The hydraulic splitter would be inserted into the hole and used to split out a sample. Fracture filling minerals will also be sampled by using pry bars and hammers.

A storage and staging trailer or building of at least 200-sq-ft is required on the surface with necessary amenities. A photographic laboratory (light-tight) approximately 8 x 13 ft with necessary amenities and one circuit with 220 V, 30-A circuit.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: SEISMIC TOMOGRAPHY/VERTICAL SEISMIC PROFILING AT THE ESF

SCPB Section 8.3.1.4.2.2.5 (Activity)

Description of Activity

The purpose of seismic tomography and vertical seismic profiling activity is to remotely characterize subsurface fracture networks. Tests to be conducted are a) surface to ramp seismic imaging, b) borehole to borehole tomographic imaging, c) ramp to borehole seismic imaging, and d) strong motion seismic monitoring.

Test (a) will be conducted in both the Topopah Springs ramp and the Calico Hills ramp. The zone over which the test will be conducted will be mainly in areas of suspected faulting, fracturing, and perched water which have been identified in the ramps from geologic mapping, surface mapping, or other geophysical or geological studies.

Test (b) will be conducted in both the Topopah Springs and the Calico Hills ramps to determine the behavior of the damage zone, map faults away from the ramps and/or zoned of perched water. The location will be in zones of principle lithology, areas of changing fracture and fault content, and zones of any water inflow.

Test (c) will be conducted if suspected faults or geologic anomalies may be present ahead of the ramps to more accurately define the location and extent of these features that may significantly affect the integrity of the ramps.

Test (d) will be passive monitoring of strong seismic ground motion at points of different lithology and depth along the ramps.

Location

See Activity Description and Sketches 1, 2, and 3.

Special Room/Alcove Requirements

No special rooms or alcoves are needed. It is anticipated that all work can be done from the ramps or from already designed rooms. The exception may be an area required for the strong motion instruments ($1m^3$) when there is no area near a required location available.

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Interference Envelope

Dry drilling is not needed or wanted, only constraints are space to set up instruments in the ramps to perform the tests and record data during the tests (a few square meters). Ground vibration from other activities should be kept to a minimum.

Constraints Controls

Because the purpose of this test is to measure ground vibration caused by the introduction of energy from a specific source controlled by the seismic-test team, other loud noises or equipment or machinery-induced vibration in or near the facility are not allowed while tests are in progress. No other special constraints are required to include this activity in the ESF testing, and no additional perturbation to natural conditions (stress, temperature, moisture, etc.) will result from this activity (i.e., no significant zone of influence results from this activity) if boreholes are dry-drilled. This test does not require dry-drilled boreholes.

Timing/Schedule Requirements

Test "a", "b", and "c" should be done as the ramps are excavated and anomalies are encountered.

Test "d" instrumentation need not be emplaced until ramp construction is finished.

ESF Design/Test Support Requirements

No special rooms or alcoves are required. It is anticipated that all work can be done from the ramps or from already designed rooms. The exception may be an area required for the strong motion instruments ($1m^3$) when there is no protected area near a required location area. Horizontal boreholes (3.5-inch diameter) will be required for each of the "b" and "c" type tests. The length of the boreholes will be a function of the zone of desired investigation.

For damage zone investigations, the minimum length will be 5 meters. The distance between boreholes will be 1/2 to 1/3 the length. For more extensive "look ahead" or fault zone studies, the length of the boreholes may be up to 100 meters. No IDS support will be required except for one data line for each location of test "d". Temporary lighting and power, 110v/20 amp or 220v/20 amp will be required for test "a", "b", and "c". The length of each test will be from one day to ten days. Test "b" may be repeated to determine temporal changes in the extent of the damage zone.

SURFACE TO RAMP SEISMIC IMAGING TEST
Type "a"

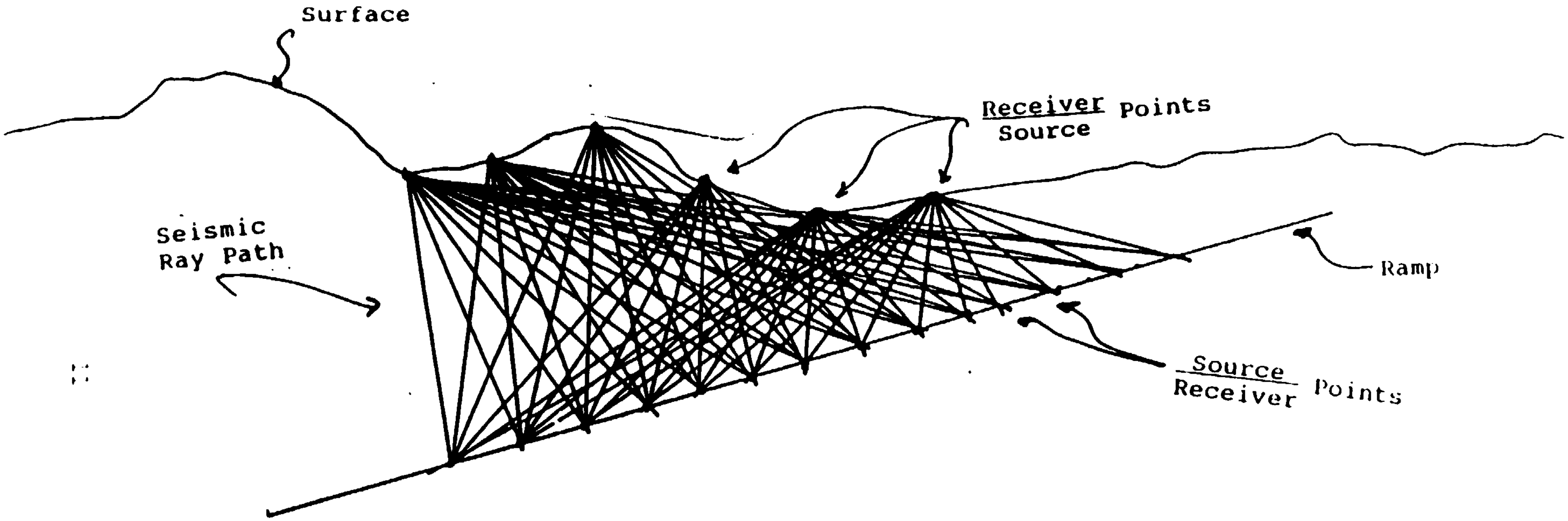

FIGURE 1. SIDE VIEW OF RAMP
(SCPB Section 8.3.1.4.2.2.5)

Note: This is pictorial only and not drawn to scale.

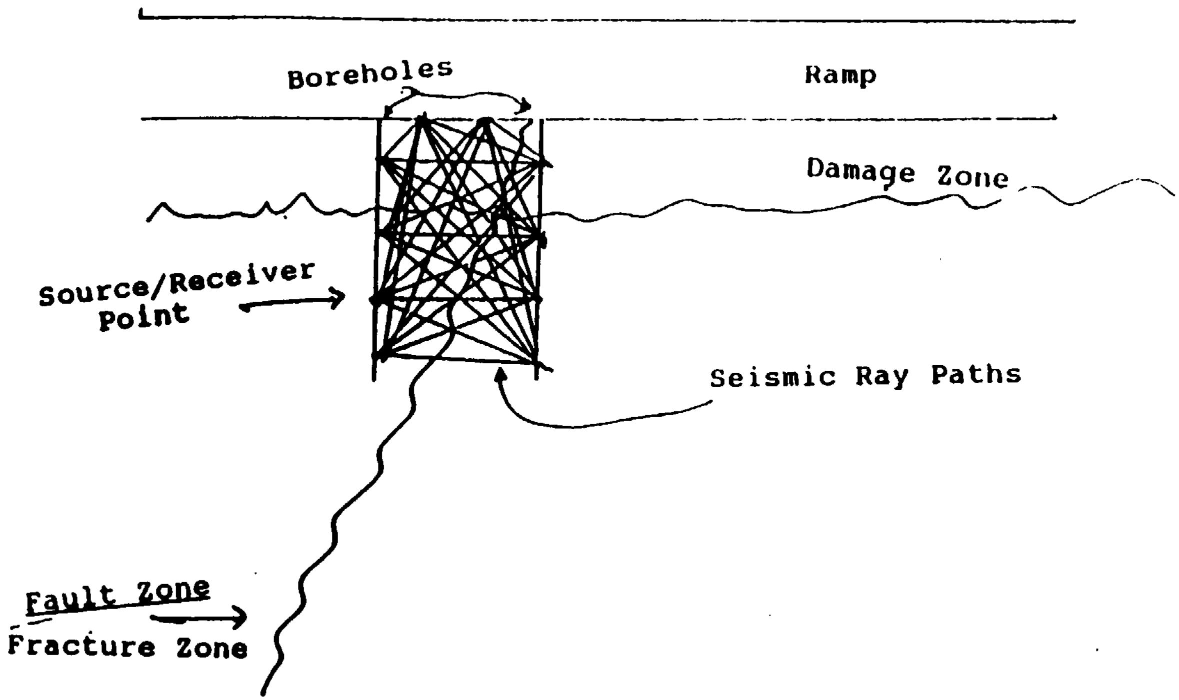

FIGURE 2. PLAN VIEW OF TOMOGRAPHIC IMAGING IN RAMPS TEST Type "b" (SCPB Section 8.3.1.4.2.2.5)

Note: This is pictorial only and not drawn to scale.

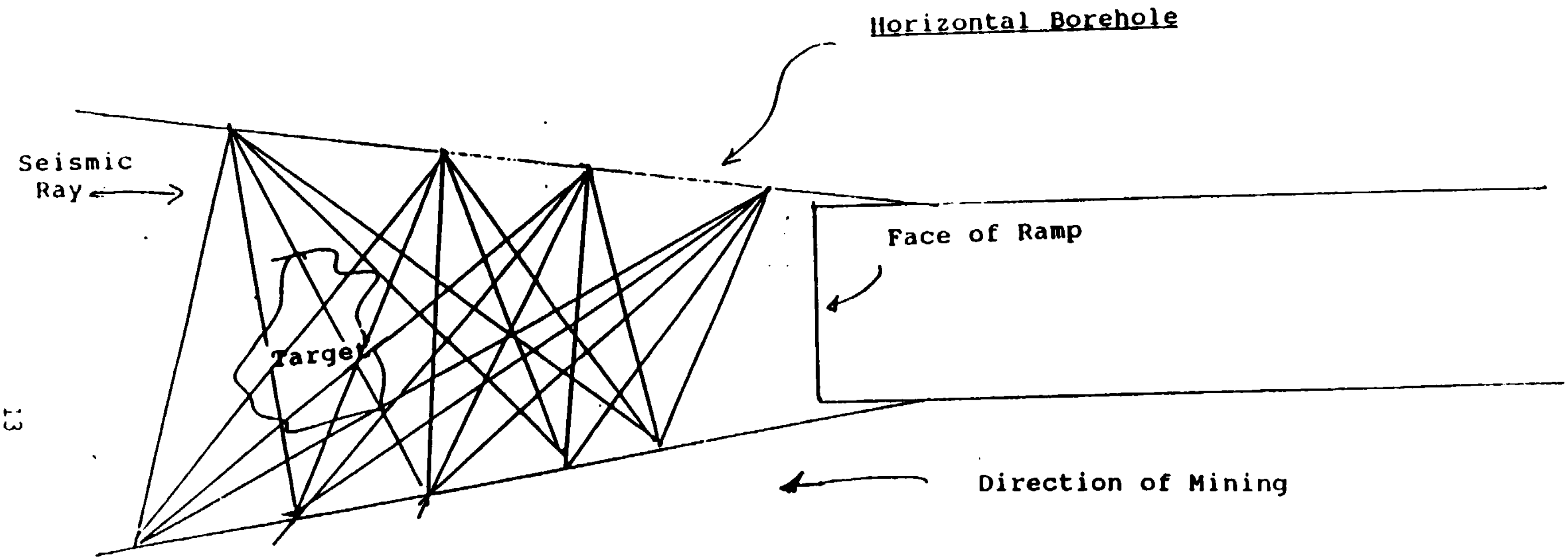

FIGURE 3. PLAN VIEW OF TEST - Type "c"
(SCPB Section 8.3.1.4.2.2.5)

Note: This is pictorial only and not drawn to scale.

PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: OVERCORE STRESS EXPERIMENT IN THE EXPLORATORY STUDIES FACILITY

SCPB Section 8.3.1.15.2.1.2 (Activity)

Description of Activity

The overcore stress experiments will be performed to determine the in situ state of stress above, within, and below the 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.

Soon after access is available, small-diameter holes will be drilled to prescribed orientations and lengths (longer than three shaft or drift diameters). A stress sensor will then be installed, and the instrumented center hole will be overcored in stages. Stress data will be taken as the instrumentation of each stage is overcored.

The test will be conducted in alcoves constructed from both the north and south ramps in the high lithophysal zone of the upper Topopah Springs welded unit, in alcoves on the main test level (one north end, one south end of block), and in the Calico Hills nonwelded unit at both the north and south ends of the block. The tests in the nonwelded Calico Hills may be either on the Calico Hills test level or from the ramps in the unit. Tests conducted in the Calico Hills unit will include hydrofracture tests conducted with low-volume amounts of water. The Calico Hills test locations should be sited so as to not be near hydrologic tests or other water-sensitive tests.

Location

The test will be conducted in alcoves constructed from both ramps in the high lithophysal zone of the upper Topopah Springs welded unit, in alcoves on the main test level (one north end, one south end of block), and in the Calico Hills nonwelded unit at both the north and south ends of the block. The tests in the nonwelded Calico Hills may be either on the Calico Hills test level or from the ramps in the unit (if applicable).

Special Room/Alcove Requirements

See "Location" statement.

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Interference Envelope

Test must be conducted at a distance equivalent to at least two opening diameters from the opening. The test must be located at least 50 ft from any heater test or be conducted prior to any heater test within 50 ft distance. If water is used in drilling/coring, any hydrologic tests can be conducted several meters away. Tests conducted in the Calico Hills unit will include hydrofracture tests conducted with low-volume amounts of water. The Calico Hills test locations should be sited so as to not be near hydrologic tests or other water-sensitive tests.

Constraints/Controls

The test should be separated from the nearest thermal test by a minimum of 50 ft or should be completed before the heaters are energized. 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 before tests are conducted. No mining, testing, or construction should take place in such a way as to influence the in situ stresses at the bottom of the test holes. Test holes should not be drilled near other instrument holes. Tests will be conducted within the approximately 50-ft-long boreholes extending downward and horizontally from the end of the excavation.

Timing/Schedule Requirements

This test does not require any special timing relative to the ESF construction.

ESF Design/Test Support Requirements

Drilling, including coring will be required. Dry drilling is not required. A mobile rock-testing facility (to be supplied by the test organization) will require an assigned space at the surface and utility hookups.

PLANNED ACTIVITY NAME: MATRIX HYDROLOGIC PROPERTIES TESTING

SCPB Section 8.3.1.2.2.3.1 (Activity)

Description of Activity

The purpose of the matrix hydrologic properties tests is to develop a comprehensive data base on matrix flux properties in the unsaturated-zone tuffs at Yucca Mountain. This activity includes collecting bulk and/or core samples, taken from the ESF. The samples may be obtained either from core holes drilled for other tests or from core drilled specifically for the collection of core for matrix properties testing. The collected samples will be packaged, labeled, and sent to a laboratory for various analyses.

Location

Various locations along the length of the ramp and other areas in the ESF to adequately characterize the matrix properties of the units. Samples will be required from near contacts; north, south, and middle of the block; and from all lithologic units encountered.

Special Room/Alcove Requirements

Small alcoves, large enough to contain a core rig, may be required in the event that additional coreholes are used to obtain samples for this test.

Interference Envelope

This test requiréd, as much as possible, in situ, samples. The samples should be collected far enough from any wet-drilling operations to insure uncontaminated samples.

Constraints/Controls

Procedures and design shall be developed to minimize the water contamination of any bulk samples. Core holes shall be drilled dry and provide core of HQ size.

Timing/Schedule Requirements

Samples do not need to be collected immediately after excavation, but should be collected as soon as possible. This is important for natural water content samples.

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ESF Design/Test Support Requirements

Large size (estimated to be large enough not to pass a 1-ft mesh) may be required for some samples. Samples should be collected as soon as possible after excavation of the opening in order to avoid changes in the natural moisture state.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: INTACT FRACTURE TEST

SCPB Section 8.3.1.2.2.4.1 (Activity)

Description of Activity

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 understanding of physics of low and for flow modeling.

Fracture-sampling locations will be selected on the basis of detailed fracture maps. At about 12 or more locations (to be determined), a small pilot hole will be drilled across a fracture, a rock bolt anchor will be installed, the pilot hole will be overcored, and the sample will be withdrawn. The sample will be packaged, labeled, and transported to an off-site laboratory for intact-fracture analyses.

Location

Sample locations will be chosen by the PI after detailed mapping information is available.

Special Room/Alcove Requirements

An alcove large enough to accommodate a core rig may be required.

Interference Envelope

Suitable sample locations will be chosen by the PI. No interference envelope is defined.

Constraints/Controls

Flexibility in sampling location is required to locate suitable fractures. Drilling and overcoring will be done using dry methods. Because only sample collection will be conducted in the ESF, no other special constraints on the layout are required. No hydrological, chemical, or thermal disturbance is expected from this activity.

Timing/Schedule Requirements

This test should be done before any lining material is installed in the ESF.

ESF Design/Test Support Requirements

Sample locations will be chosen by the PI after mapping information is available. Dry drilling and overcoring will be required. A drilling alcove may be required if in a high traffic area.

PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: RADIAL BOREHOLE TESTS IN THE ESF

SCPB Section 8.3.1.2.2.4.4 (Activity)

Description of Activity

The radial borehole tests will investigate vertical and lateral movement of gas, water, and vapor on and across hydrogeologic contacts and within the various units.

Five stratigraphic depths have been tentatively chosen as sites for drilling the "Contact Test Holes" (replace "Short Radial Boreholes) (See Sketch 1). At each depth location, four 50-ft coreholes will be drilled parallel to the contact and each other, using air as the drilling fluid. A drilling and testing alcove will be required at each location. Core will be collected, packaged, labeled, and transported to an off-site laboratory for hydrologic analyses (fracture and matrix properties). The holes will be logged and surveyed for fracture and moisture data. Air-permeability tests in packed-off intervals will be conducted to obtain gas permeability data. Cross-hole permeability tests will be conducted across stratigraphic contacts with both gas and water. Long-term monitoring of matrix water potential, pressure, and temperature will also be conducted; formation gases will be sampled periodically.

Nine stratigraphic depths have been tentatively chosen as sites for drilling the "Anisotropy Test Holes" (replace long radial boreholes) (See Sketch 2). At each location, three 50-ft coreholes will be drilled horizontal, and perpendicular to the ramp. The first location will also serve to conduct limited prototype testing (also see Hydrochemistry Test). Air permeability testing will be conducted in each borehole and between the three boreholes.

Location

See "Description of Activity" and Sketches 1 and 2.

Special Room/Alcove Requirements

Contact Test Alcoves:

- Must allow drilling of 4 - 50 ft deep ODX core holes parallel to the contact and each other.
- Minimum of 20 ft off the ramp
- Holes 1 and 2 will be up to 10 ft apart and 7 ft above the contact.

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- Holes 3 and 4 will be up to 10 ft apart and 7 ft below the contact.

- Maximum dimensions are 24 ft wide, 26 ft height, 20 ft deep, these are dependent on the angle the ramp intersects the contact.

Anisotropy Test Alcoves:

- Must allow drilling of 3 - 50 ft deep ODX coreholes in an equilateral triangle with maximum of 15 ft sides.

- Holes will be horizontal and perpendicular to the ramp.

- Dimensions are 24 ft width, 22 ft height, 20 ft off ramp.

- Alcove is perpendicular to ramp.

Interference Envelope

Contact Tests:

- The holes need to be placed such that the stress relief effects of the ramp and alcove are minimized.

- The holes need to be placed such that other tests (excavation effects, fracture tests, etc.) will not interfere.

Anisotropy Tests:

- The holes need to be placed such that stress relief effects of the ramp and alcoves are minimized.

- The holes need to be placed such that other tests will not interfere.

Constraints/Controls

Provision for data collection by the IDS must be available at each location. Both the "contact" boreholes and the "anisotropy" boreholes will be drilled deep enough to be beyond the expected zone of mechanical and hydrologic influence of the openings, but need to be placed such that stress relief effects of the ramp and alcove are minimized. The boreholes also need to be placed so that other tests will not interfere. The "contact" holes will be used to monitor the movement of any construction water from the opening in order to measure the hydrologic zone of influence resulting from shaft construction. These monitoring activities require no special constraints, nor do they alter the hydrologic or geochemical state of the rock mass. However, at the stratigraphic contacts, cross-hole permeability tests will be run with both gas and water. The water injected under low pressure is estimated to influence a zone extending 10 m from the test location.

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Geochemical effects are not expected to extend beyond the zone of influence resulting from water movement. The air injected for this test will contain a tracer to allow discrimination between the natural gas in pore spaces and the injected air. Since a portion of the hydrochemistry testing is expected to be performed at the same location as the radial borehole test, the use of an air tracer will control the potential interference between these tests. No thermal or mechanical alterations to the rock mass will result from this test.

Timing/Schedule Requirements

Contact and anisotropy testing (Radial Borehole Tests) should be conducted as soon as feasible after excavation.

ESF Design/Test Support Requirements

An alcove of approximate dimensions of 26-ft high by 24-ft wide by 20-ft deep is required for each "Contact Location" and 22-ft high by 24-ft wide by 20-ft deep for each "Anisotropy Location". The boreholes will be dry drilled and will require drilling support as well as electricity and compressed air. The facility design and operational constraints shall allow periodic access to the test locations. Access should be provided as soon as feasible after passage of the TBM for both types of locations.

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These sites will require a total of 4 - 50' ODX holes, 2 on each side of the contact.

* We do also reserve the right to test across other interesting contacts that may be encountered in excavation

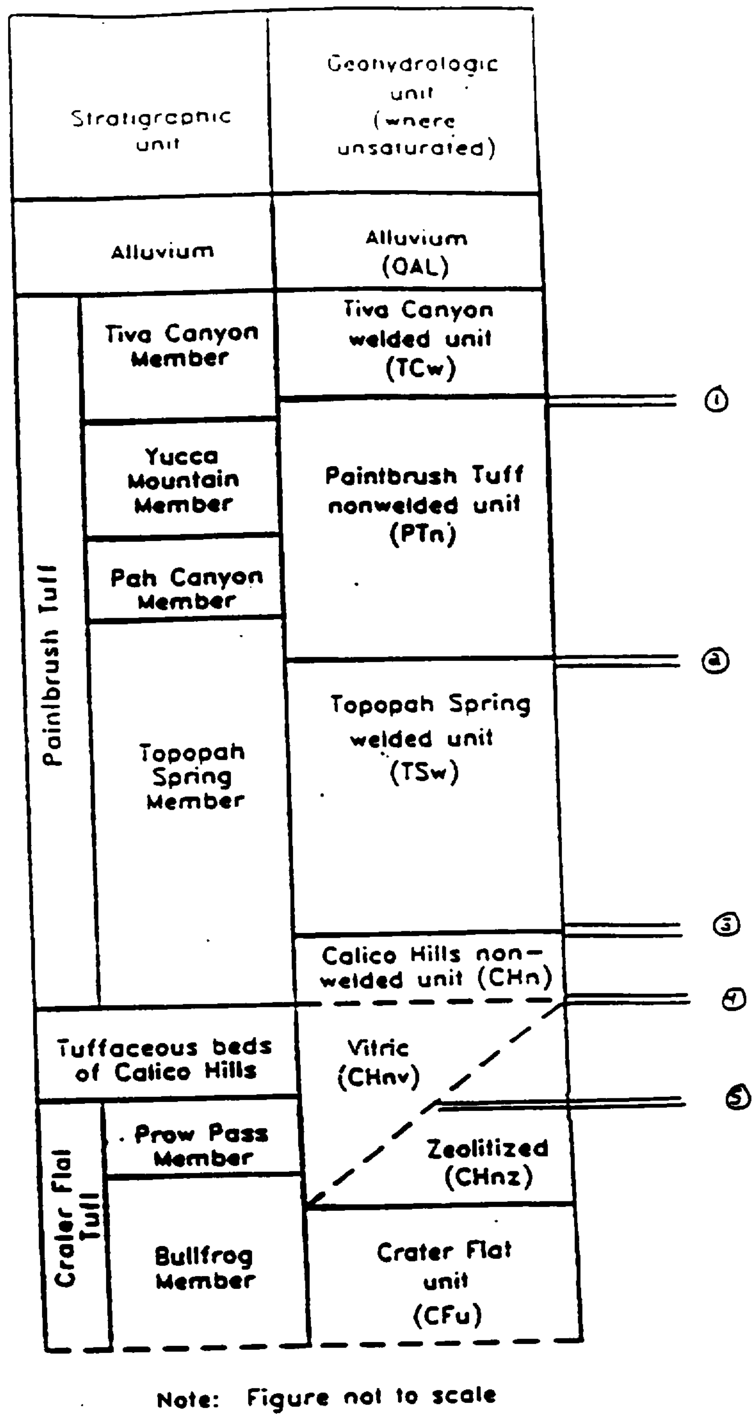

Figure 1.2-4. Diagram showing the relation of geohydrologic units to stratigraphic units (modified from Montazer and Wilson, 1984).

SKETCH 1: CONTACT TEST SITES (SCPB Section 8.3.1.2.2.4.4)

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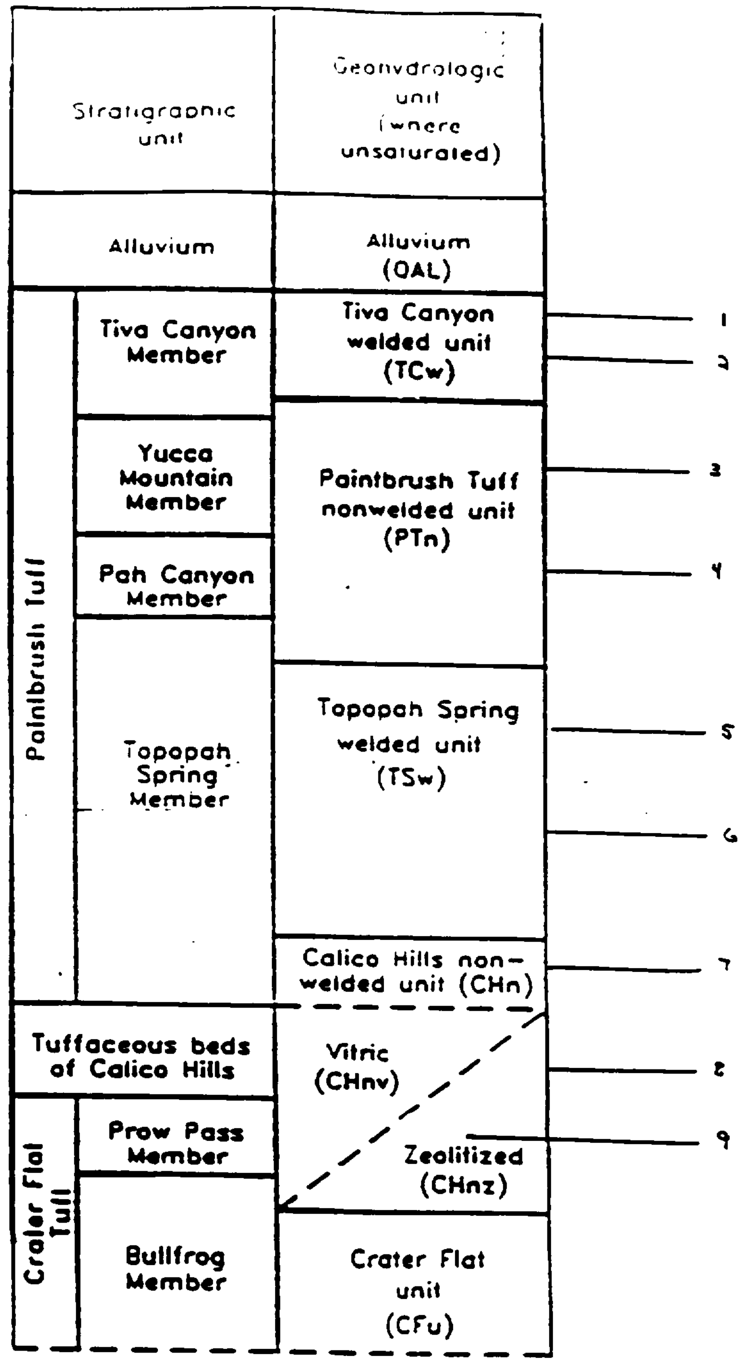

Note: Figure not to scale

Figure 1.2-4. Diagram showing the relation of geohydrologic units to stratigraphic units (modified from Montazer and Wilson, 1984).

SKETCH 2: ANISOTROPY TESTING (SCPB Section 8.3.1.2.2.4.4)

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PLANNED ACTIVITY NAME: EXCAVATION EFFECTS TEST

SCPB Section 8.3.1.2.2.4.5 (Activity)

Description of Activity

The excavation effects tests will measure stress changes in the near-field wall-rock as the ESF is excavated, and measure air-permeability changes that result from the stress redistribution.

Currently, the Calico Hills ramp from the main ramp is being considered as a possible location for this test. Other similar locations may be included at a later date. At each test location, multiple small-diameter holes will be drilled parallel or sub-parallel to the unexcavated opening wall but set back selected distances from it. All holes are planned to be air drilled/cored, logged, and surveyed; some of the holes will be instrumented to monitor stress changes and some to monitor permeability changes as the excavation is advanced. Stress and permeability data will be taken in drill holes extended beyond the excavation. Long-term permeability measurements will be made and temperature and moisture data collected. Additional holes may be drilled to handle the instrumentation packages if they are determined to be necessary during prototype testing.

Another possible location for excavation effects type testing is in the engineering boreholes along the ramp alignments. Testing impacts are expected to be minimal, but details are not yet developed.

Location

The configuration and construction methods of the ESF have limited the areas in which this test can be performed. One area in the ESF that could accommodate this test is the area in the north ramp where the shaft to the tuffaceous beds of Calico Hills begins. Boreholes could be drilled and instrumented prior to starting the Calico Hills ramps, and excavation effects data could be collected. A second possible site for the Excavation Effects Test is in the surface-based boreholes drilled in advance of the north ramp.

The site of the test is constrained by the available access to areas proximal to proposed excavations. This test will be conducted in areas that provide this proximity.

Special Room/Alcove Requirements

An alcove large enough to accommodate a core rig. After the boreholes are instrumented, the alcove will house the data acquisition equipment.

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Interference Envelope

This test must be located adjacent to where a new mined opening is to be excavated.

Constraints/Controls

Flexibility is the only significant constraint identified for this test. It is required for locating drill holes for tests. The instrument holes will be drilled at distances up to 50 ft from the excavation. They will extend as much as 100 ft beyond the excavation creating a zone of potential mechanical interference. All holes will be drilled dry. No thermal, chemical, or hydrological alteration of the rock mass is expected as a result of this activity.

Timing/Schedule Requirements

The test must be performed in conjunction with the excavation of a new opening to allow for the acquisition of the excavation effects data.

ESF Design/Test Support Requirements

Instrument leads at the test location shall be protected from damage. A drilling and testing alcove will be required for this test if conducted underground.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: PERCHED-WATER TESTING IN THE ESF

SCPB Section 8.3.1.2.2.4.7 (Activity)

Description of Activity

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, to identify perching mechanism(s), and to sample the 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, one or more small-diameter hole(s) will be drilled to enhance drainage, facilitate collection of water samples, and allow flow and/or pressure measurements to be made. The hole(s) will also be instrumented and sealed during testing to obtain data on hydraulic pressure and water potential over time.

Location

Since the occur and character of the perched-water zones can not be predicted, the actual locations can not be shown. Likewise, the type of facility needed in which to conduct the testing can not be determined at this time.

Special Room/Alcove Requirements

A room large enough to contain a small, underground coring rig may be required if drilling into a perched-water zone becomes necessary. This alcove would be needed to remove the drilling rig out of the main traffic areas in the ESF.

Interference Envelope

The perched-water test is not constrained by any interference envelope. The test will be conducted whenever and wherever perched-water is detected.

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Constraints/Controls

All boreholes will be drilled dry. Grouting in the ESF will require a chemical tracer to be added to the grout. Because of its nature and location, no special constraints on the layout or operation of the ESF are imposed by this experiment.

Because this activity only involves sampling and drilling of small-diameter holes only, no mechanical, chemical or thermal alteration of the rock mass is expected.

Timing/Schedule Requirements

The perched-water testing should be initiated as soon as possible after it is detected to insure that no data pertaining to the occurrence of perched-water is lost.

ESF Design/Test Support Requirements

All moisture or free water observed in the ESF will be sampled as soon as possible after it is detected to insure that no date pertaining to the occurrence or perched-water is lost. An alcove may be required for drilling any boreholes if access in a main traffic area is a problem. Only normal drilling and other utilities are required.

PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: HYDROCHEMISTRY TESTS IN THE ESF

SCPB Section 8.3.1.2.2.4.8 (Activity)

Description of Activity

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 core holes. The ESF will provide access for the collection of gas, rock and possibly perched-water samples. Two different types of boreholes will be used to obtain gas samples for this test. Boreholes used as part of the Radial Boreholes test will be used for long term gas sampling. In addition, short (1-2 m) boreholes will be used to provide a gas sample at selected locations as soon as possible after mining.

Location

A) In all parts of the ESF (Ramps, Drifts, Shafts, Alcoves, MTL)
(See Sketch 1 and generalized North Ramp list)

B) Generalized Locations for UZ Hydrochem Boreholes in North Ramp:

- Tiva Canyon 3 locations long and short boreholes, evenly spaced
- Near Bow Ridge Fault long and short boreholes, both sides
- Bedded and Tiva Canyon contact long and short boreholes, both sides
- Bedded Unit 1 location long and short boreholes
- Bedded and Topopah Springs contact long and short boreholes, both sides
- Topopah Springs 3 locations long and short boreholes, evenly spaced
- Drill Hole Wash structure 2 locations long and short boreholes
- Calico Hills Topopah Springs contact long and short holes, both sides
- Calico Hills nonwelded 2 locations long and short boreholes, evenly spaced
- Calico Hills vitric welded 2 locations long and short boreholes, evenly spaced

- Calico Hills zeolitized welded 2 locations long and short boreholes, evenly spaced

Special Room/Alcove Requirements

Alcoves needed to set up equipment for two week tests out of traffic areas. Equipment will require about a 6 foot by 8 foot area. Larger sized alcoves needed to house the drill rig during drilling. For most holes we can use the alcove required by the Radial Boreholes test.

Interference Envelope

Borehole sampling locations need to be about 13 feet from ramps or drifts. Pumping of boreholes could effect various pneumatic tests if held during the same time period within about 10 to 15 meters.

Constraints/Controls

Tracer specifications must take into account requirements of other tests, specifically, no chloride tracers or chlorination prior to the completion of CL36 sample collection.

Timing Schedule Requirements

As soon as possible after mining, we will require a short 1-2 meter borehole for gas sampling at all locations. The larger/longer boreholes can wait (up to several months), but should be conducted as soon as possible.

ESF Design/Test Support Requirements

All water used in the ESF will be traced. All compressed air used in coring or drilling will be tagged with SF6. Provide suitable space for gas sampling activities and equipment at each Radial Borehole location. Large rock samples (bulk) or core (HQ size) will be required from various locations in the ESF. Core samples shall be dry and bulk shall have minimal disturbance to moisture content. One to two meter long boreholes will be required for gas sampling. Radial boreholes used for gas sampling should be more than 13 ft from ramps or drifts. Access to a location early in the ESF construction for the purpose of conducting prototype testing in order to determine if the short (1-2 m) holes are required at all locations or if the longer Radial Boreholes are sufficient for gas sampling.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: HYDROLOGIC PROPERTIES OF MAJOR FAULTS ENCOUNTERED IN THE ESF

SCPB Section 8.3.1.2.2.4.10 (Activity)

Description of Activity

This activity is designed to provide hydrologic information in parallel 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. Hydraulic properties of major faults encountered in the ESF will be determined in this activity. The major faults or fault zones expected to be tested are the Bow Ridge fault, Ghost Dance fault,a suspected fault in Drill Hole Wash, the Imbricate fault zone, and the Solitario Canyon fault. Other faults will be tested if flow is observed.

On the basis of the identification of major faults by the geologic mapping activity, a hydrologic testing program will be implemented. This program will consist primarily of tests conducted in boreholes drilled through or parallel to fault zones and tests on core collected from the coreholes. The first activity will be the drilling and testing of a geothermal borehole. Sensitive temperature measurements made in the borehole will provide indications of any 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 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 holes will be tested to provide a water-content profile across the fault zone. This profile may provide information relative to any recent moisture occurrence in the fault zone.

Locations

1. Bow Ridge Fault
2. Drill Hole Wash Faults (maybe several sites)
3. Ghost Dance Fault
4. Solitario Canyon Fault
5. Imbricate Fault Zone
6. All Major Faults not Previously Identified

Special Room/Alcove Requirements

Alcoves will be required at each ramp crossing of a major fault. Sketch 1 provides a general alcove concept for each test.

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Interference Envelope

- The holes need to be placed such that stress relief effects of the ramp and alcove are minimized.

- The holes need to be placed such that other tests will not interfere.

Constraints/Controls

The hydrologic boreholes shall not be drilled until the PI has determined that effects of ventilation in the opening have been detected in the geothermal borehole at that location and drilling of the hydrologic holes can proceed.

Timing/Schedule Requirements

Testing should be conducted as soon as feasible after excavation.

ESF Design/Test Support Requirements

Geothermal holes: one hole will be air cored, near horizontally, at each location at about 45 degrees to the opening as soon after identification of the fault as possible. This borehole should be drilled from the ramp or drift, or a small drilling alcove. It may be necessary to construct a separate drilling alcove for the geothermal borehole. The intent is to have access to the borehole as soon as possible to reduce the effect of air exchange with the surrounding rock mass. These holes will be minimum of 200 ft long.

Hydrologic holes: four "cross-fault" test holes (40 ft) will be air-cored at each location. In addition, three "in fault" test holes (25 ft) will be required at each location. Each location will require access to the IDS. An alcove for hydrologic holes will be required that provides access to both sides of the fault near the ramp or drift, and also run parallel to the fault for approximately 80 to 90 ft with an approximately 20 ft offset.

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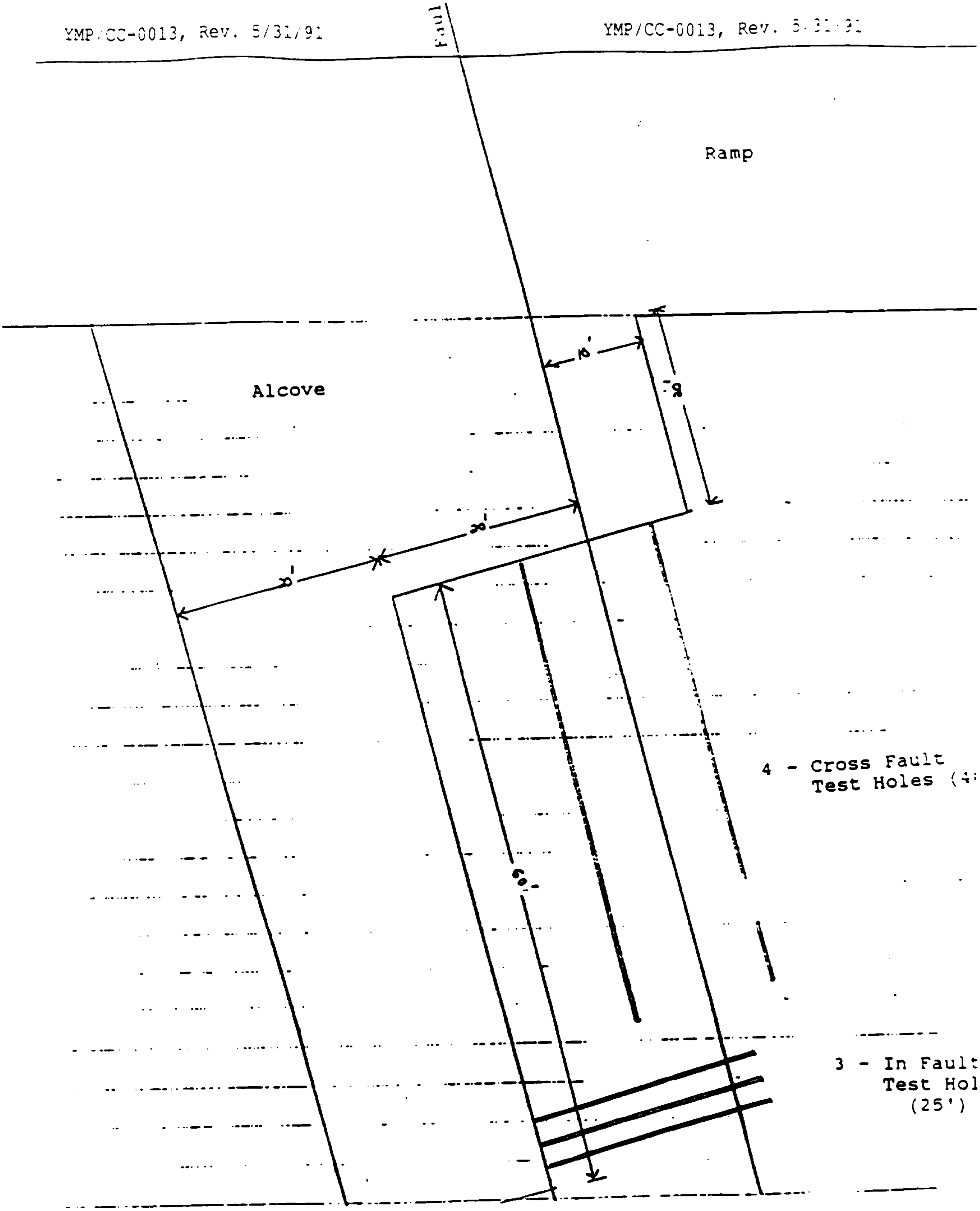

SKETCH A: MAJOR FAULT TESTS (SCPB Section 8.3.1.2.2.4.10)

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: **GEOMECHANICAL ATTRIBUTES OF THE WASTE PACKAGE ENVIRONMENT**

SCPB Section 8.3.4.2.4.3 (Study)

Description of Activity

A series of heater tests is planned in the North Ramp of the ESF as the prototype of the ESF tests. These tests are designed to characterize the geomechanical response of the rock in the near-field environment to the changing environmental conditions expected to occur over the lifetime of the repository. Some tests will study the effect of a heating/cooling cycle on the stability of rock blocks formed by excavation of the emplacement hole. Other tests will assess the potential for spalling or other types of borehole breakout that may occur due to the heating/cooling cycle and associated changes in the rock/fracture properties.

For each test, instruments will be installed to measure temperature, stress, and displacement as a function of time and location. Rock cores and blocks will also be obtained before and after the thermal cycles for laboratory determination of thermal-mechanical properties.

The heaters in the test will be cycled through heating and cooling stages and in some cases temperatures and/or stresses may be imposed on the rock which are higher than those expected in the potential repository. The intent of testing at these higher temperatures and stresses will be to accelerate the rate at which rock deformation mechanisms occur. This may serve to bound the estimates of geomechanical deformation over time.

Location

The test will be conducted in the non-lithophysal portion of the Topopah Spring Tuff unit (about 100 feet below the Tiva Canyon unit), away from major faults.

Special Room/Alcove Requirements

An alcove/room will be required that is 40 feet long, twenty feet wide and 15 feet high. In addition, two alcoves, 12'x 12', one each for instrumentation and storage, will be needed.

Interference Envelope

The test area should be at least 30 feet from other activities, and 20 feet from ramp or shaft.

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Constraints/Controls

Flexibility to adjust the test locations to avoid fracture zones.

Timing/Schedule Requirements

The test should be initiated at least two years before second phase of the ESF tests which are tied to the License Application Date (LAD).

ESF Design/Test Support Requirements

The layout and the length of the drifts and the borehole layouts must be added to the ESFDR, or provided as test design input, as no tests for this study were included in the old SDRD.

Dry drilling of boreholes up to 30" in diameter.
Slotting of the rock (10'wide x 10'deep x 0.5" to 1" aperature)
Electric power: 2 circuits of 208V, 45 amp., voltage regulated power, several circuits of 120V, 30 amp, UPS instrument power
Compressed Air: 100 psig shop air.
3 Heater holes (4", 12", 30")
Twenty four instrumentation holes for each heater hole.
Ability to obtain cubic block samples 18"x18"x18".
Transporting ability: To move, lift and load at least 1.5 tons.
Surface trailer: A trailer pad of at least 12'x60' at the surface facility of ESF.
The trailer should house office, machine shop, and change rooms.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: REPOSITORY HORIZON NEAR-FIELD HYDROLOGIC PROPERTIES (EBSFT)

SCPB Section 8.3.4.2.4.4.1 (Activity)

Description of Activity

A series of heater tests and infiltration tests are planned in the North Ramp of the ESF as the prototype tests of the ESF tests. All are designed to investigate moisture movement and saturation conditions in the host rock during heating and cooling periods of waste storage and to investigate the scale effects of the heater hole on the measured parameters. Some tests will measure the parameters during the thermal cycle using ambient moisture as the initial condition. The other tests will include a simulated percolation event to examine the effect of water percolating or diffusion through the rock mass.

For each of the tests, instruments will be installed in the rock mass around the heaters to measure temperature, moisture content, gas and liquid pore pressure, stress change, and displacement as a function of time and location. Various geophysical probes will be used to measure the moisture content in the rock before, during and after thermal cycling. Rock cores will be obtained before and after the thermal cycles for mineralogical and geochemical analyses. Laboratory measurements of hydrologic properties and thermal-mechanical properties will be made on similar samples.

The heaters in the test will be cycled through heating and cooling stages. The duration of the period during which the heater is at maximum power and the initial thermal loading for the heater are based on the criteria that the boiling conditions encompass a sufficiently large volume of rock to include several fractures within the dry hot region. Scoping calculations will be used to determine the initial power of heating and the duration of heating at the maximum power.

Location

The test will be conducted in the non-lithophysal portion of the Topopah Spring Tuff unit (about 100 feet below the Tiva Canyon unit), away from major faults.

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Special Room/Alcove Requirements

Alcove drifts totaling about 900 feet will be required. There are two sets of drift: emplacement drift and instrumentation drift. These two sets of drift will be separated by at least 25 feet vertically. In addition, two instrument alcoves 12'x12' each and two storage alcoves 12'x12' each will be needed.

Interference Envelope

The test area should be at least 30 feet from other activity, and 50 feet from ramp or shaft.

Constraints/Controls

1. A minimum of 25 feet vertical separation between the emplacement drift and the instrument drift.
2. The width of the emplacement drift be at least 20 feet.
3. At least 16" vertical and horizontal clearance at the collar of all instrument boreholes.
4. Flexibility to adjust the test locations to avoid fracture zones.
5. No rock bolts are allowed within a region of the test region plus 5 feet.
6. The heights of the instrumentation drift be sufficient to provide for drilling of an array of boreholes that extends at least 15 feet vertically.

Timing/Schedule Requirements

The test should be initiated at least two years before second phase of the ESF tests which are tied to LAD.

ESF Design/Test Support Requirements

The layout and the length of the drifts are different from that in the ESFDR, and will require either ESFDR revision, or test design input. The borehole layouts are generally the same as in the ESFDR.

Dry drilling of boreholes up to 30" in diameter.
IDS
Electric power: 3 circuits of 208V, 45 amp voltage-regulated power; several circuits of 120V, 30 amp UPS instrument power
Compressed Air: 150 scfm, 100 psig for air permeability measurement
Five Heater holes (4", 12", and 30" in diameter).
Twenty four instrumentation holes for each heater hole.
At least two horizontal holes for the infiltration tests.

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Transporting ability: To move, lift, and load at least 1.5 tons.
Infiltration water: Un-tracered un-chlorinated J-13 water, about 500 gal/week.
Surface trailer: A trailer pad of at least 12'x 60' at the surface facility of ESF. The trailer should house office, machine shop, and change rooms.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: REPOSITORY HORIZON ROCK-WATER INTERACTION

SCPB Section 8.3.4.2.4.4.2 (Activity)

Description of Activity

This activity is to obtain samples for laboratory test of rock-water interactions at high temperatures. The samples needed are 6 to 8 inch diameter cores or blocks of rock of similar sizes. 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 Vitric Calico Hills unit.

Location

Large diameter (6 to 8 in.) cores or blocks of sample from the lithophysal zone of Topopah Spring tuff at the contact of Tiva Canyon and Topopah Spring, Topopah Spring Welded unit, Basal Vitrophyre of Topopah Spring, and the top of Vitric Calico Hills unit.

Special Room/Alcove Requirements

Not required.

Interference Envelope

No.

Constraints/Controls

Dry drill and blast or dry coring to obtain the sample required.

Timing/Schedule Requirements

This test is tied to the LAD.

ESF Design/Test Support Requirements

No general ESF design requirements for this test. For test support, it will be necessary to obtain large diameter cores or blocks of rock sample.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: ACCESS CONVERGENCE TEST AT THE EXPLORATORY STUDIES FACILITY

SCPB Section 8.3.1.15.1.5.1 (Activity)

Description of Activity

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

Rock-mass deformation around the access will be monitored at measurement stations using multiple-point borehole extensometers (MPBXs) placed at 120? intervals around the opening. The MPBX's primarily consist of anchors installed at predesigned depth. Movement in the rockmass is recorded as the anchors move. Deformations are measured across the ramp diameter and as a function of distance from the access portal at multiple locations in the access. In addition to MPBX measurements, deformations are measured with rod extensometers at each of the three measurement stations. Extensometer measurements will be made along diameters in the same plane as the MPBXs at 60? from the MPBX heads.

If a liner is used, each station will also include hydraulic pressure cells in the liner to monitor radial stress changes over time as construction continues beyond the test location.

Locations

The tests will be located in each thermal/mechanical unit encountered (one in each unit), preferably more than 100 meters from major thermal/mechanical contacts and faults. At a minimum the tests should be performed with the TSw1, TSw2, and in the Calico Hills.

Special Room/Alcove Requirements

No special room or alcove needed.

Interference Envelope

The tests will sense rock mass displacements on a line approximately 15 meters from and perpendicular to the drift wall, floor, and ceiling. Tests which in any way affect the thermal/mechanical response in this region should be avoided.

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Constraints/Controls

The tests should be installed soon after the excavation passes the proposed test location. No constraint on construction is imposed by this test. Purpose of the test is to obtain deformation, in situ stress and stress change due to the excavation activities. However, it is not necessary that the stations be instrumented immediately after face has been exposed. No drilling will be allowed near the MPBX and pressure cell stations.

Timing/Schedule Requirements

The test instrumentation should be installed as close to the working face as possible.

ESF Design/Test Support Requirements

Standard underground facilities for water, air, electricity for drilling will be used for these tests. No special experimental needs are identified.

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PLANNED ACTIVITY NAME: DEMONSTRATION BREAKOUT ROOMS

SCPB Section 8.3.1.15.1.5.2 (Activity)

Description of Activity

These tests will be used to demonstrate constructability and stability of the underground openings in the upper lithophysal zone of the Topopah Spring member (TSw1) in the upper demonstration breakout room (UDBR) and in welded fractured tuff (TSw2) on the main test level at lower demonstration breakout room (LDBR).

Location

The tests will be located in the high lithophysal zone encountered in the north ramp.

Special Room/Alcove Requirements

The test itself consists of mining a separate room off the main access.

The size of the DBR openings will be consistent with the maximum width planned for repository openings. The excavation techniques for the DBRs should be similar to the excavation techniques to be used for the repository openings. This test will evaluate mining techniques and rock support requirements. Rock mass response will also be measured in the DBR excavations by using extensometers and convergence anchors.

Interference Envelope

The test will sense rock mass displacements on a line approximately 15 meters from and perpendicular to the drift wall, floor, and ceiling. Tests which in any way affect the thermal/mechanical response in this region should be avoided.

Constraints/Controls

Flexibility in the orientation of the rooms is required to insure that desired alignment relative to local geological features, such as the prevailing joint structure, is achieved. Adequate flexibility must exist to rotate the rooms depending on the geology of the test location. Other constraints include a requirement that no other mining be performed within a

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distance of approximately 50 ft from the deepest MultiPoint Borehole Extensometer (MPBX) anchors installed in the walls of the opening while the test is in progress.

Timing Schedule Requirements

The test should be performed (its mining) before major excavation are performed in the MTL. No impact to construction of the ramp.

ESF Design/Test Support Requirements

Standard underground facilities for water, air, and electricity for drilling will be used for this test. The instrument heads will be placed in a recess at the walls of the excavation. No other special experimental needs.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: HEATER EXPERIMENT IN TSw1

SCPB Section 8.3.1.15.1.6.1 (Activity)

Description of Activity

The heater experiment measures thermomechanical and thermally induced hydrologic responses in high-lithophysal rock to verify scaling relationships needed for repository design and performance calculations.

Location

The test will be located in the high lithophysal zone encountered in the north ramp (preferably in the UDBR).

Special Room/Alcove Requirements

The test will be conducted in a separate room in the TSw1 away from contacts and faults. It is preferable to use the demonstration breakout room described in Activity 8.3.1.15.1.5.2.

Interference Envelope

In the upper demonstration breakout room (UDBR), a heater-emplacement hole will be drilled approximately 8 feet (2.4 m) into the drift floor. Several instrumentation holes parallel to the heater hole will be drilled and then heater and instruments (multiple point borehole extensometers (MPBX) and thermocouples) will be installed. In a borehole near the heater, neutron logs will be run before, during, and after the heating cycle to monitor moisture content changes. After the heater is started, the rock response to thermal loading, heat flow, and moisture changes will be monitored. Because test is short and affects only a small volume of rock, no special constraints are required.

Constraints/Controls

Sufficient flexibility should be provided to locate the test so that other activities in the UDBR are not adversely affected: this test should be located about 10 m away from the next nearest test, and in an area of low traffic. Heat from this test cannot be allowed to interfere with other tests.

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Timing/Schedule Requirements

The test should be performed in a timely manner as it will help assess the viability of storing waste in, or in the vicinity of, high lithophysal rock.

ESF Design/Test Support Requirements

Standard underground facilities for water, air, and electricity for drilling will be used for this test. The instrument heads will be placed in a recess at the walls of the excavation. No other special experimental needs.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: PLATE LOADING TESTS

SCPB Section 8.3.1.15.1.7.1 (Activity)

Description of Activity

The plate loading test loads parallel, 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 ISRM and ASTM standard testing procedures.

Location

The tests will be conducted in each of the thermal/mechanical units encountered in the ramp. Most tests should be away from thermal/mechanical contacts; some test locations proximal to faults will be acceptable.

Special Room/Alcove Requirements

The tests will be conducted in alcoves extending from the access. The alcoves will be approximately 15 ft wide by 6 ft tall by 60 ft long. Five or more tests may be performed in each alcove. Surfaces in the vicinity of the test should be relatively free of blast damage.

Interference Envelope

The test should be 10 meters from the nearest test which altered the thermal/mechanical properties of the rock.

Constraints/Controls

Testing impedes traffic, therefore, test alcoves should be provided out of the way.

Timing/Schedule Requirements

The test should be performed in a timely manner as it will provide input to facility design.

ESF Design/Test Support Requirements

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

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: EVALUATION OF MINING METHODS

SCPB Section 8.3.1.15.1.8.1 (Activity)

Description of Activity

These tests will monitor and evaluate mining methods for ramp and drift openings, with emphasis on rock responses in a variety of lithologic and structural settings that may be encountered in the long exploratory drifts. This activity will be to develop recommendations for mining in the repository. Mining investigations will include TBM performance measurements, and examination of induced damage, as appropriate.

Location

The tests will be conducted in all of the thermal/mechanical units encountered in the ramp.

Special Room/Alcove Requirements

None required.

Interference Envelope

No special requirements.

Constraints/Controls

This test has no identified constraints.

Timing/Schedule Requirements

As the excavation proceeds.

ESF Design/Test Support Requirements

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

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PLANNED ACTIVITY NAME: MONITORING OF GROUND SUPPORT SYSTEMS

SCPB Section 8.3.1.15.1.8.2 (Activity)

Description of Activity

This activity will develop recommendations for a ground support in drifts in the 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 ramps and on the main test level. The selection, installation, and performance of the support systems used will be monitored. Experimentation with ground supports will include pull tests on rock bolts. Observation of unsupported rock, strength measurements on shotcrete cores, and trails of alternate ground-support configurations from those prescribed for the ESF. The effects of heat on ground support will be considered in the heated room experiment.

Location

The tests will be conducted in all of the thermal/mechanical units encountered in the ramp.

Special Room/Alcove Requirements

No special room/alcove is required.

Interference Envelope

No interference envelope. However, pull tests may temporarily block movement of vehicles in ramp.

Constraints/Controls

None identified for this activity.

Timing/Schedule Requirements

No conflict with facility construction.

ESF Design/Test Support Requirements

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

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: MONITORING DRIFT STABILITY

SCPB Section 8.3.1.15.1.8.3 (Activity)

Description of Activity

These tests will monitor drift convergence throughout the ESF, along accesses and in the Calico Hills. This activity involves monitoring drift convergences and drift maintenance activities. Convergence measurement stations will be selected by the Principal Investigator. In the long drifts, convergence measurements will be taken in a continuous manner, if practical. Rock-mass relaxation will be investigated in repository-scale portions of the long drifts using multiple-point borehole extensometers. Rock falls and maintenance activities will be documented.

Location

The tests will be conducted in each of the thermal/mechanical units encountered in the ramp.

Special Room/Alcove Requirements

No special room/alcove is required.

Interference Envelope

No interference envelope.

Constraints/Controls

Field observations of ground conditions will be necessary before final locations of measurement stations can be specified. The design of service hardware in the drifts (such as ventilation ducts, cable trays, etc.) must accommodate these measurements. MPBX's and tape extensometer anchors should be installed as close to the advancing face as possible. Provision for data collection by the IDS must be available prior to beginning this test.

Timing/Schedule Requirements

No conflict with facility construction. It is desirable to install the instrumentation as soon as practical behind the excavation equipment.

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ESF Design/Test Support Requirements

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

YMP 02-1113, Rev. 5 31 91

PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: AIR QUALITY AND VENTILATION EXPERIMENT

SCPB Section 8.3.1.15.1.8.4 (Activity)

Description of Activity

The purpose of these tests is to assess the impact of site characteristics on ventilation requirements to ensure a safe working environment. This activity consists of (1) measurements of radon emanation; (2) surveys of air-flow and pressure, temperature, and humidity; (3) determinations of air resistance factors; and (4) dust characterization. The radon emanation measurements will be made in a dead-end drift that has been sealed with a bulkhead at equilibrium conditions and at various rates of airflow. Radon concentrations might also be measured in a borehole. The air quality and ventilation measurements are not expected to interfere significantly with other underground activities.

Location

The tests will be conducted throughout the ESF after construction is completed. The end section of the drift to the Ghost Dance Fault will be sealed with a bulkhead to allow measurement of radon gas emanation.

Special Room/Alcove Requirements

No special room/alcove is required.

Interference Envelope

No interference envelope.

Constraints/Controls

This experiment will measure the rate of radon emanation from the TSw2 formation and will be conducted on the main test level. Because this requires only periodic air sampling, no special constraints are required to include this activity in the ESF testing, and no additional perturbation to natural conditions (stress, temperature, moisture, etc.) will result from this activity.

Timing/Schedule Requirements

No conflict with facility construction.

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ESF Design/Test Support Requirements

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

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: **LABORATORY TESTS (THERMAL AND MECHANICAL) USING SAMPLES OBTAINED FROM THE EXPLORATORY STUDIES FACILITY**

SCPB Sections 8.3.1.15.1.1.1, 8.3.1.15.1.1.2, 8.3.1.15.1.1.3, 8.3.1.15.1.2.1, 8.3.1.15.1.3.1, 8.3.1.15.1.3.2, 8.3.1.15.1.4.1, 8.3.1.15.1.4.2 (Activities)

1. Density and Porosity Characterization (thermal properties)
2. Volumetric Heat Capacity Characterization
3. Thermal Conductivity Characterization
4. Thermal Expansion Characterization
5. Compressive Mechanical Properties of Intact Rock at Baseline Experiment Conditions
6. Effects of Variable Environmental Conditions on Mechanical Properties (intact rock)
7. Mechanical Properties of Fractures at Baseline Experiment Conditions.
8. Effects of Variable Environmental Conditions on Mechanical Properties of Fractures

Description of Activity

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. The ESF activities are basically the collection, packaging, and labeling of the selected bulk samples or core taken from the shafts or drifts. The laboratory test activities are described individually in SCPB Section 8.3.1.15.1.

Location

The tests require sampling throughout the ESF. The tests are laboratory tests.

Special Room/Alcove Requirements

No special room/alcove is required.

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Interference Envelope

No interference envelope. Samples should be taken from rock that has not been disturbed by excavation or testing conditions. Dry coring may be required in some cases.

Constraints/Controls

None. Provide capabilities to drill cores or collect samples and transport them to the surface for shipment to laboratories.

Timing/Schedule Requirements

No conflict with facility construction.

ESF Design/Test Support Requirements

Standard underground facilities for water, air, and electricity for drilling will be used for this test. No other special experimental needs. Capability should exist to extract cores of various sizes up to 15 inches in diameter.

YMP CC-0013, Rev. 5 31 91

PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: **DEVELOPMENT AND DEMONSTRATION OF REQUIRED EQUIPMENT**

SCPB Section 8.3.2.5.6 (Information Need)

Description of Activity

This SCP activity was originally proposed for the purpose of development and demonstration of special equipment. Further specific equipment needs have not been identified to date.

Location

To be determined.

Special Room/Alcove Requirements

To be determined.

Interference Envelope

To be determined interference envelope.

Constraints/Controls

None identified.

Timing/Schedule Requirements

No conflict with facility construction.

ESF Design/Test Support Requirements

Standard underground facilities for water, air, and electricity for drilling will be used for this test. No other special experimental needs are currently identified.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: IN SITU TESTING OF SEAL COMPONENTS

SCPB Section 8.3.3.2.2.3 (Study)

Description of Activity

Because one of the 'sealing' concepts for the Yucca Mountain Project (YMP) is drainage of water through the highly fractured rock, two areas of characterization are essential: first, characterizing the potential of discrete structural features to introduce water into the ramp, and second, characterizing the ability of the rock mass to drain water by determining the rock mass hydraulic conductivity.

Because of the overall performance of the repository, including the performance of the sealing components, is, in part, tied to the air conductivity of the rock mass above the repository, measurements of air conductivity of discrete features and the bulk rock are necessary. Therefore, part of this activity involves determination of the air conductivity of discrete features and the bulk rock to assess the potential for flow out of the repository. A related test will involve contrasting the modified permeability zone (MPZ) in the main ramp with the MPZ in the parallel 3.1m-diameter drifts.

Finally, the performance of sealing components, primarily backfilled crushed tuff and engineered filter designs, will be evaluated. The primary concern is the migration of fines under various hydrologic conditions and the potential of these fines to migrate into the fractures and reduce the hydraulic conductivity. Tests to support the borehole sealing program will also be performed primarily in the nonwelded and bedded tuffs.

Two categories of tests are necessary in the sealing program:

a. intrinsic permeability characterization of discrete structural features to evaluate water inflow and air outflow,

b. assessment of selected rock mass locations to drain water and leak air, evaluation of sealing component performance, and characterization of the modified permeability zone (MPZ) in the main ramps and in the drifts parallel to the main ramp.

Location

The tests will be conducted in the densely welded Tiva Canyon unit, the bedded tuffs below the Tiva Canyon unit, and in the Topopah Spring unit. Locations for the tests in the north ramp access are provided in Figure 1.

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Special Room/Alcove Requirements

The locations for the sealing related tests are defined on Figure 1.

Category A Testing -

- Bow Ridge fault
- Characteristic fault or fracture zone beneath alluvium downgrade from the Bow Ridge fault
- Characteristic fault or fracture zone downgrade from the alluvial area
- Characteristic fault or fracture zones in the Topopah Spring Member (2 locations)

The purpose in characterizing these structural features through air conductivity testing is to provide information that will be used to refine the design requirements for seals. If these structural features do not produce water, an alcove 6.1m x 6.1m x 3.1m (height) should be developed after construction of the main ramp and it should be located approximately 6.1m from the structural feature of interest. There are five potential locations identified in the ramp. These locations are identified in Figure 1.

Note: If water occurs in these typical zones, no alcove is necessary. However, it will be necessary to monitor the inflows for the life of the facility. Quantification of these inflows is as essential for the sealing program as it is for developing a performance assessment model. Because this information has very broad usage, it is not necessary for this information to be acquired under the sealing program. In fact, the intrinsic permeability testing of major structural zones penetrated by the ramp may already be defined by others in the project.

Category B Testing -

- Tiva Canyon densely welded zone
- Middle and lower portion of the bedded tuff zone and the upper portion of the Topopah Spring unit
- a characteristic portion of the densely welded, highly fractured Topopah Spring unit

In each of these areas a 3.1m-diameter drift should be developed parallel to the main ramp and at the same inclination as the main ramp. These drifts should be at least three tunnel diameters from the main ramp. These drifts should also be developed using smooth wall blasting to simulate as closely as possible the conditions in the main ramp.

Interference Envelope

For all testing it is necessary that no water injection in the rock mass occurs prior to the air conductivity testing. The drifts for Category B testing should be at least 3 tunnel diameters away from the main ramp.

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Constraints/Controls

Exploratory boreholes, currently anticipated to be drilled at 1000 foot spacings along the alignment of the ramps, should not intercept the ramp. If deemed to be necessary, the boreholes should be offset from the ramp, perhaps 3 tunnel diameters.

Dry drilling of core holes in the test areas should be attempted first. The standard project drilling technique will be used first. If this presents unusual difficulties drilling should be performed using air foam.

If the test locations are to have multi-uses, then the floor shall be protected from fines clogging the floor of the drifts by the placement of geomembrane materials or equivalent. This applies only to the three drifts parallel to the main ramp.

In the three, 3.1m-diameter drifts and the alcoves, the contractor shall limit the zone of overbreak through either smooth wall blasting or presplitting.

The initial testing of all areas will use air. Water injection should not occur prior to the air testing.

Because the tests evaluate drainage characteristics, no fluids from underground repository excavation should be disposed of in the test areas.

If the testing of sealing systems is needed under flooding scenarios, then a significant amount of water may be required. If this is required, then a hydrologic zone of influence may result. The impact of this zone of influence may then need to be analyzed.

The floor of the main ramp shall be protected from fines entering the fractures in the floor as soon as practical.

Unless required for safety reasons, no grouting should be performed in the ramp.

All water inflows should be monitored as soon as possible after the inflows are encountered.

Timing/Schedule Requirements

Testing of the rock and the structural features can be performed any time after the development of the main ramp. The only exception to this will be the measurement of water inflows as soon as possible after their occurrence.

ESF Design/Test Support Requirements

The three, 3.1m drifts shall be parallel to the main ramp and be at the same grade as the main ramp.

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Excavated rock should be stockpiled according to general stratigraphy, i.e., Tiva Canyon Member welded zones, nonwelded and bedded tuff zones, and the Topopah Spring Member welded zones.

Required Test Support - For both categories of testing standard facilities support, such as electricity, water, and air, will be necessary. In addition the following support is required.

Category A Testing -

Each of the alcoves should be large enough for a drilling machine that can core a distance of approximately 20m. Two horizontal holes will penetrate the fault or fractured zone. The first hole will be drilled perpendicular to the structural feature and one will be drilled to intercept the fault plane at a currently unspecified angle. The intrinsic permeability of the zone upgrade from the fault zone, at the fault zone, and downgrade from the fault zone will be characterized. This testing will involve a data acquisition system and a system to determine the intrinsic permeability of these zones, possibly a guarded-straddle-packer system. Because we intend to determine the permeability through the use of air injection, a uniform supply of compressed air will be necessary.

Category B Testing -

Each of the 3.1m-diameter drifts will require borehole drilling and coring support to characterize the natural fracturing and excavation induced fracturing. In the main ramp the fractures along the same parallel segment as the 3.1m-diameter ramps will also be characterized. The number of the boreholes depends on the nature of the fractured system. Testing similar to the Category A testing will be performed to characterize the fractured rock. Therefore, a uniform compressed air supply will be necessary. Because the bedded tuff drift will also support the borehole sealing activity, it is anticipated that horizontal coring into the bedded tuffs would also be performed. The exact amount of drilling is not currently defined.

Measurement of the air conductivity at a drift scale will also be performed. This will require the pressurization of a segment of the drift and injection of a tracer. Because of the scale of this test, a larger compressed air supply will be necessary. The requirement of the size of the air supply depends on the quality of rock being evaluated. Large-scale testing of the drifts will require construction of temporary bulkheads, constructed possibly of cinder blocks and sealed with gunite.

Testing of seal designs will also be performed in these drifts. This type of testing would require the placement of temporary bulkheads and the placement of backfill through mechanical compaction and pneumatic emplacement. This would require material handling of graded materials to the seal test areas. The first series of tests would be performed in the Tiva Canyon drift. When adequate backfill and filter designs are developed more realistic backfilling operations will be performed in the bedded tuff and Topopah Spring tuff alcoves. Because mechanical compaction and pneumatic emplacement are both being considered to

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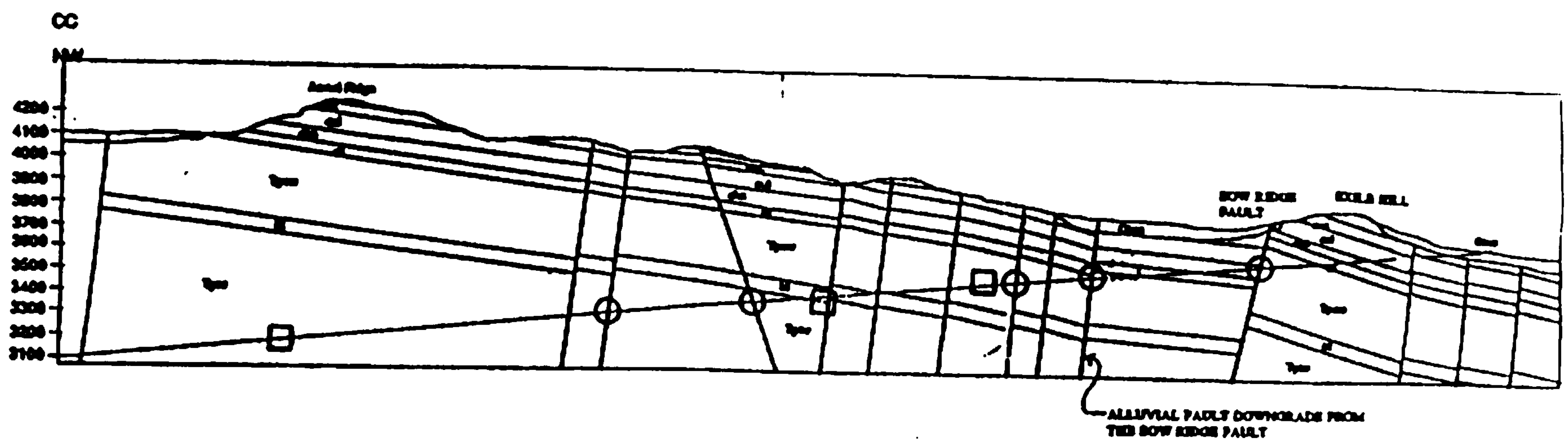
backfill drifts and multiple designs may be used to seal the ramps and the underground facility, crushed tuff will be emplaced in the test drifts and removed from the drifts several times. These multiple tests will be required to optimize the backfill and filter designs.

Note: If another underground test facility is defined, some of this seal emplacement testing need not be performed in these drifts. However, the selected designs should be emplaced in each zone to validate the emplaced performance of the backfill and the filters. Part of the test may involve the injection of water into the backfill.

PRELIMINARY DRAFT



O = CATEGORY A TESTING

□ = CATEGORY B TESTING

FIGURE B. (SCPB Section 8.3.3.2.2.3)

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PLANNED ACTIVITY NAME: CHLORIDE AND CHLORINE-36 MEASUREMENT OF PERCOLATION AT YUCCA MOUNTAIN

SCPB Section 8.3.1.2.2.2.1 (Activity)

Description of Activity

These measurements will be made at various depths to determine the rate of water movement downward through the unsaturated-zone tuffs using the chlorine-36/chloride concentration ratio. Large bulk samples from up to 30 locations will be periodically collected, packaged, and labeled for laboratory analysis as described in SCPB Section 8.3.1.2.2.2.1. Because of the requirement to extract pore water to conduct the chlorine-36 test, several hundred pounds of samples may be needed at each sampling location. In the event that perched water is encountered, perched water samples will also be provided to Los Alamos.

Location

This is a sample collecting activity. Along ramps samples will be collected every 100 m. For a vertical shaft, samples will be collected every 30 m. Samples will also be required at contacts, faults, and fracture zones when encountered in either type of excavation. Each sample will consist of 100 to 200 kg of rock that has been loaded and sealed into 208-L (55 gal.) drums. If tunnel boring is conducted dry, then chips can be used.

Special Room/Alcove Requirements

No special room or alcove is required.

Interference Envelope

No identifiable interference envelope, but samples must be collected avoiding any interferences from possible contamination by other sources of chloride and bromide.

Constraints/Controls

Dry construction is the preferred ESF excavation method for this test. If liquids are used then dry drilling will be used to obtain samples.

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Timing/Schedule Requirements

This test is an ESF sampling activity and can be conducted during facility construction without impact to construction activities.

ESF Design/Test Support Requirements

Design and test support requirements will differ if a tunnel boring machine is used with liquids. In that case, samples will have to be collected by drilling rather than using excavation cuttings. Only other required utility is lights. Sampling locations will have to be surveyed. Sampling should follow completion of geologic mapping activities.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: DIFFUSION TESTS IN THE EXPLORATORY STUDIES FACILITY

SCPB Section 8.3.1.2.2.5.1 (Activity)

Description of Activity

The diffusion test in the ESF Topopah Spring North ramp will use a specially constructed alcove in non-welded material. Each test will require boreholes dry-drilled, vertically downward, or subhorizontally in each alcove. Each hole will be approximately 10 cm diameter for the upper 10 meters and about 4 cm diameter for the bottom 45 cm. The bottom of each hole will serve as a source region for the tracer diffusion tests. The core removed from the bottom of each hole will be examined for fractures in order to minimize the possibility of fractures intersecting the source region. In addition, the boreholes will be examined for fractures using a downhole borescope.

About 10 ml of solution containing a suite of tracers will be placed at the bottom of the 4 cm diameter hole. One of the tracers will be bromide. The 10 cm diameter hole will be sealed with an inflatable packer to isolate the bottom of the hole from air pressure and humidity changes in the alcove while diffusion occurs. The hole will then be overcored, and the bottom portion of the core will be sectioned and analyzed for tracer concentration as a function of position.

The results of the diffusion experiments will be used to estimate the effective diffusion coefficients of conservative radionuclides in the unsaturated zone. There will be two sets of experiments performed. The initial experiment (3 months) will be performed to establish the length of time required and the size and type of overcoring needed to effect the transport rate via diffusion through the unsaturated tuff unit. Then a period of one year will be required to conduct a conclusive experiment to be reported in a milestone report.

Location

This test will be conducted in an alcove located near the middle of the non-welded Paintbrush Tuff Unit below the Tiva.

Special Room/Alcove Requirements

An alcove that is 6-m in diameter is required. Drill hole will be located in center of alcove so alcove should have sufficient height to accommodate drilling equipment. Hole will be dry drilled. The diameter of this hole is 10 cm over the first 10 -m and 4 cm over the next 0.45 m.

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Interference Envelope

No other test or additional construction within 6 m of this facility.

Constraints/Controls

Construction and drilling should be done dry. Minimize the introduction of chloride and bromide into the alcove.

Timing/Schedule Requirements

This test must be initiated four years prior to the completion of milestone R537 which is titled "Significant Physical Processes Affecting Transport" being conducted under the Retardation Sensitivity Study (WBS 1.2.3.4.1.5.1).

ESF Design/Test Support Requirements

No differences from the ESFDR except the test will be conducted in non-welded tuff.

Utilities include lights, electricity (110 and 220v), and compressed air. Location should be surveyed and geologic mapping should be completed prior to test initiation.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: HISTORY OF MINERALOGIC AND GEOCHEMICAL ALTERATION OF YUCCA MOUNTAIN

SCPB Section 8.3.1.3.2.1.1 (Activity)

Description of Activity

This study will include petrologic analysis of alteration sequences and structures. Mineral growth sequences will be studied using an electron microprobe. Ages of alteration events will be estimated using potassium-argon dating of clays and zeolites and electron spin resonance dating of quartz and calcite.

Samples will be collected from the bottom of the Topopah Spring Member and the Calico Hills. The underground samples will provide large oriented samples of alteration products. Any natural gels found in the ESF will be sampled.

Location

Samples will be collected from the lower Topopah Spring and throughout the Calico Hills unit. Samples of any gels encountered will be collected at any location in the facility.

Special Room/Alcove Requirements

No special room or alcove is needed.

Interference Envelope

There is no interference of other tests on this test. Samples can be collected at any location (shafts/ramps) that has been identified by geologist.

Constraints/Controls

There are no special constraints required by this test.

Timing/Schedule Requirements

Test is sampling so can be conducted following excavation. Gels must be sampled as soon as possible after exposure by excavation.

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ESF Design/Test Support Requirements

This test is listed in the ESFDR under Mineralogy and Petrology sampling. Requirements will change depending on the excavation method.

Drilling may be required to collect samples. Geologic mapping should be complete and sample locations surveyed prior to sample collection.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: FRACTURE MINERALOGY STUDIES OF THE EXPLORATORY STUDIES FACILITY

SCPB Section 8.3.1.3.2.1.3 (Activity)

Description of Activity

The fracture mineralogy studies will be conducted to determine mineralogic variability throughout the Exploratory Studies Facility (ESF) to establish the time and conditions of fracture mineralogy deposition alteration, and to identify fracture-coating mineral types, sorptive characteristics, and health hazard potential of fibrous zeolites.

In addition to mineralogic sampling by drilling cores and collecting samples from walls and at the face in the ESF drifts, samples may be collected on the surface from the muck removed. The samples will be packaged and labeled for shipment to a Los Alamos laboratory for detailed analyses, including age determinations. The site parameters gathered by this activity are presented in Table 2.1.

Location

Study will be conducted throughout the facility where fractures are located.

Special Room Alcove Requirements

No special room or alcove is needed.

Interference Envelope

There is no interference from other tests on this test.

Constraints/Controls

Constraints are clean walls and ability to obtain core when requested. Sampling sites will need to be surveyed.

Timing/Schedule Requirements

This is basically sample collection and it does not have to be performed until geologic mapping has been completed and drilling equipment is available.

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ESF Design/Test Support Requirements

This test is listed in the ESFDR under Mineralogy and Petrology sampling. Requirements will change depending on the excavation methods.

Depending on excavation technique, drilling may be required to obtain samples for characterization.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: BIOLOGICAL SORPTION AND TRANSPORT

SCPB Section 8.3.1.3.4.2 (Study)

Description of Activity

Underground operations will introduce microorganisms into the environment. This study will address the effects of these organisms on retardation (either positive or negative) of radionuclides. This study will determine the growth of microorganisms in fluids used in excavation and drilling, evaluate the influence of microorganisms on actinide mobility, and determine binding constants of microorganisms to actinides. Indigenous populations must be characterized as well as introduced organisms.

Microorganisms will be cultured from samples collected by drilling and from the ESF. These organisms will then be cultured in the presence of fluids expected to be introduced to examine growth. These microorganisms will also be used to examine actinide sorption characteristics.

Location

Test is sampling for microbial populations throughout the facility within all units and at contacts.

Special Room/Alcove Requirements

No special room or alcove.

Interference Envelope

Samples must be collected in a manner to avoid any contamination by biological sources. Either drill and blast or mechanical excavation methods can be used given that sufficiently large sizes of muck can be collected so that a 100-gm sample can be collected aseptically.

Constraints/Controls

Ability to collect aseptic samples. This activity is sample collection. Samples will be identified by the principal investigator. No constraints are imposed by this activity on either construction or other testing activities. Samples must be of sufficient size to minimize contamination so that 100-gm of material can be collected aseptically. Either fluid used in excavation or chemicals used in blasting are not expected to affect samples if they are of sufficient size so that coring can be employed to obtain aseptic sample.

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Timing/Schedule Requirements

This is a sampling activity so no impact on construction is expected.

ESF Design/Test Support Requirements

This test is not currently listed in the ESFDR. All test and facility requirements will be developed. Samples will have to be collected aseptically.

Samples must be of sufficient size so the aseptic techniques can be used.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

PLANNED ACTIVITY NAME: PETROLOGIC STRATIGRAPHY OF THE TOPOPAH SPRING MEMBER

SCPB Section 8.3.1.3.2.1.1 (Activity)

Description of Activity

The goal for this activity is to determine the petrologic variability within the devitrified Topopah Spring Member at Yucca Mountain, and to define the stratigraphic distribution of this variability using samples taken from locations throughout the TS member in the ESF. Studies of the distribution of phenocyst and rock matrix textures in this member have been shown to be useful for defining stratigraphic position. Analysis will be conducted with X-ray diffraction. Chemical analyses will also be used to determine variability.

Location

This test will be conducted throughout the Topopah Spring Member in the ESF.

Special Room/Alcove Requirements

No special room or alcove is needed.

Interference Envelope

No interference envelope. Geologic mapping should be completed prior to this test.

Constraints/Controls

There are no constraints imposed by this activity.

Timing/Schedule Requirements

This test is sample collection so it should not interfere with construction.

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ESF Design/Test Support Requirements

This test was listed in the ESFDR under Mineralogy and Petrology sampling. Requirements will change depending on the excavation method. No special requirements are imposed on the design of the ESF. Ability must exist to obtain oriented samples and to transport samples to the surface.

Drilling may be required to obtain samples for laboratory analyses.

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PRE-TITLE II DESIGN STUDIES
PLANNED ESF TESTS - NORTH RAMP ACCESS

INTEGRATED DATA SYSTEM (IDS) NORTH RAMP FACILITY REQUIREMENTS

An analysis of the information with regard to test support requirements from Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Sandia, and United States Geological Survey indicate that IDS will require alcove space as a part of the Exploratory Studies Facility development. The alcoves are projected to be approximately 10'0" X 10'0" minimum and will be located in the immediate vicinity of the IDS test supported. An extension of the test alcove is acceptable.

Firm locations and quantities of alcoves will be provided during the development of Title II design.

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2.3 Scientific Manpower Requirements for Testing

2.3.1 Definition of Test

This testing integration study defines the recommended planning and design assumptions for on-site scientific manpower requirements to support ESF testing.

2.3.2 Functional Requirements

1. Provide the system design sufficient flexibility to accommodate ESF testing requirements.

2.3.3 Performance Criteria

1. The ESF should be designed to accommodate a nominal scientific workforce of 100 persons.

2. Peak scientific manpower, during day shift in the first few months as the MTL test areas first become available, is estimated to be 120 people.

2.3.4 Assumptions

1. The analysis was based on a network of 670 test activities with resource loading. This network contained input from 19 PIs. The judgments and assumptions are discussed in a Los Alamos letter dated July 12, 1988

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(ESD-WX4-7/88-7). Subsequent revision by the PIs allowed the recommended peak scientific manpower to be reduced to 120 people.

2. This manpower estimate does not include
   A. Drilling crews
   B. Cable plant installation
   C. Construction activities
   D. Official visitors

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2.4 Laboratory/Office/Storage Space Requirements

2.4.1 Functional Requirements

1. Provide adequate space at the ESF, surface and underground, for each testing organization to be able to satisfactorily perform the following tests.

    - Min/Pet Sampling Test (LANL)
    - Hydrologic Properties Sampling Test (USGS-Hyd)
    - Chlorine-36 Test (LANL)
    - Geoengineering Laboratory Samples Test (SNL)
    - Diffusion Test (LANL)
    - Overcore Stress Test (USGS-Mech)

2. Provide adequate space at the ESF, surface and underground, for each testing organization to be able to satisfactorily perform the following tests.

    - Demonstration Breakout Room Test (UDBR and MTL)(SNL)
    - Plate Loading Test (SNL)
    - TSw1 Heater Test (SNL)
    - Sequential Drift Mining Test (SNL)
    - Horizontal Boring Machine Test (SNL)
    - Excavation Effects Test (UDBR and MTL)(USGS-Hyd)
    - Intact Fracture Test (USGS-Hyd)
    - Equipment Development Test (SNL)

3. Provide adequate space at the ESF, surface and underground, for each testing organization to be able to satisfactorily perform the following tests.

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- Underground Geologic Mapping Test (USGS-Geo)
- Vertical Seismic Profiling Test (LBL)
- Shaft Convergence Test (SNL)
- Radial Borehole Test (USGS-Hyd)
- Perched Water Test (USGS-Hyd)
- Hydrochemistry Test (USGS-Hyd)

2.4.1 4. Provide adequate space at the ESF, surface and underground, for each testing organization to be able to satisfactorily perform the following tests.

- Evaluation of Mining Methods Test (SNL)
- Monitoring of Ground Support Systems Test (SNL)
- Monitoring Drift Stability Test (SNL)
- Air Quality and Ventilation Test (SNL)

5. Provide adequate space at the ESF, surface and underground for each testing organization to be able to satisfactorily perform the following tests.

- Canister Scale Heater Test (SNL)
- Yucca Mountain Heated Block Test (SNL)
- Thermal Stress Measurements Test (SNL)
- Rock Mass Response Test (SNL)

6. Provide adequate space at the ESF, surface and underground for each testing organization to be able to satisfactorily perform the following tests.

- Infiltration Test (USGS-Hyd)
- Bulk Permeability Test (USGS-Hyd)
- Calico Hills Test (USGS-Hyd)

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2.4.1 7. Provide adequate space at the ESF, surface and underground for each testing organization to be able to satisfactorily perform the following tests.

- Heated Room Test (SNL)
- Engineered Barrier Design Test (LLNL)

2.4.2 Performance Criteria

1a. 150 sq ft of office space and limited storage space at the ESF (surface) will be provided.

1b. 150 sq ft of storage space for three rock collection bins. This space will be located near the ES-1 shaft, and will be common to the sample collection point at the ES-1 collar.

1c. An alcove 10 ft x 10 ft x 16 ft will be provided at the MTL and the CHDR to perform the drilling for the Diffusion Test (see performance Criteria 6c.)

1d. Storage space for four nitrogen bottles will be provided in the Diffusion Test alcove.

1e. Adequate space will be provided in the drifts at the MTL and CHDR to perform overcoring for the Overcore Stress Test.

1f. 1000 sq ft of space will be provided at the auxiliary pad for two semi-trailer units. (purpose?)

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2a. 200 sq ft of office space and limited storage space at the ESF (surface) will be provided.

2b. The Demonstration Breakout Room will require an area 25 ft wide x 19 ft high x 150 ft long at both the UDBR and MTL. The 150 ft length begins at the corner of any opening perpendicular to the DBR drift and extends without any alcoves or openings within the drift for 150 ft.

2c. A DAS will be provided for the SNL tests at the UDBR and the DBR at the MTL. It will require an area 17 ft wide x 14 ft high x 26 ft long.

2d. Space for the TSw1 Heater Test will be provided at the UDBR. At this time, no additional excavation is needed.

2e. Space for the Plate Loading Tests will be provided at the UDBR and MTL. Approximately 15 plate loading tests will be performed in the ESF, and no additional excavation is planned at this time.

2f. Space for the Excavation Effect Test will be provided at the UDBR and MTL. No additional excavation is planned at this time.

2g. A DAS will be provided for the Excavation Effects Test at the UDBR. Dimensions for the DAS are 17 ft wide x 14 ft high x 26 ft long.

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2h. Space for the Equipment Development Test will be provided at the MTL. No additional excavation is required at this time.

2i. Three drifts will be excavated for the Sequential Drift Mining Test. Two instrumentation drifts will be 16 ft wide x 14 ft high x 180 ft long. The third (center) drift will be 25 ft wide x 10 ft high x 180 ft long.

2j. Two DAS alcoves are required for the Sequential Drift Mining Test. Each DAS alcove will be 17 ft wide x 12 ft high x 26 ft long.

2k. An organization computer alcove is also required for the Sequential Drift Mining Test. This alcove is 20 ft width x 12 ft high x 25 ft long.

2l. Space for the Intact Fracture Test will be needed in the shaft for drilling purposes.

3a. 100 sq ft of office space, storage space and lab lay down area at the ESF (surface) will be provided.

3b. An alcove will be excavated at the MTL for storing equipment and supplies. This alcove will be constructed to afford no access to unauthorized personnel. The minimum dimensions will be 16 ft wide x 10 ft high x 20 ft long.

3c. Alcoves will be excavated in the shaft rib at depths of 70.86 m (232.48 ft), 190.86 m (626.20

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ft) and 310.86 m (1019.92 ft) for the shaft convergence data collection units. The units are 4 ft wide x 8 ft high x 4 ft deep. (Shaft Convergence Test 1 and 2 can share the data collection units with Radial Borehole Test 7.)

3d. Alcoves for the Short Radial Boreholes will be excavated in the shaft rib at depths of 28.35 m (93 ft), 34.44 m (113 ft), 79.55 m (261 ft), 85.64 m (281 ft), 120.69 m (396 ft), 243.22 m (798 ft), for the Radial Borehole Test data collection units. The units are 4 ft wide x 8 ft high x 4 ft deep (see performance criteria 3c). The alcove should be constructed to accommodate a shelf 4 ft wide x 3 ft high x 4 ft deep. Total alcove dimensions will be 4 ft wide x 8 ft high x 4 ft deep.

3e. The Hydrochemistry Test will require an alcove at the UDBR and MTL. The dimensions of this alcove are 10 ft wide x 10 ft high x 8 ft long.

4a. 100 sq ft of office space and limited storage space at the ESF (surface) will be provided.

4b. No additional excavation will be required for the Evaluation of Mining Methods Test, Monitoring of Ground Support Systems Test, and Air Quality and Ventilation Test.

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4c. Space will be provided at the end of the Ghost Dance Fault drift to perform the Air Quality and Ventilation Drift. This portion of the drift will be sealed by a bulk head.

5a. 100 sq ft of office space and limited storage space at the ESF (surface) will be provided.

5b. An alcove at the MTL will be required for the Canister Scale Heater Test. The dimensions of this alcove are 14 ft wide x 14 ft high x 25 feet deep.

5c. An alcove at the MTL will be required for the Heated Block Test. The dimensions of this alcove are 27 ft wide x 14 ft high x 27 ft deep.

5d. A DAS alcove will be needed for the Canister Scale Heater Test and the Heated Block Test. The dimensions for this alcove are 25 ft wide x 12 ft high x 21 ft long.

5e. An organizational computer alcove will be required. The dimensions for this alcove are 20 ft wide x 12 ft high x 25 ft long.

5f. Space for the Thermal Stress Measurements Test will be provided. No additional excavation is required for this test.

5g. Space for the Rock Mass Response Test will be required at five locations throughout the MTL. No additional excavation is required for this test.

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6a. 100 sq ft of office space and limited storage space at the ESF (surface) will be provided.

6b. Space for the Infiltration Test will be provided. Dimensions for this test will TBD.

6c. A DAS alcove is needed for this test. Dimensions for this alcove are 17 ft wide x 12 ft high x 46 ft long. This DAS will be shared with the Diffusion Test.

6d. Space for the Bulk Permeability Test will be provided. The Bulk Permeability Test is composed of four separate drill rooms, two at each end of service drift four, and two whose locations and dimensions will be determined at a later date.

6e. A DAS alcove will be required for each separate Bulk Permeability Test. Dimensions for each of these alcoves are 17 ft wide x 12 ft high x 46 ft long.

7a. 500 sq ft of office space and limited storage space at the ESF (surface) will be provided.

7b. Space for the Heated Room Test will be required. No additional excavation for this test is needed.

7c. The Heated Room Test will require an organizational computer alcove. Dimensions for this alcove are 20 ft wide x 12 ft high x 25 ft long.

7d. The Heated Room Test will require a DAS alcove.

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The dimensions for this alcove are 17 ft wide x 12 ft high x 26 ft deep.

7e. 200 sq ft of space will be provided on the surface at the auxiliary pad for a machine shop trailer.

7f. The Engineered Barrier System Field Tests will require subsurface storage space and alcoves for organizational computers as shown in Figures B-2.33-A to 2.33-C. The dimensions for each storage alcove and each computer alcove are 15 ft by 15 ft in horizontal dimensions and a minimum height of 8 ft.

7g. The Engineered Barrier Test requires two DAS alcoves. The dimensions for these alcoves are 17 ft wide x 12 ft high x 26 ft long.

7h. The Engineered Barrier System Field Test is composed of drifts as defined in Figures 2.33-A to 2.33-C. The instrumentation drift which parallel the test drift are connected to the MTL by ramps.

Constraints

None

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2.5 Electrical Power Requirements for ESF Testing

Location: **Shaft**

Test Name	Volts	Phase	Watts	Use
Shaft Wall Mapping	120	Single	600	Lights
Min/Pet Sampling				
Vertical Seismic Profiling (1)	120	Single	300	Instrumentation
Shaft Convergence (1) (2)	120	Single	300	Instrumentation
Hydrologic Properties Samples (1)				
Radial Boreholes (1) (3)	120	Single	300	Instrumentation
	120	Single	150	Logging
Perched Water (1)	120	Single	300	Instrumentation
Hydrochemistry				
Chlorine-36 (1)				

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2.5 Electrical Power Requirements for ESF Testing

Location: Upper Demonstration Breakout Room

Test Name	Volts	Phase	Watts	Use
Drift Wall Mapping	120	Single	600	Lights
Min/Pet Sampling				
Vertical Seismic Profiling (4)	120	Single	300	Instrumentation
Upper Demonstration Breakout Room	120	Single	1200	Lights
TSw1 Heater Test	120	Single	300	Instrumentation
	120	Single	600	Lights
	208	Triple	1200	Heater
Overcore Stress	120	Single	600	TV Borehole Camera
Hydrologic Properties Samples (4)				
Excavation Effects	120	Single	600	Instrumentation
Plate Loading	120	Single	600	Lights
	120	Single	300	Instrumentation

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2.5 Electrical Power Requirements for ESF Testing

Location: **Main Test Level**

Test Name	Volts	Phase	Watts	Use
Drift Wall Mapping	120	Single	600	Lights
Min/Pet Sampling				
Vertical Seismic Profiling (4)	120	Single	300	Instrumentation
Demonstration Breakout Room	120	Single	1200	Lights
	120	Single	300	Instrumentation
Sequential Drift Mining	120	Single	2400	Lights
	120	Single	600	Instrumentation
Canister Scale Heater	120	Single	600	Lights
	120	Single	300	Instrumentation
	208	Triple	5000	Heater
Heated Block	120	Single	600	Lights
	120	Single	300	Instrumentation
	480	Triple	14000	Heaters
Thermal Stress	120	Single	600	Lights
	220	Single	300	Instrumentation
	480	Triple	24000	Heaters
Heated Room	120	Single	600	Lights
	120	Single	300	Instrumentation
	480	Triple	96000	Heaters

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2.5 Electrical Power Requirements for ESF Testing

Location: **Main Test Level**

Test Name	Volts	Phase	Watts	Use
Horizontal Boring	480	Triple	10000	Power to Machines
Plate Loading (5)	120	Single	2400	Lights
	120	Single	600	Instrumentation
Rock Mass Response	120	Single	600	Lights
	120	Single	300	Instrumentation
Evaluation of Mining Methods				
Ground Support				
Monitoring Drift Stability (6)	120	Single	900	Instrumentation
Air Quality & (7) Ventilation	120	Single	300	Instrumentation
Overcore Stress	120	Single	150	TV Borehole Camera
Hydrologic Properties Samples (4)	120	Single	1200	Lights
	120	Single	300	Instrumentation
Infiltration Test	120	Single	1200	Lights
	120	Single	300	Instrumentation
Excavation Effects	120	Single	600	Instrumentation
Hydrochemistry Test	12	Direct Current	1000	20 Peristaltic Pumps @ 50 Watts Each

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2.5 Electrical Power Requirements for ESF Testing

Location: **Main Test Level**

Test Name	Volts	Phase	Watts	Use
Diffusion Test (8)	120	Single	600	Lights
	120	Single	300	Instrumentation
Engineered Barrier Design	120	Single	65000	Instrumentation (UPS Power)
	120	Single	65000	Misc. Equipment
	208	Triple	28000	Heater (Voltage Regulated Standby)
	208	Triple	56000	Guard Heaters (Standby Power)
	208	Triple	25000	Misc. Equipment

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2.5 Electrical Power Requirements for ESF Testing

Footnotes and Clarification Notes

1. The lights for shaft wall mapping can be used.

2. Shaft Convergence Test has three locations in ES-1.

3. Radial Boreholes Test has eight locations in ES-1.

4. The lights for Drift Wall Mapping can be used.

5. Plate Loading is in DBR and drifts A, B, C of the Sequential Drift Mining Test.

6. Location is in all three long drifts.

7. Location is at the end of one of the long drifts.

8. Many tests that will be repeated in the Calico Hills unit (if testing is done in that horizon) will have power requirements that can be assumed to be the same as the corresponding test at other locations in the ESF.

9. Unless otherwise defined, normal lighting values from design handbooks for laboratories and offices are acceptable in the testing alcoves.

10. Where no requirements for a specific test have been stated, this is intended to imply that no "special" requirements for power have been identified for that test.

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2.6 Water System Design Requirements For ESF Testing

2.6.1 Definition of Study

This testing integration study defines the water system requirements to support ESF testing.

2.6.2 Functional Requirement

1. Provide the system design with sufficient flexibility to accommodate ESF testing requirements.

2.6.3 Performance Criteria

1. Each test location will have water provided.

2. All water will be tagged with a suitable tracer as defined in the Hydrochemistry Test requirements (2.3.29).

3. All water use in or around the ESF for each activity will be monitored and appropriate quantity records will be provided to the Test Manager's Office.

4. The Engineered Barrier System Field Test has a special requirement for up to 500 gal/week of pristine J-13 water (no tracers).

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2.6.4 Constraints

1. Unless otherwise defined, a supply line capable of providing an intermittent flow rate of 10 gpm to each test area is required.

2. The water supply for each test shall be provided to an access coupling and an isolation valve near each test location.

3. A monitoring system will be installed to monitor water in/water out of the ESF.

4. Water leakage will be kept to a minimum and will be contained to the maximum extent possible.

5. No chlorine may be added to the water used in underground construction until a performance assessment evaluation has been made to determine if such chlorine could be detrimental to waste package materials.

2.6.5 Assumptions

1. Standard mine plant water is acceptable.

2. The test organization will be responsible for the distribution system downstream from the isolation valve.

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2.6.5 3. Each organization will be responsible for adding a tracer to its respective test (if needed) subject to tracer limitations necessitated by other tests.

4. Standards for water meter accuracy conforming to American Water Works Association standard C700-77 will be adequate.

5. Water metering will be required, as a minimum, at each tracer injection location (Reference 2.2.29).

6. Water usage quantity records will be collected and handled using procedures developed by the project and approved by the Test Manager. It is anticipated that a "best effort" criterion will apply.

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2.7 Compressed Air System Design Requirements for ESF Testing

2.7.1 Definition of Test

This testing integration study defines the compressed air system requirements to support ESF testing.

2.7.2 Functional Requirements

1. The functional design requirement is to provide the flexibility in the compressed air system to accommodate ESF testing requirements.

2.7.3 Performance Criteria

1. Each test location will have compressed air provided.

2. All compressed air will be tagged with SF6 tracer to a nominal concentration of 20 parts per trillion.

2.7.4 Constraints

1. Provision will be made to prevent the introduction of liquid water from the compressed air supply into tests that are sensitive to water, such as the Diffusion Test, the Bulk Permeability Test, the Engineered Barrier System Field Tests, and the Radial Borehole Test.

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2.7.5 Interfaces

1. The compressed air supply for each test shall be provided to an access coupling and an isolation valve near each test location.

2.7.6 Assumptions

1. Standard mine plant compressed air is suitable for all test areas.

2. The test organization will be responsible for the distribution downstream from the isolation valve.

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2.8 Common Sampling Design Requirements in the ESF

2.8.1 Definition of Study

Sample collection requirements occur whenever coring is required and as a part of four specific tests: 1) Mineralogy Petrology Sampling (2.2.2), 2) Hydrologic Properties Samples (2.2.21), 3) Chlorine 36 Test (2.2.31), and 4) Geoengineering Laboratory Samples (2.2.34). Control and collection procedures will be developed by the PIs and the Sample Management Facility staff.

2.8.2 Functional Requirements

1. The functional design requirement is to provide a system design and construction specifications with sufficient flexibility to accommodate ESF sample collection requirements.

2.8.3 Performance Criteria

1. Sample collection will be required to satisfy the Performance Criteria, Constraints and Assumptions contained in following specific test requirements:

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- Mineralogy Petrology Sampling (2.2.2)
- Hydrologic Properties Samples (2.2.21)
- Chlorine 36 Test (2.2.31)
- Geoengineering Laboratory Samples (2.2.34)

2. Core samples from coring operations (reference Appendix C of the ESF SDRD) in the ESF will be handled and controlled using procedures developed by the PIs and the Sample Management Facility staff.

2.8.4 Constraints

2.8.5 Assumptions

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2.9 Communications System Design Requirements for ESF Testing

2.9.1 Definition of Study

This testing integration study defines the communication system requirements to support ESF Testing.

2.9.2 Functional Requirements

1. The functional design requirement is to provide intercom and telephone service to all locations and tests given in the attached Summary ESF Communication Requirements.

2.9.3 Performance Criteria

1. Permanent intercom stations must be provided in each of the major IDS equipment enclosures. This includes the IDS Surface Facility, the Interim IDS surface enclosure, the Upper and Lower Demonstration Breakout Room IDS Data Acquisition Stations, the Main Test Level Alcove DAS and all the IDS Data Acquisition Stations distributed on the Main Test Level.

2. Permanent intercom stations must be provided in each of the organizational computer enclosures and individual test alcoves.

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2.9.3 3. Plug-in intercom connections must be provided adjacent to other IDS components including:

* Each In-shaft Data Acquisition Station
* Each Zone Box associated with the sensor used to generate Site Characterization Data.

4. The intercom system must be flexible enough to allow additional plug-in and permanent stations to be added as the need arises.

5. The intercom system must provide the following capabilities:

* Point-to-point conversation between any two stations.
* Full duplex conversational mode.
* Simultaneous multiple conversations. For example, Station A must be able to converse with Station B while Station C converses with Station D. Each of these conversations must be totally independent of the other.
* A master broadcast mode which allows a station to transmit and receive messages to all other stations on the intercom network.
* Audible and visual signals to indicate when a station is being called.

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2.9.3

6. Multiline telephones will be provided in the surface IDS facility. These telephone sets will include a comm line capability to allow communication with the other stations in the IDS system.

7. Single line telephone sets will be provided in each of the major IDS equipment enclosures including the Interim Surface enclosure, the Upper and Lower Demonstration Breakout Rooms, the Main Test Level IDS Alcove and each of the Main Test Level IDS Data Acquisition Stations. Each of these locations will be provided with a separate number.

8. Single line telephone sets will be provided in each of the Organization Computer enclosures and individual test alcoves.

2.9.4 Constraints

1. The intercom and telephone systems cabling and equipment must be designed such that no detectable electromagnetic signals are induced into the IDS data acquisition equipment or any associated sensor.

2. No data to be used for Site Characterization will be transmitted over the telephone or intercom systems.

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2.9.4 3. Both telephone and intercom systems will be powered from uninterruptable power supplies.

4. The intercom system will be designed and constructed to prevent radio-frequency interference that could affect electromagnetic measurements to be made.

2.9.5 Interfaces

1. The IDS telephone units will be connected to the NTS telephone system.

2.9.6 Assumptions

1. The type of cabling or other media used to support the intercom and telephone systems is left to the designer.

2. The features given are considered to provide the minimum level of support for IDS operations. Additional features are acceptable as long as they do not interfere with the basic operational requirements.

3. This study does not address mining operations intercom or telephone requirements. While some of the equipment may have common components, it is beyond the scope of this study to define mining communications requirements.

Summary of ESF Communications Requirements

Test Name	Orgn.	Intercom Station	Telephone	Test Location
Surface Facility	IDS	Permanent	Yes	Surface
Temporary Surface Facility	IDS	Permanent	Yes	Surface
IDS Alcove (DAS #4)	IDS	Permanent	Yes	MTL
Sensor Zone Boxes	IDS	Plug-in	No	Each Box
Fracture Mineralogy Studies in ES-1	LANL	No	No	ES-1
Topopah Spring Stratigraphy Test	LANL	No	No	ES-1
Alteration History Test	LANL	No	No	ES-1
Chloride and Chlorine 36 Test	LANL	No	No	ES-1
Fracture Mineralogy Studies in Drifts	LANL	No	No	Drifts
Diffusion Test	LANL	Permanent	Yes	MTL
Diffusion Test (DAS #6)(used also by Percolation Test)	IDS	Permanent	Yes	MTL
Diffusion Test (Pending)	LANL	Permanent	Yes	Calico Hills
Eng. Barrier Design Test #1 (Vertical)	LLNL	Permanent	Yes	MTL
Eng. Barrier Design Test #2 (Vertical)(see EDBT #1)	LLNL	-	-	MTL
Eng. Barrier Design Test #3 (Vertical)(see EDBT #1)	LLNL	-	-	MTL
Eng. Barrier Design Test (in DAS #9)	IDS	Permanent	Yes	MTL
Shaft Convergence Test #1	SNL	Plug-in	No	ES-1
Shaft Convergence Test #2	SNL	Plug-in	No	ES-1

Intercom Test

Test Name	Orgn.	Station	Telephone	Location
Shaft Convergence Test #3	SNL	Plug-in	No	ES-1
Shaft Convergence Test #1 (see SRBT #4 for IDS)	IDS	Plug-in	No	ES-1
Shaft Convergence Test #2 (see SRBT #7 for IDS)	IDS	Plug-in	No	ES-1
Shaft Convergence Test #3	IDS	Plug-in	No	ES-1
Demonstration Breakout Room Test (Upper)	SNL	Permanent	Yes	UBDR
Demonstration Breakout Room Test (Lower)	SNL	Permanent	Yes	LDBR
Demonstration Breakout Room Test (Upper)(in DAS #1)	IDS	Permanent	Yes	UBDR
Demonstration Breakout Room Test (Lower)(in DAS #3)	IDS	Permanent	Yes	LDBR
Sequential Drift Mining Test	SNL	Permanent	Yes	MTL
Sequential Drift Mining Test (in DAS #10 and DAS #11)	IDS	Permanent	Yes	MTL
Heater Experiment in Unit TSw1 (see UDBR Test, SNL)	SNL	-	-	UDBR
Canister Scale Heater Experiment	SNL	Plug-in	No	MTL
Yucca Mountain Heated Block Test	SNL	Plug-in	No	MTL
Thermal Stress Measurement Test (see UDBR Test, SNL)	SNL	-	-	UDBR
Thermal Stress Measurement Test (see LDBR Test, SNL)	SNL	-	-	LDBR
Heated Room Test	SNL	Permanent	Yes	MTL
Heated Room Test (in DAS #7)	IDS	Permanent	Yes	MTL
Development & Demonstration of Required Equipment	SNL	Plug-in	No	MTL

Test Name	Orgn.	Intercom Station	Telephone	Test Location
Plate Loading Tests (UDBR)] 10 to 20	SNL	Plug-in	No	UDBR
Plate Loading Tests (MTL)] Unspecified	SNL	Plug-in	No	MTL
Plate Loading Tests (Long Drifts)] Locations	SNL	Plug-in	No	Long Drifts
Rock Mass Response Experiment #1 (Slot Strength)	SNL	Plug-in	No	LDBR
Rock Mass Response Experiment #2 (Slot Strength)	SNL	Plug-in	No	UDBR
Drift Stability Test	SNL	Plug-in	No	Long Drifts
Ground Support Systems Test	SNL	Plug-in	No	Long Drifts
Mining Methods Test	SNL	Plug-in	No	Long Drifts
Air Quality and Ventilation Test	SNL	Plug-in	No	Long Drifts
Seismic Tomography and Vertical Seismic Profiling	LBNL	Plug-in	No	ES-1
Geologic Mapping of ES-1	USGS	No	No	ES-1
Geologic Mapping of ES-2	USGS	No	No	ES-2
Excavation Effects Test (UDBR)	USGS	Permanent	Yes	UDBR
Excavation Effects Test (MTL)	USGS	Permanent	Yes	MTL
Excavation Effect Test (UDBR)(in DAS #2)	IDS	Permanent	Yes	UDBR
Excavation Effects Test (MTL)(in DAS #16)	IDS	Permanent	Yes	MTL
Matrix Hydrologic Properties Testing	USGS	Plug-in	No	ES-1
Intact Fracture Tests #1	USGS	Plug-in	No	ES-1

Test Name	Orgn.	Intercom Station	Telephone	Test Location
Intact Fracture Tests #2	USGS	Plug-in	No	ES-1
Intact Fracture Tests #3	USGS	Plug-in	No	ES-1
Intact Fracture Tests #4	USGS	Plug-in	No	ES-1
Intact Fracture Tests #5	USGS	Plug-in	No	ES-1
Short Radial Boreholes Test #1	USGS	Plug-in	No	ES-1
Short Radial Boreholes Test #2	USGS	Plug-in	No	ES-1
Short Radial Boreholes Test #3	USGS	Plug-in	No	ES-1
Short Radial Boreholes Test #4	USGS	Plug-in	No	ES-1
Short Radial Boreholes Test #5	USGS	Plug-in	No	ES-1
Short Radial Boreholes Test #6	USGS	Plug-in	No	ES-1
Short Radial Boreholes Test #7	USGS	Plug-in	No	ES-1
Short Radial Boreholes Test #8 (Pending)	USGS	Plug-in	No	ES-1 (CH)
Short Radial Boreholes Test #1	IDS	Plug-in	No	ES-1
Short Radial Boreholes Test #2	IDS	Plug-in	No	ES-1
Short Radial Boreholes Test #3	IDS	Plug-in	No	ES-1
Short Radial Boreholes Test #4 (used also by SCT #1)	IDS	-	-	ES-1
Short Radial Boreholes Test #5	IDS	Plug-in	No	ES-1
Short Radial Boreholes Test #6	IDS	Plug-in	No	ES-1

Test Name	Orgn.	Intercom Station	Telephone	Test Location
Short Radial Boreholes Test #7 (used also by SCT #2)	IDS	-	-	ES-1
Short Radial Boreholes Test #8 (Pending)	IDS	Plug-in	No	ES-1 (CH)
Perched Water Test (if perched water encountered	USGS	No	No	ES-1
Hydrochemistry Test	USGS	No	No	ES-1
Long Radial Boreholes Test #1	USGS	Plug-in	No	ES-1
Long Radial Boreholes Test #2	USGS	Plug-in	No	ES-1
Long Radial Boreholes Test #3	USGS	Plug-in	No	ES-1
Long Radial Boreholes Test #4	USGS	Plug-in	No	ES-1
Long Radial Boreholes Test #5	USGS	Plug-in	No	ES-1
Long Radial Boreholes Test #6	USGS	Plug-in	No	ES-1
Seismic Tomography and Vertical Seismic Profiling	LBNL	Plug-in	No	MTL
Seismic Tomography and Vertical Seismic Profiling	LBNL	Plug-in	No	Long Drifts
Geologic Mapping of Drifts	USGS	No	No	MTL
Geologic Mapping of Drifts (Pending)	USGS	No	No	Calico Hills
Geologic Mapping of Drifts	USGS	No	No	Long Drifts
Overcore Stress Test #1	USGS	No	No	ES-1
Overcore Stress Test #2	USGS	No	No	ES-1
Overcore Stress Test #3	USGS	No	No	ES-1

Test Name	Orgn.	Intercom Station	Telephone	Test Location
Percolation Test	USGS	Plug-in	Yes	MTL
Percolation Test (see Diffusion Test)	IDS	-	-	MTL
Bulk Permeability Test #1 (West)	USGS	Permanent	Yes	MTL
Bulk Permeability Test #2 (North)	USGS	Permanent	Yes	Long Drift
Bulk Permeability Test #3 (East)	USGS	Permanent	Yes	Long Drift
Bulk Permeability Test #4 (South)	USGS	Permanent	Yes	Long Drift
Bulk Permeability Test #1 (West)(in DAS #5)	IDS	Permanent	Yes	MTL
Bulk Permeability Test #2 (North)(in DAS #14)	IDS	Permanent	Yes	Long Drift
Bulk Permeability Test #3 (East)(in DAS #13)	IDS	Permanent	Yes	Long Drift
Bulk Permeability Test #4 (South)(in DAS #10)	IDS	Permanent	Yes	Long Drift
Calico Hills Cross Hole Test (Pending)	USGS	Permanent	Yes	Calico Hills
CH Drillholes at Contact (Pending)(see 1st CH Test)	USGS	-	-	Calico Hills
Calico Hills Drillholes at Ghost Dance Fault (Pending)(see 1st CH Test)	USGS	-	-	Calico Hills
Calico Hills Vertical Hole to Water Table (Pending)(see 1st CH Test)	USGS	-	-	Calico Hills
Calico Hills Cross Hole Test (Pending)(in DAS #15)	IDS	Permanent	Yes	Calico Hills
Perched Water Test (if perched water available)	USGS	No	No	MTL

NOTES: A dash (-) in a column indicates that this item has been previously addressed in another test (see the Test Name for the previous location).

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APPENDIX C

ESF DRILLING REQUIREMENTS

(TO BE PROVIDED PRIOR TO TITLE II DESIGN)

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APPENDIX D

(RESERVED FOR FUTURE USE)

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APPENDIX E

APPLICABLE REGULATIONS, CODES, STANDARDS, AND DOE ORDERS

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APPLICABLE REGULATIONS, CODES, STANDARDS, AND DOE ORDERS

General

The design and construction of the ESF shall be in accordance with all applicable parts of the following:

CODE OF FEDERAL REGULATIONS (CFR)

- 10 CFR 60, Disposal of High-Level Radioactive Wastes in Geologic Repositories
- 10 CFR 960, General Guidelines for the Recommendation of Sites for the Nuclear Waste Repositories
- 29 CFR 1910, Occupational Safety and Health Standards (OSHA)
- 29 CFR 1926, Safety and Health Regulations for Construction (OSHA)
- 30 CFR CHAPTER I , Mine Safety and Health Administration (MSHA)

U.S. CONGRESS

- Nuclear Waste Policy Act of 1982, Public Law 97-425
- Nuclear Waste Policy Act Amendments of 1987, Public Law 100-203

U.S. DEPARTMENT OF ENERGY (DOE)

- DOE Order 5400, Environmental Quality and Impact (Also refer to ESFDR Appendix J, "Exploratory Shaft Facility Environmental Requirements" which contains ESF-related environmental requirements)
  - DOE Order 5480.1B, Environmental Protection, Safety, and Health Protection Program
  - DOE/NV Order 5480.1B-20, Environmental Safety and Health Program for DOE
  - DOE Order 5480.4, Environmental Protection, Safety, and Health Protection Standards
  - DOE/NV Order 5480.4-17, Environmental Protection, Safety, and Health Protection Standards, July 2, 1986
  - DOE Order 5480.7, Fire Protection
  - DOE Order 5480.9, Construction Safety and Health Program

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- DOE Order 5480.10, Contractor Industrial Hygiene Program
- DOE/NV Order 5480.10-26, Contractor Industrial Hygiene Program
- DOE Order 5481.1B, Safety Analysis and Review System
- DOE/NV Order 5481.1B-21, Safety Analysis and Review System, January 25, 1988
- DOE Order 5482.1B, Environmental Protection, Safety, and Health Protection Appraisal Program
- DOE/NV Order 5482.1B-19, Environmental, Safety, and Health Appraisal
- DOE Order 5483.1A, 6-22-83, Occupational Safety and Health Program for Government Owned Contractor-Operated Facilities
- DOE Order 5484.1, Environmental Protection, Safety and Health Protection Information Reporting Requirements
- DOE/NV 54XA.1-2, NTS Traffic Regulations (proposed)
- DOE/NV 54XB.1-28, Laser Safety (proposed)

• DOE Order 5900, Energy Information

• DOE Order 6400, Construction and Engineering

  - DOE Order 6430.1A, General Design Criteria

• DOE/RW-0005, Mission Plan for the Civilian Radioactive Waste Management Program

• DOE/AD/06212-1, Site Development Planning Handbook

• DOE/NV/00410-77, Reynolds Electrical and Engineering Company Safety and Health Program Plan, Nevada Nuclear Waste Storage Investigations Exploratory Shaft at Yucca Mountain

• UCRL- 15910, Design Evaluation guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards, Draft (Rev. 4), May, 1989.

• DOE/EP 0108, Standard for Fire Protection of DOE Electronic Computer/Data Processing Systems

• DOE/EV 0043, Stand on Fire Protection for Portable Structures

• DOE/EV 0051/1, Electrical Safety Criteria for Research and Development Activities

• DOE/EV 06194-3, DOE Explosive Safety Manual

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- DOE (U.S. Department of Energy), Site Characterization Program Baseline, YMP/CM-0011, Rev. 0, Las Vegas, NV, February 21, 1991 nze14

STATE OF NEVADA

- Nevada Revised Statutes (NRS) Title 40, Public Health and Safety
  - Chapter 444, Sanitation
  - Chapter 445, Water Controls , Air Pollution
- NRS Title 46, Chapter 512, State of Nevada Health and Safety Standards for Open Pit and Underground Metal and Nonmetal Mines and Sand, Gravel, and Crushed Stone Operations
- Nevada Administrative Code
  - Chapter 444, Hazardous Waste Disposal
  - Chapter 445, Water Pollution Control, Air Pollution
  - Chapter 512,
- Department of Transportation (DH)
  - Standard Specifications for Road and Bridge Construction
  - Standard Plans for Road and Bridge Construction
  - Road Design Division, Design Manual, Parts 1 and 2

Industrial and Professional Society Publications

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (ASSHTO)

- A Policy on Geometric Design f Highways and Streets

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

- Threshold Limit Values and Biological Exposure Indices

AMERICAN CONCRETE INSTITUTE (ACI)

- ACI 301, Specifications for Structural Concrete for Buildings
- ACI 304, Recommended Practice for Measuring, Mixing, Transporting , and Placing Concrete
- ACI 305, Recommended practice for Hot Weather Concreting
- ACI 308, Standard Practice for Curing Concrete

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- ACI 316, Recommended Practice for Construction of Concrete Pavements and Concrete Bases
- ACI 318, Building Code Requirements for Reinforced Concrete
- ACI 318.1, Building Code Requirements for Structural Plain Concrete
- ACI 347, Recommended Practice for Concrete Formwork

PRESTRESSED CONCRETE INSTITUTE

- Standards

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

- Manual of Steel Construction

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- B31.3, Chemical Plant and and Petroleum Refinery Piping
- C2, National Electrical Safety Code
- ANS-2.3, Standard for Estimating Tornado and Extreme Wind Characteristics at Nuclear Power Sites
- ANS-2.5, Standard for Determining Meteorological Information at Nuclear Power Sites
- ANS-2.8, Standard for determining Design Basis Flooding at Power Reactor Sites

AMERICAN SOCIETY OF CIVIL ENGINEERS

- 7-88, Minimum Design Loads for Buildings and Other Structures

AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR CONDITIONING ENGINEERS (ASHRAE)

- 1985 Handbooks, Fundamentals
- 1988 Handbook, Equipment
- 1987 Handbook, HVAC Systems and Applications
- 1986 Handbook, Refrigeration
- 62, Ventilation for Acceptable Indoor Air Quality
- 90, Energy Conservation in New Building Design

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AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

- Boiler and Pressure Vessel Code: Section VIII, Division I, Unfired Pressure Vessel Code

AMERICAN SOCIETY OF TESTING MATERIALS (ASTM)

- A184, Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
- A185, Standard Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
- A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- A775, Standard Specification for Epoxy-Coated Reinforcing Steel Bars
- C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction
- E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements

AMERICAN WELDING SOCIETY

- AWS D1.1 Structural Welding Code - Steel

DIESEL ENGINE MANUFACTURER ASSOCIATION (DEMA)

- Standard Practices for Stationary Diesel and Gas Engines

INSTRUMENTATION SOCIETY OF AMERICA (ISA)

- Standards and Specifications

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

- 141, Recommended Practice for Electrical Power Distribution for Industrial Plants
- 142, Recommended Practice for Grounding of Industrial and Commercial Power Systems
- 387, Standard Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Generating Stations
- 485, Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations
- 583, Standard Modular Instrumentation and Digital Interface System

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- 595, Standard Serial Highway Interface System
- 650, Qualification of Class 1E Battery Chargers and Inverters for Nuclear Power Generating Stations

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS

- Uniform Building Code (UBC)
- Uniform Mechanical Code (UMC)
- Uniform Plumbing Code (UPC)

NATIONAL ASSOCIATION OF PLUMBING-HEATING-COOLING CONTRACTORS

- National Standard Plumbing Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- National Fire Codes
- 22, Water Tanks for Private Fire Protection
- 20, Centrifugal Fire Pumps
- 24, Installation of Private Fire Service Mains and Their Appurtenances
- 70, National Electrical Code

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APPENDIX F.1

CROSS REFERENCE 10 CFR 60 TO ESFDR, VOLUME 1

YMP CC-0013, Rev. 5/31/91

10 CFR 60 Quote	ESFDR Location
10 CFR 60.15(b)	1.2.6.4 PC 1a.
10 CFR 60.15(b)	1.2.6.5 PC 1a.
10 CFR 60.15(b)	1.2.6.6 PC 1a.
10 CFR 60.15(c)(1)	1.2.6.0 C C.(1)
10 CFR 60.15(c)(1)	1.2.6.4 PC 2a.
10 CFR 60.15(c)(1)	1.2.6.5 PC 2a.
10 CFR 60.15(c)(1)	1.2.6.6 PC 2a.
10 CFR 60.15(c)(1)	1.2.6.7 C B.
10 CFR 60.15(c)(2)	1.2.6.0 C C.(2)
10 CFR 60.15(c)(2)	1.2.6.4 PC 1b.
10 CFR 60.15(c)(2)	1.2.6.5 PC 1b.
10 CFR 60.15(c)(2)	1.2.6.6 PC 1b.
10 CFR 60.15(c)(3)	1.2.6.0 C C.(3)
10 CFR 60.15(c)(3)	1.2.6.1.1 C A.
10 CFR 60.15(c)(3)	1.2.6.4 PC 2b.
10 CFR 60.15(c)(3)	1.2.6.5 PC 2b.
10 CFR 60.15(c)(3)	1.2.6.6 PC 2b.
10 CFR 60.15(c)(3)	1.2.6.8 C D.
10 CFR 60.15(c)(4)	1.2.6.0 C C.(4)
10 CFR 60.15(c)(4)	1.2.6.6 PC 2c.
10 CFR 60.74(a)	1.2.6.0 C D.
10 CFR 60.74(a)	1.2.6.4 C A.
10 CFR 60.74(a)	1.2.6.5 C A.
10 CFR 60.74(a)	1.2.6.6 C A.
10 CFR 60.74(a)	1.2.6.7 C C.
10 CFR 60.74(b)	1.2.6.0 C D.[2]
10 CFR 60.74(b)	1.2.6.4 C A.[2]
10 CFR 60.74(b)	1.2.6.5 C A.[2]
10 CFR 60.74(b)	1.2.6.6 C A.[2]
10 CFR 60.130	1.2.6.0 C E.
10 CFR 60.130	1.2.6.4 PC 2c.
10 CFR 60.130	1.2.6.5 PC 2c.
10 CFR 60.130	1.2.6.6 PC 2d.
10 CFR 60.131(b)(9)	1.2.6.0 C G.
10 CFR 60.133(a)(1)	1.2.6.4 PC 2d.
10 CFR 60.133(a)(1)	1.2.6.5 PC 2d.
10 CFR 60.133(a)(1)	1.2.6.6 PC 2e.
10 CFR 60.133(a)(2)	1.2.6.4 PC 2e.
10 CFR 60.133(a)(2)	1.2.6.5 PC 2e.
10 CFR 60.133(a)(2)	1.2.6.6 PC 2f.
10 CFR 60.133(a)(2)	1.2.6.7 C D.
10 CFR 60.133(b)	1.2.6.4 PC 2f.
10 CFR 60.133(b)	1.2.6.5 PC 2f.
10 CFR 60.133(b)	1.2.6.6 PC 2g.
10 CFR 60.133(b)	1.2.6.7 C E.
10 CFR 60.133(d)	1.2.6.0 PC 2e.
10 CFR 60.133(d)	1.2.6.4 PC 2g.
10 CFR 60.133(d)	1.2.6.5 PC 2g.
10 CFR 60.133(d)	1.2.6.6 PC 2h.
10 CFR 60.133(d)	1.2.6.7 C F.
10 CFR 60.133(d)	1.2.6.8 C E.

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10 CFR 60 Quote	ESFDR Location
10 CFR 60.133(e)(2)	1.2.6.4 PC 2h.
10 CFR 60.133(e)(2)	1.2.6.5 PC 2h.
10 CFR 60.133(e)(2)	1.2.6.6 PC 2i.
10 CFR 60.133(f)	1.2.6.4 PC 2i.
10 CFR 60.133(f)	1.2.6.5 PC 2i.
10 CFR 60.133(f)	1.2.6.6 PC 2j.
10 CFR 60.133(i)	1.2.6.4 PC 2j.
10 CFR 60.133(i)	1.2.6.5 PC 2j.
10 CFR 60.133(i)	1.2.6.6 PC 2k.
10 CFR 60.134	1.2.6.0 C H.
10 CFR 60.134(a)	1.2.6.4 PC 2l.
10 CFR 60.134(a)	1.2.6.5 PC 2k.
10 CFR 60.134(a)	1.2.6.6 PC 2l.
10 CFR 60.134(a)(2)	1.2.6.6 PC 2l.v
10 CFR 60.134(b)	1.2.6.4 PC 2k.[2]
10 CFR 60.134(b)	1.2.6.5 PC 2k.[2]
10 CFR 60.134(b)	1.2.6.6 PC 2l.[2]
10 CFR 60.137	1.2.6.4 C B.
10 CFR 60.137	1.2.6.5 C B.
10 CFR 60.137	1.2.6.6 C B.
10 CFR 60.137	1.2.6.7 C G.

Sections Not Quoted verbatum

(10 CFR 60.72 "satisfy req")	1.2.6.0 PC 1f.
(10 CFR 60.112 "meet perf obj")	1.2.6.2 C F.
(10 CFR 60.122 "meet req")	1.2.6.1 C C.iii
(10 CFR 60.122 "meet req")	1.2.6.2 C F.
(10 CFR 60.122(c)(1) "in accord")	1.2.6.1.4 C A.
(10 CFR 60.141 and 142 "meet req")	1.2.6.4 C B.i
(10 CFR 60.141 and 142 "meet req")	1.2.6.5 C B.i
(10 CFR 60.141 and 142 "meet req")	1.2.6.6 C B.i

Sections Not Addressed (See ESFDR Introduction)

10 CFR 60.4
10 CFR 60.16
10 CFR 60.17
10 CFR 60.21
10 CFR 60.24(a)
10 CFR 60.111(a)
10 CFR 60.111(b)
10 CFR 60.112
10 CFR 60.113(a)
10 CFR 60.113(b)(2)
10 CFR 60.113(b)(3)
10 CFR 60.113(b)(4)
10 CFR 60.122
10 CFR 60.131(a)
10 CFR 60.131(b)
10 CFR 60.133(c)
10 CFR 60.133(e)(1)

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Sections Not Addressed (See ESFDR Introduction)

10 CFR 60.133(g)
10 CFR 60.133(h)
10 CFR 60.140
10 CFR 60.141
10 CFR 60.142
10 CFR 60.143
10 CFR 60.151
10 CFR 60.152

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APPENDIX F.2

CROSS REFERENCE ESFDR, VOLUME 1, TO 10 CFR 60

YMP/CC-0013, Rev. 5/31/91

ESFDR Location	10 CFR 60 Quote
1.2.6.0 PC 1f.	(10 CFR 60.72 "satisfy req")
1.2.6.0 PC 2e.	10 CFR 60.133(d)
1.2.6.0 C C.(1)	10 CFR 60.15(c)(1)
1.2.6.0 C C.(2)	10 CFR 60.15(c)(2)
1.2.6.0 C C.(3)	10 CFR 60.15(c)(3)
1.2.6.0 C C.(4)	10 CFR 60.15(c)(4)
1.2.6.0 C D.	10 CFR 60.74(a)
1.2.6.0 C D.[2]	10 CFR 60.74(b)
1.2.6.0 C E.	10 CFR 60.130
1.2.6.0 C G.	10 CFR 60.131(b)(9)
1.2.6.0 C H.	10 CFR 60.134
1.2.6.1 C C.iii	(10 CFR 60.122 "meet req")
1.2.6.1.1 C A	10 CFR 60.15(c)(3)
1.2.6.1.4 C A.	(10 CFR 60.122(c)(1) "in accord")
1.2.6.2 C F.	(10 CFR 60.122 "meet req")
1.2.6.4 PC 1a.	10 CFR 60.15(b)
1.2.6.4 PC 1b.	10 CFR 60.15(c)(2)
1.2.6.4 PC 2a.	10 CFR 60.15(c)(1)
1.2.6.4 PC 2b.	10 CFR 60.15(c)(3)
1.2.6.4 PC 2c.	10 CFR 60.130
1.2.6.4 PC 2d.	10 CFR 60.133(a)(1)
1.2.6.4 PC 2e.	10 CFR 60.133(a)(2)
1.2.6.4 PC 2f.	10 CFR 60.133(b)
1.2.6.4 PC 2g.	10 CFR 60.133(d)
1.2.6.4 PC 2h.	10 CFR 60.133(e)(2)
1.2.6.4 PC 2i.	10 CFR 60.133(f)
1.2.6.4 PC 2j.	10 CFR 60.133(i)
1.2.6.4 PC 2k.	10 CFR 60.134(a)
1.2.6.4 PC 2k.[2]	10 CFR 60.134(b)
1.2.6.4 C A.	10 CFR 60.74(a)
1.2.6.4 C A.[2]	10 CFR 60.74(b)
1.2.6.4 C B.	10 CFR 60.137
1.2.6.4 C B.i	(10 CFR 60.141 and 142 "meet req")
1.2.6.5 PC 1a.	10 CFR 60.15(b)
1.2.6.5 PC 1b.	10 CFR 60.15(c)(2)
1.2.6.5 PC 2a.	10 CFR 60.15(c)(1)
1.2.6.5 PC 2b.	10 CFR 60.15(c)(3)
1.2.6.5 PC 2c.	10 CFR 60.130
1.2.6.5 PC 2d.	10 CFR 60.133(a)(1)
1.2.6.5 PC 2e.	10 CFR 60.133(a)(2)
1.2.6.5 PC 2f.	10 CFR 60.133(b)
1.2.6.5 PC 2g.	10 CFR 60.133(d)
1.2.6.5 PC 2h.	10 CFR 60.133(e)(2)
1.2.6.5 PC 2i.	10 CFR 60.133(f)
1.2.6.5 PC 2j.	10 CFR 60.133(i)
1.2.6.5 PC 2k.	10 CFR 60.134(a)
1.2.6.5 PC 2k.[2]	10 CFR 60.134(b)
1.2.6.5 C A.	10 CFR 60.74(a)
1.2.6.5 C A.[2]	10 CFR 60.74(b)
1.2.6.5 C B.	10 CFR 60.137
1.2.6.5 C B.i	(10 CFR 60.141 and 142 "meet req")

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ESFDR Location	10 CFR 60 Quote
1.2.6.6 PC 1a.	10 CFR 60.15(b)
1.2.6.6 PC 1b.	10 CFR 60.15(c)(2)
1.2.6.6 PC 2a.	10 CFR 60.15(c)(1)
1.2.6.6 PC 2b.	10 CFR 60.15(c)(3)
1.2.6.6 PC 2c.	10 CFR 60.15(c)(4)
1.2.6.6 PC 2d.	10 CFR 60.130
1.2.6.6 PC 2e.	10 CFR 60.133(a)(1)
1.2.6.6 PC 2f.	10 CFR 60.133(a)(2)
1.2.6.6 PC 2g.	10 CFR 60.133(b)
1.2.6.6 PC 2h.	10 CFR 60.133(d)
1.2.6.6 PC 2i.	10 CFR 60.133(e)(2)
1.2.6.6 PC 2j.	10 CFR 60.133(f)
1.2.6.6 PC 2k.	10 CFR 60.133(i)
1.2.6.6 PC 2l.	10 CFR 60.134(a)
1.2.6.6 PC 2l.[2]	10 CFR 60.134(b)
1.2.6.6 PC 2l.v	10 CFR 60.134(a)(2)
1.2.6.6 C A.	10 CFR 60.74(a)
1.2.6.6 C A.[2]	10 CFR 60.74(b)
1.2.6.6 C B.	10 CFR 60.137
1.2.6.6 C B.i	(10 CFR 60.141 and 142 "meet req")
1.2.6.7 C B.	10 CFR 60.15(c)(1)
1.2.6.7 C C.	10 CFR 60.74(a)
1.2.6.7 C D.	10 CFR 60.133(a)(2)
1.2.6.7 C E.	10 CFR 60.133(b)
1.2.6.7 C F.	10 CFR 60.133(d)
1.2.6.7 C G.	10 CFR 60.137
1.2.6.8 C D.	10 CFR 60.15(c)(3)
1.2.6.8 C E.	10 CFR 60.133(d)

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APPENDIX G

ESF SYSTEMS, FUNCTIONS, AND REQUIREMENTS ANALYSIS LOGIC TREE

YMP/CC-0013, Rev. 5/31/91

SYSTEMS, FUNCTIONS, AND REQUIREMENTS ANALYSIS
FOR THE EXPLORATORY STUDIES FACILITY (ESF) AT YUCCA MOUNTAIN

The logic tree shown in this appendix identifies graphically the systems, functions and requirements for the ESF. It may be viewed as an activities tree for the ESF depicting how its mission will be accomplished.

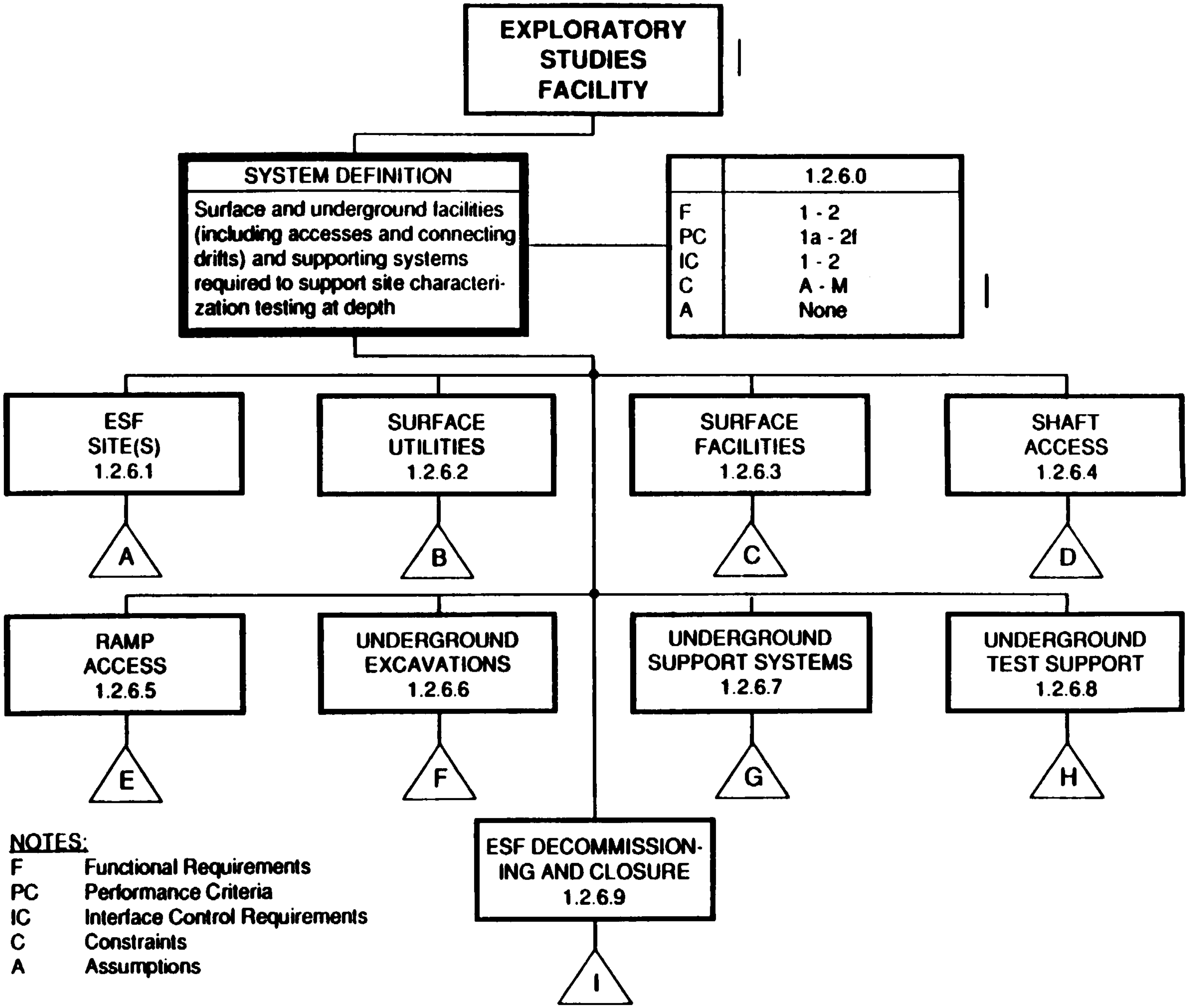
A description of the logic tree is as follows: Each major system is stated in a bold-lined rectangle. Lower-tier subsystems are identified in the rectangles immediately below the superior system. The systems are those identified in the ESFDR document text; i.e., 1.2.6.0 Exploratory Shaft Facility (ESF) identifies the main all-encompassing system, and 1.2.6.1 ESF site(s) identifies a lower-tier or subelement system to 1.2.6.0. Main site(s) (1.2.6.1.1) is yet a lower-tier to 1.2.6.1 and so forth.

Functions and Requirements are shown for each system in the thin-lined rectangle connected to the immediate right of each system rectangle. The functions and requirements are listed in the rectangle and are identified as follows:

F = Functional requirements
PC = Performance Criteria
IC = Interface Control requirements
C = Constraints
A = Assumptions

Definitions of these elements are stated in the ESFDR Introduction.

Numerous triangles containing at least one letter and possibly a number occur throughout the tree. These are "off-page connectors." As one proceeds downward from the top of the tree, an off page connector symbol means that the tree is continued on another page at the corresponding set of alphabet letters.



NOTES:

F	Functional Requirements
PC	Performance Criteria
IC	Interface Control Requirements
C	Constraints
A	Assumptions

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MAIN SITE(S)

A1

SYSTEM DEFINITION

Located on the surface, accommodates structures, systems, and components for direct construction of shaft(s) and/or ramps to provide access to the underground site characterization areas but does not include initial construction and test support facilities.

	1.2.6.1.1
F	1
PC	1a - 1b
IC	None
C	A - B
A	1

AUXILIARY SITE(S)

A2

SYSTEM DEFINITION

The Auxiliary Site(s) consist of the areas prepared to support the ESF construction and operation

	1.2.6.1.2
F	1
PC	1a - 1b
IC	None
C	A - D
A	1 - 2

YMP CC-0013, Rev.

ACCESS ROADS

A3

SYSTEM DEFINITION
All features needed to provide vehicular access to all surface areas designated as required to support the ESF.

	1.2.6.1.3
F	1
PC	1a - 1d
IC	None
C	A - G
A	None

SITE DRAINAGE

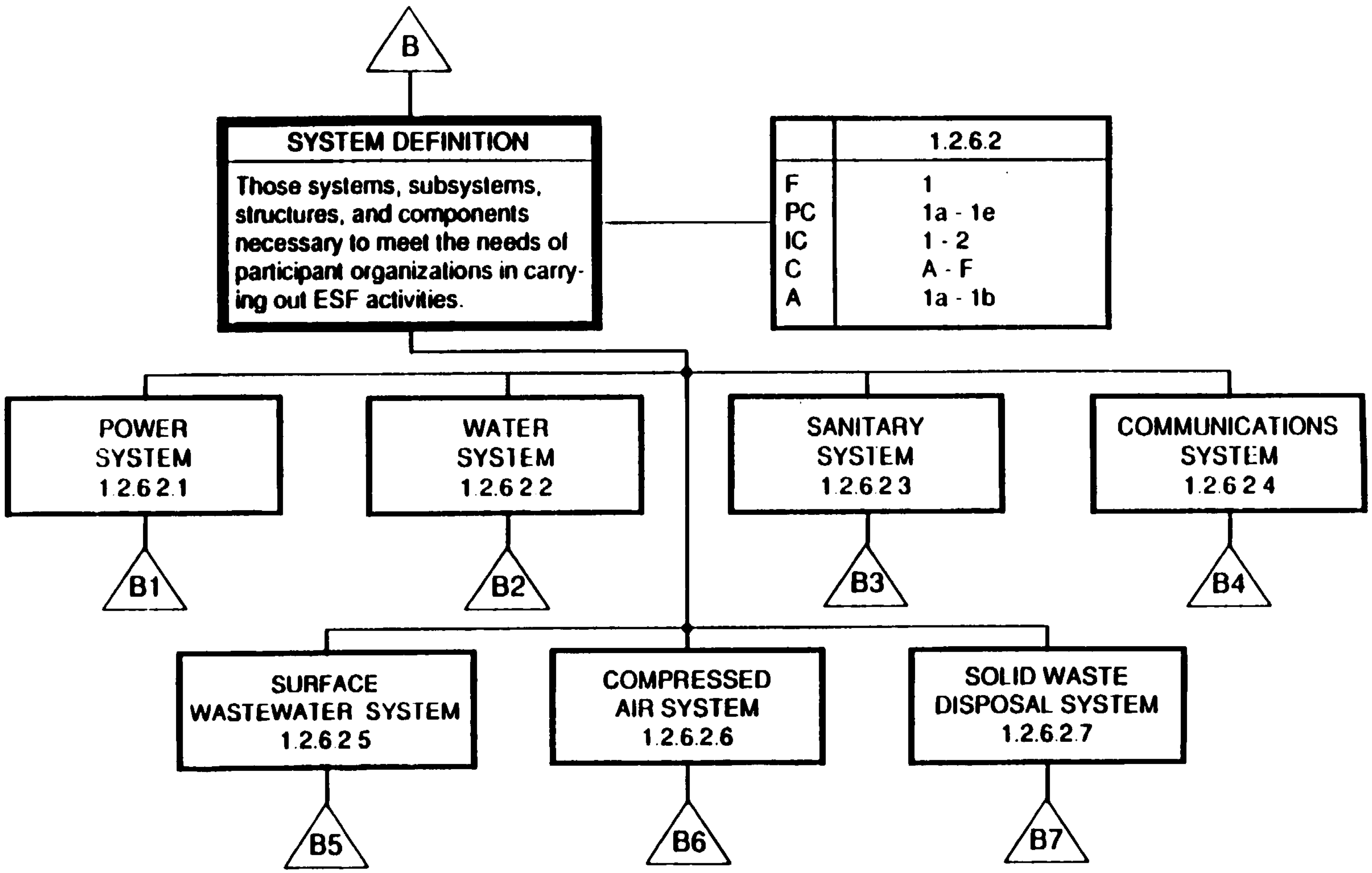
A4

SYSTEM DEFINITION
Defined as those items and measures utilized to control drainage and runoff water to preclude damage by erosion or flooding.

	1.2.6.1.4
F	1
PC	1
IC	None
C	A
A	None

YMP CC-0013, Rev.

SURFACE UTILITIES



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POWER SYSTEM

B1

SYSTEM DEFINITION

Those systems, subsystems, components, and structures that supply electrical power to the ESF Site.

	1.2.6.2.1
F	1
PC	1a - 1j
IC	None
C	A - G
A	None

WATER SYSTEM

B2

SYSTEM DEFINITION

Those systems, subsystems, and components that supply and distribute the potable and process water for ESF facilities, site preparation, and testing.

	1.2.6.2.2
F	1
PC	1a - 1i
IC	None
C	A - G
A	1

SANITARY SYSTEM

B3

SYSTEM DEFINITION

Those systems, subsystems, and components that provide for the collection, treatment, and disposal of sanitary sewage for the support of ESF operations and during in situ site characterization.

	1.2.6.2.3
F	1
PC	1a - 1c
IC	None
C	A - C
A	None

COMMUNICATIONS SYSTEM

B4

SYSTEM DEFINITION

Those systems, subsystems, and components that provide equipment and services for linking the surface areas, the underground areas, and the facilities with each other and with all outside commercial communications systems.

	1.2.6.2.4
F	1
PC	1a - 1g
IC	None
C	A - J
A	1

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SURFACE WASTEWATER SYSTEM

B5

SYSTEM DEFINITION

Those systems, subsystems, and components that provide equipment for collection, transfer, treatment, and disposal of liquid non-sanitary wastes generated underground in the ESF during construction and operations.

	1.2.6.2.5
F	1
PC	1
IC	None
C	A - C
A	None

COMPRESSED AIR SYSTEM

B6

SYSTEM DEFINITION

Those systems, subsystems, and components that provide the production and distribution of compressed air throughout the ESF.

	1.2.6.2.6
F	1
PC	1a - 1d
IC	None
C	A
A	None

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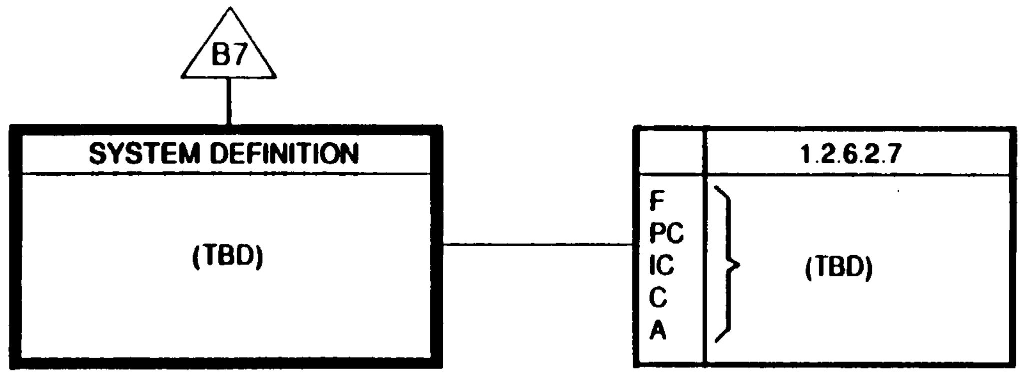
SOLID WASTE DISPOSAL SYSTEM



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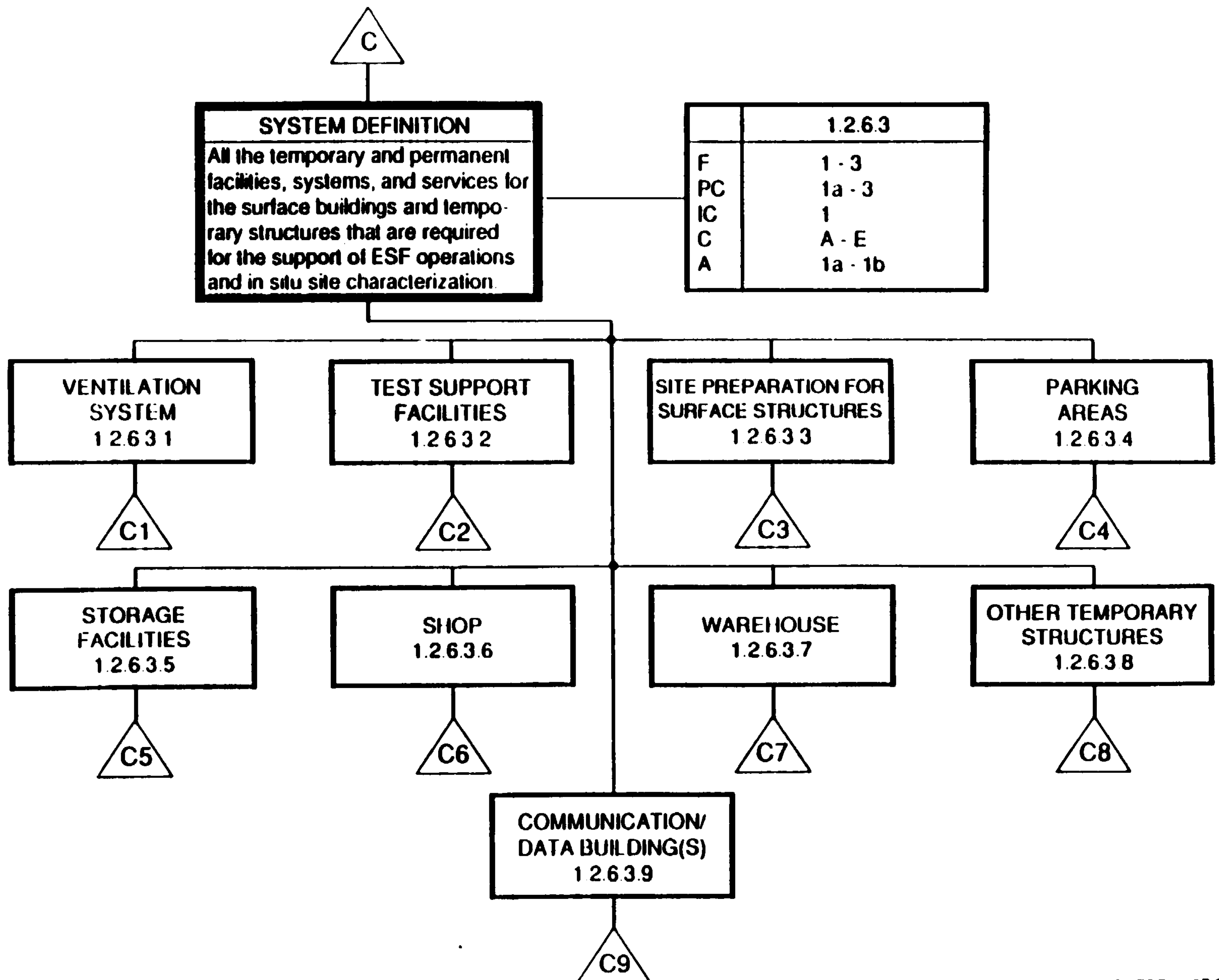
SURFACE FACILITIES



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VENTILATION SYSTEM

C1

SYSTEM DEFINITION

Those surface systems, subsystems, and components that supply fresh air, conditioned if required, to the ventilation distribution system.

	1.2.6.3.1
F	1
PC	1a - 1e
IC	None
C	A - D
A	1

TEST SUPPORT FACILITIES

C2

SYSTEM DEFINITION

Those surface facilities that accommodate the Principal Investigators' testing apparatus for equipment assembly, check out, and repair.

	1.2.6.3.2
F	1
PC	1
IC	None
C	None
A	None

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SITE PREPARATION FOR SURFACE STRUCTURES

C3

SYSTEM DEFINITION

All of the facilities, systems, and services required by the structures during construction and operation of the ESF.

	1.2.6.3.3
F	1
PC	1a - 1b
IC	None
C	None
A	None

PARKING AREAS

C4

SYSTEM DEFINITION

All space and allowances for vehicle parking required to support construction, operation, and testing in the ESF.

	1.2.6.3.4
F	1
PC	1a - 1e
IC	None
C	A - B
A	None

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STORAGE FACILITIES

C5

SYSTEM DEFINITION

All areas, structures, and supporting services to store equipment, supplies, and vehicles in a yard type environment.

	1.2.6.3.5
F	1
PC	1a - 1c
IC	None
C	A - B
A	None

SHOP

C6

SYSTEM DEFINITION

All of the facilities, systems, and services for the routine maintenance and repair of the construction and testing equipment and of the equipment for maintenance of the grounds designated for the ESF.

	1.2.6.3.6
F	1
PC	1a - 1e
IC	None
C	A - E
A	1

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WAREHOUSE

C7

SYSTEM DEFINITION
All the facilities, systems, and services for the safe storage and dispensing of ESF materials that require indoor storage and are not stored in the open areas provided under 1.2.6.3.5, Storage Facilities.

	1.2.6.3.7
F	1
PC	1a - 1b
IC	None
C	A - E
A	None

OTHER TEMPORARY STRUCTURES

C8

SYSTEM DEFINITION
The systems and services that will be utilized for the offices, change rooms, first aid and underground rescue apparatus center, security offices, and space required to support ESF construction, scientific, operations, and maintenance personnel for the Site Characterization Program including site preparation.

	1.2.6.3.8
F	1
PC	1a - 1e
IC	None
C	A - B
A	1 - 2

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COMMUNICATIONS/DATA BUILDING(S)

C9

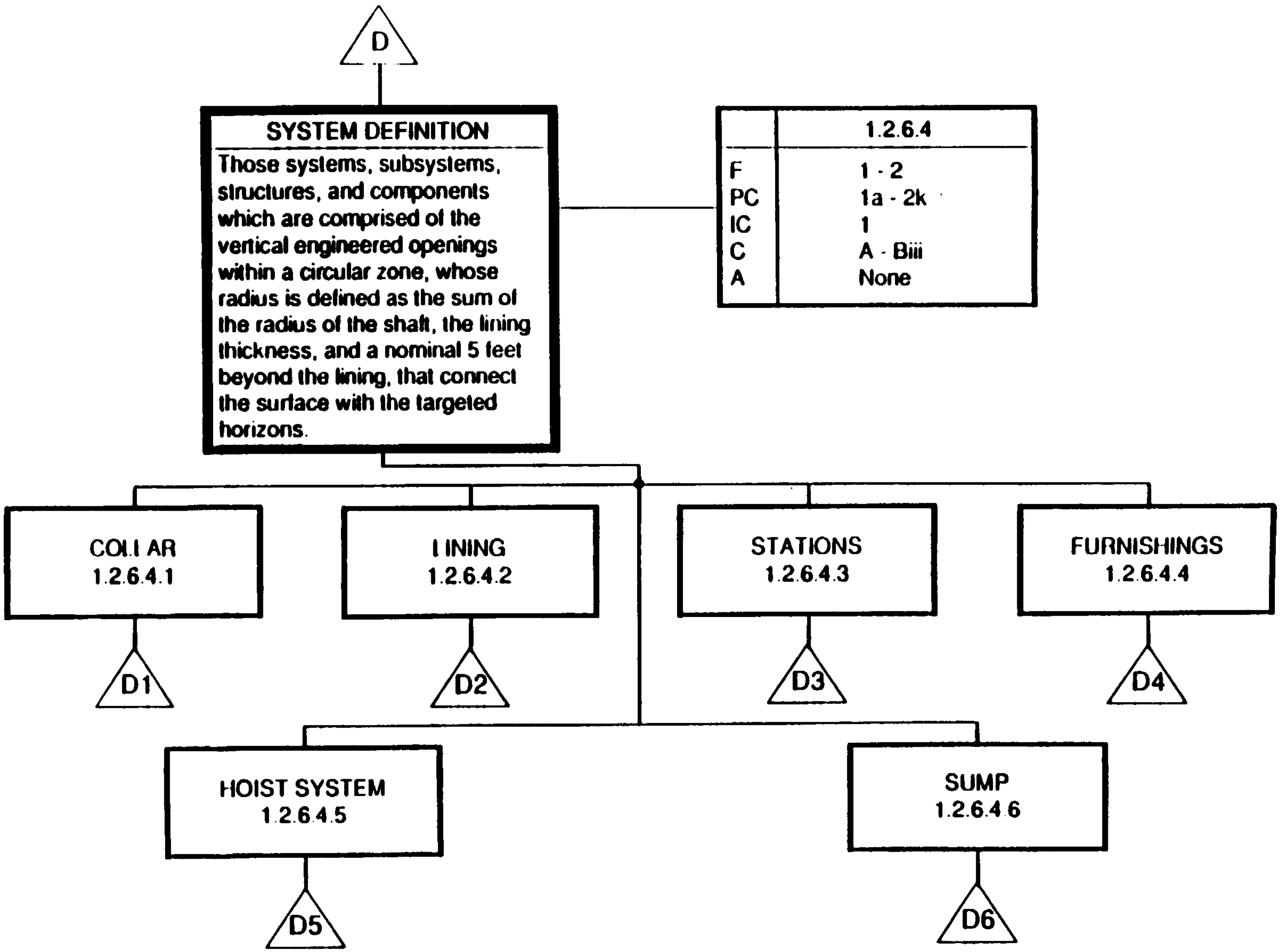
SYSTEM DEFINITION

Provides for all the facilities, systems, and services for the communications, data collection, and transmissions that are required to support construction and testing.

	1.2.6.3.9
F	1
PC	1a - 1d
IC	None
C	A
A	None

WMP/CC-0013, Rev. 5/31/91

SHAFT ACCESS



APPENDIX G-16

COLLAR

D1

SYSTEM DEFINITION
The foundation at the uppermost portion of the shaft used to support the headframe and shaft construction activities.

	1.2.6.4.1
F	1
PC	1a - 1b
IC	None
C	A - B
A	None

LINING

D2

SYSTEM DEFINITION
Those components (e.g., concrete) which are provided to maintain the integrity of the intended opening.

	1.2.6.4.2
F	1
PC	1a - 1d
IC	None
C	A - C
A	None

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STATIONS

D3

SYSTEM DEFINITION
The initial underground opening at predetermined horizons adjacent to the shaft.

	1.2.6.4.3
F	1
PC	1a - 1h
IC	None
C	None
A	None

FURNISHINGS

D4

SYSTEM DEFINITION
Those structural steel sets consisting of buntons attached to fabricated brackets, which are fixed to the shaft wall or to other structural members.

	1.2.6.4.4
F	1
PC	1a - 1l
IC	None
C	A - C
A	None

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HOIST SYSTEM

D5

SYSTEM DEFINITION

Those systems and components for the transportation of personnel and equipment between the surface and subsurface to meet the needs of shaft construction and underground site characterization testing.

	1.2.6.4.5
F	1
PC	1a - 1j
IC	None
C	A - I
A	None

SUMP

D6

SYSTEM DEFINITION

The area at the bottom of the shaft, below the adjacent horizontal excavation, that contains collection and transfer equipment for the underground wastewater system.

	1.2.6.4.6
F	1
PC	1a - 1c
IC	None
C	A - B
A	None

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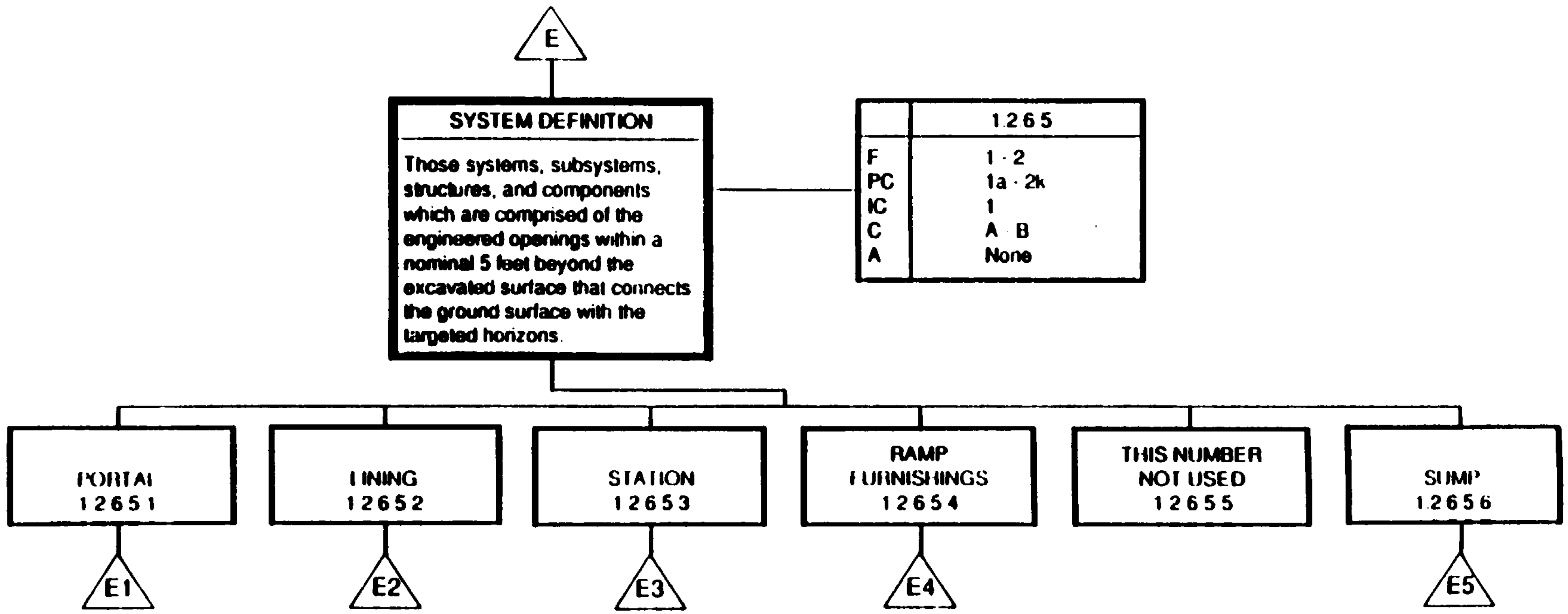
RAMP ACCESS



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PORTAL

E1

SYSTEM DEFINITION

Ramp Portal is the rock face and retaining structure at the uppermost portion of the ramp.

	1.2.6.5.1
F	1
PC	1
IC	None
C	A - B
A	None

LINING

E2

SYSTEM DEFINITION

Lining is those components which are provided to maintain integrity of the intended opening (e.g., concrete).

	1.2.6.5.2
F	1
PC	1a - 1e
IC	None
C	A - C
A	None

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STATION

E3

SYSTEM DEFINITION

Station is the initial underground opening at the predetermined horizon adjacent to the ramp.

	1.2.6.5.3
F	1
PC	1a - 1e
IC	None
C	None
A	None

RAMP FURNISHINGS

E4

SYSTEM DEFINITION

Furnishings include fabricated brackets which are fixed to the ramp wall or other support members.

	1.2.6.5.4
F	1
PC	1a - 1c
IC	None
C	A - C
A	None

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SUMP

E5

SYSTEM DEFINITION

Sump is the area(s) within the ramp that contains the underground wastewater system collection and transfer equipment.

	1.2.6.5.6
F	1
PC	1a - 1b
IC	None
C	None
A	None

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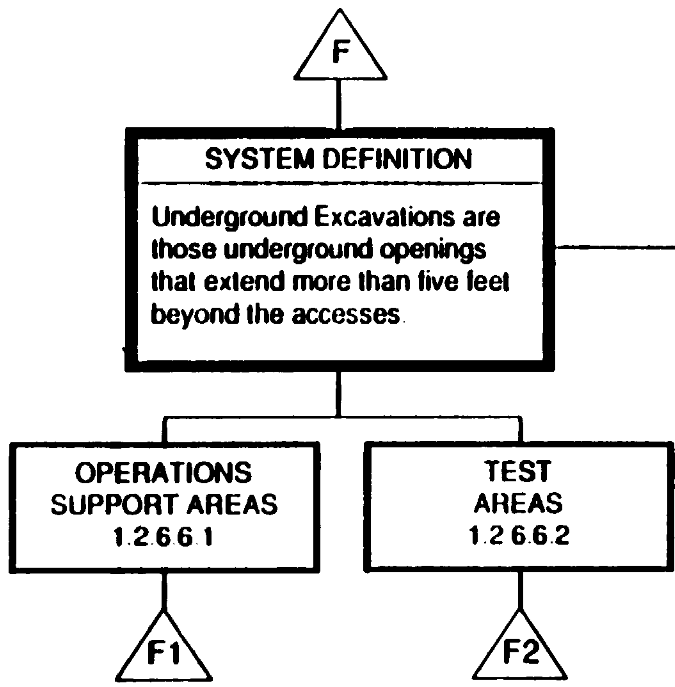
UNDERGROUND EXCAVATIONS



	1.2.6.6
F	1 - 2
PC	1a - 2l
IC	1
C	A - B
A	1

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OPERATIONS SUPPORT AREAS

F1

SYSTEM DEFINITION
Operations Support Areas are underground openings: drift(s), refuge room(s), operations admin. area, underground shop(s), lunchroom(s), storage facility(ies), maintenance shop(s), power dist. areas, fuel storage, and equipment storage.

	1.2.6.6.1
F	1
PC	1a - 1c
IC	None
C	A - B
A	None

TEST AREAS*

F2

SYSTEM DEFINITION
Test Areas are openings excavated off the ESF access stations at the upper demonstration breakout room, the main test level, and other required levels.

	1.2.6.6.2
F	1
PC	1
IC	None
C	A - B
A	None

* The tests that will be performed in these areas are defined in Appendices B & C of the ESFDR.

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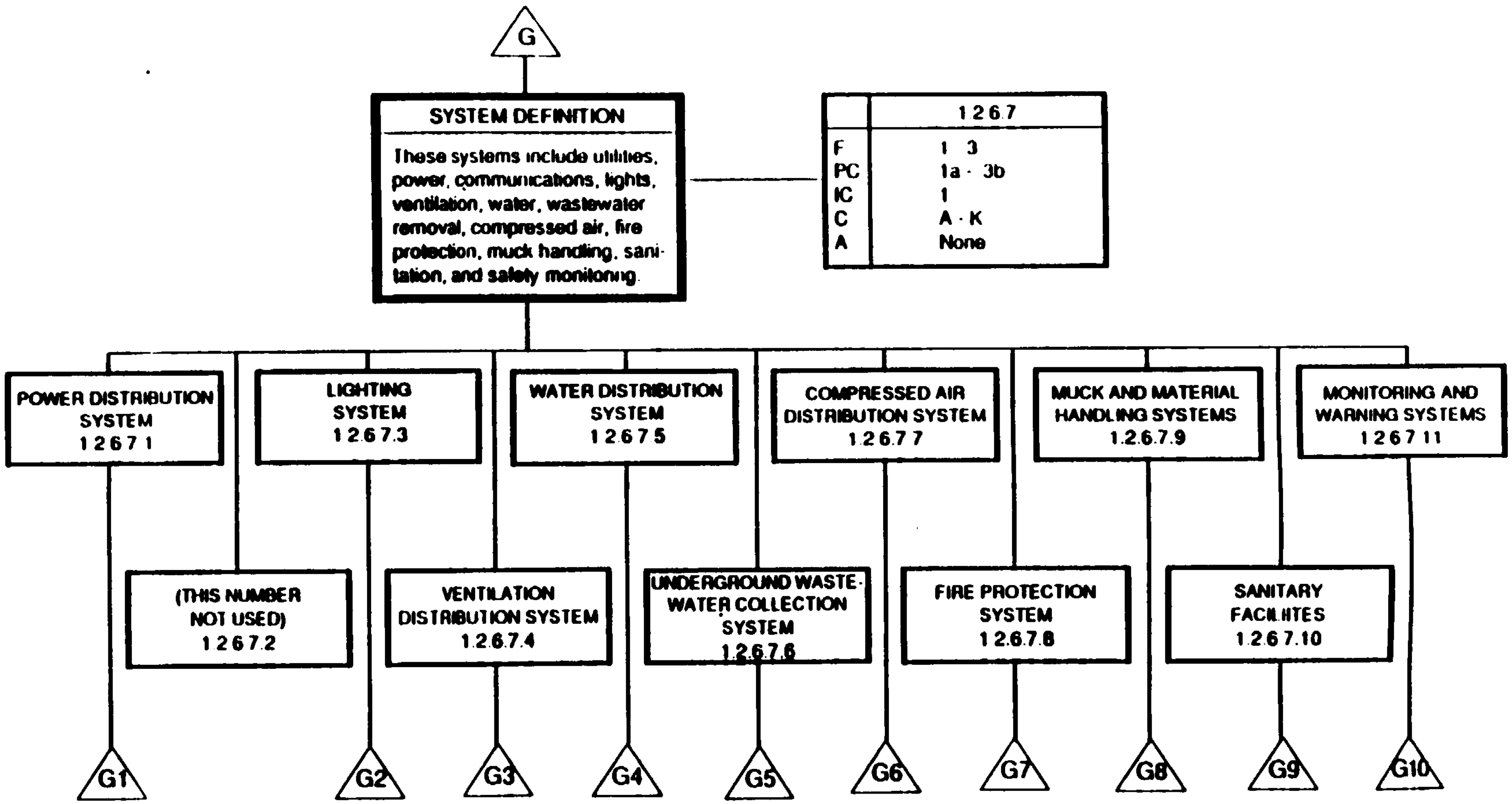
UNDERGROUND SUPPORT SYSTEMS



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APPENDIX G-26

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POWER DISTRIBUTION SYSTEM

G1

SYSTEM DEFINITION

Systems, subsystems, and components that distribute electric power to the underground system.

	1.2.6.7.1
F	1
PC	1a - 1d
IC	None
C	A - F
A	None

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LIGHTING SYSTEM

G2

SYSTEM DEFINITION

Systems, subsystems, and components that provide for the illumination of the ESF underground areas.

	1.2.6.7.3
F	1
PC	1a - 1d
IC	None
C	A - C
A	None

VENTILATION DISTRIBUTION SYSTEM

G3

SYSTEM DEFINITION

Systems, subsystems, and components that allow fresh air to be supplied and exhaust air to be removed from the underground working areas.

	1.2.6.7.4
F	1
PC	1a - 1g
IC	None
C	A - I
A	1

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WATER DISTRIBUTION SYSTEM

G4

SYSTEM DEFINITION

Systems, subsystems, and components that distribute water within the underground facility.

	1.2.6.7.5
F	1
PC	1
IC	None
C	A
A	1

UNDERGROUND WASTEWATER COLLECTION SYSTEM

G5

SYSTEM DEFINITION

Systems, subsystems, and components that collect, control, and transfer to the surface wastewater system (1.2.6.2.5).

	1.2.6.7.6
F	1
PC	1a - 1l
IC	None
C	A
A	None

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COMPRESSED AIR DISTRIBUTION SYSTEM

G6

SYSTEM DEFINITION

Systems, subsystems, and components that distribute compressed air throughout the underground ESF facility.

	1.2.6.7.7
F	1
PC	1
IC	None
C	None
A	None

FIRE PROTECTION SYSTEM

G7

SYSTEM DEFINITION

Systems, subsystems, and components that provide detection corrective response to extinguish fires.

	1.2.6.7.8
F	1
PC	1a - 1c
IC	None
C	A - C
A	None

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MUCK AND MATERIAL HANDLING SYSTEMS

G8

SYSTEM DEFINITION

Systems, subsystems, structures, equipment, and components that transport excavated rock (muck), materials, and equipment between surface and subsurface.

	1.2.6.7.9
F	1
PC	1a - 1c
IC	None
C	A - E
A	None

SANITARY FACILITIES

G9

SYSTEM DEFINITION

System that provides for human waste collection.

	1.2.6.7.10
F	1
PC	1a - 1c
IC	None
C	None
A	None

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MONITORING AND WARNING SYSTEMS

G10

SYSTEM DEFINITION

System required to monitor underground conditions and to alert onsite personnel of possible dangerous situations.

	1.2.6.7.11
F	1
PC	1a - 1f
IC	None
C	A - B
A	None

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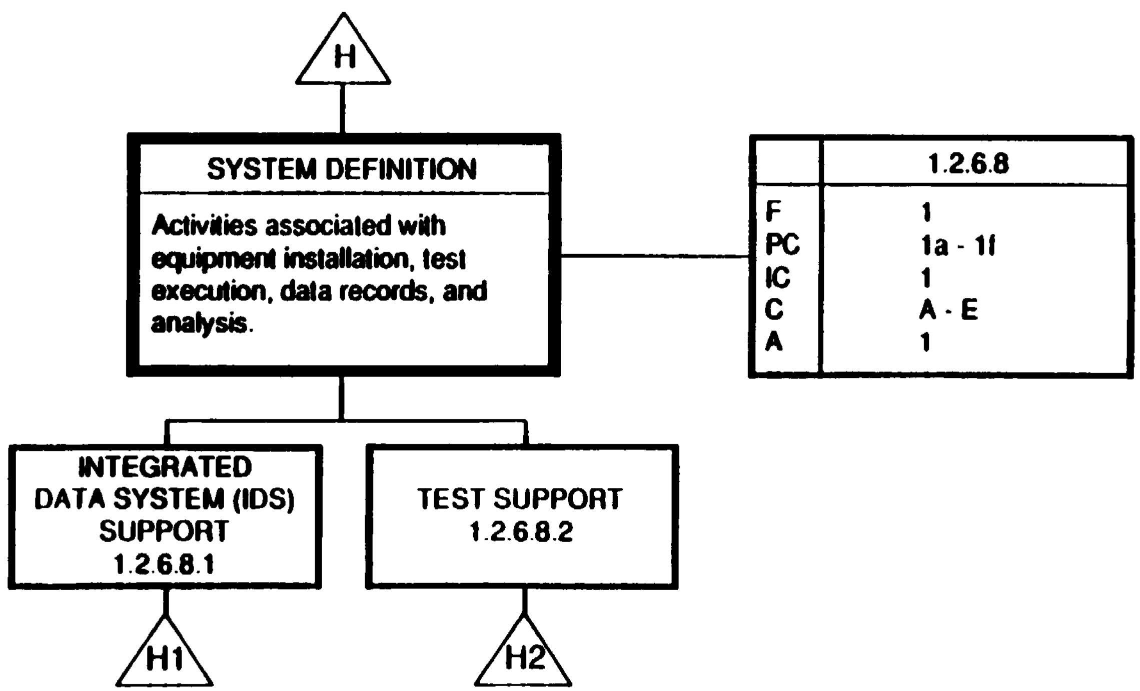
UNDERGROUND TEST SUPPORT*



* Tests are defined in Appendices B & C of the ESFDR.

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INTEGRATED DATA SYSTEM (IDS) SUPPORT

H1

SYSTEM DEFINITION

Providing facilities as described in ESFDR Appendix B

	1.2.6.8.1
F	1
PC	1
IC	1 - 2
C	None
A	None

TEST SUPPORT

H2.

SYSTEM DEFINITION

Four types of tests:

- Geologic
- Geomechanic
- Near-field and thermally perturbed
- Hydrologic and transport phenomena

	1.2.6.8.2
F	1
PC	1
IC	None
C	A
A	None

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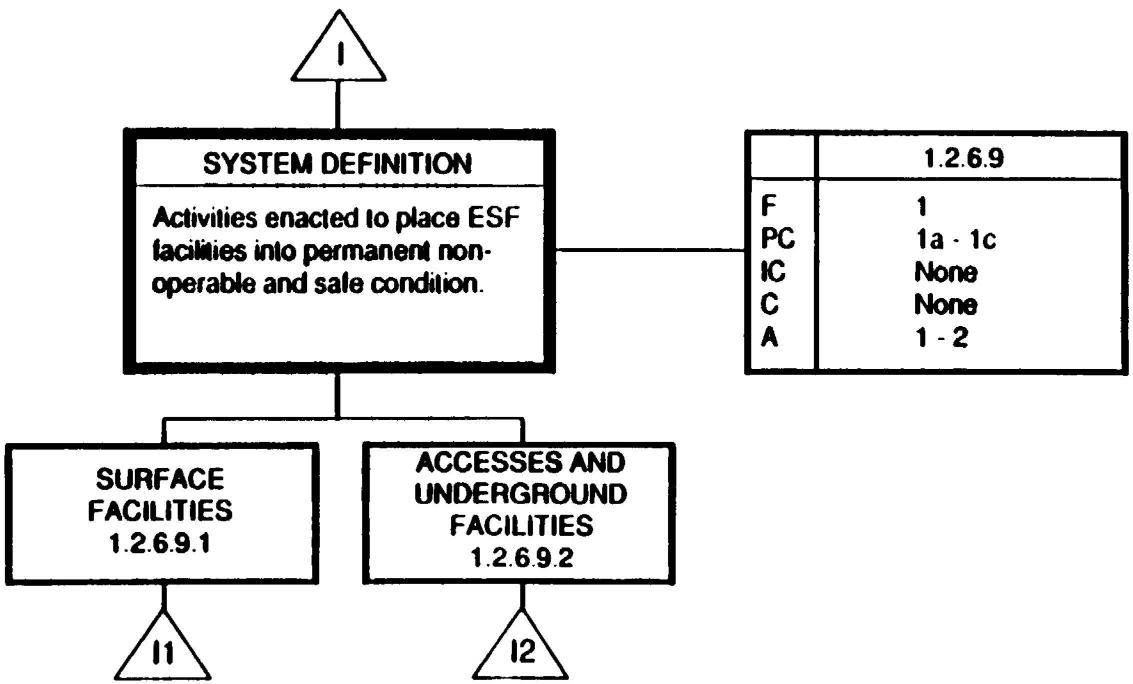
ESF DECOMMISSIONING AND CLOSURE



ESFDR2.057/3 26 91

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SURFACE FACILITIES

I1

SYSTEM DEFINITION
All facilities, systems, and subsystems as defined in previous sections (ESF site, surface utilities, facilities, etc.).

	1.2.6.9.1
F	1
PC	1a - 1b
IC	None
C	A - B
A	None

ACCESSES AND UNDERGROUND FACILITIES

I2

SYSTEM DEFINITION
All facilities, systems, and subsystems described in previous sections (accesses, underground excavations, utility systems, etc.).

	1.2.6.9.2
F	1
PC	1
IC	None
C	A
A	None

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APPENDIX H

RESPONSIBILITY MATRIX

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APPENDIX H

The terms and format of the Responsibility Matrix are explained as follows:

Column (1), ESFDR Section, lists the requirements by ESFDR section number. Please refer to the ESFDR for the actual requirements.

Column (2), DAA Recommendations, provides information that identifies the ESFDR requirements that correspond to DAA recommendations (see ESF Title I Design Acceptability Analysis and Comparative Evaluations of Alternative ESF Locations, Volume 1, Page 2-54 through 2-58). Typical references used to identify recommendations are C2-5 and C2-5,7. The C2 identifies this as a recommendation related to NRC Concern #2. The 5 and 7 identify specific Recommendations Numbers 5 and 7 related to NRC Concern #2.

Column (3), Category, provides information regarding the verification of the ESF requirements to a source of authority. The status codes used in this category column are identified on the bottom of each page. TBV indicates this requirement is "TO BE VERIFIED." A second term in this column may appear as a TBD which indicated this requirement needs a quantified value or range and is "TO BE DETERMINED."

Column (4), Responsible Organization, shows the organization(s) that have accepted responsibility to design and implement per that requirement. If two or more organizations appear in this column, responsibility may be shared or responsibility may be assigned to one organization. Resolution of disputes will be referred to higher authority as needed. The same is true for support organizations.

Column (5), Support Organization, identifies the organizations that might provide analysis support for quantifying the requirement (i.e., value or range) and may or may not be the same as the Responsible Organization. This task will include verification of analysis, such as independent technical review. Other examples of support might be acquisition of permits or tests.

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.0 EXPLORATORY STUDIES FACILITY				
1.2.6.0 DEF		NV	RSN	
1.2.6.0 BI		NV	RSN	
1.2.6.0 ARCS		NV	RSN	
1.2.6.0 ARCS [2]		NV	RSN	
1.2.6.0 ARCS [3]		NV	RSN	
1.2.6.0 FR 1.		OK	PO	RSN/LANL/SNL/REECO
1.2.6.0 FR 2.		OK	SNL	RSN
1.2.6.0 PC 1a.		OK	SNL	
1.2.6.0 PC 1b.		OK	SNL RSN	
1.2.6.0 PC 1c.		OK	SNL	
1.2.6.0 PC 1d.		OK TBD	LANL	
1.2.6.0 PC 1d.i		NV	RSN	
1.2.6.0 PC 1d.ii		NV	RSN	
1.2.6.0 PC 1d.iii		NV TBD	RSN	
1.2.6.0 PC 1e.		OK	RSN	
1.2.6.0 PC 1f.		OK	RSN	
1.2.6.0 PC 1g.		OK	RSN	
1.2.6.0 PC 1h.		OK	RSN	
1.2.6.0 PC 1i.		OK	RSN	SNL
1.2.6.0 PC 1j.		OK	RSN	
1.2.6.0 PC 1j.i		NV	RSN	
1.2.6.0 PC 1j.ii		NV	RSN	PO/REEC
1.2.6.0 PC 1k.		OK	RSN	
1.2.6.0 PC 2a.		OK	SNL/RSN	
1.2.6.0 PC 2b.		OK	SNL/RSN	
1.2.6.0 PC 2b.i		NV	SNL/RSN	
1.2.6.0 PC 2b.ii		NV	SNL/RSN	
1.2.6.0 PC 2b.iii		NV	SNL/RSN	
1.2.6.0 PC 2b.iv		NV	SNL/RSN	
1.2.6.0 PC 2b. (end)		NV	RSN	
1.2.6.0 PC 2c.		OK	RSN	SNL
1.2.6.0 PC 2c.i		NV	RSN	SNL/REECO
1.2.6.0 PC 2c.ii		NV	RSN	SNL/REECO
1.2.6.0 PC 2c.iii		NV	RSN	SNL/REECO

(3) Category:
OK = Verified source of authority; NV = Not verified to source of authority;
(Blank) = Test not available for source check

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.0 PC 2c.iv		NV	RSN	SNL/REECO
1.2.6.0 PC 2c.v	C1-12, -20	NV	RSN	SNL/REECO
1.2.6.0 PC 2c.vi		NV	RSN	SNL
1.2.6.0 PC 2d.		OK	SNL	
1.2.6.0 PC 2e.		OK	RSN	SNL
1.2.6.0 PC 2f.		OK	RSN	
1.2.6.0 PC 2f.i		NV	RSN/LANL	
1.2.6.0 PC 2f.i.a		NV	RSN/LANL	
1.2.6.0 ICR 1.		OK TBD	PO	T&MSS
1.2.6.0 ICR 2.		NV	RSN	
1.2.6.0 C A.		OK	PO	
1.2.6.0 C B.		OK	REECO	PO
1.2.6.0 C C.		OK	LANL	
1.2.6.0 C C.(1)		OK	LANL	
1.2.6.0 C C.(2)		OK	RSN	LANL/SNL
1.2.6.0 C C.(3)		OK	RSN	LANL/SNL
1.2.6.0 C C.(4)		OK	LANL	RSN/SNL
1.2.6.0 C C.i		NV	LANL/REECO	
1.2.6.0 C C.ii		NV	LANL	
1.2.6.0 C C.iii		OK	SNL/LANL	
1.2.6.0 C C.iv		NV TBD	RSN/SNL/LANL	SNL/LANL
1.2.6.0 C C.v		NV	LANL	REECO
1.2.6.0 C C.v[2]		NV	RSN	
1.2.6.0 C C.v[3]		NV	RSN	
1.2.6.0 C C.vi		NV	LANL	
1.2.6.0 C C.vii		NV	REECO	
1.2.6.0 C C.viii		NV	SNL	
1.2.6.0 C D.		OK	PO	LANL
1.2.6.0 C D.[2]		OK	LANL/SNL	
1.2.6.0 C E.		OK	RSN	
1.2.6.0 C E.i		NV	SNL	RSN
1.2.6.0 C E.ii		NV	RSN	
1.2.6.0 C F.		OK	RSN	LANL
1.2.6.0 C G.		OK	RSN	REECO
1.2.6.0 C G.i		NV	RSN	
1.2.6.0 C H.		OK	RSN	
1.2.6.0 C I.		OK	RSN	
1.2.6.0 C J.		OK	REECO	RSN
1.2.6.0 C K.		OK	RSN	
1.2.6.0 C L.		OK TBD	RSN	
1.2.6.0 C M.		OK	RSN	
1.2.6.1. ESF SITE(S)				
1.2.6.1 DEF		NV	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.1 BI		NV	RSN	
1.2.6.1 ARCS 1.		NV	RSN	
1.2.6.1 ARCS 2.		NV	RSN	
1.2.6.1 ARCS 3.		NV		
1.2.6.1 ARCS 4.		NV	RSN	
1.2.6.1 ARCS 5.		NV	RSN	
1.2.6.1 ARCS 6.		NV	RSN	
1.2.6.1 ARCS (end)		NV	RSN	
1.2.6.1 FR 1.		OK		
1.2.6.1 PC 1a.		OK	RSN	
1.2.6.1 PC 1b.		OK	RSN	
1.2.6.1 PC 1c.		OK	RSN	
1.2.6.1 PC 1d.		OK	RSN	
1.2.6.1 PC 1e.		OK	RSN	
1.2.6.1 PC 1f.		NV	RSN	
1.2.6.1 PC 1g.		OK	RSN	
1.2.6.1 PC 1h.		OK	RSN	
1.2.6.1 ICR 1.		NV	RSN	
1.2.6.1 ICR (end)		NV	RSN	
1.2.6.1 C A.	C1-1,2,4,6,7,8,9, 10,11,12,14,15,17, 18,19,20	OK TBD	SNL	
1.2.6.1 C B.		OK	RSN	
1.2.6.1 C C.		OK		
1.2.6.1 C C.i		NV TBD	SNL	SNL
1.2.6.1 C C.ii	C1-1, C2-6	NV	RSN	SNL
1.2.6.1 C C.iii	C1-1,2,3,4,5,6,7, 8,10,11,12,13,14, 15,16,18,19,20	NV	RSN	
1.2.6.1 C D.	C2-4	OK	RSN	LANL
1.2.6.1 C E.		OK	LANL/RSN	
1.2.6.1 C F.		OK		
1.2.6.1 C F.i		NV	RSN	LANL
1.2.6.1 C F.ii		NV	RSN	SNL/LANL
1.2.6.1 C F.iii		NV	RSN	
1.2.6.1 C F.iv		NV TBD	RSN	LANL
1.2.6.1 C F.v		NV	RSN	LANL
1.2.6.1 C G.		OK	RSN	
1.2.6.1 C H.		OK	RSN	
1.2.6.1 C I.		OK	RSN	
1.2.6.1 C J.		OK	RSN	
1.2.6.1 C K.		OK	RSN	
1.2.6.1 C L.		OK	RSN	
1.2.6.1 C M.		OK	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.1 C N.		OK	RSN	REECO/LANL
1.2.6.1 C O.		OK	RSN	LANL
1.2.6.1 A 1.		NV	RSN	
1.2.6.1 A 2.		NV	RSN	
1.2.6.1 A 3.		NV	RSN	LANL
1.2.6.1.1 DEF		NV	RSN	
1.2.6.1.1 BI		NV	RSN	
1.2.6.1.1 FR 1.		OK	RSN	
1.2.6.1.1 PC 1a.		OK		
1.2.6.1.1 PC 1a.i		OK	RSN	
1.2.6.1.1 PC 1a.ii		OK	RSN	
1.2.6.1.1 PC 1a.iii		OK	RSN	
1.2.6.1.1 PC 1a.iv		OK	RSN	
1.2.6.1.1 PC 1a.v		OK	RSN	
1.2.6.1.1 PC 1a.vi		OK	RSN	
1.2.6.1.1 PC 1a.vii		OK	RSN	
1.2.6.1.1 PC 1a.viii		OK	RSN	
1.2.6.1.1 PC 1a.ix		OK	RSN	
1.2.6.1.1 PC 1a.x		OK	RSN	
1.2.6.1.1 PC 1a.xi		OK	RSN	
1.2.6.1.1 PC 1a.xii		OK	RSN	
1.2.6.1.1 PC 1b.		OK	RSN	
1.2.6.1.1 C A.		OK	RSN	
1.2.6.1.1 C B.		OK	RSN	
1.2.6.1.1 A 1.		NV	RSN	
1.2.6.1.2 DEF		NV	RSN	
1.2.6.1.2 BI		NV	RSN	
1.2.6.1.2 FR 1.		OK	RSN	
1.2.6.1.2 PC 1a.		NV	RSN	
1.2.6.1.2 PC 1a.i		NV	RSN	
1.2.6.1.2 PC 1a.i.a		NV	RSN	
1.2.6.1.2 PC 1a.i.b		NV	RSN	
1.2.6.1.2 PC 1a.i.c		NV	RSN	
1.2.6.1.2 PC 1a.i.d		NV	RSN	
1.2.6.1.2 PC 1a.i.e		NV	RSN	
1.2.6.1.2 PC 1a.i.f		NV	RSN	
1.2.6.1.2 PC 1a.ii		NV	RSN	LANL
1.2.6.1.2 PC 1a.ii.a		NV	RSN	
1.2.6.1.2 PC 1a.ii.b		NV	RSN	
1.2.6.1.2 PC 1a.ii.c		NV	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.1.2 PC 1a.ii.d		NV	RSN	
1.2.6.1.2 PC 1a.ii.e		NV	RSN	
1.2.6.1.2 PC 1a.ii.f		NV	RSN	
1.2.6.1.2 PC 1a.ii.g		NV	RSN	
1.2.6.1.2 PC 1a.ii.h		NV	RSN	
1.2.6.1.2 PC 1a.ii.i		NV	RSN	
1.2.6.1.2 PC 1a.ii.j		NV	RSN	
1.2.6.1.2 PC 1a.iii		NV	RSN	
1.2.6.1.2 PC 1a.iii.a		NV	RSN	
1.2.6.1.2 PC 1a.iii.b		NV	RSN	
1.2.6.1.2 PC 1a.iii.c		NV	RSN	
1.2.6.1.2 PC 1a.iii.d		NV	RSN	
1.2.6.1.2 PC 1a.iii.e		NV	RSN	
1.2.6.1.2 PC 1a.iii.f		NV	RSN	
1.2.6.1.2 PC 1a.iv		NV	RSN	
1.2.6.1.2 PC 1a.iv.a		NV	RSN	
1.2.6.1.2 PC 1a.v		NV	RSN	LANL
1.2.6.1.2 PC 1a.v.a		NV	RSN	LANL
1.2.6.1.2 PC 1a.v.b		NV	RSN	LANL
1.2.6.1.2 PC 1a.v.c		NV	RSN	LANL
1.2.6.1.2 PC 1a.v.d		NV	RSN	LANL
1.2.6.1.2 PC 1a.v.e		NV	RSN	LANL
1.2.6.1.2 PC 1a.v.f		NV	RSN	LANL
1.2.6.1.2 PC 1a.v.g		NV	RSN	
1.2.6.1.2 PC 1a.vi		NV	RSN	LANL
1.2.6.1.2 PC 1a.vi.a		NV	RSN	LANL
1.2.6.1.2 PC 1a.vi.b		NV	RSN	LANL
1.2.6.1.2 PC 1a.vi.c		NV	RSN	LANL
1.2.6.1.2 PC 1a.vi.d		NV	RSN	LANL
1.2.6.1.2 PC 1a.vi.e		NV	RSN	LANL
1.2.6.1.2 PC 1b.		OK	RSN	
1.2.6.1.2 PC 1b.i		OK	RSN	
1.2.6.1.2 PC 1b.ii		OK	RSN	
1.2.6.1.2 PC 1b.iii		OK	RSN	
1.2.6.1.2 PC 1b.iv		OK	RSN	
1.2.6.1.2 PC 1b.v		OK	RSN	
1.2.6.1.2 C A.		OK	RSN	
1.2.6.1.2 C B.		OK	RSN	
1.2.6.1.2 C C.		OK	RSN	
1.2.6.1.2 C D.		OK	RSN	
1.2.6.1.2 A 1.		NV	RSN	
1.2.6.1.2 A 2.		NV	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.1.3 DEF		NV	RSN	
1.2.6.1.3 BI		NV	RSN	
1.2.6.1.3 FR 1.		OK	RSN	
1.2.6.1.3 PC 1a.		OK	RSN	
1.2.6.1.3 PC 1b.		OK	RSN	
1.2.6.1.3 PC 1c.		OK	RSN	
1.2.6.1.3 PC 1d.		OK	RSN	
1.2.6.1.3 C A.		OK TBD	RSN	
1.2.6.1.3 C B.		OK TBD	RSN	
1.2.6.1.3 C C.		OK	RSN	
1.2.6.1.3 C D.		OK	RSN	
1.2.6.1.3 C E.		OK	RSN	
1.2.6.1.3 C F.		OK	RSN	
1.2.6.1.3 C G.		OK	RSN	
1.2.6.1.4 DEF		NV	RSN	
1.2.6.1.4 BI		NV	RSN	
1.2.6.1.4 FR 1.		OK	RSN	
1.2.6.1.4 PC 1.		OK	RSN	
1.2.6.1.4 C A.		OK	RSN	
1.2.6.2 SURFACE UTILITIES				
1.2.6.2 DEF		NV	RSN	
1.2.6.2 BI		NV	RSN	
1.2.6.2 ARCS		NV	RSN	
1.2.6.2 ARCS EP		NV	RSN	
1.2.6.2 ARCS 1.		NV	RSN	
1.2.6.2 ARCS 2.		NV	RSN	
1.2.6.2 ARCS 3.		NV	RSN	
1.2.6.2 ARCS L		NV	RSN	
1.2.6.2 ARCS 1.		NV	RSN	
1.2.6.2 ARCS SP		NV	RSN	
1.2.6.2 ARCS 1.		NV	RSN	
1.2.6.2 ARCS 2.		NV	RSN	
1.2.6.2 ARCS UP		NV	RSN	
1.2.6.2 ARCS 1.		NV	RSN	
1.2.6.2 ARCS 2.		NV	RSN	
1.2.6.2 ARCS 3.		NV	RSN	
1.2.6.2 ARCS WS		NV	RSN	
1.2.6.2 ARCS 1.		NV	RSN	
1.2.6.2 ARCS 2.		NV	RSN	
1.2.6.2 ARCS 3.		NV	RSN	

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1.2.6.2 ARCS SS		NV	RSN	
1.2.6.2 ARCS 1.		NV	RSN	
1.2.6.2 ARCS 2.		NV	RSN	
1.2.6.2 ARCS CS		NV	RSN	
1.2.6.2 ARCS 1.		NV	RSN	
1.2.6.2 ARCS SWW		NV	RSN	
1.2.6.2 ARCS 1.		NV	RSN	
1.2.6.2 ARCS 2.		NV	RSN	
1.2.6.2 ARCS CA		NV	RSN	
1.2.6.2 ARCS 1.		NV	RSN	
1.2.6.2 ARCS (end)		NV	RSN	
1.2.6.2 FR 1.		OK	RSN	LANL
1.2.6.2 PC 1a.		OK	RSN	LANL
1.2.6.2 PC 1b.		OK	RSN	
1.2.6.2 PC 1c.		OK	RSN	
1.2.6.2 PC 1d.		OK	RSN	LANL
1.2.6.2 PC 1e.		OK	RSN	
1.2.6.2 ICR 1.		NV	SNL	
1.2.6.2 ICR 2.		NV	RSN	
1.2.6.2 ICR (end)		NV	RSN	
1.2.6.2 C A.		OK	SNL	
1.2.6.2 C B.		OK	RSN	
1.2.6.2 C C.		OK	RSN	
1.2.6.2 C D.		OK	RSN	LANL
1.2.6.2 C E.	C1-4	OK	RSN	
1.2.6.2 C F.		OK	RSN	
1.2.6.2 A 1.		NV	RSN	
1.2.6.2 A 1.a		NV	RSN	
1.2.6.2 A 1.b		NV	RSN	
1.2.6.2.1 DEF		NV	RSN	
1.2.6.2.1 DEF [2]		NV	RSN	
1.2.6.2.1 BI		NV	RSN	
1.2.6.2.1 FR 1.		OK	RSN	
1.2.6.2.1 PC 1a.		OK	RSN	LANL
1.2.6.2.1 PC 1b.		OK	RSN	LANL
1.2.6.2.1 PC 1c.		OK	RSN	
1.2.6.2.1 PC 1d.		OK	RSN	
1.2.6.2.1 PC 1e.		OK	RSN	
1.2.6.2.1 PC 1f.		OK	RSN	
1.2.6.2.1 PC 1g.		OK TBV	RSN	
1.2.6.2.1 PC 1g.i		NV TBV	RSN	
1.2.6.2.1 PC 1g.ii		NV TBV	RSN	
1.2.6.2.1 PC 1g.iii		NV TBV	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.2.1 PC 1g.iv		NV TBV	RSN	
1.2.6.2.1 PC 1g.v		NV TBV	RSN	
1.2.6.2.1 PC 1g.vi		NV TBV	RSN	
1.2.6.2.1 PC 1g.vii		NV TBV	RSN	
1.2.6.2.1 PC 1g.viii		NV TBV	RSN	
1.2.6.2.1 PC 1g.ix		NV TBV	RSN	
1.2.6.2.1 PC 1g.x		NV TBV	RSN	
1.2.6.2.1 PC 1g.xi		NV TBV	RSN	
1.2.6.2.1 PC 1h.		OK	RSN	
1.2.6.2.1 PC 1i.		OK	RSN	
1.2.6.2.1 PC 1i.i		NV	RSN	
1.2.6.2.1 PC 1i.ii		NV	RSN	REECO
1.2.6.2.1 PC 1j.		OK	RSN	LANL
1.2.6.2.1 PC 1j.i		NV	RSN	LANL
1.2.6.2.1 C A.		OK	RSN	
1.2.6.2.1 C B.		OK	RSN	
1.2.6.2.1 C C.		OK	RSN	
1.2.6.2.1 C D.		OK	RSN	
1.2.6.2.1 C E.		OK	RSN	
1.2.6.2.1 C F.		OK	RSN	
1.2.6.2.1 C G.		OK	RSN	
1.2.6.2.2 DEF		NV	RSN	
1.2.6.2.2 BI		NV	RSN	
1.2.6.2.2 FR 1.		OK	RSN	LANL
1.2.6.2.2 PC 1a.		OK	RSN	LANL
1.2.6.2.2 PC 1b.		OK	RSN	
1.2.6.2.2 PC 1c.		OK	RSN	
1.2.6.2.2 PC 1d.		OK	RSN	
1.2.6.2.2 PC 1e.		OK	RSN	
1.2.6.2.2 PC 1f.		OK	RSN	
1.2.6.2.2 PC 1g.		OK	RSN	
1.2.6.2.2 PC 1h.		OK	RSN	LANL
1.2.6.2.2 PC 1i.		OK	RSN	
1.2.6.2.2 C A.		OK	RSN	
1.2.6.2.2 C B.		OK	RSN	
1.2.6.2.2 C C.		OK	RSN	
1.2.6.2.2 C D.		OK	RSN	
1.2.6.2.2 C E.		OK	RSN	LANL
1.2.6.2.2 C F.		OK	RSN	
1.2.6.2.2 C F.i		NV	RSN	
1.2.6.2.2 C G.		OK	RSN	LANL
1.2.6.2.2 A 1.		NV	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.2.3 DEF		NV	RSN	
1.2.6.2.3 BI		NV	RSN	
1.2.6.2.3 FR 1.		OK	RSN	
1.2.6.2.3 PC 1a.		OK	RSN	
1.2.6.2.3 PC 1b.		OK	RSN	
1.2.6.2.3 PC 1c.		OK TBD	RSN	
1.2.6.2.3 C A.		OK	RSN	
1.2.6.2.3 C B.		OK TBD	RSN	SNL
1.2.6.2.3 C C.		OK	RSN	
1.2.6.2.4 DEF		NV	RSN	
1.2.6.2.4 BI		NV	RSN	
1.2.6.2.4 FR 1.		OK	RSN	LANL
1.2.6.2.4 PC 1a.		OK	RSN	
1.2.6.2.4 PC 1b.		OK	RSN	
1.2.6.2.4 PC 1c.		OK	RSN	
1.2.6.2.4 PC 1d.		OK	RSN	
1.2.6.2.4 PC 1e.		OK	RSN	LANL
1.2.6.2.4 PC 1f.		OK	RSN	
1.2.6.2.4 PC 1g.		OK	RSN	
1.2.6.2.4 C A.		OK	RSN	
1.2.6.2.4 C B.		OK	RSN	
1.2.6.2.4 C C.		OK	RSN	
1.2.6.2.4 C D.		OK	RSN	
1.2.6.2.4 C E.		OK	RSN	
1.2.6.2.4 C F.		OK	RSN	
1.2.6.2.4 C G.		OK	RSN	LANL
1.2.6.2.4 C H.		OK	RSN	
1.2.6.2.4 C I.		OK	RSN	
1.2.6.2.4 C J.		OK	RSN	
1.2.6.2.4 A 1.		NV	RSN	
1.2.6.2.5 DEF		NV	RSN	
1.2.6.2.5 BI		NV	RSN	
1.2.6.2.5 FR 1.		OK	RSN	
1.2.6.2.5 PC 1.		OK TBD	RSN	
1.2.6.2.5 C A.		OK TBD	RSN	SNL/LANL
1.2.6.2.5 C B.		OK TBD	SNL	SNL/LANL
1.2.6.2.5 C C.		OK	RSN	
1.2.6.2.6 DEF		NV	RSN	
1.2.6.2.6 BI		NV	RSN	
1.2.6.2.6 FR 1.		OK	RSN	
1.2.6.2.6 PC 1a.		OK	RSN	LANL
1.2.6.2.6 PC 1b.		OK	RSN	LANL

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1.2.6.2.6 PC 1c.		OK	RSN	LANL
1.2.6.2.6 PC 1d.		OK	RSN	
1.2.6.2.6 C A.		OK	RSN	
1.2.6.3 SURFACE FACILITIES				
1.2.6.3 DEF		NV	PO	RSN/LANL
1.2.6.3 BI		NV	RSN	
1.2.6.3 ARCS		NV	RSN	
1.2.6.3 ARCS 1.		NV	RSN	
1.2.6.3 ARCS 2.		NV	RSN	
1.2.6.3 ARCS (end)		NV	RSN	
1.2.6.3 FR 1.		OK	RSN	
1.2.6.3 FR 2.		OK	RSN	
1.2.6.3 FR 3.		OK	RSN	
1.2.6.3 PC 1a.		OK	RSN	
1.2.6.3 PC 1a.i		OK	RSN	
1.2.6.3 PC 1a.ii		OK	RSN	LANL
1.2.6.3 PC 1a.iii		OK	RSN	
1.2.6.3 PC 1a.iv		OK	RSN	
1.2.6.3 PC 1a.v		OK	RSN	LANL
1.2.6.3 PC 1a.vi		OK	RSN	LANL
1.2.6.3 PC 1a.vii		OK	RSN	LANL
1.2.6.3 PC 1a.viii		OK	RSN	LANL
1.2.6.3 PC 1a.ix		OK	RSN	
1.2.6.3 PC 1a.x		OK	RSN	
1.2.6.3 PC 1a.xi		OK	RSN	
1.2.6.3 PC 1a.xii		OK	RSN	
1.2.6.3 PC 1a.xiii		OK	RSN	
1.2.6.3 PC 1a.xiv		OK	RSN	
1.2.6.3 PC 1a.xv		OK	RSN	
1.2.6.3 PC 1a.xvi		OK	RSN	
1.2.6.3 PC 1a.xvii		OK	RSN	
1.2.6.3 PC 1a.xviii		OK	RSN	
1.2.6.3 PC 1a.xix		OK	RSN	
1.2.6.3 PC 1a.xx		OK	RSN	
1.2.6.3 PC 1a.xxi		OK	RSN	
1.2.6.3 PC 1b.		OK	RSN	LANL
1.2.6.3 PC 1c.		OK	RSN	
1.2.6.3 PC 1d.		OK	RSN	PO/LANL
1.2.6.3 PC 1e.		OK	RSN	
1.2.6.3 PC 1f.		OK	RSN	
1.2.6.3 PC 1g.		OK	RSN	LANL
1.2.6.3 PC 1h.		OK	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.3 PC 1i.		OK	RSN	
1.2.6.3 PC 2a.		OK	RSN	
1.2.6.3 PC 2b.		OK	RSN	
1.2.6.3 PC 3.		OK	RSN	
1.2.6.3 ICR 1.		NV	RSN	
1.2.6.3 ICR (end)		NV	RSN	
1.2.6.3 C A.		OK	RSN	
1.2.6.3 C B.		OK	RSN	
1.2.6.3 C C.		OK	RSN	
1.2.6.3 C D.		OK	RSN	
1.2.6.3 C E.		OK	RSN	
1.2.6.3 A 1.		NV	RSN	
1.2.6.3 A 1.a		NV	RSN	
1.2.6.3 A 1.b		NV	RSN	
1.2.6.3.1 DEF		NV	RSN	
1.2.6.3.1 BI		NV	RSN	
1.2.6.3.1 FR 1.		OK	RSN	
1.2.6.3.1 PC 1a.		OK	RSN	
1.2.6.3.1 PC 1b.		OK	RSN	
1.2.6.3.1 PC 1c.		OK	RSN	
1.2.6.3.1 PC 1d.		OK	RSN	
1.2.6.3.1 PC 1e.		OK	RSN	
1.2.6.3.1 C A.		OK	RSN	LANL
1.2.6.3.1 C B.		OK	RSN	LANL
1.2.6.3.1 C C.		OK	RSN	
1.2.6.3.1 C D.		OK	RSN	
1.2.6.3.1 A 1.		NV	RSN	
1.2.6.3.2 DEF		NV	RSN	
1.2.6.3.2 BI		NV	RSN	LANL
1.2.6.3.2 FR 1.		OK TBD	RSN	LANL
1.2.6.3.2 PC 1.		OK	RSN	LANL
1.2.6.3.3 DEF		NV	RSN	
1.2.6.3.3 BI		NV	RSN	
1.2.6.3.3 FR 1.		OK	RSN	
1.2.6.3.3 PC 1a.		OK	RSN	LANL
1.2.6.3.3 PC 1b.		OK	RSN	
1.2.6.3.4 DEF		NV	RSN	
1.2.6.3.4 BI		NV	RSN	
1.2.6.3.4 FR 1.		OK	RSN	
1.2.6.3.4 PC 1a.		OK	RSN	
1.2.6.3.4 PC 1a.i		OK	RSN	

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1.2.6.3.4 PC 1a.ii		OK	RSN	
1.2.6.3.4 PC 1a.iii		OK	RSN	
1.2.6.3.4 PC 1a.iv		OK	RSN	
1.2.6.3.4 PC 1a.v		OK	RSN	
1.2.6.3.4 PC 1a.vi		OK	RSN	
1.2.6.3.4 PC 1b.		OK	RSN	
1.2.6.3.4 PC 1c.		OK	RSN	
1.2.6.3.4 PC 1d.		OK	RSN	
1.2.6.3.4 PC 1e.		OK	RSN	
1.2.6.3.4 C A.		OK	RSN	
1.2.6.3.4 C B.		OK	RSN	
1.2.6.3.5 DEF		NV	RSN	
1.2.6.3.5 BI		NV	RSN	
1.2.6.3.5 FR 1.		OK	RSN	LANL
1.2.6.3.5 PC 1a.		OK	RSN	
1.2.6.3.5 PC 1a.i		OK	RSN	
1.2.6.3.5 PC 1a.ii		OK	RSN	
1.2.6.3.5 PC 1a.iii		OK	RSN	
1.2.6.3.5 PC 1a.iv		OK	RSN	
1.2.6.3.5 PC 1a.v		OK	RSN	
1.2.6.3.5 PC 1a.vi		OK	RSN	
1.2.6.3.5 PC 1a.vii		OK	RSN	
1.2.6.3.5 PC 1a.viii		OK	RSN	
1.2.6.3.5 PC 1a.ix		OK	RSN	
1.2.6.3.5 PC 1a.x		OK	RSN	
1.2.6.3.5 PC 1a.xi		OK	RSN	
1.2.6.3.5 PC 1b.		OK	RSN	
1.2.6.3.5 PC 1c.		OK	RSN	
1.2.6.3.5 C A.		OK	RSN	
1.2.6.3.5 C B.		OK	RSN	
1.2.6.3.6 DEF		NV	RSN	
1.2.6.3.6 BI		NV	RSN	
1.2.6.3.6 FR 1.		OK	RSN	LANL
1.2.6.3.6 PC 1a.		OK	RSN	LANL
1.2.6.3.6 PC 1b.		OK	RSN	LANL
1.2.6.3.6 PC 1c.		OK	RSN	REECO
1.2.6.3.6 PC 1d.		OK	RSN	
1.2.6.3.6 PC 1e.		OK	RSN	
1.2.6.3.6 C A.		OK	RSN	
1.2.6.3.6 C B.		OK	RSN	
1.2.6.3.6 C C.		OK	RSN	

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1.2.6.3.6 C D.		OK	RSN	
1.2.6.3.6 C E.		OK	RSN	
1.2.6.3.6 A 1.		NV	RSN	
1.2.6.3.7 DEF		NV	RSN	
1.2.6.3.7 BI		NV	RSN	
1.2.6.3.7 FR 1.		OK	RSN	LANL
1.2.6.3.7 PC 1a.		OK	RSN	LANL
1.2.6.3.7 PC 1b.		OK	RSN	LANL
1.2.6.3.7 C A.		OK	RSN	
1.2.6.3.7 C B.		OK	RSN	
1.2.6.3.7 C C.		OK	RSN	
1.2.6.3.7 C D.		OK	RSN	
1.2.6.3.7 C E.		OK	RSN	
1.2.6.3.8 DEF		NV	RSN	
1.2.6.3.8 BI		NV	RSN	
1.2.6.3.8 FR 1.		OK	RSN	
1.2.6.3.8 PC 1a.		OK	RSN	
1.2.6.3.8 PC 1a.i		OK	RSN	
1.2.6.3.8 PC 1a.ii		OK	RSN	
1.2.6.3.8 PC 1a.iii		OK	RSN	
1.2.6.3.8 PC 1a.iv		OK	RSN	LANL
1.2.6.3.8 PC 1a.v		OK	LANL	
1.2.6.3.8 PC 1a.vi		OK	RSN	
1.2.6.3.8 PC 1b.		OK	RSN	
1.2.6.3.8 PC 1c.		OK	RSN	
1.2.6.3.8 PC 1d.		OK	RSN	
1.2.6.3.8 PC 1e.		OK	RSN	LANL
1.2.6.3.8 C A.		OK	RSN	
1.2.6.3.8 C B.		OK	RSN	
1.2.6.3.8 A 1.		OK	RSN	
1.2.6.3.8 A 2.		OK	RSN	
1.2.6.3.9 DEF		NV	RSN	
1.2.6.3.9 BI		NV	RSN	
1.2.6.3.9 FR 1.		OK	RSN	LANL
1.2.6.3.9 PC 1a.		OK	RSN	
1.2.6.3.9 PC 1b.		OK	RSN	LANL
1.2.6.3.9 PC 1c.		OK	RSN/LANL	
1.2.6.3.9 PC 1c.i		OK	RSN	LANL
1.2.6.3.9 PC 1c.ii		OK	RSN	LANL
1.2.6.3.9 PC 1c.iii		OK	RSN	LANL
1.2.6.3.9 PC 1c.iv		OK	RSN	LANL
1.2.6.3.9 PC 1c.v		OK	RSN	LANL

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.3.9 PC 1c.vi		OK	RSN	LANL
1.2.6.3.9 PC 1c.vii		OK	RSN	LANL
1.2.6.3.9 PC 1d.		OK	LANL	
1.2.6.3.9 C A.		OK	RSN	
1.2.6.4 SHAFT ACCESS				
1.2.6.4 DEF		NV TBV	RSN	
1.2.6.4 BI		NV	RSN	LANL
1.2.6.4 ARCS		NV	RSN	
1.2.6.4 FR 1.		OK	RSN	
1.2.6.4 FR 2.		OK	RSN	
1.2.6.4 PC 1a.		OK	LANL/PO	LANL
1.2.6.4 PC 1a.i		NV	RSN	LANL
1.2.6.4 PC 1a.ii		NV TBD	RSN	LANL
1.2.6.4 PC 1a.iii	C3-1	NV	RSN	LANL
1.2.6.4 PC 1a.iv	C2-10	NV TBD	RSN	LANL
1.2.6.4 PC 1b.		OK	RSN	LANL
1.2.6.4 PC 1c.		OK	RSN	
1.2.6.4 PC 1c.i	C3-3	NV	RSN	LANL
1.2.6.4 PC 1c.ii		NV	RSN	LANL
1.2.6.4 PC 1c.iii		NV TBD	RSN	LANL
1.2.6.4 PC 1c.iv		NV TBD	RSN	LANL/SNL
1.2.6.4 PC 1d.		OK	RSN	
1.2.6.4 PC 1d.i		NV TBD	RSN	LANL/SNL
1.2.6.4 PC 1d.ii		NV	RSN	
1.2.6.4 PC 1d.iii	C2-2	NV TBD	SNL	LANL
1.2.6.4 PC 1d.iv		NV	RSN	
1.2.6.4 PC 1d.v		NV	RSN	
1.2.6.4 PC 1d.vi		NV	LANL	SNL
1.2.6.4 PC 1d.vii		NV TBD	LANL	
1.2.6.4 PC 1d.viii		NV	RSN	SNL/LANL
1.2.6.4 PC 1d.ix		NV TBD	SNL	LANL
1.2.6.4 PC 1d.x		NV	RSN	LANL
1.2.6.4 PC 1d.xi		NV	RSN	LANL
1.2.6.4 PC 1d.xii		NV TBD	SNL	SNL/LANL
1.2.6.4 PC 1e.		OK	RSN	
1.2.6.4 PC 1f.		OK	RSN	
1.2.6.4 PC 1f.i		NV	RSN	
1.2.6.4 PC 1f.ii		NV	RSN	LANL
1.2.6.4 PC 1g.		OK	RSN	
1.2.6.4 PC 1h.		OK	RSN	
1.2.6.4 PC 1h.i		NV	RSN	
1.2.6.4 PC 1h.ii		NV	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.4 PC 1i.		OK	RSN	
1.2.6.4 PC 1i.i		NV	RSN	LANL
1.2.6.4 PC 1i.ii		NV TBD	RSN	
1.2.6.4 PC 1i.iii		NV	RSN	LANL
1.2.6.4 PC 1j.		OK	RSN	
1.2.6.4 PC 1j.i		NV	RSN	LANL
1.2.6.4 PC 1j.ii		NV	RSN	LANL
1.2.6.4 PC 2a.		OK	RSN	LANL
1.2.6.4 PC 2a.i		NV	RSN	
1.2.6.4 PC 2a.ii		NV TBD	RSN	
1.2.6.4 PC 2a.ii.a		NV	RSN	
1.2.6.4 PC 2a.ii.b		NV	RSN	
1.2.6.4 PC 2a.ii.c	C1-6	NV	RSN	
1.2.6.4 PC 2a.ii.d		NV	RSN	
1.2.6.4 PC 2a.ii.e		NV	RSN	
1.2.6.4 PC 2a.ii.f		NV	RSN	
1.2.6.4 PC 2a.iii		NV TBD	LANL	SNL/LLNL
1.2.6.4 PC 2a.iv	C1-6	NV TBD	SNL	LANL
1.2.6.4 PC 2a.v		NV TBD	SNL	
1.2.6.4 PC 2b.		OK	RSN	LANL/SNL
1.2.6.4 PC 2b.i		NV	RSN	LANL/SNL
1.2.6.4 PC 2b.ii		NV TBD	RSN	LANL
1.2.6.4 PC 2b.iii		NV TBD	SNL	
1.2.6.4 PC 2b.iv.		NV TBD	RSN	SNL
1.2.6.4 PC 2c.		OK	RSN	
1.2.6.4 PC 2d.		OK	RSN	LANL
1.2.6.4 PC 2d.i		NV TBD	SNL	
1.2.6.4 PC 2d.ii		NV TBD	SNL	
1.2.6.4 PC 2d.iii		NV TBD	SNL	LANL
1.2.6.4 PC 2d.iv		NV	RSN	
1.2.6.4 PC 2d.v		NV TBD	RSN	
1.2.6.4 PC 2e.		OK	RSN	
1.2.6.4 PC 2e.i		NV	RSN	
1.2.6.4 PC 2e.ii		NV TBD	RSN	SNL
1.2.6.4 PC 2f.		OK	RSN	LANL
1.2.6.4 PC 2g.		OK	RSN	SNL
1.2.6.4 PC 2g.i		NV	RSN	SNL
1.2.6.4 PC 2g.ii		NV TBD	RSN	
1.2.6.4 PC 2g.iii		NV TBD	RSN	
1.2.6.4 PC 2g.iv		NV TBD	RSN	
1.2.6.4 PC 2h.		NV	RSN	LANL
1.2.6.4 PC 2h.i		NV	RSN	
1.2.6.4 PC 2h.ii		NV TBD	SNL	SNL/LANL
1.2.6.4 PC 2h.iii		NV	RSN	
1.2.6.4 PC 2i.		OK	RSN	LANL

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.4 PC 2i.i		NV	RSN	
1.2.6.4 PC 2i.ii		NV	RSN	
1.2.6.4 PC 2i.iii		NV	RSN	
1.2.6.4 PC 2i.iii.a		NV TBD	RSN	
1.2.6.4 PC 2i.iii.b		NV TBD	RSN	
1.2.6.4 PC 2i.iii.c		NV TBD	RSN	
1.2.6.4 PC 2i.iii.d		NV TBD	RSN	
1.2.6.4 PC 2i.iv		NV	RSN	
1.2.6.4 PC 2i.iv.a		NV	RSN	
1.2.6.4 PC 2i.iv.b		NV	RSN	
1.2.6.4 PC 2i.iv.c		NV	RSN	
1.2.6.4 PC 2i.iv.d		NV	RSM	
1.2.6.4 PC 2i.v		NV	RSN	
1.2.6.4 PC 2i.v (end)		NV	RSN	
1.2.6.4 PC 2i.v.a		NV TBD	SNL	SNL
1.2.6.4 PC 2i.v.b		NV	RSN	
1.2.6.4 PC 2i.vi		NV TBD	RSN	LANL/SNL
1.2.6.4 PC 2i.vii		NV TBD	RSN	SNL/LANL
1.2.6.4 PC 2i.viii		NV	RSN	
1.2.6.4 PC 2j.		NV	RSN	
1.2.6.4 PC 2j.i		NV	RSN	LANL
1.2.6.4 PC 2j.ii		NV	RSN	
1.2.6.4 PC 2j.iii	C1-18	NV TBD	RSN	
1.2.6.4 PC 2k.		OK	RSN	SNL/LANL
1.2.6.4 PC 2k. [2]		OK	RSN	SNL/LANL
1.2.6.4 PC 2k.i		NV	RSN	SNL/LANL
1.2.6.4 PC 2k.ii	C1-17	NV	RSN	
1.2.6.4 PC 2k.iii		NV	RSN	SNL/LANL
1.2.6.4 PC 2k.iii.a		NV	RSN	SNL/LANL
1.2.6.4 PC 2k.iii.b		NV	RSN	SNL/LANL
1.2.6.4 PC 2k.iii.c		NV	RSN	SNL/LANL
1.2.6.4 PC 2k.iii NOTE		NV	RSN	SNL/LANL
1.2.6.4 PC 2k.iv		NV	RSN	
1.2.6.4 PC 2k.v		NV	RSN	SNL/LANL
1.2.6.4 ICR 1.		NV	RSN	
1.2.6.4 ICR (end)		NV	RSN	
1.2.6.4 C A.		OK	PO	LANL
1.2.6.4 C A. [2]		OK	LANL	SNL
1.2.6.4 C A.i		NV TBD	RSN	LANL
1.2.6.4 C B.		OK	RSN	
1.2.6.4 C B.i		NV	RSN	LANL
1.2.6.4 C B.ii		NV TBD	RSN	LANL
1.2.6.4 C B.iii		NV	RSN	LANL

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1.2.6.4.1 DEF		NV	RSN	
1.2.6.4.1 BI		NV	RSN	
1.2.6.4.1 FR 1.		OK	RSN	
1.2.6.4.1 PC 1a.		OK	RSN	
1.2.6.4.1 PC 1b.		OK	RSN	
1.2.6.4.1 C A.		OK TBD	RSN	
1.2.6.4.1 C B.		OK	RSN	
1.2.6.4.2 DEF		NV	RSN	
1.2.6.4.2 BI		NV	RSN	
1.2.6.4.2 FR 1.		OK	RSN	LANL
1.2.6.4.2 PC 1a.		OK	RSN	
1.2.6.4.2 PC 1b.		OK TBD	RSN	LANL
1.2.6.4.2 PC 1c.		OK	RSN	
1.2.6.4.2 PC 1d.		OK	RSN	
1.2.6.4.2 C A.		OK	RSN	
1.2.6.4.2 C B.		OK	RSN	LANL
1.2.6.4.2 C C.		OK	RSN	
1.2.6.4.3 DEF		NV	RSN	
1.2.6.4.3 BI		NV	RSN	
1.2.6.4.3 FR 1.		OK	RSN	LANL
1.2.6.4.3 PC 1a.		OK	RSN	LANL
1.2.6.4.3 PC 1b.		OK	RSN	
1.2.6.4.3 PC 1c.		OK	RSN	
1.2.6.4.3 PC 1d.		OK	RSN	
1.2.6.4.3 PC 1e.		OK	RSN	
1.2.6.4.3 PC 1f.		OK	RSN	
1.2.6.4.3 PC 1g.		OK	RSN	
1.2.6.4.3 PC 1h.		OK	RSN	LANL
1.2.6.4.4 DEF		NV	RSN	
1.2.6.4.4 BI		NV	RSN	
1.2.6.4.4 FR 1.		OK	RSN	
1.2.6.4.4 PC 1a.		OK	RSN	
1.2.6.4.4 PC 1b.		OK	RSN	
1.2.6.4.4 PC 1c.		OK	RSN	
1.2.6.4.4 PC 1d		OK	RSN	
1.2.6.4.4 PC 1e.		OK	RSN	LANL
1.2.6.4.4 PC 1f.		OK	RSN	LANL
1.2.6.4.4 PC 1f.i		OK	RSN	LANL
1.2.6.4.4 PC 1f.ii		OK	RSN	LANL
1.2.6.4.4 PC 1f.iii		OK	RSN	LANL
1.2.6.4.4 PC 1f.iv		OK	RSN	LANL

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1.2.6.4.4 PC 1f.v		OK	RSN	LANL
1.2.6.4.4 PC 1f.vi		OK	RSN	LANL
1.2.6.4.4 PC 1f.vii		OK	RSN	
1.2.6.4.4 PC 1f.viii		OK	RSN	
1.2.6.4.4 C A.		OK	RSN	
1.2.6.4.4 C B.		OK	RSN	
1.2.6.4.4 C C.		OK	RSN	
1.2.6.4.5 DEF		NV	RSN	
1.2.6.4.5 DEF [2]		NV	RSN	
1.2.6.4.5 BI		NV	RSN	
1.2.6.4.5 FR 1.		OK	RSN	LANL
1.2.6.4.5 PC 1a.		OK	RSN	
1.2.6.4.5 PC 1b.		OK	RSN	
1.2.6.4.5 PC 1c.		OK	RSN	LANL
1.2.6.4.5 PC 1d.		OK	RSN	
1.2.6.4.5 PC 1e.		OK	RSN	
1.2.6.4.5 PC 1f.		OK	RSN	
1.2.6.4.5 PC 1g.		OK	RSN	
1.2.6.4.5 PC 1h.		OK	RSN	
1.2.6.4.5 PC 1i.		OK	RSN	
1.2.6.4.5 PC 1j.		OK	RSN	
1.2.6.4.5 C A.		OK	RSN	
1.2.6.4.5 C B.		OK	RSN	
1.2.6.4.5 C C.		OK	RSN	
1.2.6.4.5 C D.		OK	RSN	
1.2.6.4.5 C E.		OK	RSN	
1.2.6.4.5 C F.		OK	RSN	
1.2.6.4.5 C G.		OK	RSN	
1.2.6.4.5 C H.		OK	RSN	
1.2.6.4.5 C I.		OK	RSN	
1.2.6.4.6 DEF		NV	RSN	
1.2.6.4.6 BI		NV	RSN	
1.2.6.4.6 FR 1.		OK	RSN	LANL
1.2.6.4.6 PC 1a.		OK	RSN	
1.2.6.4.6 PC 1b.		OK	RSN	
1.2.6.4.6 PC 1c.		OK	RSN	
1.2.6.4.6 C A.		OK TBV	RSN	SNL
1.2.6.4.6 C B.		OK	RSN	
1.2.6.5 RAMP ACCESS				
1.2.6.5 DEF		NV TBV	RSN	
1.2.6.5 BI		NV	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.5 ARCS		NV	RSN	
1.2.6.5 FR 1.		OK	RSN	
1.2.6.5 FR 2.		OK	RSN	
1.2.6.5 PC 1a.		OK	RSN	LANL
1.2.6.5 PC 1a.i		NV	RSN	LANL
1.2.6.5 PC 1a.ii		NV TBD	RSN	LANL
1.2.6.5 PC 1a.iii	C3-1	NV	RSN	LANL
1.2.6.5 PC 1b.		OK	RSN	LANL
1.2.6.5 PC 1c.		OK	RSN	
1.2.6.5 PC 1c.i	C3-3	NV	RSN	LANL
1.2.6.5 PC 1c.ii		NV	RSN	LANL
1.2.6.5 PC 1c.iii		NV	RSN	LANL
1.2.6.5 PC 1c.iv		NV	RSN	
1.2.6.5 PC 1c.v		NV	RSN	
1.2.6.5 PC 1d.		OK	RSN	
1.2.6.5 PC 1d.i		NV TBD	RSN	LANL
1.2.6.5 PC 1d.ii		NV	RSN	LANL
1.2.6.5 PC 1d.iii	C2-2	NV TBD	RSN	LANL
1.2.6.5 PC 1d.iv		NV	RSN	LANL
1.2.6.5 PC 1d.v		NV	RSN	LANL/SNL
1.2.6.5 PC 1d.vi		NV	LANL	SNL
1.2.6.5 PC 1d.vii		NV TBD	LANL	
1.2.6.5 PC 1d.viii		NV	RSN	LANL
1.2.6.5 PC 1d.ix		NV TBD	RSN	LANL
1.2.6.5 PC 1d.x		NV	RSN	LANL
1.2.6.5 PC 1d.xi		NV	RSN	LANL
1.2.6.5 PC 1d.xii		NV TBD	RSN	SNL/LANL
1.2.6.5 PC 1e.		OK	RSN	
1.2.6.5 PC 1f.		OK	RSN	
1.2.6.5 PC 1f.i		NV	RSN	
1.2.6.5 PC 1f.ii		NV	RSN	
1.2.6.5 PC 1f.iii		NV	RSN	
1.2.6.5 PC 1f.iv		NV	RSN	
1.2.6.5 PC 1f.v		NV	RSN	
1.2.6.5 PC 1g.		OK	RSN	
1.2.6.5 PC 1h.		OK	RSN	
1.2.6.5 PC 1h.i		NV	RSN	
1.2.6.5 PC 1h.ii		NV	RSN	
1.2.6.5 PC 1i.		OK	RSN	
1.2.6.5 PC 1i.i		NV	RSN	
1.2.6.5 PC 1i.ii		NV	RSN	
1.2.6.5 PC 1i.iii		NV	RSN	
1.2.6.5 PC 1i.iv		NV TBD	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.5 PC 1i.v		NV	RSN	
1.2.6.5 PC 1j.		OK	RSN	
1.2.6.5 PC 1j.i		NV	RSN	
1.2.6.5 PC 1j.ii		NV	RSN	
1.2.6.5 PC 2a.		OK	SNL	
1.2.6.5 PC 2a.i		NV	SNL	SNL/LANL
1.2.6.5 PC 2a.ii		NV TBD	RSN	
1.2.6.5 PC 2a.ii.a		NV	RSN	
1.2.6.5 PC 2a.ii.b		NV	RSN	
1.2.6.5 PC 2a.ii.c	C1-6	NV	RSN	
1.2.6.5 PC 2a.ii.d		NV	RSN	
1.2.6.5 PC 2a.ii.e		NV	RSN	
1.2.6.5 PC 2a.ii.f		NV	RSN	
1.2.6.5 PC 2a.iii		NV TBD	SNL	SNL/LANL
1.2.6.5 PC 2a.iv	C1-6	NV TBD	RSN	LANL
1.2.6.5 PC 2a.v		NV TBD	RSN	
1.2.6.5 PC 2b.		OK	RSN	
1.2.6.5 PC 2b.i		NV	RSN	
1.2.6.5 PC 2b.ii		NV TBD	RSN	LANL
1.2.6.5 PC 2b.iii		NV TBD	RSN	
1.2.6.5 PC 2b.iv		NV TBD	RSN	
1.2.6.5 PC 2c.		OK	RSN	
1.2.6.5 PC 2d.		OK	RSN	
1.2.6.5 PC 2d.i		NV TBD	RSN	
1.2.6.5 PC 2d.ii		NV TBD	SNL	
1.2.6.5 PC 2d.iii		NV TBD	RSN	
1.2.6.5 PC 2d.iv		NV	RSN	
1.2.6.5 PC 2d.v		NV TBD	RSN	
1.2.6.5 PC 2e.		OK	RSN	
1.2.6.5 PC 2e.i		NV	RSN	
1.2.6.5 PC 2e.ii		NV TBD	RSN	
1.2.6.5 PC 2f.		OK	RSN	LANL
1.2.6.5 PC 2g.		OK	RSN	LANL
1.2.6.5 PC 2g.i		NV TBD	RSN	
1.2.6.5 PC 2g.ii		NV	RSN	SNL
1.2.6.5 PC 2g.iii		NV TBD	TBD	SNL
1.2.6.5 PC 2g.iv		NV TBD	RSN	LANL
1.2.6.5 PC 2g.v		NV TBD	RSN	
1.2.6.5 PC 2h.		OK	RSN	
1.2.6.5 PC 2h.i		NV	RSN	
1.2.6.5 PC 2h.ii		NV TBD	LANL	SNL
1.2.6.5 PC 2h.iii		NV	RSN	
1.2.6.5 PC 2i.		OK	RSN	
1.2.6.5 PC 2i.i		NV	RSN	
1.2.6.5 PC 2i.ii		NV	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.5 PC 2i.iii		NV	RSN	
1.2.6.5 PC 2i.iii.a		NV TBD	RSN	
1.2.6.5 PC 2i.iii.b		NV TBD	RSN	
1.2.6.5 PC 2i.iii.c		NV TBD	RSN	
1.2.6.5 PC 2i.iii.d		NV TBD	RSN	
1.2.6.5 PC 2i.iv		NV	RSN	
1.2.6.5 PC 2i.iv.a		NV	RSN	
1.2.6.5 PC 2i.iv.b		NV	RSN	
1.2.6.5 PC 2i.iv.c		NV	RSN	
1.2.6.5 PC 2i.iv.d		NV	RSN	
1.2.6.5 PC 2i.v		NV	RSN	
1.2.6.5 PC 2i [end]		NV	RSN	
1.2.6.5 PC 2i.v.a		NV TBV	SNL	SNL
1.2.6.5 PC 2i.v.b		NV	RSN	
1.2.6.5 PC 2i.vi		NV TBD	RSN	LANL/SNL
1.2.6.5 PC 2i.vii		NV TBD	RSN	LANL/SNL
1.2.6.5 PC 2i.viii		NV	RSN	
1.2.6.5 PC 2j.		OK	RSN	
1.2.6.5 PC 2j.i		NV	RSN	
1.2.6.5 PC 2j.ii		NV	RSN	
1.2.6.5 PC 2j.iii	C1-18	NV TBD	RSN	
1.2.6.5 PC 2k.		OK	RSN	
1.2.6.5 PC 2k. [2]		OK	RSN	
1.2.6.5 PC 2k.i		NV	RSN	
1.2.6.5 PC 2k.ii	C1-17	NV	RSN	
1.2.6.5 PC 2k.iii		NV	RSN	
1.2.6.5 PC 2k.iii.a		NV	RSN	
1.2.6.5 PC 2k.iii.b		NV	RSN	
1.2.6.5 PC 2k.iii.c		NV	RSN	
1.2.6.5 PC 2k.iv		NV	RSN	
1.2.6.5 PC 2k.v		NV	RSN	
1.2.6.5 ICR 1.		NV	RSN	
1.2.6.5 ICR (end)		NV	RSN	
1.2.6.5 C A.		OK	RSN	LANL
1.2.6.5 C A. [2]		OK	RSN	
1.2.6.5 C A.i		NV TBD	RSN	LANL
1.2.6.5 C B.		OK	RSN	LANL
1.2.6.5 C B.i		NV	RSN	
1.2.6.5 C B.ii		NV TBD	RSN	LANL
1.2.6.5 C B.iii		NV	RSN	LANL
1.2.6.5.1 DEF		NV	RSN	
1.2.6.5.1 BI		NV	RSN	

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1.2.6.5.1 FR 1.		OK	RSN	
1.2.6.5.1 PC 1.		OK	RSN	
1.2.6.5.1 C A.		OK TBD	RSN	
1.2.6.5.1 C B.		OK	RSN	
1.2.6.5.2 DEF		NV	RSN	
1.2.6.5.2 BI		NV	RSN	
1.2.6.5.2 FR 1.		OK	RSN	
1.2.6.5.2 PC 1a.		OK	RSN	
1.2.6.5.2 PC 1b.		OK	RSN	
1.2.6.5.2 PC 1c.		OK	RSN	
1.2.6.5.2 PC 1d.		OK	RSN	
1.2.6.5.2 PC 1e.		OK	RSN	
1.2.6.5.2 C A.		OK	RSN	
1.2.6.5.2 C B.		OK	RSN	LANL
1.2.6.5.2 C C.		NV	RSN	
1.2.6.5.3 DEF		NV	RSN	
1.2.6.5.3 BI		NV	RSN	
1.2.6.5.3 FR 1.		OK	RSN	LANL
1.2.6.5.3 PC 1a.		OK	RSN	LANL
1.2.6.5.3 PC 1b.		OK	RSN	LANL
1.2.6.5.3 PC 1c.		OK	RSN	
1.2.6.5.3 PC 1d.		OK	RSN	
1.2.6.5.3 PC 1e.		OK	RSN	
1.2.6.5.4 DEF		NV	RSN	
1.2.6.5.4 BI		NV	RSN	
1.2.6.5.4 FR 1.		OK	RSN	
1.2.6.5.4 PC 1a.		OK	RSN	
1.2.6.5.4 PC 1b.		OK	RSN	
1.2.6.5.4 PC 1c.		OK	RSN	LANL
1.2.6.5.4 PC 1c.i		OK	RSN	LANL
1.2.6.5.4 PC 1c.ii		OK	RSN	LANL
1.2.6.5.4 PC 1c.iii		OK	RSN	LANL
1.2.6.5.4 PC 1c.iv		OK	RSN	LANL
1.2.6.5.4 PC 1c.v		OK	RSN	LANL
1.2.6.5.4 PC 1c.vi		OK	RSN	LANL
1.2.6.5.4 PC 1c.vii		OK	RSN	
1.2.6.5.4 PC 1c.viii		OK	RSN	
1.2.6.5.4 C A.		OK	RSN	
1.2.6.5.4 C B.		OK	RSN	
1.2.6.5.4 C C.		OK	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.5.5 This number not used				
1.2.6.5.6 DEF		NV	RSN	
1.2.6.5.6 BI		NV	RSN	
1.2.6.5.6 FR 1.		OK	RSN	LANL
1.2.6.5.6 PC 1a.		OK	RSN	
1.2.6.5.6 PC 1b.		OK	RSN	
1.2.6.6 UNDERGROUND EXCAVATIONS				
1.2.6.6 DEF		NV TBV	RSN	
1.2.6.6 BI		NV	RSN	
1.2.6.6 ARCS		NV	RSN	
1.2.6.6 FR 1.		OK	RSN	LANL
1.2.6.6 FR 2.		OK	RSN	
1.2.6.6 PC 1a.		OK	RSN	LANL
1.2.6.6 PC 1a.i		NV	RSN	LANL
1.2.6.6 PC 1a.ii		NV	RSN	LANL
1.2.6.6 PC 1a.iii		NV	RSN	LANL
1.2.6.6 PC 1a.iv		NV TBD	RSN	
1.2.6.6 PC 1b.		OK	RSN	LANL
1.2.6.6 PC 1b.i		NV	RSN	
1.2.6.6 PC 1b.ii		NV	RSN	LANL
1.2.6.6 PC 1c.		OK	RSN	
1.2.6.6 PC 1c.i		NV	RSN	LANL
1.2.6.6 PC 1c.ii	C3-3	NV	RSN	LANL
1.2.6.6 PC 1c.iii		NV	RSN	LANL
1.2.6.6 PC 1c.iv		NV	RSN	LANL
1.2.6.6 PC 1c.v		NV	RSN	LANL
1.2.6.6 PC 1c.vi		NV	RSN	LANL
1.2.6.6 PC 1c.vii		NV TBD	RSN	LANL
1.2.6.6 PC 1c.viii		NV TBD	RSN	
1.2.6.6 PC 1c.ix		NV TBD	RSN	
1.2.6.6 PC 1c.x		NV	RSN	
1.2.6.6 PC 1d.		OK	RSN	
1.2.6.6 PC 1d.i		NV	RSN	LANL
1.2.6.6 PC 1d.ii		NV TBD	SNL	LANL
1.2.6.6 PC 1d.iii		NV TBD	SNL	LANL
1.2.6.6 PC 1d.iv		NV TBD	RSN	LANL
1.2.6.6 PC 1d.v		NV	RSN	
1.2.6.6 PC 1d.vi	C2-2	NV TBD	SNL	LANL
1.2.6.6 PC 1d.vii	C2-7	NV	RSN	LANL
1.2.6.6 PC 1d.viii	C2-2	NV	RSN	LANL

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.6 PC 1d.ix		NV	LANL	
1.2.6.6 PC 1d.x	C2-3	NV TBD	RSN	LANL/SNL
1.2.6.6 PC 1d.xi		NV	RSN	
1.2.6.6 PC 1d.xii		NV	SNL	LANL/REECO
1.2.6.6 PC 1d.xiii		NV TBD	SNL	
1.2.6.6 PC 1d.xiv	C2-5	NV	RSN	LANL
1.2.6.6 PC 1d.xv		NV	RSN	LANL
1.2.6.6 PC 1d.xvi		NV	RSN	LANL
1.2.6.6 PC 1d.xvii		NV TBD	SNL	LANL
1.2.6.6 PC 1e.		OK	RSN	
1.2.6.6 PC 1e.i		NV TBD	SNL	
1.2.6.6 PC 1f.		OK	RSN	
1.2.6.6 PC 1f.i		NV	RSN	LANL
1.2.6.6 PC 1f.ii		NV	RSN	
1.2.6.6 PC 1f.iii		NV	RSN	LANL
1.2.6.6 PC 1g.		OK	RSN	
1.2.6.6 PC 1h.		NV	RSN	
1.2.6.6 PC 1h.i		NV	RSN	
1.2.6.6 PC 1h.ii		NV	RSN	
1.2.6.6 PC 1h.iii		NV	RSN	LANL
1.2.6.6 PC 1h.iv		NV	RSN	
1.2.6.6 PC 1i.		OK	RSN	
1.2.6.6 PC 1i.i		NV	RSN	LANL
1.2.6.6 PC 1i.ii		NV	RSN	
1.2.6.6 PC 1i.iii		NV	RSN	
1.2.6.6 PC 2a.		OK	RSN	LANL
1.2.6.6 PC 2a.i		NV TBD	SNL	LANL
1.2.6.6 PC 2a.ii		NV TBD	RSN	
1.2.6.6 PC 2a.ii.a		NV	RSN	
1.2.6.6 PC 2a.ii.b		NV	RSN	
1.2.6.6 PC 2a.ii.c	C1-6	NV	RSN	
1.2.6.6 PC 2a.ii.d		NV	RSN	
1.2.6.6 PC 2a.ii.e		NV	RSN	
1.2.6.6 PC 2a.ii.f		NV	RSN	
1.2.6.6 PC 2a.iii	C1-6	NV TBD	RSN	LANL
1.2.6.6 PC 2a.iv		NV TBD	RSN	
1.2.6.6 PC 2b.		OK	RSN	LANL
1.2.6.6 PC 2b.i	C1-14	NV	RSN	LANL
1.2.6.6 PC 2b.ii	C1-15	NV TBV	SNL	LANL
1.2.6.6 PC 2b.iii		NV	RSN	LANL
1.2.6.6 PC 2b.iii.a		NV	RSN	LANL
1.2.6.6 PC 2b.iii.b		NV	RSN	
1.2.6.6 PC 2b.iii.c	C1-13	NV	RSN	LANL
1.2.6.6 PC 2c.		OK	RSN	LANL
1.2.6.6 PC 2c.i		NV	RSN	

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1.2.6.6 PC 2c.ii		NV TBV	RSN	LANL
1.2.6.6 PC 2c.iii		NV TBD	RSN	
1.2.6.6 PC 2c.iv		NV TBD	RSN	
1.2.6.6 PC 2c.v		NV TBD	RSN	
1.2.6.6 PC 2c.vi		NV	RSN	LANL
1.2.6.6 PC 2c.vii		NV TBD	RSN	
1.2.6.6 PC 2c.viii		NV	RSN	LANL
1.2.6.6 PC 2c.ix		NV TBV	RSN	
1.2.6.6 PC 2c.x		NV TBD	RSN	
1.2.6.6 PC 2d.		OK	RSN	LANL
1.2.6.6 PC 2e.		OK	RSN	LANL
1.2.6.6 PC 2e.i		NV	SNL	LANL
1.2.6.6 PC 2e.ii	C1-16,C2-5,-9	NV TBV	SNL	LANL
1.2.6.6 PC 2e.iii		NV	RSN	
1.2.6.6 PC 2e.iv		NV TBD	SNL	
1.2.6.6 PC 2e.v		NV	RSN	
1.2.6.6 PC 2f.		OK	RSN	
1.2.6.6 PC 2f.i		NV	RSN	
1.2.6.6 PC 2f.ii	C1-9	NV TBD	SNL	
1.2.6.6 PC 2f.iii		NV	RSN	
1.2.6.6 PC 2f.iv		NV	RSN	
1.2.6.6 PC 2g.		OK	RSN	LANL
1.2.6.6 PC 2g.i		NV TBD	SNL	LANL
1.2.6.6 PC 2g.ii	C1-12	NV	RSN	
1.2.6.6 PC 2g.iii		NV	RSN	LANL
1.2.6.6 PC 2h.		OK	RSN	LANL
1.2.6.6 PC 2h.i		NV	RSN	
1.2.6.6 PC 2h.ii		NV	RSN	
1.2.6.6 PC 2h.iii		NV TBD	RSN	LANL
1.2.6.6 PC 2h.iv		NV	RSN	LANL
1.2.6.6 PC 2h.v		NV TBD	SNL	
1.2.6.6 PC 2h.vi		NV TBD	RSN	LANL
1.2.6.6 PC 2h.vii	C1-2	NV TBD	RSN	
1.2.6.6 PC 2i.		OK	RSN	LANL
1.2.6.6 PC 2i.i		NV	RSN	
1.2.6.6 PC 2i.ii		NV	RSN	
1.2.6.6 PC 2i.iii		NV	RSN	
1.2.6.6 PC 2i.iv		NV	RSN	LANL
1.2.6.6 PC 2i.v		NV	RSN	LANL
1.2.6.6 PC 2j.		OK	RSN	LANL
1.2.6.6 PC 2j.i		NV	RSN	LANL
1.2.6.6 PC 2j.ii		NV	RSN	
1.2.6.6 PC 2j.iii		NV	RSN	
1.2.6.6 PC 2j.iii.a		NV TBD	RSN	
1.2.6.6 PC 2j.iii.b		NV TBD	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.6 PC 2j.iii.c		NV TBD	RSN	
1.2.6.6 PC 2j.iii.d		NV TBD	RSN	
1.2.6.6 PC 2j.iv		NV	RSN	
1.2.6.6 PC 2j.iv[2]		NV	RSN	
1.2.6.6 PC 2j.v		NV	RSN	
1.2.6.6 PC 2j.v.a		NV	RSN	
1.2.6.6 PC 2j.v.b		NV	RSN	
1.2.6.6 PC 2j.v.c		NV	RSN	
1.2.6.6 PC 2j.v.d		NV	RSN	
1.2.6.6 PC 2j.vi		NV	RSM	
1.2.6.6 PC 2j.vi[2]		NV	RSN	
1.2.6.6 PC 2j.vi.a		NV TBV	SNL	SNL/LANL
1.2.6.6 PC 2j.vi.b		NV	RSN	
1.2.6.6 PC 2j.vii		NV	RSN	
1.2.6.6 PC 2j.viii		NV	RSN	
1.2.6.6 PC 2j.ix		NV TBD	RSN	LANL
1.2.6.6 PC 2j.x	C2-1	NV TBD	RSN	LANL
1.2.6.6 PC 2k.		OK	RSN	
1.2.6.6 PC 2k.i	C1-19	NV	RSN	
1.2.6.6 PC 2k.ii		NV	RSN	
1.2.6.6 PC 2k.iii		NV TBD	RSN	LANL
1.2.6.6 PC 2k.iv		NV	RSN	
1.2.6.6 PC 2k.v		NV	RSN	LANL
1.2.6.6 PC 2l.		OK	RSN	
1.2.6.6 PC 2l. [2]		OK	RSN	
1.2.6.6 PC 2l.i		NV	RSN	
1.2.6.6 PC 2l.ii		NV	RSN	
1.2.6.6 PC 2l.iii		NV TBD	RSN	
1.2.6.6 PC 2l.iv		NV	RSN	
1.2.6.6 PC 2l.v		NV	RSN	
1.2.6.6 PC 2l.vi		NV	RSN	
1.2.6.6 PC 2l.vi.a		NV	RSN	
1.2.6.6 PC 2l.vi.b		NV TBD	RSN	
1.2.6.6 PC 2l.vi.c		NV TBD	RSN	
1.2.6.6 PC 2l.vi.d		NV TBD	RSN	
1.2.6.6 ICR		NV	RSN	
1.2.6.6 ICR (end)		NV	RSN	
1.2.6.6 C A.		OK	RSN	LANL
1.2.6.6 C A. [2]		OK	RSN	
1.2.6.6 C A.i		NV TBD	SNL	LANL
1.2.6.6 C A.ii		NV	RSN	
1.2.6.6 C B.		OK	RSN	LANL
1.2.6.6 C B.i		NV	RSN	LANL
1.2.6.6 C B.ii		NV TBD	RSN	LANL

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.6 C B.iii		NV	RSN	LANL
1.2.6.6 A 1.		NV	RSN	
1.2.6.6.1 DEF		NV	RSN	
1.2.6.6.1 BI		NV	RSN	
1.2.6.6.1 FR 1.		OK	RSN	LANL
1.2.6.6.1 PC 1a.		OK	RSN	LANL
1.2.6.6.1 PC 1b.		OK	RSN	
1.2.6.6.1 PC 1c.		OK	RSN	LANL
1.2.6.6.1 C A.		OK	RSN	LANL
1.2.6.6.1 C B.		OK	RSN	
1.2.6.6.2 DEF		NV	RSN	
1.2.6.6.2 BI		NV	RSN	
1.2.6.6.2 FR 1.		OK	RSN	LANL
1.2.6.6.2 PC 1.		OK	RSN	LANL
1.2.6.6.2 C A.		OK	RSN	LANL
1.2.6.6.2 C B.		OK	RSN	LANL
1.2.6.7 UNDERGROUND SUPPORT SYSTEMS				
1.2.6.7 DEF		NV	RSN	
1.2.6.7 BI		NV	RSN	
1.2.6.7 ARCS G 1.		NV	RSN	
1.2.6.7 ARCS G 2.		NV	RSN	
1.2.6.7 ARCS E 1.		NV	RSN	
1.2.6.7 ARCS E 2.		NV	RSN	
1.2.6.7 ARCS E 3.		NV	RSN	
1.2.6.7 ARCS L 1.		NV	RSN	
1.2.6.7 ARCS UP 1.		NV	RSN	
1.2.6.7 ARCS UP 2.		NV	RSN	
1.2.6.7 ARCS UP 3.		NV	RSN	
1.2.6.7 ARCS WS 1.		NV	RSN	
1.2.6.7 ARCS WS 2.		NV	RSN	
1.2.6.7 ARCS WS 3.		NV	RSN	
1.2.6.7 ARCS UWCS 1.		NV	RSN	
1.2.6.7 ARCS UWCS 2.		NV	RSN	
1.2.6.7 ARCS VSDC 1.		NV	RSN	
1.2.6.7 ARCS VSDC 2.		NV	RSN	
1.2.6.7 ARCS VSDC (end)		NV	RSN	
1.2.6.7 FR 1.		OK	RSN	LANL
1.2.6.7 FR 2.		OK	RSN	
1.2.6.7 FR 3.		OK	RSN	
1.2.6.7 PC 1a.		OK	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.7 PC 1b.		OK	RSN	LANL
1.2.6.7 PC 1c.		OK	RSN	
1.2.6.7 PC 1d.		OK	RSN	LANL
1.2.6.7 PC 1e.		OK	RSN	LANL
1.2.6.7 PC 1f.		OK	RSN	
1.2.6.7 PC 2a.		OK	RSN	LANL
1.2.6.7 PC 2b.		OK	RSN	
1.2.6.7 PC 3a.		OK	RSN	LANL
1.2.6.7 PC 3b.		OK	RSN	
1.2.6.7 ICR 1.		NV	RSN	
1.2.6.7 ICR (end)		NV	RSN	
1.2.6.7 C A.		OK	RSN	
1.2.6.7 C B.		OK	RSN	
1.2.6.7 C B.i		NV	RSN	
1.2.6.7 C C.		OK	RSN	LANL
1.2.6.7 C C.i		NV	RSN	LANL
1.2.6.7 C D.		OK	RSN	
1.2.6.7 C D.i		NV	RSN	
1.2.6.7 C D.ii		NV	RSN	
1.2.6.7 C E.		OK	RSN	LANL
1.2.6.7 C E.i		NV TBD	RSN	LANL
1.2.6.7 C E.ii		NV	RSN	LANL
1.2.6.7 C E.iii	C3-3	NV TBD	RSN	LANL
1.2.6.7 C F.		OK	RSN	
1.2.6.7 C F.i		NV	RSN	
1.2.6.7 C F.ii		NV	RSN	
1.2.6.7 C F.iii		NV	RSN	LANL
1.2.6.7 C G.		OK	RSN	
1.2.6.7 C G.i		NV	RSN	LANL
1.2.6.7 C H.		OK	RSN	LANL
1.2.6.7 C I.		OK	RSN	
1.2.6.7 C J.		OK	RSN	
1.2.6.7 C K.		OK	RSN	
1.2.6.7.1 DEF		NV	RSN	
1.2.6.7.1 BI		NV	RSN	
1.2.6.7.1 FR 1.		OK	RSN	
1.2.6.7.1 PC 1a.		OK	RSN	
1.2.6.7.1 PC 1b.		OK	RSN	
1.2.6.7.1 PC 1c.		OK	RSN	
1.2.6.7.1 PC 1d.		OK	RSN	LANL
1.2.6.7.1 C A.		OK	RSN	
1.2.6.7.1 C B.		OK	RSN	
1.2.6.7.1 C C.		OK	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.7.1 C D.		OK	RSN	
1.2.6.7.1 C E.		OK	RSN	
1.2.6.7.1 C F.		OK	RSN	
1.2.6.7.2 This number not used				
1.2.6.7.3 DEF		NV	RSN	
1.2.6.7.3 BI		NV	RSN	
1.2.6.7.3 FR 1.		OK	RSN	LANL
1.2.6.7.3 PC 1a.		OK	RSN	LANL
1.2.6.7.3 PC 1b.		OK	RSN	LANL
1.2.6.7.3 PC 1c.		OK	RSN	
1.2.6.7.3 PC 1d.		OK	RSN	LANL
1.2.6.7.3 C A.		OK	RSN	LANL
1.2.6.7.3 C B.		OK	RSN	
1.2.6.7.3 C C.		OK	RSN	
1.2.6.7.4 DEF		NV	RSN	
1.2.6.7.4 BI		NV	RSN	
1.2.6.7.4 FR 1.		OK	RSN	
1.2.6.7.4 PC 1a.		OK	RSN	
1.2.6.7.4 PC 1b.		OK	RSN	
1.2.6.7.4 PC 1c.		OK	RSN	
1.2.6.7.4 PC 1d.		OK	RSN	LANL
1.2.6.7.4 PC 1e.		OK	RSN	
1.2.6.7.4 PC 1f.		OK	RSN	
1.2.6.7.4 PC 1g.		OK	RSN	
1.2.6.7.4 C A.		OK	RSN	
1.2.6.7.4 C B.		OK	RSN	
1.2.6.7.4 C C.		OK	RSN	
1.2.6.7.4 C D.		OK	RSN	
1.2.6.7.4 C E.		OK	RSN	
1.2.6.7.4 C F.		OK	RSN	
1.2.6.7.4 C G.		OK	RSN	
1.2.6.7.4 C H.		OK	RSN	
1.2.6.7.4 C I.		OK	RSN	
1.2.6.7.4 A 1.		NV	RSN	
1.2.6.7.5 DEF		NV	RSN	
1.2.6.7.5 BI		NV	RSN	
1.2.6.7.5 FR 1.		OK	RSN	
1.2.6.7.5 PC 1.		OK	RSN	LANL
1.2.6.7.5 C A.		OK	LANL	
1.2.6.7.5 A 1.		NV	RSN	

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1.2.6.7.6 DEF		NV	RSN	
1.2.6.7.6 BI		NV	RSN	
1.2.6.7.6 FR 1.		OK	RSN	
1.2.6.7.6 PC 1a.		OK	RSN	
1.2.6.7.6 PC 1b.		OK	RSN	LANL
1.2.6.7.6 PC 1b.i		NV	RSN	
1.2.6.7.6 PC 1b.ii		NV	RSN	
1.2.6.7.6 PC 1b.iii		NV	RSN	
1.2.6.7.6 PC 1b.iv		NV	RSN	LANL
1.2.6.7.6 PC 1b.v		NV	RSN	
1.2.6.7.6 PC 1c.		OK	RSN	LANL
1.2.6.7.6 PC 1c.i		NV	RSN	
1.2.6.7.6 PC 1d.		OK	RSN	
1.2.6.7.6 PC 1e.		OK	RSN	
1.2.6.7.6 PC 1f.		OK	RSN	
1.2.6.7.6 C A.		OK	RSN	
1.2.6.7.7 DEF		NV	RSN	
1.2.6.7.7 BI		NV	RSN	
1.2.6.7.7 FR 1.		OK	RSN	LANL
1.2.6.7.7 PC 1.		OK	RSN	LANL
1.2.6.7.8 DEF		NV	RSN	
1.2.6.7.8 BI		NV	RSN	
1.2.6.7.8 FR 1.		OK	RSN	
1.2.6.7.8 PC 1a.		OK	RSN	
1.2.6.7.8 PC 1b.		OK	RSN	
1.2.6.7.8 PC 1c.		OK	REECO	
1.2.6.7.8 C A.		OK	RSN	LANL
1.2.6.7.8 C B.		OK	RSN	
1.2.6.7.8 C C.		OK	RSN	LANL
1.2.6.7.9 DEF		NV	RSN	
1.2.6.7.9 BI		NV	RSN	
1.2.6.7.9 FR 1.		OK	RSN	
1.2.6.7.9 PC 1a.		OK	RSN	LANL
1.2.6.7.9 PC 1b.		OK	RSN	
1.2.6.7.9 PC 1c.		OK	RSN	
1.2.6.7.9 C A.		OK	RSN	
1.2.6.7.9 C B.		OK	RSN	
1.2.6.7.9 C C.		OK	RSN	
1.2.6.7.9 C D.		OK	RSN	
1.2.6.7.9 C E.		OK	RSN	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.7.10 DEF		NV	REECO	
1.2.6.7.10 BI		NV	REECO	
1.2.6.7.10 FR 1.		OK	REECO	
1.2.6.7.10 PC 1a.		OK	REECO	
1.2.6.7.10 PC 1b.		OK	REECO	
1.2.6.7.10 PC 1c.		OK	REECO	
1.2.6.7.11 DEF		NV	RSN	
1.2.6.7.11 BI		NV	RSN	
1.2.6.7.11 FR 1.		OK	RSN	
1.2.6.7.11 PC 1a.		OK	RSN	LANL
1.2.6.7.11 PC 1b.		OK	RSN	LANL
1.2.6.7.11 PC 1c.		OK	RSN	LANL
1.2.6.7.11 PC 1d.		OK	RSN	
1.2.6.7.11 PC 1e.		OK	RSN	LANL
1.2.6.7.11 PC 1e.i		NV	RSN	LANL
1.2.6.7.11 PC 1f.		OK	RSN	
1.2.6.7.11 C A.		OK	RSN	LANL
1.2.6.7.11 C B.		OK	RSN	
1.2.6.8 UNDERGROUND TEST SUPPORT				
1.2.6.8 DEF		NV	RSN	
1.2.6.8 BI		NV	RSN	
1.2.6.8 ARCS		NV	RSN	
1.2.6.8 FR 1.		OK	RSN	LANL
1.2.6.8 PC 1a.		OK	RSN	LANL
1.2.6.8 PC 1b.		OK	RSN	LANL
1.2.6.8 PC 1c.		OK	LANL	LANL
1.2.6.8 PC 1d.		OK	RSN	LANL
1.2.6.8 PC 1e.		OK	RSN	LANL
1.2.6.8 PC 1f.		OK	RSN	
1.2.6.8 ICR 1.		NV	RSN	LANL
1.2.6.8 C A.		OK	LANL	SNL
1.2.6.8 C B.		OK	LANL	LANL
1.2.6.8 C B.i		NV TBD	RSN	
1.2.6.8 C C.		OK	RSN	LANL
1.2.6.8 C C.i		NV TBD	LANL	LANL
1.2.6.8 C D.		OK	RSN	LANL
1.2.6.8 C D.i	C1-11	NV	RSN	LANL
1.2.6.8 C D.ii		NV TBD	RSN	LANL
1.2.6.8 C D.iii	C1-14	NV TBD	LANL	SNL
1.2.6.8 C E.		OK	RSN	LANL
1.2.6.8 C E.i	C1-6,C2-2	NV	LANL	

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.8 C E.ii	C1-5	NV TBD	SNL	LANL
1.2.6.8 C E.iii		NV TBD	SNL	LANL
1.2.6.8 C E.iv		NV	RSN	LANL
1.2.6.8 C E.v		NV	RSN	LANL
1.2.6.8 C E.vi		NV	RSN	LANL
1.2.6.8 C E.vii		NV	RSN	LANL
1.2.6.8 C E.viii	C1-5, C2-8	NV TBD	RSN	LANL
1.2.6.8 C E.ix		NV	RSN	LANL/SNL
1.2.6.8 A 1.		NV	LANL	RSN
1.2.6.8.1 DEF		NV	RSN	LANL
1.2.6.8.1 BI		NV	RSN	LANL
1.2.6.8.1 FR 1.		OK	RSN	LANL
1.2.6.8.1 PC 1.		NV	RSN	LANL
1.2.6.8.1 ICR 1.		NV	RSN	LANL
1.2.6.8.1 ICR 1. (end)		NV	RSN	LANL
1.2.6.8.1 ICR 2.		NV	LANL	LANL
1.2.6.8.1 ICR 2.i		NV	LANL	LANL
1.2.6.8.1 ICR 2.ii		NV	LANL	LANL
1.2.6.8.2 DEF		NV	RSN	LANL
1.2.6.8.2 DEF [2]		NV	RSN	LANL
1.2.6.8.2 DEF [3]		NV	RSN	LANL
1.2.6.8.2 DEF [4]		NV	RSN	LANL
1.2.6.8.2 BI		NV	RSN	LANL
1.2.6.8.2 FR 1.		OK	RSN	LANL
1.2.6.8.2 PC 1.		OK	RSN	LANL
1.2.6.8.2 C A.		OK	RSN	
1.2.6.9 ESF DECOMMISSIONING AND CLOSURE				
1.2.6.9 DEF		NV	RSN	
1.2.6.9 BI		NV	RSN	
1.2.6.9 ARCS		NV	RSN	
1.2.6.9 FR 1.		NV	RSN	LANL
1.2.6.9 PC 1a.		OK	RSN	
1.2.6.9 PC 1b.		OK	RSN	LANL
1.2.6.9 PC 1c.		NV	RSN	
1.2.6.9 A 1.		NV	RSN	LANL
1.2.6.9 A 2.		NV	RSN	LANL

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(1) ESFDR Section	(2) DAA Recommendations	(3) Category	(4) Resp Org	(5) Sup Org
1.2.6.9.1 DEF		NV	RSN	
1.2.6.9.1 BI		NV	RSN	
1.2.6.9.1 FR 1.		OK	RSN	
1.2.6.9.1 PC 1a.		OK	RSN	
1.2.6.9.1 PC 1b.		OK	RSN	
1.2.6.9.1 C A.		NV	RSN	
1.2.6.9.1 C A.i		NV	RSN	
1.2.6.9.1 C A.ii		NV	RSN	
1.2.6.9.1 C A.iii		NV	RSN	
1.2.6.9.1 C B.		OK TBD	RSN	
1.2.6.9.2 DEF		NV	RSN	
1.2.6.9.2 BI		NV	RSN	
1.2.6.9.2 FR 1.		OK	RSN	LANL
1.2.6.9.2 PC 1.		OK	RSN	LANL
1.2.6.9.2 C A.		NV	RSN	LANL
1.2.6.9.2 C A.i		NV	RSN	
1.2.6.9.2 C A.ii		NV	RSN	
1.2.6.9.2 C A.iii		NV	RSN	
1.2.6.9.2 C A.iv		NV	RSN	

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APPENDIX I

PERFORMANCE ASSESSMENT ANALYSES

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APPENDIX I: PERFORMANCE ASSESSMENT ANALYSES

I.1 Introduction

This appendix presents the relationship between the NRC regulations governing the design, construction, and operation of the Exploratory Shaft Facility (ESF) and the ESF design requirements (ESF DR) for which analysis support is necessary. Summaries of the analyses defined to address a subset of these requirements and their application to the ESF DR are also included.

The relationships among ESF DR requirements, the NRC 10 CFR 60 requirements, and support analyses are discussed in Section I.1. Summaries of support analyses defined to date and recommendations derived from the results of the analyses are presented in Section I.2. The ESF DR sections requiring support analyses and the corresponding 10 CFR 60 requirements are included in Section I.3.

Table I.1 contains a list of the analyses defined to date. These analyses were defined to quantify criteria in Chapters 0 through 5 of the ESF SDRD benchmark 5 and were grouped by disciplines: hydraulics, rock mechanics, thermal, chemical, and safety. Since their definition, the SDRD has evolved into the ESF DR of which these analyses are applicable but not exhaustive. Analyses 1--9 have been completed while analyses 10 and 11 are integral parts of the design and construction process and are ongoing. These analyses are based on available data and on the present conceptual understanding of the processes and mechanisms perceived active at Yucca Mountain and may be refined as better understanding evolves through site characterization and through additional analyses, which will address uncertainties and the sensitivity of the results to alternate conceptual models. Recommendations based on the results of these analyses are intended to provide guidance for applying engineering judgment during the design, construction, and operation of the ESF. Additional analyses will be defined as appropriate, through interactions among analysts, architectural engineers, and investigators responsible for site characterization activities.

Table I.2 presents the ESF DR sections requiring analyses support; their relationship with the 10 CFR 60 regulations for the design, construction, and operation of the ESF; and the current status of support analyses. Table I.2 is the reference baseline for analysis support for the ESF DR. Support analyses are identified by analysis number (from Table I.1) in the final column of Table I.2. This and other descriptive notes are included at the end of Table I-2.

I.2 Analyses Summary

The analyses summarized in this appendix are based on widely used conceptual and mathematical models that incorporate our present understanding of processes and mechanisms ongoing at Yucca Mountain. It should be emphasized that the results of these analyses may not agree with results of similar analyses based on alternate conceptual models. As our knowledge of the site increases these uncertainties may be reduced or removed by future analyses.

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TABLE I.1 Analyses Supporting ESF Design

Analysis Number	Title
1	Surface Construction Water Movement
2	Shaft Construction Water Movement
3	Sewage and Settling Pond Water Movement
4	Water Entry into Shafts Through Rock Mass Surrounding Shaft Collar & Liner
5	Shaft and Main Pad Blasting Effects
6	Shaft and Collar Creep
7	Shaft and Collar Thermal Stress
8	Far Field Thermal Effects
9	Systems and Components Important to Safety
10	Hydrologic and Geochemical Effects of Tracers
11	Hydrologic and Geochemical Effects of Chemicals

Table I.2 Analysis Support for the ESF

10 CFR Requirement	ESF DR Requirement	ESF DR Description	Subsystem	Status ESF DR	Status SA
60.15(b)					
60.15(c)(1)	1.2.6.1 C A.	Limit potential for adverse impacts on repository performance	Main site	TBD	*
60.15(c)(1)	1.2.6.4 PC 2a.i	Limit potential for adverse impacts on repository performance	Shaft	TBD	*
60.15(c)(1)	1.2.6.5 PC 2a.i	Limit potential for adverse impacts on repository performance	Ramp	TBD	*
60.15(c)(1)	1.2.6.6 PC 2a.i	Limit potential for adverse impacts on repository performance	MTL	TBD	*
60.15(c)(1)	1.2.6.7 C B.i	Limit potential for adverse impacts on repository performance	UU		*
60.15(c)(1)	1.2.6.4 PC 2a.ii	All materials or substances shall be reviewed before used	Shaft	TBD	11
60.15(c)(1)	1.2.6.5 PC 2a.ii	All materials or substances shall be reviewed before used	Ramp	TBD	11
60.15(c)(1)	1.2.6.6 PC 2a.ii	All materials or substances shall be reviewed before used	UE	TBD	11
60.15(c)(1)	1.2.6.4 PC 2a.iv	Materials control program	Shaft	TBD	11
60.15(c)(1)	1.2.6.5 PC 2a.iv	Materials control program	Ramp	TBD	11
60.15(c)(1)	1.2.6.6 PC 2a.iii	Materials control program	UE	TBD	11
60.15(c)(1)	1.2.6.4 PC 1d.ix	Evaluate chemical content of blasting agents & explosives	Shaft	TBD	*
60.15(c)(1)	1.2.6.5 PC 1d.ix	Evaluate chemical content of blasting agents & explosives	Ramp	TBD	*
60.15(c)(1)	1.2.6.6 PC 1d.xiii	Evaluate chemical content of blasting agents & explosives	UE	TBD	*
60.15(c)(1)	1.2.6.4 PC 2g.i	Limit water use in underground construction to 15 gal/ton of rock execav.	Shaft		*
60.15(c)(1)	1.2.6.5 PC 2g.ii	Limit water use in underground construction to 15 gal/ton of rock execav.	Ramp		*
60.15(c)(1)	1.2.6.6 PC 2h.iv	Limit water use in underground construction to 15 gal/ton of rock execav.	UE		*
60.15(c)(2)					
60.15(c)(3)	1.2.6.8 C D.iii	Boreholes shall not penetrate TSW2 base without evaluation	UT	TBD	*
60.15(c)(4)	1.2.6.0 C C.iii	Control all substances & tracers			10,11
60.15(c)(4)	1.2.6.0 C C.iv	Hydrocarbons & solvents comply with performance criteria requirements		TBD	11
60.16					

Table I.2 Analysis Support for the ESF (cont.)

10 CFR Requirement	ESF DR Requirement	ESF DR Description	Subsystem	Status ESF DR	Status SA
60.21(c)(1)(ii)(D)					
60.21(c)(11)					
60.111					
60.112					
60.113(a)(1)(i)					
60.130					
60.131(b)(2)					
60.131(b)(4)(i)					
60.133(a)(1)	1.2.6.4 PC 1d.xii	Accesses shall be located so as to not interfere with each other	Shaft	*	2
60.133(a)(1)	1.2.6.5 PC 1d.xii	Accesses shall be located so as to not interfere with each other	Ramp	*	2
60.133(a)(1)	1.2.6.6 PC 2e.ii	Spacing between drifts >= two drift diameters	UE	TBV	f
60.133(a)(2)	1.2.6.4 PC 2e.ii	Design collar to prevent significant water inflow during floods	Shaft	*	4
60.133(a)(2)	1.2.6.5 PC 2e.ii	Design portal to prevent significant water inflow during floods	Ramp	TBD	f
60.133(b)					
60.133(d)	1.2.6.1 C F.i	Water limited consistent with performance objectives	Surface		1
60.133(d)	1.2.6.4 PC 1d.vi	Fluids & materials shall be evaluated before used	Shaft		11
60.133(d)	1.2.6.5 PC 1d.vi	Fluids & materials shall be evaluated before used	Ramp		11
60.133(d)	1.2.6.6 PC 1d.ix	Fluids & materials shall be evaluated before used	UF		11
60.133(d)	1.2.6.4 PC 2g.ii	Water use in const./oper. to limit increase in avg. saturation to ___	Shaft	TBD	2f
60.133(d)	1.2.6.5 PC 2g.iii	Water use in const./oper. to limit increase in avg. saturation to ___	Ramp	TBD	2f
60.133(d)	1.2.6.6 PC 2h.v	Water use in const./oper. to limit increase in avg. saturation to ___	UF	TBD	2f
60.133(d)	1.2.6.8 C E.iii	Water use in testing. to limit increase in avg. saturation to ___	UT	TBD	2f
60.133(d)	1.2.6.7.6 PC 1e	Proper disposal of fluids recovered during construction	Shaft		3,11
60.133(d)	1.2.6.8 C E.v	Proper disposal of fluids recovered during construction	UT		3,11
60.133(d)	1.2.6.7.6 PC 1b.i	Groundwater collection system, etc. to include water inflow from rock	Shaft		4f

Table I.2 Analysis Support for the ESF (cont.)

10 CFR Requirement	ESF DR Requirement	ESF DR Description	Subsystem	Status	
				ESF DR	SA
60.133(d)	1.2.6.4 PC 1d.iii	Water use in const./oper. shall not cause interference of tests	Shaft	*	2
60.133(d)	1.2.6.5 PC 1d.iii	Water use in const./oper. shall not cause interference of tests	Ramp	*	2
60.133(d)	1.2.6.6 PC 1d.vi	Water use in const./oper. shall not cause interference of tests	UF	TBD	f
60.133(d)	1.2.6.8 C E.ii	Limit water use to limit effects on waste containment & isolation	UT	TBD	*
60.133(d)	1.2.6.4 PC 1d.vii	Tag fluids, gases, and other materials	Shaft	TBD	10
60.133(d)	1.2.6.5 PC 1d.vii	Tag fluids, gases, and other materials	Ramp	TBD	10
60.133(d)	1.2.6.6 PC 1d.x	Tag fluids, gases, and other materials	UE	TBD	10
60.133(e)(2)	1.2.6.4 PC 2h.ii	Locate accesses to limit potential mech. & hydrological interference	Shaft	TBD	2f
60.133(e)(2)	1.2.6.5 PC 2h.ii	Locate accesses to limit potential mech. & hydrological interference	Ramp	TBD	2f
60.133(f)	1.2.6.1 C C.i	Shall not significantly increase pathways/reduce performance	Main site	TBD	5
60.133(f)	1.2.6.1 C C.ii	Control blasting to limit damage to prevent creating perf. pathways	Main site		4,5
60.133(f)	1.2.6.4 PC 2i.va	Blast induced change in permeability < .5 opening dimension < 1 O.M.	Shaft	TBD	5
60.133(f)	1.2.6.5 PC 2i.va	Blast induced change in permeability < .5 opening dimension < 1 O.M.	Ramp		f
60.133(f)	1.2.6.6 PC 2j.via	Blast induced change in permeability < .5 opening dimension < 1 O.M.	UE	TBV	5
60.133(f)	1.2.6.4 PC 2i.iiia	Areas w/o thermal load, daimetrical closure rate decreasing after const.	Shaft		f
60.133(f)	1.2.6.5 PC 2i.iiia	Areas w/o thermal load, daimetrical closure rate decreasing after const.	Ramp		
60.133(f)	1.2.6.6 PC 2j.iiia	Areas w/o thermal load, closure rate decreasing after const.	Drifts	TBD	f
60.133(f)	1.2.6.4 PC 2i.iiib	Areas with thermal load, closure rate <= 3 times thermoelastic	Shaft		f
60.133(f)	1.2.6.5 PC 2i.iiib	Areas with thermal load, closure rate <= 3 times thermoelastic	Ramp		
60.133(f)	1.2.6.6 PC 2j.iiib	Areas with thermal load, closure rate <= 3 times thermoelastic	Drifts	TBD	f
60.133(f)	1.2.6.4 PC 2i.vii	Use controlled blasting to limit excavation induced damage	Shaft	TBD	5
60.133(f)	1.2.6.5 PC 2i.vii	Use tunnel boring machine to limit excavation induced damage	Ramp	TBD	5
60.133(f)	1.2.6.6 PC 2j.xii	Controlled drilling and blasting methods shall provide for site char.	UE		f
60.133(h)					

Table I.2 Analysis Support for the ESF (conc.)

10 CFR Requirement	ESF DR Requirement	ESF DR Description	Subsystem	Status ESF DR	Status SA
60.133(i)	1.2.6.4 PC 2j.i	Consider thermomechanical response of host rock & ground water	Shaft		6f
60.133(i)	1.2.6.5 PC 2j.i	Consider thermomechanical response of host rock & ground water	Ramp		6f
60.133(i)	1.2.6.6 PC 2k.i	Consider thermomechanical response of host rock & ground water	UE		6f
60.133(i)	1.2.6.4 PC 2j.iii	The liner shall withstand pressures exerted along its length...	Shaft	TBD	7
60.133(i)	1.2.6.5 PC 2j.iii	The liner shall withstand pressures exerted along its length...	Ramp	TBD	f
60.133(i)	1.2.6.6 PC 2k.iii	The liner shall withstand pressures exerted along its length...	UE	TBD	f
60.133(i)	1.2.6.6 PC 2k.v	Thermal effects shall not increase temp. in TSw3 or CHn above 115 C	UT		8
60.134					
60.137					
60.140(c)					
60.140(d)(1)					
	1.2.6.2.3 C B.	Location of sewage ponds to be determined by PA	SS	*	3
	1.2.6.2.5 C A.	Dispose of liquid wastes in an environmentally safe way	MWS	TBD	11
	1.2.6.2.5 C B.	Location of wastewater ponds to be determined by PA	MWS	*	3

Column	Definition
Subsystem	
MTL	Main test level
MWS	Mine wastewater system
SS	Sewage system
TA	Test areas
UE	Underground excavation
UF	Underground facilities
USS	Underground support system
UT	Underground testing
UU	Underground utilities

Column	Definition
Status ESF DR	
TBD	To be determined
TBV	To be verified
*	Removal of TBD or TBV
Status SA	
Number	Analysis number from Table I.1 (indicates that results from that analysis apply)
*	Results from the 11 analysis apply; more analysis may be required
f	Future analyses are required

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Recommendations based on these analyses are provided only as guidance and will be evaluated and revised through continual interactions among the architectural engineers, analysts, and investigators responsible for site characterization. Thus, refinement of the results is an ongoing and iterative process, which must complement site characterization.

I.2.1 Analysis 1. Surface Construction Water Movement Above the Repository

Purpose

To provide numerical criteria for limiting the amount of water that can be placed on the surface above the repository and for determining the lateral extent of water as it flows within the mountain due to the application of water at the surface.

The calculations were performed in accordance with SNL internal documents Problem Definition Memos PDM 72-28 (one-dimensional) and PDM 72-29 (two-dimensional).

A series of one-dimensional calculations were made using TOSPAC to estimate changes in saturation at depth and to provide input to the two-dimensional calculations. The two-dimensional calculations were performed using NORIA-SP to substantiate the one-dimensional results and to determine the lateral movement of the water within the mountain due to application of water at the surface.

The physics associated with water transport at the surface are complicated and include unpredictable unknowns such as the weather and surface topology. Thus, the amount of water that will enter the mountain can only be inferred from measurements of rainfall, surface evaporation, run-off, the amount of water applied on the surface and through a surface water balance. Because only the water that enters the mountain can effect repository performance and underground tests, these calculations were posed in terms of the amount of water penetrating the surface rather than the amount of water applied to the surface. This minimizes complications and uncertainties associated with surface water balances and scenarios for water application in the calculations.

The result of this analysis shows that 16 cubic meters of water per square meter of surface area can enter the mountain without increasing the saturation at the repository horizon within 10,000 years. Additionally, the lateral extent of the water is confined to within four times the assumed pad surface area. Using the Title I design area for the ESF pad and roads this corresponds to 6.256 million cubic meters of water.

These values apply to ESF DR requirement 1.2.6.1 C F.i.

Recommendation: The results of Analysis 1 indicate that a goal for the amount of water used by operations on the shafts/ramps surface sites which limits the total water budget to 2 gallons/yard^2/day over a five-year period will not impact the performance of the repository in 10,000 years (1.2.6.1 C F.i). Following discussions with constructors, a similar value consistent with standard practices may be considered as a more practical limit.

The problem definition memos (which include citations for the data used, lists of assumptions, and results) from which these conclusions and recommendations were drawn can be found in SNL's YMP record center under file codes 72/12147/PDM 72-28/1.0/QA and 72/12147/PDM 72-29/1.0/QA.

I.2.2 Analysis 2. Analyses of Shaft Construction Water Movement

<u>Purpose</u>

To estimate the potential for water used in the construction of shafts and ramps to interfere with experiments conducted in the surrounding host rock.

The calculations were performed in accordance with the SNL internal document Problem Definition Memo PDM 72-30.

One-dimensional calculations using NORIA-SP were performed to determine construction water movement from shafts and drifts. The results and conclusions for drifts may also be applied to ramps. These calculations are extensions of the analyses performed by Eaton and Peterson [1988] but at higher construction water requirements and higher retention factors (i.e., for more water entering the surrounding host rock). The calculations were performed as summarized below:

- Shafts
  - Geometry
    - One-dimensional axisymmetric
    - Shaft radius: 2.21 m
    - Modified Permeability Zone (MPZ): one diameter
  - Parameters
    - Yucca Mountain Stratigraphic Units: Tiva Canyon, Paintbrush, Topopah Springs, Calico Hills
    - Construction water used: 2.856 cubic meters per meter of shaft
    - Retention factor
      - Without ventilation: 15 percent
      - With ventilation: 10, 15, 20 percent
- Drifts
  - Geometry
    - One-dimensional cartesian
    - Wall dimensions: height 1m, length 25 m
    - Modified Permeability Zone (MPZ): 2.76 m
  - Parameters
    - Yucca Mountain Stratigraphic Units: Topopah Springs, Calico Hills
    - Construction water used: 2.918 cubic meters per meter of drift
    - Retention factor
      - Without ventilation: 15 percent
      - With ventilation: 10, 15, 20 percent

The results of these calculations show that ventilation removes the retained construction water and dries out the surrounding rock.

The penetration of water into the rock at constant values of saturation change is illustrated as a function of time. These curves provide bounds for evaluating the interference of construction water with experiments conducted in the surrounding host rock and remove the TBD's associated with ESF DR requirements 1.2.6.4 PC 1d.xii, 1.2.6.5 PC 1.d.xii, 1.2.6.4 PC 1d.iii, and 1.2.6.5 PC 1d.iii. These curves also provide the hydrological information to remove TBD's in requirements 1.2.6.4 PC 2h.ii and 1.2.6.5 PC 2h.ii.

Recommendation: The results of Analysis 2 indicate that a goal for the amount of water used in the construction of the Title I shaft design shall be limited to 230 gallons/foot of advance (1.2.6.4 PC 1d.iii and 1.2.6.5 PC 1d.iii). Following discussions with constructors, a similar value consistent with standard practices may be considered as a more practical limit.

Recommendation: The results of Analysis 2 indicate that a goal for the distance between accesses (shafts and ramps) that limits potential hydrological interference between the accesses is 15 m (1.2.6.4 PC 1d.xii, 1.2.6.5 PC 1d.xii, 1.2.6.4 PC 1d.iii and 1.2.6.5 PC 1d.iii). Following discussions with constructors, a similar value consistent with standard practices may be considered as a more practical limit.

The problem definition memo (which includes citations for the data used, lists of assumptions, and results) from which these conclusions and recommendations were drawn can be found in SNL's YMP record center under file code 72/12147/PDM 72-30/1.0/QA.

I.2.3 Analysis 3. Analyses of Sewage and Settling Pond Water Movement

Purpose

To estimate the potential for water leakage from settling ponds in the muck storage area and discharged from the sewage pond system to interfere with experiments conducted in the ESF.

The calculations were performed in accordance with Problem Definition Memo PDM 72-31.

Calculations were performed to evaluate both sewage ponds and settling ponds using the conditions summarized below.

Sewage ponds

The potential effects of the sewage pond locations were investigated by performing calculations at two locations; one near the edge of the repository block and the other approximately two miles east of the repository boundary. These calculations predicted water movement from the sewage ponds at the two locations. These locations were selected to correspond to the Title I design for the locations for muck settling ponds and sewage ponds.

The Title I design was used for sewage pond size and the pond was assumed to be unlined and to contain a constant 1.83 meters of sewage for five years.

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Settling ponds

Water movement from settling ponds and the effects of leaks in pond liners were predicted by calculations for leakages which correspond to 100, 10, and 1 percent of the Title I design settling pond surface area. Leaks were assumed to be discrete with negligible impedance to flow and the depth of the pond was assumed to be a constant 3.05 m.

These calculations show that water leakage from settling pond in the muck storage area and in the location of the sewage ponds have no effect on the saturation at the repository horizon and will not interfere with experiments conducted in the ESF. These results remove the TBD's associated with ESF DR requirements 1.2.6.2.3 C B. and 1.2.6.2.5 C B. and apply to requirements 1.2.6.7.6 PC 1e and 1.2.6.8 C E.v. for fluids with transport properties similar to water.

Recommendation: The results of Analysis 3 indicate that the proposed location of the sewage pond beyond the perimeter of the repository subsurface facility referenced in Title I will not interfere with site characterization activities (1.2.6.2.3 C B.).

Recommendation: The results of Analysis 3 indicate that the proposed location of the wastewater system referenced in Title I will not interfere with site characterization activities (1.2.6.2.5 C B.).

Recommendation: The results of Analysis 3 indicate that fluids with transport properties similar to water recovered during construction and testing can be disposed of in settling ponds to avoid potential impacts on performance (1.2.6.7.6 PC 1e, and 1.2.6.8 C E.v).

The problem definition memo (which includes citations for the data used, lists of assumptions, and results) from which these conclusions and recommendations were drawn can be found in SNL's YMP record center under file code 72/12147/PDM 72-31/1.0/QA.

I.2.4 Analysis 4. Water Entry Into Shafts Through Rock Mass Surrounding Shaft Collar and Liner

Purpose

To determine the amount of water entering the shaft through the near-surface fracture network.

These calculations were performed in accordance with the SNL internal document Problem Definition Memo PDM 76-08.

Three scenarios considered in this study are as described below (Fernandez et al., 1989):

(1) The rainfall rate scenario in which the flow of water into the fractures is controlled by the rate of rainfall. Rain falling in excess of the fracture network's ability to absorb water is

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assumed to drain off of the ES pad. This implies that no restoration of the ES occurs and that the engineered drainage features around the ES pad will function to maintain drainage.

(2) The sheet flow scenario in which sheet flow is assumed to occur over the pad. This scenario assumes that no restoration of the ES pad occurs and that the amount of water entering the fracture network is limited only be the network's ability to absorb water.

(3) The channel flow scenario in which channel flow is assumed to occur to Coyote Wash. This channel is 82 m away from the Exploratory Shaft at its closest point. This calculation showed that the ES is outside of the zone of influence of floodwaters in Coyote Wash and did not contribute to water inflow to the ES.

These analyses were performed under the assumption that no remedial measures were performed in the vicinity of the shaft to limit water inflow into the rock matrix. In fact the retarding effect of an alluvial cover was conservatively neglected.

The primary conclusion of this analysis is that the water entry into the exploratory shaft by way of the rock mass behind the shaft collar is less than the storage and drainage capacity of the shaft sump under the host rock conditions. Performance implications associated with this water flow are not expected. For this reason no design constraints are imposed on the shaft collar to limit the permeability of rock behind the collar. This conclusion removes the TBD associated with ESF DR requirement 1.2.6.4 PC 2e.ii and applies to requirements 1.2.6.7.6 PC 1b.i and 1.2.6.1 C C.ii.

It is necessary to emphasize that should significant water entry occur behind the shaft collar as a result of shaft excavation, remedial measures may be applied. These remedial measures include grouting the fractures near the collar and restoring the pad area at closure using the strategies to control infiltration given in Section 8.3.2 of Fernandez et al. (1989).

Recommendation: The results of Analysis 4 indicate that significant water inflow from a flooding event during site characterization and repository operation will not adversely impact testing in the underground portion of the repository if standard engineering practices are employed during construction for the shaft collar (1.2.6.4 PC 2e.ii).

The problem definition memo (which includes citations for the data used, lists of assumptions, and results) from which these conclusions and recommendations were drawn can be found in SNL's YMP record center under file code 70/12471/PDM 76-8/1.0/QA.

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I.2.5 Analysis 5. Shaft and Main Pad Blasting Effects

Purpose

To provide quantitative estimates of the extent of fracturing which may result from blasting used to excavate the shaft and bring the pad area to grade. The blast design will be assessed to determine the length of fractures predicted to extend from blast holes.

This evaluation was performed in accordance with the SNL internal document Design Investigation Memo DIM 257.

As assessment of the extent of fracturing in preparation of the pad, collar, and shaft for the Exploratory Shaft Facility has been completed. The investigation provides background and guidance for determining if controlled blasting can be used to limit excavation-induced damage to the rock. For this analysis a preliminary conceptual design for the pad was used because no reference design for the pad existed. For the collar and shaft the extent of fracturing was based on a report entitled "NNWSI Exploratory Shaft Facility - ESF Controlled Blasting Report (Study No. 4 of 11) Revision 1" by Fenix & Scisson, Inc. (1987).

For the pad, the assessment indicates that if the Tiva Canyon unit is locally high in lithophysal content, then surface preparations (which must include a cut and fill operation) could be completed by ripping. If the Tiva Canyon unit is low in lithophysal content, a bench blast design is conceived to minimize damage. This information applies to ESF DR requirements 1.2.6.1 C C.i and 1.2.6.1 C C.ii.

For the shaft, a review of the blast design prepared by Fenix and Scisson indicates that damage caused by blasting could extend 3 to 4 feet (0.9 to 1.2 m) beyond the excavation wall. The comments on this design provide a means to understand and possibly decrease the expected blast-induced damage. This information applies to ESF DR requirements 1.2.6.4 PC 2i.va and 1.2.6.6 PC 2j.via.

The empirical methods used in this analysis specifically were not developed for tuff and may not be directly applicable. Computer analysis methods employing a more quantitative approach will be conducted as the required data (e.g., dynamic rock properties) become available.

Recommendation: **The results of Analysis 5 indicate that a goal for the extension of blast-induced fracturing into intact rock should be limited to less than 1 m using controlled blasting (1.2.6.4 PC 2i.va and 1.2.6.6 PC 2j.via). Following discussions with constructors, a similar value consistent with standard practices may be considered as a more practical limit.**

Recommendation: The results of Analysis 5 indicate that excavation methods incorporating ripping in high lithophysae material and a bench blast design for low lithophysae material should be considered to limit damage to the underlying rock mass (1.2.6.1 C C.i and 1.2.6.1.C Cii). Following discussions with constructors, other excavation methods consistent with standard practices may be considered.

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The design information memo (which includes citations for the data used, lists of assumptions, and results) from which these conclusions and recommendations were drawn can be found in SNL's YMP record center under file code 60/12147/DIM 257/1.0/QA.

1.2.6 Analysis 6. Shaft and Collar Creep

Purpose

The purpose of this analysis is to estimate the potential for rock creep and its effect on the shaft and collar.

This analysis was performed in accordance with the SNL internal document Design Investigation Memo DIM 256.

This investigation provides background and guidance to assess if total closure of the rock around the shaft is expected to be less than 76 mm (3 inches) in 100 years and if the diametrical closure will average less than 1 mm per year.

The thermal and mechanical environment in the vicinity of the shafts (unlined) for the 100-year operational period is reviewed in light of potential time- dependent deformation mechanisms. Magnitudes of creep strains will be on the same order as the magnitudes of the instantaneous elastic and plastic strains resulting from excavation of the shaft ($\sim 10^{-3}$). Data from existing tunnels in rocks having mineralogies, structures (joints, fractures, and deformation), and overburden similar to those at the Yucca Mountain site suggest that creep deformation is not likely to lead to deformations that produce instability. Calculations of the creep strain in granitic rocks at temperatures and stresses more severe than those expected at the ESF result in creep strain magnitudes that are on the same order as the elastic and plastic strain magnitudes expected in tuff. The most significant unknown in this study is the potential magnitude of creep along fractures. It is concluded that creep strains on favorably oriented fractures may exceed the estimated matrix strains. The strain magnitudes postulated based on the review of available information can be accommodated in an appropriate liner design for the ESF.

Data available for predicting the creep strains at the ESF are sparse. The potential creep phenomena should be further studied through an integrated laboratory and field experimentation program and monitoring program coupled with analyses.

This analysis applies to the thermomechanical response of the rocks in ESF DR requirements 1.2.6.4 PC 2j.i, 1.2.6.5 PC 2j.i, and 1.2.6.6 2k.i.

Recommendation: The results of Analysis 6 indicate that the thermomechanical response of the host rock matrix and surrounding strata to time-dependent deformation mechanisms will be comparable to the instantaneous elastic and plastic strains ($\sim 10^{-3}$) resulting from excavation of the shaft (1.2.6.4 PC 2j.i, 1.2.6.5 PC 2j.i and 1.2.6.6 2k.i). Following discussions with constructors, a similar value consistent with standard practices may be considered as a more practical limit.

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The design information memo (which includes the citations for the data used, lists of assumptions, and results) from which these conclusions and recommendations were drawn may be found in SNL's YMP record center under file code 60/12147/DIM 256/1.0/QA.

I.2.7 Analysis 7. Shaft and Collar Thermal Stress

Purpose

The purpose of this analysis is to provide quantitative estimates of the thermal stresses expected on the shaft liner and collar, through the shaft breakout zones, the main test level, and along the main access drifts in the potential repository.

The analysis was performed in accordance with the SNL internal document Problem Definition Memo PDM 75-13 Rev C.

The computer code STRES3D was used to predict the temperature, stress and strain resulting from the emplacement of heat generating high-level waste. This model simplifies the geometry of the potential repository as a semi-infinite elastic half space. The panels containing waste are modeled as four exponentially decaying source terms for the first 1,000 years after waste emplacement and six source terms for times of 1,000 to 10,000 years. Waste is assumed to be emplaced within 25 years. A total of 130 plate elements were used to model the waste panels.

The thermally-induced axial stress (vertical) change at the location of ES1 and ES2 indicate a stress decrease at all times. The thermally-induced horizontal normal stresses are compressive at elevations below 3450 ft elevation (in and below the TSw2) at both shaft locations with negative stress changes generated near the surface.

At the ES1 location, changes in the north-south and east-west horizontal stresses peak at approximately the same value at 2000 years. The maximum north-south horizontal stress change is approximately 1.8 MPa and the maximum east-west horizontal stress change is approximately 1.7 MPa. The maximum vertical stress change at the ES1 location occurs 300 years after the start of waste emplacement and is approximately 2.2 MPa (negative).

At the location of ES2, the maximum temperature is slightly less than that for ES1. The maximum vertical stress change is 1.6 MPa (negative) and occurs at 300 years. The maximum north-south horizontal stress change occurs at 2000 years at a value of approximately 1.7 MPa (compressive). The maximum east- west horizontal stress change of approximately 2.1 MPa (compressive) occurs at 500 years.

The temperature changes at the upper and lower breakout rooms are significantly lower than at the MTL. The temperatures and stress changes at the MTL are strongly dependent on the location relative to the closest waste emplacement panels.

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Stress and temperature changes along the centerline of the mains and the exploratory drifts are presented. The temperature at the centerline of the main drifts will reach approximately 57? C (a change of 32? C). For the exploratory drifts, which later function as panel access drifts, temperature changes of approximately 70? C are predicted and the horizontal compressive stress at the drift location is predicted to increase by 11 MPa.

The numerical values presented are based on thermal and thermomechanical properties which are cited in PDM 75-13 Rev. C., and are sensitive to the repository layout, waste emplacement loading density, and the in situ site conditions.

The analysis applies to ESF DR requirement 1.2.6.4 PC 2j.iii.

Recommendation: The results of Analysis 7 indicate that the thermal and thermomechanical response of the host rock at the location of ES1 and ES2 indicates a decrease in vertical stress of less than 2 MPa due to waste emplacement at 100 years (1.2.6.4 PC 2j.iii).

Recommendation: The results of Analysis 7 indicate that horizontal stresses increase at the ES locations on the order of 0.3 MPa (maximum north-south horizontal stress change for first 100 years) and on the order of 1.3 MPa (maximum east-west horizontal stress change due to thermal loading of the repository). The maximum vertical stress is expected to decrease on the order of 1.7 MPa for the same time frame (1.2.6.4 PC 2j.iii).

The problem definition memo (which includes citations for the data used, lists of assumptions, and results) from which these conclusions and recommendations were drawn can be found in SNL's YMP record center under file code 70/124232/PDM 75-13 Rev. C/1.0/QA.

I.2.8 Analysis 8. Far Field Thermal Effects

Purpose

To provide three-dimensional far-field predictions for the temperatures surrounding a potential repository.

The analysis was performed in accordance with the SNL internal document Problem Definition Memo PDM 75-13.

The thermal calculations were conducted as part of the thermal-mechanical calculations using STRES3D and are discussed in analysis 7. The results of this analysis applies to ESF DR requirements 1.2.6.4 PC 2j.i and 1.2.6.6 PC 2k.v.

Recommendation: The results of Analysis 8 indicate that the thermal and thermomechanical response of the host rock at the location of ES1 and ES2 indicates a net decrease in the vertical stress of approximately 1.7 MPa at 100 years after waste emplacement (1.2.6.4 PC 2j.iii).

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Recommendation: The results of Analysis 8 indicate that the maximum temperature from waste emplacement at the TSw3-CHn boundary will be less than 45?C (1.2.6.6 PC 2k.v).

The problem definition memo (which includes citations for the data used, lists of assumptions, and results) from which these conclusions and recommendations were drawn can be found in SNL's YMP record center under file codes
70/124232/PDM 75-13 Rev. C/1.0/QA.

I.2.9 Analysis 9. Systems and Components Important to Safety

Purpose

To perform a technical review of the documentation identifying Items Important to Safety; Items Important to Waste Isolation and the Quality Activities List.

The documents describing the Q-List, the Quality Activities List and the Project Requirements List have been reviewed and published by the Quality Review Board as YMP/90-55, YMP/90-56, and YMP/90-57 respectively. The results of this analysis apply to 10 CFR 60.151, which is excluded from the ESF DR. (See the introduction of the ESF DR for the explanation.)

Recommendation: Items and activities to be included as Items Important to Safety, Items Important to Waste Isolation and the Quality Activities List are identified in the results of Analysis 9.

I.2.10 Analysis 10. Analyses of the Hydrologic and Geochemical Effects of Tracers

Purpose

To identify, characterize and control tracer tagging compounds and to evaluate their potential effects on experiments and waste isolation.

Analysis 10 and 11 have been combined into a Memo of Understanding (MOU 330011) among YMP participants which creates a control committee for tracers and materials including water which will be used at Yucca Mountain. This document formalizes the relationships required to perform the work described in Analyses 10 and 11.

Recommendation: Analysis 10 is ongoing as part of memorandum of understanding 330011. The region of influence related to hydrological and geochemical effects of tracers is assumed to be similiar to the area influenced by water (1.2.6.0 C C.iii). After the tracers have been identified and their transport properties characterized, analyses may show that the transport of certain tracers may significantly differ from the transport of water.

The analysis applies to ESF DR requirements 1.2.6.0 C C.iii, 1.2.6.4 PC 1d.vii, 1.2.6.5 PC 1d.vii and 1.2.6.6 PC 1d.x.

I.2.11 Analysis 11. Analyses of the Hydrologic and Geochemical Effects of Chemicals

Purpose

To identify, characterize, and control materials and chemicals and to evaluate their potential effects on experiments and waste isolation.

Analysis 10 and 11 have been combined into a Memo of Understanding (MOU 330011) among YMP participants which creates a control committee for tracers and materials including water which will be used at Yucca mountain. This document formalizes the relationships required to perform the work described in Analyses 10 and 11.

This analysis applies to ESF DR requirements 1.2.6.4 PC 2a.ii, 1.2.6.5 PC 2a.ii, 1.2.6.6 PC 2a.ii, 1.2.6.4 PC 2a.iv, 1.2.6.5 PC 2a.iv, 1.2.6.6 PC 2a.iii, 1.2.6.0 C C.iii, 1.2.6.0 C C.iv, 1.2.6.4 PC 1d.vi, 1.2.6.5 PC 1d.vi, 1.2.6.6 PC 1d.ix, 1.2.6.7.6 PC 1e, 1.2.6.8 C E.v, 1.2.6.2.5 C A..

Recommendation: Analysis 11 is ongoing as part of memorandum of understanding 330011. The region of influence related to hydrological and geochemical effects of hydrocarbons and solvents is assumed to be similiar to the area influenced by water (1.2.6.0 C C.iv). After the materials and chemicals have been identified and their transport properties characterized, analyses may show that the transport of certain materials and chemicals may significantly differ from the transport of water.

References

1. Eaton, R. R. and A. L. Peterson, 1990. Computed Distribution of Residual Shaft Drilling and Construction Water in the Exploratory Facilities at Yucca Mountain, Nevada, in: Proc. Int'l. High-Level Radioactive Waste Management Conference, April 1990.

2. Fernandez, J. A., T. E. Hinkebein and J. B. Case, 1989. Selected Analyses to Evaluate the Effect of the Exploratory Shafts on Repository Performance at Yucca Mountain. SAND 85-0598, Sandia National Laboratories.

I.3 NRC Requirements and ESF DR Sections Requiring Analysis Support

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10 CFR 60.15(b)
Unless the Commission determines with respect to the site described in the application that it is not necessary, site characterization shall include a program of in situ exploration and testing at the depths that waste would be emplaced.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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10 CFR 60.15(c)(1)
Investigations to obtain the required information shall be conducted in such a manner as to limit adverse effects on the long-term performance of the geologic repository to the extent practical.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

In accordance with 10 CFR 60.15(c)(1), the location, design, construction, and operation of the ___*___ shall incorporate aspects specifically directed at limiting the potential for adverse effects on the long term performance of the repository.

1.2.6.1 C A.	*	main site and auxilliary sites
1.2.6.4 PC 2a.i	*	shaft
1.2.6.5 PC 2a.i	*	ramp
1.2.6.6 PC 2a.i	*	main test level
1.2.6.7 C Bi	*	underground utilities

All materials or substances to be used underground shall first be reviewed for potential effects on engineered barriers and waste isolation. They may be used only following review and approval, and only in

those areas where use has been approved, and subject to whatever controls are established. Such materials or substances include, but are limited to, the following:

a. Concrete and other cementitious materials, such as shotcrete and grout.

b. Ground support materials, including chemical/resin anchorages.

c. Water (pH and organic content) and any additives to water for identification (tracers) or construction, operation, or testing.

d. Hydrocarbons and solvents.

e. Organic materials.

f. Explosives and blasting ancillaries, including the introduction of pressurized drilling water into the rock, and the chemical residues that are the products of blasting.

1.2.6.4 PC 2a.ii	-- refers to shafts
1.2.6.5 PC 2a.ii	-- refers to ramps
1.2.6.6 PC 2a.ii	-- refers to underground excavations

A materials control program shall be implemented to enable establishment of limits on the inventory of materials left after decommissioning.

1.2.6.4 PC 2a.iv	-- refers to shafts
1.2.6.5 PC 2a.iv	-- refers to ramps
1.2.6.6 PC 2a.iii	-- refers to underground excavations

The chemical content of the blasting agents and explosives shall be evaluated during their selection process and the chemical content of the blasts sampled, recorded, and the data used as necessary to preclude adverse effects on in situ site characterization.

1.2.6.4 PC 1d.ix	-- refers to shafts
1.2.6.5 PC 1d.ix	-- refers to ramps
1.2.6.6 PC 1d.xiii	-- refers to underground excavations

10 CFR 60.15(c)(1)

The amount of water used in construction and operations shall be limited to that required for dust control and proper equipment operation so as to limit the effects on the containment and isolation capability of the site. The maximum quantity of water (based on use during construction) shall not exceed 15 gallons per ton of rock excavated.

1.2.6.4 PC 2g.i	-- refers to ramps
1.2.6.5 PC 2g.ii	-- refers to shafts
1.2.6.6 PC 2h.iv	-- refers to underground excavations

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10 CFR 60.15(c)(2)
The number of exploratory boreholes and shafts shall be limited to the extent practical consistent with obtaining the information needed for site characterization.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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10 CFR 60.15(c)(3)
To the extent practical, exploratory boreholes and shafts in the geologic repository operations area shall be located where shafts are planned for underground facility construction and operation or where large unexcavated pillars are planned.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

1.2.6.8 C D.iii — Boreholes drilled from the main test level shall not penetrate significantly below the base of the TWw2 host rock, unless the impacts of doing so, on the waste isolation performance of the site, have been evaluated and found to be acceptable.

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10 CFR 60.15(c)(4)
Subsurface exploratory drilling, excavation, and in situ testing before and during construction shall be planned and coordinated with geologic repository operations area design and construction.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

1.2.6.0 C C.iii — All substances and tracers intended to be added to water to be piped underground for such purposes as drilling and dust control shall first be reviewed for potential to affect site characterization testing, repository testing or monitoring, and waste isolation. They may be added only following review and approval.

10 CFR 60.15(c)(4)

1.2.6.0 C C.iv — Use of hydrocarbons and solvents underground shall comply with criteria to be determined by performance assessment.

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10 CFR 60.16
Before proceeding to sink shafts at any area which has been approved by the President for site characterization, DOE shall submit to the Director, for review and comment, a site characterization plan for such area. DOE shall defer the sinking of such shafts until such time as there has been an opportunity for Commission comments thereon to have been solicited and considered by DOE.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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10 CFR 60.21(c)(1)(ii)(D)
The assessment shall contain the effectiveness of engineered and natural barriers, including barriers that may not be themselves a part of the geologic repository operations area, against the release of radioactive material to the environment. The analysis shall also include a comparative evaluation of alternatives to the major design features that are important to waste isolation, with particular attention to the alternatives that would provide longer radionuclide containment and isolation.

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ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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10 CFR 60.21(c)(11)
The safety analysis report shall include a description of design considerations that are intended to facilitate permanent closure and decontamination or dismantlement of surface facilities.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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10 CFR 60.111
(a) Protection against radiation exposures and releases of radioactive material. The geologic repository operations area shall be designed so that until permanent closure has been completed, radiation exposures and radiation levels, and releases of radioactive materials to unrestricted areas, will at all times be maintained within the limits specified in Part 20 of this chapter and such generally applicable environmental standards for radioactivity as may have been established by the Environmental Protection Agency.

(b)(1) The geologic repository operations area shall be designed to preserve the option of waste retrieval throughout the period during which wastes are being emplaced and, thereafter, until the completion of a performance confirmation program and Commission review of the information obtained from such a program. To satisfy this objective, the geologic repository operations area shall be designed so that any or all of the emplaced waste could be retrieved on a reasonable schedule starting at any time up to 50 years after waste emplacement operations are initiated, unless a different time period is approved or specified by the Commission. This different time period may be established on a case-by-case basis consistent with the emplacement schedule and the planned performance confirmation program.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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10 CFR 60.112
The geologic setting shall be selected and the engineered barrier system and the shafts, boreholes and their seals shall be designed to assure that releases of radioactive materials to the accessible environment following permanent closure conform to such generally applicable environmental standards for radioactivity as may have been established by the Environmental Protection Agency with respect to both anticipated processes and events and unanticipated processes and events.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

10 CFR 60.113(a)(1)(i)
The engineered barrier system shall be designed so that assuming anticipated processes and events: (A) Containment of HLW will be substantially complete during the period when radiation and thermal conditions in the engineered barrier system are dominated by fission product decay: and (B) any release of radionuclides from the engineered barrier system shall be a gradual process which results in small fractional releases to the geologic setting over long times. For disposal in the saturated zone, both the partial and complete filling with groundwater of available void spaces in the underground facility shall be appropriately considered and analyzed among the anticipated processes and events in designing the engineered barrier system.

(ii) In satisfying the preceding requirement, the engineered barrier system shall be designed, assuming anticipated process and events, so that: (A) Containment of HLW within the waste packages will be substantially complete for a period to be determined by the Commission taking into account the factors specified in ?(b) provided, that such period shall be not less than 300 years nor more than 1,000 years after permanent closure of the geologic repository: and

(B) The release rate of any radionuclide from the engineered barrier system following the containment period shall not exceed one part in 100,000 per year of the inventory of that radionuclide calculated to be present at 1,000 years following permanent closure, or such other fraction of the inventory as may be approved or specified by the Commission; provided, that this requirement does not apply to any radionuclide which is released at a rate less than 0.1% of the calculated total release rate limit. The calculated total release rate limit shall be taken to be one part in 100,000 per year of the inventory of radioactive waste, originally emplaced in the underground facility, that remains after 1,000 years of radioactive decay.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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10 CFR 60.130
Sections 60.131 through 60.134 specify minimum criteria for the design of the geologic repository operations area. These design criteria are not intended to be exhaustive, however. Omissions in ?? 60.131 through 60.134 do not relieve DOE from any obligation to provide such safety features in a specific facility needed to achieve the performance objectives. All design bases must be consistent with the results of site characterization activities.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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10 CFR 60.131(b)(2)
The structures, systems, and components important to safety shall be designed to withstand dynamic effects such as missile impacts, that could result from equipment failure, and similar events and conditions that could lead to loss of their safety functions.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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10 CFR 60.131(b)(4)(i)
The structures, systems, and components important to safety shall be designed to maintain control of radioactive waste and radioactive effluents, and permit prompt termination of operations and evacuation of personnel during an emergency.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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10 CFR 60.133(a)(1)
The orientation, geometry, layout, and depth of the underground facility, and the design of any engineered barriers that are part of the underground facility shall contribute to the containment and isolation of radionuclides.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

	Location of a shaft relative to any other access shall be such that testing in either access will not be adversely affected by activities in the other.
1.2.6.4 PC 1d.xii	-- refers to shafts
1.2.6.5 PC 1d.xii	-- refers to ramps
1.2.6.6 PC 2e.ii	The spacing between adjacent ESF drifts shall be a minimum of two drift diameters (using the maximum diameter of either opening and considering the closest proximity of any part of each opening) consistent with obtaining reliable and adequate information from site characterization, except where required otherwise by specific test requirements.

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10 CFR 60.133(a)(2)
The underground facility shall be designed so that the effects of credible disruptive events during the period of operations, such as flooding, fires and explosions, will not spread through the facility.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

The ___*___ shall be designed to prevent significant water inflow from a flooding event during site characterization and the planned period of repository operation, such that testing in the underground portion of the ESF and waste emplacement are not adversely affected.

1.2.6.4 PC 2e.ii	*	shaft collar
1.2.6.5 PC 2e.ii	*	ramp portal

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10 CFR 60.133(b)
The underground facility shall be designed with sufficient flexibility to allow adjustments where necessary to accommodate specific site conditions identified through in situ monitoring, testing, or excavation.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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10 CFR 60.133(d)
The design of the underground facility shall provide for control of water or gas intrusion.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

1.2.6.1 C F.i — The amount of water used in site preparation and operations should be limited to that required for sanitation, dust control, compaction of engineered fill material, and proper equipment operation so as to limit the effects on the containment and isolation capability of the site.

Fluids and materials planned for use in the ___*___ shall be evaluated with respect to intended use and possible effects on site characterization or other testing, and appropriate controls implemented.

1.2.6.4 PC 1d.vi	*	shaft
1.2.6.5 PC 1d.vi	*	ramp
1.2.6.6 PC 1d.ix	*	ESF underground facility

10 CFR 60.133(d)

Water use in ___*___ shall be generally consistent with repository design goals to limit the increase in average percent saturation of the repository horizon to [TBD] percent, and limit the increase in the local percent saturation to [TBD] percent in waste emplacement areas.

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1.2.6.4 PC 2g.ii	* shaft construction
1.2.6.5 PC 2g.iii	* ramp construction
1.2.6.6 PC 2h.v	* the underground facility
1.2.6.8 C E.iii	* testing
	Fluids recovered during ____*____ operations shall be disposed of in such a way to avoid potential for performance impacts.
1.2.6.7.6 PC 1e.	* construction -- refers to shafts
1.2.6.8 C E.v	* testing
1.2.6.7.6 PC 1b.i	Water handling and control underground shall be designed for all credible inflows, including inflow from penetration of fault structures or from perched water horizons, use of fire protection sprinklers, and from water line breakage.
	The amount of water used in the construction ___*___ shall be limited to preclude interference with tests.
1.2.6.4 PC 1d.iii	* and operation of the shaft
1.2.6.5 PC 1d.iii	* of the ramp
1.2.6.6 PC 1d.vi	* of the underground facility
1.2.6.8 C E.ii	The amount of water used in testing and operations shall be limited so as to limit the effects on the containment and isolation capability of the site.
	Fluids, gases, and other materials used in ESF construction and operations, and/or injected into the rock mass, shall be appropriately tagged. Selection of tracers shall consider, but not be limited to: (1) the possible future need to account for the mobility and disposition of all such materials as part of site characterization, and (2) the effects of tracers on site characterization.
1.2.6.4 PC 1d.vii	-- refers to shafts
1.2.6.5 PC 1d.vii	-- refers to ramps
1.2.6.6 PC 1d.x	-- refers to underground excavation

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10 CFR 60.133(e)(2)
Openings in the underground facility shall be designed to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

An adequate distance between accesses shall be provided to limit potential mechanical and hydrological interference between the accesses and to reduce the potential for deleterious rock movement so they do not impact the capability to reliably and adequately characterize the site.

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1.2.6.4 PC 2h.ii	-- refers to shafts
1.2.6.5 PC 2h.ii	-- refers to ramps

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10 CFR 60.133(f)
The design of the underground facility shall incorporate excavation methods that will limit the potential for creating a preferential pathway for groundwater to contact the waste packages or radionuclide migration to the accessible environment.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

1.2.6.1 C C.i

The design and construction of the site (civil improvements) for the permanent and non-permanent ESF structures, systems, and components shall not significantly increase the preferential pathways for groundwater or radioactive waste migration to the accessible environment or otherwise significantly reduce the ability of the site to meet the performance objective as stated in the approved SCP.

1.2.6.1 C C.ii

Foundations for equipment, buildings, and structures shall be constructed using excavation methods such as controlled blasting to limit damage to the underlying rock mass, to the extent that it could affect the adequacy or reliability of information from site characterization. Methods shall be designed by the responsible organization to facilitate investigation and monitoring of such effects during and after construction.

Blast-induced changes to the average in situ permeability of the rock beyond a dimension (into the rock) equal to one half of the maximum opening dimension shall be less than one order of magnitude.

1.2.6.4 PC 2i.va	-- refers to shafts
1.2.6.5 PC 2i.va	-- refers to ramps
1.2.6.6 PC 2j.via	-- refers to underground excavations

10 CFR 60.133(f)

In areas not affected by thermal load, ____*____ rate decreasing at all times after construction.

1.2.6.4 PC 2i.iiia	* <u>diametrical closure</u>-- refers to shafts
1.2.6.5 PC 2i.iiia	* <u>diametrical closure</u>-- refers to ramps
1.2.6.6 PC 2j.iia	* <u>closure</u>-- refers to underground excavations

In areas affected by thermal load, closure rate no greater than three times that predicted by thermoelastic models.

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1.2.6.4 PC 2i.iiib	-- refers to shafts
1.2.6.5 PC 2i.iiib	-- refers to ramps
1.2.6.6 PC 2j.iiib	-- refers to underground excavations

1.2.6.4 PC 2i.vii — Where required or preferred, the shaft and shaft stations shall be constructed using controlled blasting methods, to limit overbreak and damage to the surrounding rock mass, which could affect the adequacy or reliability of information from site characterization. The methods shall be designed to provide for the requirements of specific site characterization tests, such as limitations on the extent of excavation-induced damage, or the type of ground support that may be installed. The methods shall be designed to facilitate investigation and monitoring of excavation effects during and after construction.

1.2.6.5 PC 2i.vii — The typical cross section of the ESF ramp shall be constructed using a tunnel boring machine, to limit the damage to the surrounding rock mass, which could affect the adequacy or reliability of information from site characterization. Ramp stations and other secondary excavation may be developed by controlled drilling and blasting methods. The excavation methods shall be designed to provide for the requirements of specific site characterization tests, such as limitations on the extent of excavation-induced damage, or the type of ground support that may be installed. The methods shall be designed to facilitate investigation and monitoring of such effects during and after construction.

10 CFR 60.133(f)

1.2.6.6 PC 2j.xii — If the shaft or ramp breakouts and main test level of the ESF are constructed using controlled drilling and blasting methods to limit overbreak and damage to the surrounding rock mass; the methods shall be designed to provide for the requirements of specific site characterization tests, such as limitations on the extent of excavation-induced damage, or the type of ground support that may be installed. The methods shall be designed to facilitate investigation and monitoring of excavation effects during and after construction.

10 CFR 60.133(h)
Engineered barriers shall be designed to assist the geologic setting in meeting the performance objectives for the period following permanent closure.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

10 CFR 60.133(i)
The underground facility shall be designed so that the performance objectives will be met taking into account the predicted thermal and thermomechanical response of the host rock, and surrounding strata, groundwater system.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

The predicted thermal and thermomechanical response of the host rock and surrounding strata and the groundwater system shall be considered in the ESF design.

1.2.6.4 PC 2j.i	-- refers to shafts
1.2.6.5 PC 2j.i	-- refers to ramps
1.2.6.6 PC 2k.i	-- refers to underground facilities

The ___*___ liner shall withstand pressures exerted along its length and around the entire perimeter under anticipated conditions, including reaction to thermally-induced stresses resulting from thermal loads.

1.2.6.4 PC 2j.iii	*	shaft
1.2.6.5 PC 2j.iii	*	ramp
1.2.6.6 PC 2k.iii	*	underground excavation support system

10 CFR 60.133.(i)

1.2.6.6 PC 2k.v

The ESF shall be designed so that the thermal effects of ESF testing do not result in temperatures in excess of 115 degrees C in either the TSw3 or CHn units, compatible with the performance measure for the repository listed in Table 8.3.2.2-4 in Volume VI, Part B, of the Site Characterization Plan for the Yucca Mountain Site.

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10 CFR 60.134
(a) Seals for shafts [and ramps] and boreholes shall be designed so that following permanent closure they do not become pathways that compromise the geologic repository's ability to meet the performance objective for the period following permanent closure. (b) Materials and placement methods for seals shall be selected to reduce, to the extent practical: (1) The potential for creating a preferential pathway for groundwater to contact the waste packages or (2) for radionuclide migration through existing pathways.

(b) Materials and placement methods for seals shall be selected to reduce, to the extent practical: (1) The potential for creating a preferential pathway for groundwater to contact the waste packages or (2) For radionuclide migration through existing pathways.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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10 CFR 60.137
The geologic repository operations area shall be designed so as to permit implementation of a performance confirmation program that meets the requirements of Subpart F of this part.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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10 CFR 60.140(c)
The program shall include in situ monitoring, laboratory and field testing, and in situ experiments, as may be appropriate to accomplish the objective as stated above.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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10 CFR 60.140(d)(1)
The program shall be implemented so that:
(1) It does not adversely affect the ability of the natural and engineered elements of the geologic repository to meet the performance objectives.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

None

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The following ESF DR requirements are not direct descendants of 10 CFR 60 requirements:

1.2.6.2.3 C B. Sanitary wastes shall be disposed of by means of collection piping from all buildings and trailers and discharged to a sanitary waste disposal system located beyond the perimeter of the proposed repository subsurface facility a distance to be determined by performance assessment. The sewage system shall be designed to prevent interference with site characterization activities.

1.2.6.2.5 C A. Liquid wastes that cannot be disposed of on the ESF site in an environmentally acceptable manner shall be removed from the site for disposal in an appropriate facility.

1.2.6.2.5 C B. The surface mine wastewater collection system shall discharge to a wastewater pond consistent with location constraints to be determined by performance assessment. The surface mine wastewater system shall be designed, operated, and maintained in such a way as to prevent interference with the site characterization activities.

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APPENDIX J

EXPLORATORY SHAFT FACILITY ENVIRONMENTAL REQUIREMENTS

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EXPLORATORY SHAFT FACILITY ENVIRONMENTAL REQUIREMENTS

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APPENDIX C

EXPLORATORY SHAFT FACILITY ENVIRONMENTAL REQUIREMENTS

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this appendix to the Exploratory Shaft Facility (ESF) Requirements Document is to provide a brief, but comprehensive, presentation of the environmental requirements (Federal, State, and local) that apply to all ESF activities. These requirements affect all phases of the ESF process, from permitting before work is allowed to commence, through construction, operation, and closure. Inclusion of these requirements in the design of site characterization activities is essential to ensuring that the activities are conducted in a manner that will protect, maintain, and restore environmental quality; minimize potential threats to the environment, and comply with environmental regulations and policies.

1.2 OVERVIEW OF THE ENVIRONMENTAL PROGRAM

The U.S. Department of Energy (DOE) is committed to performing its activities in an environmentally safe and sound manner, and will comply with all applicable environmental statutes and regulations. To fulfill this commitment at the Yucca Mountain site, the DOE has established an environmental program that assures that site characterization studies will be conducted in such a way that applicable environmental regulatory and programmatic requirements are met. The Yucca Mountain Site Characterization Project (YMP) environmental program is structured to satisfy the statutory requirements of the Nuclear Waste Policy Act (NWPA), as amended; the National Environmental Policy Act (NEPA); the Atomic Energy Act (AEA); and other applicable statutes, regulations and DOE Orders.

The YMP environmental program has been delineated in documents previously issued by the DOE. The Environmental Management Plan describes how the program is managed and integrated with other parts of the YMP.

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Federal and State statutes, regulations, requirements, and DOE Orders that apply to the YMP, and a brief description of each, are presented in the Environmental Regulatory and Compliance Plan (ERCP; DOE, 1988a). The ERCP describes how the YMP would satisfy the environmental regulatory requirements for site characterization, and identifies the information necessary to prepare a specific permit application. Environmental monitoring and mitigation program requirements being implemented by the YMP, as required by by the NWPA as amended, are set forth in the Environmental Monitoring and Mitigation Plan (EMMP; DOE, 1988b). Reclamation requirements applicable to the YMP are described in the Reclamation Implementation Plan (RIP; DOE, 1991), and the requirements to be satisfied for the Environmental Impact Statement (EIS) will be defined in the EIS Implementation Plan, to be prepared after EIS scoping meetings have been held. Data collection required by these plans is planned and performed as described in the Environmental Field Activity Plans (EFAPs).

1.3 SCOPE OF APPENDIX J

The documents mentioned in the previous section represent various elements of the YMP environmental program. Together, they (and certain others not essential to this document) provide a network of plans designed to ensure that the Yucca Mountain environment is protected throughout the period of site characterization study. Not all portions of the plans are relevant to ESF activities, however. The remainder of this document uses information provided in appropriate sections of these various plans to define the requirements that must be satisfied to comply with Federal, State, and local environmental regulations during the performance of ESF activities. Requirements are given for each of the major environmental areas of concern (e.g., air, water, biological resources, hazardous waste management, etc.) likely to be affected by ESF activities.

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2.0 AIR POLLUTION CONTROL

2.1 CLEAN AIR ACT, as amended (P.L. 95-95; 42 USC 7401-7642; 40 CFR 50-53, 58, 60-61, 81.300-81.400, 124; EO 11738; EO 12088; NRS 445.401 et seq; Nevada Administrative Code 445.430-445-995)

Background

The Clean Air Act (CAA, 1977) establishes Federal policy for preserving and enhancing the quality of the Nation's air resources to protect the public health and welfare. The Act ensures, through a State-issued permit program, that adequate steps are taken to control the release of air contaminants from industrial processes and land-disturbing activities. Section 118 of the CAA requires Federal agencies to comply with all Federal, State, interstate, and local requirements regarding the control and abatement of air pollution in the same manner, and to the same extent, as any non-governmental entity.

In 1980, the EPA approved Nevada's plan to implement and enforce the CAA (Nevada's State Implementation Plan [SIP]). On May 30, 1988, the EPA granted Nevada the authority to implement the "Prevention of Significant Deterioration" (PSD) Program. Authority to regulate radioactive air emissions has been retained by the EPA, however. Responsibility for implementing and enforcing the CAA in Nevada resides with the Nevada Division of Environmental Protection (NDEP).

Applicability to the ESF

Site characterization activities such as construction and operation of the exploratory shaft, operation of concrete-batch plants, and land disturbances from field testing and site preparation will generate particulate and gaseous emissions of air pollutants. The origin of most particulates will be non-point sources, e.g., drilling, blasting, rock removal and storage, surface grading and leveling, wind erosion, vehicle travel, and diesel and gasoline engines. Permits will be required for the performance of many of these activities.

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Requirements for the ESF

- An Air Quality Surface Disturbance Permit is required before any land-disturbing activities are initiated (CAA and Nevada Revised Statutes [NRS 445.401-601]). A strategy for dust minimization, in particular, must be included in any plan for surface-disturbing activities.

- All stationary sources (point sources) of air emissions shall comply with the applicable provisions of the CAA, as amended (42 USC 7401), which may include Prevention of Significant Deterioration (PSD) permitting, or offset Policy Review, or both. Federal regulations pertaining to compliance with the CAA include: 40 CFR 50 (National Primary and Secondary Ambient Air Quality Standards) and 40 CFR 60 (Standards of Performance for New Stationary Sources). The YMP shall comply with the State or local standards included under the stipulations of NRS Chapter 445.401-601 for Air Quality - (1) Permit to Construct, (2) Prevention of Significant Deterioration, and (3) Permit to Operate.

- Registration Certificates

  Registration Certificates are required for all new sources (property and/or equipment) that may emit air contaminants, including concrete batch plant, shaker plant, and ESF Exhaust Shaft.

  A separate Registration Certificate is required for each new single source of contaminants prior to the commencement of the activity generating the contaminants.

  The Registration Certificate for a point source will be denied if the point source (1) will prevent the maintenance of State and National ambient air-quality standards; (2) is contrary to the State's air-pollution control strategy; (3) will cause a violation

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of 40 CFR 60-61 (New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants); or (4) if the best available technology is not defined and adopted as an emission limitation for the source.

Exemptions to these requirements that are pertinent to site characterization at Yucca Mountain include air-conditioning equipment or fuel-burning equipment that has a heat-input rating of less than 4,000,000 Btu per hour; motor vehicles and internal combustion engines; incinerators with rated burning capacity of less then 25 pounds per hour; storage containers for gasoline, petroleum distillates, or other volatile organic compounds having a capacity of less then 40,000 gallons; equipment used solely for the processing of food for human consumption; disturbing less than 20 acres per year of topsoil; and process weight rates of less than 50 pounds per hour.

- Operating Permits

A valid Registration Certificate for the source must be in-hand before an Operating Permit is issued.

An Operating Permit is required within 180 days after start-up for each new source that emits or may emit air contaminants. It is a document issued and signed by the Air Quality Officer (AQO) that approves the operation of a new or existing single source of air contaminants. The Operating Permit may or may not include stipulations.

After obtaining an Operating Permit, the operator (in this case, the DOE) is responsible for maintaining emissions of air pollutants within the limits specified in the permit.

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If limits are exceeded or if scheduled maintenance or equipment malfunctions occur, the operator is required to inform the AQO within 24 hours and prepare a written report to be sent to the State within 15 days of the event (Nevada Administrative Code 445.667).

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3.0 WATER APPROPRIATIONS

3.1 NEVADA WATER LAW, (Nevada Administrative Code 533.325-540; 534.010-190)

Background

The State of Nevada requires a permit for the appropriation of State waters. The purpose of a Water Appropriation Permit is to prevent possible interference with prior water rights and/or improper use of waters not legally available for use. The Nevada State Engineer's Office administers Nevada water law.

Applicability to the ESF

Site characterization activities will require water. These requirements are currently based on the use of water from Well J-13, but apply to water from any well at the site.

Requirements for the ESF

- Water withdrawal cannot start until a permit is obtained.

- Construction of new facilities, including pumps and the water pipeline to the ESF, cannot begin until a permit is obtained.

- Water use must not exceed quantities allowed by the permit.

- Pump tests are generally excluded from a permit but the exclusion must be requested for each pump test.

- Any dam that will be 10 feet or more in height or, if less than 10 feet in height, will impound more than 10 acre feet of water, must be approved by the State Engineer at least 30 days before construction is to begin.

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4.0 DRINKING WATER PROTECTION

4.1 SAFE DRINKING WATER ACT OF 1974, as amended (P.L. 93-523; 42 USC 300f-300j-10; 40 CFR 124, 141, 143; EO 12088; NRS 445.361 et seq; Nevada Administrative Code 445.244-445.420)

Background

The Safe Drinking Water Act (SDWA, 1974) grants the EPA authority to regulate public drinking water supplies by establishing drinking water regulations, delegating authority for enforcement of drinking water standards to the States, and protecting aquifers from such things as injection of wastes and other materials into wells.

In 1978, the EPA approved Nevada's program for enforcing the drinking water standards established by the EPA. The Nevada Division of Health within the Nevada Department of Human Resources is the agency responsible for this enforcement.

Construction characteristics of water-supply wells are addressed in NAC 445.358 through 445.400. Storage and distribution specifications required for a public drinking water supply are discussed in NAC 445.410-445.418.

Applicability to the ESF

A drinking water system is planned for the ESF. By definition, the water supply is considered a "public water supply" since it will probably service 15 or more connections or 25 people for more than 60 days per year.

Requirements for the ESF

- A permit is needed to construct a drinking water system (NAC 445.370-445.420).

- Drinking water must meet the standards set forth in 40 CFR 141 and NAC 445.244 to 445.262.

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- The water quality monitoring system shall have the capability to sample, measure, and analyze physical, chemical, and biological conditions consistent with the requirements of the Clean Water Act (CWA, 1972) (33 USC 1251) and the SDWA (42 USC 300f). Such capability must also be compatible with the type and range of concentrations/occurrences of conditions specified in the governing regulations (e.g., 40 CFR 122, 125, 141, 142, 143, and State and local regulations).

- Periodic testing of the system's water quality (at the discretion of the State Health Officer, but probably monthly for bacteriological content) will be required.

4.2 UNDERGROUND INJECTION CONTROL PROGRAM OF THE SAFE DRINKING WATER ACT OF 1974 (91 Stat. 1397; P.L. 93-523; 42 USC 300h (Part C); 40 CFR Part 124, 144-147; Chapter 445 of the Nevada Administrative Code, Sections 1 through 96.1; NRS 445.131-445.354.

Background

Federal agencies engaged in any activity resulting in an underground injection that may jeopardize a drinking water supply must comply with all Federal, State, and local requirements concerning underground injections. The EPA granted the State of Nevada's Division of Environmental Protection the authority to implement and enforce an underground injection control (UIC) program. Nevada's UIC program seeks to prohibit the pollution of existing and potential sources of underground drinking water in Nevada. Exemptions to obtaining a permit would be granted only if the affected groundwater is not now, and will not be, a source of drinking water, or if the total dissolved solids of the affected groundwater exceeds 10,000 milligrams per liter but the water is not reasonably expected to become a supply of drinking water (Chapter 445 of the Nevada Administrative Code, Section 30).

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Applicability to the ESF

Studies proposed for the ESF to characterize the hydrologic environment of Yucca Mountain may require the use of tracers. The State of Nevada has determined that the use of tracers must be regulated under the UIC program.

Requirements for the ESF

- A permit must be obtained for any activity that includes underground injection (NRS 445.131-354).
- Tracers added to the water system must be of a composition and concentration compatible with the sanitary waste disposal system.
- Infiltration studies using tracers may require a permit.

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5.0 WATER POLLUTION CONTROL

5.1 FEDERAL WATER POLLUTION CONTROL ACT, as amended by the Clean Water Act of 1977, and the WATER QUALITY ACT OF 1987, as amended (33 USC 1251-1376; 33 CFR 209, 320, 323-330; 40 CFR 110, 112, 116, 117, 121, 122-125, 129, 133, 136, 230, 401, and 403; EO 11735; EO 12088; Nevada Administrative Code 445.70- 445.241)

The Federal Acts cited in this section are referred to collectively throughout the remainder of this discussion as "the Clean Water Act." The Clean Water Act (CWA, 1972) establishes Federal policy for restoring and maintaining the chemical, physical, and biological integrity of the Nation's waters. Among other things, the Act provides for the EPA or Federally-authorized States to implement permit programs for regulating the discharge of pollutants to navigable waters from any point source, as follows:

- Title IV of the Act (i.e., Permits and Licenses, Section 402, the National Pollutant Discharge Elimination System [NPDES]) is administered by the State of Nevada;
- Federal effluent limitations for direct discharges, and pre-treatment standards for discharges into publicly-owned treatment works (Title III of the Act) are enforced by the EPA;
- A program to regulate the discharge of oil and hazardous substances (Section 311 of the Act) is enforced by the EPA; and
- A permit system for the use of dredge and fill material (Section 404 of the Act) is administered by the U.S. Army Corps of Engineers.

5.1.1 NPDES Permit Program

Background

Section 313 of the CWA directs Federal agencies to comply with all Federal, State, interstate, and local requirements regarding the control and

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abatement of water pollution in the same manner, and to the same extent, as any non-government entity.

On September 9, 1975, the EPA approved Nevada's NPDES permit program and authorized Nevada to implement and enforce the program. The Nevada Department of Environmental Protection (NDEP) is the agency responsible for issuing or denying NPDES permits.

Applicability to the ESF

Water-related activities which may require an NPDES permit include all point source discharges. Examples of these are sewage treatment facilities, mine waste-water ponds, rock storage piles, pump tests, drinking-water supplies, monitoring and injection wells, and infiltration studies.

Requirements for the ESF

- AN NPDES permit must be obtained for effluent discharges.

- All waste waters shall be treated and disposed of in accordance with NPDES permit conditions.

- NPDES permits may contain written effluent limitations based on a variety of criteria, including the effects of the discharge on the receiving waters and the use of these receiving waters (Nevada Administrative Code 445.155).

- The permit may also require, at the discretion of the Water Quality Officer (WQO), the installation, use, and maintenance of equipment to monitor specified pollutants, and that monitoring records be retained, generally for three years.

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- If monitoring is required, the results of the monitoring will be reported to the WQO on a schedule specified in the permit, but not less frequently than once a year.

- The WQO has the authority to enter any premises where a permitted discharge is located for purposes of accessing and copying records, inspecting monitoring equipment, and sampling discharges. The costs of any test associated with these visits are the responsibility of the DOE.

- Any modifications of the facility or increases in the rate or type of permitted discharge must be reported to the WQO. If the modifications exceed permit conditions, a new NPDES permit must be obtained. An NPDES permit can be modified, suspended, or revoked by the WQO if, among other things, the terms of the permit are violated.

- A permit is valid for no more than 5 years. Renewal must be made to the WQO within 180 days of expiration.

5.1.2 Corps of Engineers Section 404 Permit

Background

Any Federal agency, State or individual that plans to dredge, fill, modify, or discharge into navigable waters or waters of the United States, as defined in the CWA, must first receive a Section 404 permit from the U.S. Army Corps of Engineers (Corps) (Section 404 of the CWA [33 CFR 320.2(g)]). Section 404 establishes Federal policy for restoring and maintaining the chemical, physical, and biological characteristics of the Nation's waterways.

Applicability to the ESF

On April 28, 1988, the DOE submitted an informal opinion to the Corps concerning the applicability of Section 404 of the CWA to site characterization at Yucca Mountain, and requested a formal determination by the Corps

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regarding Section 404 permitting applicability. Site characterization will require re-routing small segments of several dry washes along the east side of Yucca Mountain. The Corps conducted an on-site inspection at Yucca Mountain on October 18, 1989. On November 15, 1989, the Corps made a formal determination that re-routing of washes for site characterization would require Section 404 permitting, to be authorized under a Nationwide General Permit. This type of Section 404 permit allows the discharge of dredged or fill material into isolated, nontidal waters of the United States, including wetlands that are not part of a surface tributary system to interstate waters of the United States. The Corps included the YMP in a nationwide permit on August 17, 1990. Any significant changes in ESF design may require a review of our current Section 404 permit.

Requirements for the ESF

- A Section 404 permit must be obtained (or modified) before Yucca Mountain washes can be altered.

5.2 NEVADA WATER POLLUTION CONTROL LAW, (NRS 445.131-354)

Background

The Nevada Water Pollution Control Law was enacted to maintain the quality of the waters of the State of Nevada for public health and enjoyment, protection of animal life, operation of existing industries, the pursuit of agriculture, and the economic development of the State. This law is administered by the NDEP which requires that discharges of pollutants into the subsurface be controlled if the potential for contamination of groundwater supplies exists. If the NDEP determines that there is a potential for contamination, the agency will generally require, through issuance of zero-discharge permits, that impoundments be lined sufficiently to prevent seepage of pollutants into the ground.

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Applicability to the ESF

Site characterization activities such as the construction and use of sewage lagoons and mud and cutting pits, must be evaluated to determine their potential to contaminate groundwater supplies.

Requirements for the ESF

- A discharge permit will be obtained or zero-discharge demonstrated for all ponds and water impoundments.
- Runoff from disturbed areas will be controlled to minimize erosion (see Reclamation Section).
- Runoff from potentially contaminated areas (e.g., parking lots) will be controlled.

5.3 SANITARY AND SEWAGE-COLLECTION SYSTEM REGULATIONS (NAC 445.179-182; 445.750-840)

Background

The purpose of this permit authority is to regulate the design, construction, and operation of sanitary and sewage collection systems and to grant operating permits for such facilities in an effort to prevent or limit discharges of pollutants into waters of the State. NDEP administers this regulation.

Applicability to the ESF

The ESF will require a sanitary and sewage collection system.

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Requirements for the ESF

- A permit will be required for sanitary and sewage collection or treatment systems.

- The design of the system must comply with NAC 445.140-174.

- Construction plans must be prepared by a licensed engineer.

- The facility must be located outside of the floodplain.

- The ultimate disposal of sludge from the wastewater treatment facilities shall be performed in accordance with the requirements of Section 405 of the CWA, in addition to any applicable permit conditions.

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6.0 SOLID AND HAZARDOUS WASTE MANAGEMENT

6.1 RESOURCE CONSERVATION AND RECOVERY ACT OF 1976, as amended (P.L. 94-580; 42 USC 6901-6987; 40 CFR 124, 240-247, 260-264, 266, 270, 271, and 280; NRS 459.400 et seq. Nevada Administrative Code 444.570 through 444.748, and 444.842 through 444.9335).

Background

Management and disposal of solid and hazardous wastes (excluding radioactive wastes) shall be conducted in accordance with the requirements of the Resource Conservation and Recovery Act (RCRA), as amended, which includes RCRA permitting for hazardous wastes. The EPA has authorized the State of Nevada to administer Subtitle C of RCRA, regulating the management and disposal of hazardous wastes.

Applicability to the ESF

ESF activities may require the use of hazardous materials and the generation of both solid and hazardous wastes. The proper handling and disposal of solid and hazardous materials will require compliance with various federal and state regulations. Reporting requirements in the event of spills are included. Activities covered in this section include hazardous materials, landfills, use of insecticides and pesticides, toxic substances, and transportation of hazardous materials.

Requirements for the ESF

- Use of hazardous materials onsite must receive prior approval from the Yucca Mountain Site Characterization Project Office (YMPO), as per AP-6.13.

- The use of hazardous materials onsite must conform to the guidelines provided in the Hazardous Materials Management and Handling Program (HMMHP).

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- The requirements for management and disposal of hazardous wastes must be satisfied in accordance with Subtitle C of RCRA.

- Use of underground storage tanks must be in accordance with Subtitle I, RCRA.

- Use of recycled and recovered materials shall be given high priority, as required by Subtitle F.

- Non-hazardous solid waste will be recollected and hauled to an approved landfill, as required by NRS 444.440-620.

- Soil contaminated with spilled oil or fuel must be disposed of in an approved landfill or by another approved method.

6.2 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) (42 USC 9601 et seq; 40 CFR 300, 302, 355, 370, and 372; Executive Orders 12286, 12288, and 12580)

Background

CERCLA (as amended by SARA), also known as "Superfund," was created in 1980. The act provides for the clean-up of, and emergency response to, hazardous substances released into the environment, and for the clean-up of hazardous waste sites that present a substantial danger to public health and welfare. The emergency response and clean-up of hazardous substances released into the environment shall be conducted according to CERCLA.

Applicability to the ESF

The use of hazardous materials at the ESF will require that materials be transported, handled, stored, and disposed of properly, and may result in spills requiring corrective action.

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Requirements for the ESF

- Any spills of hazardous substances must be reported to appropriate agencies and officials, and be cleaned up in compliance with the Superfund Act.
- A "Spill Contingency Plan" is required for ESF activities.
- All field personnel must be trained in the proper handling of hazardous substances and in response actions to be taken in the event of a spill.
- Use of hazardous materials must comply with Community-Right-To-Know regulations under Title III of SARA.
- Transportation of all hazardous materials to the Yucca Mountain site must meet the requirements of the Hazardous Material Transportation Act (49 USC 1801; 49 CFR 171-178).
- The handling, use, and disposal of any toxic substances shall comply with the requirements of the Toxic Substances Control Act (TSCA), as amended (15 USC 2601).
- The use of pesticides shall comply with the requirements of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA, P.L.2-140 and P.L.95-396).

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7.0 BIOLOGICAL RESOURCE PROTECTION

7.1 ENDANGERED SPECIES ACT of 1973 (P.L. 93-205, as amended; 16 USC 1531-1543; 50 CFR Sections 17.11, 17.12, and 17.94-96; 50 CFR Parts 13, 222, 226, 227, 402, 424, and 450-453).

Background

Any Federal activity or Federally-supported activity must be performed in compliance with the Endangered Species Act (ESA, 1973). Accordingly, any Federal activity that could directly affect protected fish, wildlife, or vegetation, or destroy or alter the specific habitat of protected species, must be designed to avoid or mitigate all potentially adverse impacts.

Applicability to the ESF

The desert tortoise, existing at the Yucca Mountain site, has been listed as a Federally-protected, threatened species. ESF activities will require the performance of surface-disturbing work having the potential to affect the desert tortoise. Actions taken during site characterization must not jeopardize the continued existence of this species.

Requirements for the ESF

The following constraints are derived from requirements set forth in the Biological Opinion (BO) rendered by the U.S. Fish and Wildlife Service (McNatt, 1990) and are consistent with accepted revisions to the BO.

- Threatened or endangered species must be protected, in compliance with the ESA, as stipulated in the BO.

- Prior to any land disturbance, a preactivity survey must be conducted by qualified Project Office-designated participants to determine if the proposed activity will impact any important biological resources.

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- All personnel working at the site must complete the Environmental Requirements Training Program (ERTP).

- Any harassment of the desert tortoise is to be avoided. Neither the animal itself nor its burrow is to be touched or disturbed by other than a qualified biologist. Stay at least ten feet away from any burrow six inches or larger in height or width.

- If a desert tortoise is seen in the construction area, work shall cease and the Yucca Mountain Project Office (YMPO) and the Project Site Manager shall be notified. It may be necessary for a qualified biologist to relocate the tortoise before work may resume.

- Avoid hitting any animals which may be crossing roads or trails.

- Field participants are required to notify the YMPO immediately upon finding an injured or dead tortoise.

- Covered trash containers will be provided so that food and other garbage is discarded in a manner that will not attract ravens.

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8.0 ARCHAEOLOGICAL RESOURCE PROTECTION

8.1 NATIONAL HISTORIC PRESERVATION ACT OF 1966, as amended (16 USC 470 et seq; 36 CFR Parts 60, 61, 63, 65, 67, 68, and 800; Executive Order 11593), HISTORIC SITES, BUILDINGS, AND ANTIQUITIES ACT, as amended (16 USC 461-467), ARCHAEOLOGICAL AND HISTORIC PRESERVATION ACT (16 USC 469-469c)

AMERICAN INDIAN RELIGIOUS FREEDOM ACT OF 1978, (P.L. 95-341; 42 USC 1996; 36 CFR Part 296; 43 CFR Part 7)

ANTIQUITIES ACT (16 USC 431, 432, and 433; 25 CFR 261; 36 CFR 296; 43 CFR 3 and 7)

ARCHAEOLOGICAL RESOURCES PROTECTION ACT of 1979, (16 USC, Sections 470aa-470ll; 36 CFR 296; 43 CFR 7)

Background

The goal of all of the laws listed above, in terms of Federal activities, is to ensure consideration of the values of historic properties in carrying out Federal activities, and to make every effort to identify and mitigate impacts to significant historic properties. The National Historic Preservation Act (NHPA) is the principal authority to which the DOE will respond with regard to the protection of historic properties. The NHPA requires all Federal agencies to take into account the effects of their undertakings (e.g., site characterization) on historic properties, and to allow the Advisory Council on Historic Preservation (ACHP) to comment on the adequacy of the agency's plans. Historic properties are defined as any properties included in, or eligible for inclusion in, the National Register of Historic Places.

Applicability to the ESF

The YMP area contains many historic sites and artifacts which require protection under the NHPA, Antiquities Act (AA), the American Indian

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Religious Freedom Act (AIRFA), and the Archaeological Resources Protection Act (ARPA). The implementation of the "Programmatic Agreement" between the DOE and the ACHP will satisfy the YMP's commitments and responsibilities under these various Acts.

Requirements for the ESF

The following constraints established to protect archaeological resources are consistent with applicable Federal, State, and local environmental regulations.

- A preactivity survey must be conducted by qualified YMPO contractors to determine if the proposed activity will affect archaeological resources.

- If archaeological resources are identified within the area proposed for the activity, it may be necessary to relocate the activity, to recover data from the site prior to trenching, or to designate an "Inclusion Area" for the activity. An Inclusion Area should clearly delineate an area within which surface-disturbing activities are restricted. Any area beyond the Inclusion Area boundary is off-limits to equipment and personnel to prevent inadvertent disturbance of an archaeological resource.

- A site-specific Data Recovery Plan shall be prepared by a designated archaeologist and approved by the ACHP prior to recovering data from the site.

- If archaeological resources are discovered within the area approved for activity, work shall cease and the YMPO Operations Control Branch and Project Site Manager will be notified.

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9.0 RECLAMATION

Background

In compliance with the NWPA, as amended, the DOE has developed a program for the reclamation of areas disturbed by site characterization. This program requires that disturbed land be returned to a stable ecological state with a form and productivity similar to its predisturbed state.

Applicability to the ESF

BLM Right-of-Way-Reservations and the NWPA Section 113(b)(1)(A) require that areas altered by site characterization activities be reclaimed. Any surface-disturbing activities to be undertaken at Yucca Mountain under the purview of the YMP must be planned in accordance with the Reclamation Implementation Plan (RIP; DOE, 1991).

Requirements for the ESF

- Reclamation activities will be carried out as described in the RIP.
- A preactivity survey must be conducted to determine biotic, soil type, and reclamation capabilities of each site.
- Surface-disturbing activity reclamation specifications shall include considerations to minimize dust and other environmental impacts.
- Guidelines in the RIP should be followed, including requirements for:
  - Site inventory
  - Site clearing
  - Topsoil storage and management

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- Erosion control
- Drainage control
- Site abandonment and facility decommissioning
- Recontouring
- Revegetation
- Irrigation
- Post-reclamation monitoring

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10.0 RADIOLOGICAL HEALTH AND SAFETY

Background

The NWPA, as amended, and the NEPA require the DOE to conduct radiological studies and radiological monitoring at the Yucca Mountain site. The DOE, the EPA, and the NRC each have established rules, regulations, and orders pertaining to radiological health and safety. In the event of conflicts or duplications among the radiological requirements listed in the Yucca Mountain Regulatory Compliance Plan (YMP/90-33, September, 1990), the requirement holding the highest authority will prevail. In general, Public Laws are the most authoritative, followed by the Code of Federal Regulations, Project Positions and NRC guidance. Department Orders are the least authoritative. In the absence of more authoritative requirements, however, site characterization activities will be carried out in compliance with DOE Orders relating to radiological health, safety and environmental protection, as described in the Radiological Monitoring Plan (DOE, 1990).

Applicability to the ESF

It is anticipated that four potential sources of radioactive materials will exist at the Yucca Mountain site during site characterization.

1. Release of naturally-occurring radionuclides from mining activities;

2. Discharge of groundwater, expected to contain only natural background radioactivity, to the surface;

3. Resuspension of radioactive materials previously deposited during nuclear testing at the NTS; and

4. Release of short-lived radioactive tracers as part of geohydrological modeling, and the small potential for release of radioactive material during well-logging activities.

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Because only a small volume of rock will be mined and a small amount of groundwater released to the surface during site characterization, it is estimated that radioactive releases will amount to only a small fraction of the natural background radiation always present, and will not constitute a significant radiological impact.

The resuspension of previously-deposited radioactive materials during site characterization is also expected to be insignificant compared to natural background because of the low concentration of radioactive materials present in the existing environment. However, estimates presented in the Environmental Assessment (DOE, 1986) may include inherent uncertainties because past radiological monitoring at and around the Yucca Mountain site has been limited. To verify that there will be no significant impact, as mandated by the Environmental Monitoring and Mitigation Plan (EMMP; DOE, 1988b), radiological monitoring will be conducted in the areas of (1) radioactive material concentrations in air, soils, biota, and groundwater; and (2) external radiation background field.

Requirements for the ESF

- The ESF shall comply with the requirements of the Yucca Mountain Project Radiological Monitoring Plan (RMP; DOE, 1990).

- Consistent with the requirements of DOE Order 5480.11, equipment is considered to be potentially contaminated if it has been used or stored in a controlled area that has contained unconfined radioactive material. Prior to its use, such equipment must be surveyed to determine whether both removable and total surface contamination is greater than the levels specified in DOE Order 5400.5.

- The T&MSS Radiological Field Programs Department should be notified at least three weeks prior to initiation of an activity. Notification shall include date, duration, and description of all field activities being initiated so that potential changes to the radiological data can be reconciled consistent with the EMMP.

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- Limited radon monitoring in a mine or in mine exhaust is required when the mine is initially opened, and may be necessary throughout the duration of many site characterization activities.

- If radioactive tracers are used, the DOE will comply with 40 CFR Part 144 and NAC Chapter 445.

- If radioactive material or radiation-producing equipment is used on State or private land (not controlled by the U.S. Government), compliance with the State of Nevada Regulations for Radiation Control is required.

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11.0 LAND ACCESS

11.1 FEDERAL LAND POLICY AND MANAGEMENT ACT of 1976 (P.L. 94-579; 43 USC 1701-1784; 43 CFR 2800)

Background

The Federal Land Policy and Management Plan (FLPMA) establishes U.S. Government policy with regard to government-owned lands administered by the Bureau of Land Management (BLM). FLPMA mandates that such lands be managed in a manner that will (1) protect the quality of scientific, scenic, historical, ecological, environmental, and archaeological values; (2) preserve and protect certain public lands in their natural condition; (3) provide food and habitat for fish and domestic animals; and (4) provide for outdoor recreation and human occupancy and use.

Applicability to the ESF

Federal activities requiring access to, and activity on, public lands require compliance with the FLPMA. Because the Yucca Mountain site is partially on BLM-administered public land and BLM-administered Air Force land, and because activities will occur on BLM lands, as well, DOE compliance with BLM requirements for access and use of this land is mandatory.

The DOE obtained access to the BLM and Air Force lands for site characterization through Rights-of-Way granted in January 1988 and October 1989.

Requirements for the ESF

In issuing these Rights-of-Way, the BLM has stipulated specific environmental requirements which include:

- Access approval for the activity must be confirmed by the Project Office.

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- A copy of the BLM Right-of-Way Reservation (ROWR) Agreement (BLM, 1988; BLM, 1989) must be available at the job-site when work is being conducted in the field.

- Stipulations listed in the ROWR Agreement (BLM, 1988; BLM, 1989) must be followed.

- Off-road driving or parking is prohibited unless specifically permitted in writing by the YMPO. Any access route or area of disturbance will be specifically approved through the environmental review process. Existing trails may be used if prior environmental approval is obtained.

- Sand and gravel must be obtained from a source authorized by a BLM free-use permit or from a duly permitted commercial source.

- Core holes and wells containing potentially usable water should be left in a manner which facilitates their development as water sources. Prior to termination of the agreement or abandonment of the holes/wells, the DOE will consult BLM to determine if the holes will be sealed and capped, plugged, or turned over to the BLM as is.

- The DOE is required to fulfill all requirements applicable to the NEPA, as well as all requirements for mitigation, stabilization, and rehabilitation, as described in the Plan of Development and listed in Sections 4.1.1.4 and 4.1.2.6 of the Yucca Mountain Environmental Assessment (DOE, 1986). This responsibility will continue until the requirements are met, regardless of expiration of the Right-of-Way reservation.

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12.0 FLOODPLAIN PROTECTION

Background

Executive Order (EO) 11988 requires that each Federal agency take action to reduce the risk of flood damage, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values served by floodplains.

Applicability to the ESF

Activities planned within the 100-year floodplain at the Yucca Mountain site require certain compliance actions (EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT; as implemented by 10 CFR Part 1022).

Requirements for the ESF

- Any activity conducted in a floodplain must be preceded by a floodplain/wetlands assessment, in compliance with 10 CFR Part 1022.

- Alternatives to building in the defined 100-year floodplain must be identified and considered.

- Structures/facilities built in the floodplain should be designed to both minimize effects on the floodplain and protect the structure/facilities in the floodplain.

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13.0 NOISE

13.1 THE NOISE CONTROL ACT (NCA) OF 1972, as amended by the Quiet Communities Act of 1978, (42 USC 4901-4918; Executive Order 12088)

Background

Federal agencies must carry out their programs in a manner that promotes an environment free of noise that could jeopardize public health or welfare.

Applicability to the ESF

Construction and operational activities for the ESF will cause noise pollution that must be monitored to ensure that the noise does not jeopardize worker health or cause significant impacts to wildlife.

Requirements for the ESF

- Noise levels must be controlled and monitored, in accordance with regulations implementing the NCA (40 CFR Chapter 1, Subchapter G).

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APPENDIX K

CORRELATION OF DAA CRITERIA WITH CORRESPONDING ESFDR CRITERIA

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APPENDIX K

The ESF Title I Design Acceptability Analysis and Comparative Evaluation of Alternative ESF Locations (DAA) was, in part, a review of the adequacy of ESF Title I design for three concerns expressed by the NRC. The three concerns are listed on page INTRO-2 of this document. This appendix contains the text of the criteria used in the review to evaluate ESF design. Appendix I-3 of the DAA contains a detailed discussion of the development process for the criteria.

This appendix enables the user to correlate DAA criteria with corresponding ESFDR criteria, and to understand how the criteria implement higher-level 10 CFR 60 requirements. The references shown in parentheses indicate the location of a corresponding statement in the ESFDR.

Some of the 10 CFR 60's (and corresponding DAA criteria) do not directly influence the ESF design and consequently do not appear in the ESFDR text. These have been listed in the ESFDR Introduction under the section titled 10 CFR 60 Requirements. They have been separated into the following five separate categories.

1. The 10 CFR 60 requirements that regulate the handling and control of radioactive material do not appear in the ESFDR because it is anticipated that radioactive waste will not be used during the ESF testing. These are identified as (I-1) under the DAA number.

2. Similarly, the 10 CFR 60 requirements for structures systems and components that protect the public's radiological health and safety do not appear in the ESFDR because such structures would not be needed where there is no radioactive material. These are identified as (I-2) under the DAA number.

3. The administrative requirements of 10 CFR 60 do not appear in the ESFDR because they are covered elsewhere and are irrelevant to the ESF design. These are identified as (I-3) under the DAA number.

4. There are 10 CFR 60 requirements that do not appear in the ESFDR simply because they cannot be evaluated or implemented at this time. These are identified as (I-4) under the DAA number.

5. Finally, the ESFDR has been revised to eliminate all requirements applicable to actual performance confirmation program because these belong in the SCPB. These are identified as (I-5) in the DAA number.

Additionally, there are some DAA requirements pertaining to underground testing that do not appear in the ESFDR Volume 1 but will be incorporated in the test plan reference Appendix B in ESFDR Volume 2. These are identified as (TP) under the DAA number.

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The criteria list is arranged in a structured fashion that is based upon a four element reference code, that contains information about the specific NRC concern (first element), 10 CFR 60 requirement (second element), ESF physical system (third element), and criterion (fourth element).

The specific requirements of 10 CFR 60 that are addressed by the criteria list are different for each NRC concern. The requirements that are relevant to each concern are indicated on the attached correlation matrix. Within the reference code, the specific requirements of 10 CFR 60 relevant to each of the NRC concerns are assigned a sequential number for each of the NRC concerns.

The third element of the code is based on the nine fourth-level elements of the ESF Physical System Description. These elements are:

1. ESF SITE
2. SURFACE UTILITIES
3. SURFACE FACILITIES
4. SHAFT ACCESS
5. RAMP ACCESS
6. UNDERGROUND EXCAVATIONS
7. UNDERGROUND SUPPORT SYSTEMS
8. UNDERGROUND TEST SUPPORT
9. ESF DECOMMISSIONING AND CLOSURE

The fourth element of the code is a sequential numbering of the criteria for each specific entry number under an ESF Physical System Element.

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NRC CONCERN NO: 1

The ESF design, construction, and operations should not compromise the ability of the site to isolate waste.

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1.1 Requirement 60.15(d)(1): Investigations to obtain the required information shall be conducted in such a manner as to limit adverse effects on the long term performance of the geologic repository to the extent practicable. *

1.1.1 Site

1.1.1.1 (1.2.6.1CA) The design of the main pad shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the main pad shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository.

1.1.2 Surface Utilities

1.1.2.1 (1.2.6.2CA) The design of the surface utilities, including the waste water ponds and water handling system, shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the surface utilities shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository.

1.1.4 First shaft

1.1.4.1 (1.2.6.4PC2a.i) The design of the first shaft shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the first shaft shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository.

1.1.5 Second shaft

1.1.5.1 (1.2.6.5PC2a.i) The design of the second shaft shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the second shaft shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository.

1.1.6 Underground excavation

1.1.6.1 (1.2.6.6PC2a.i) The design of the underground excavation shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the underground excavation shall be performed in a manner that limits the potential for

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adverse impacts of the long term performance of the repository.

1.1.7 Underground utilities

1.1.7.1 (1.2.6.7CB.i) The design of the underground utilities shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the underground utilities shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository.

1.1.8 Underground testing

1.1.8.1 (TP) The design of the underground testing program shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and implementation and operation of the underground testing program shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository.

1.1.8.2 (TP) Prior to implementing the underground testing program, or prior to implementing additional tests, an evaluation of the potential impacts of such testing on the waste isolation capability of the site shall be performed.

1.1.9 Decommissioning

1.1.9.1 (I-2) The first shaft, second shaft, all underground excavations, and all boreholes shall be constructed to allow backfilling and sealing as necessary to limit the release of radioactive material to the environment.

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1.2 Requirement: 60.15(d)(3) To the extent practical, exploratory boreholes and shafts in the geologic repository operations area shall be located where shafts are planned for underground facility construction and operation or where large unexcavated pillars are planned.

1.2.4 First shaft

1.2.4.1 (1.2.6.0PC2c.v) The shaft pillar is the buffer zone surrounding the shaft beyond which any instability of other underground openings has a negligible effect on shaft stability. Within the shaft pillar area, all facilities and openings shall be designed to be stable for a 100 year life and to limit any adverse effects on the stability of the shafts that could impact the ability of the site to isolate waste.

1.2.4.2 (1.2.6.4PC2b.i) The exploratory shafts shall be located, to the extent practicable, where shafts are planned for the repository facility.

1.2.5 Second shaft

1.2.5.1 (1.2.6.0PC2c.v) The shaft pillar is the buffer zone surrounding the shaft beyond which any instability of other underground openings has a negligible effect on shaft stability. Within the shaft pillar area, all facilities and openings shall be designed to be stable for a 100 year life and to limit any adverse effects on the stability of the shafts that could impact the ability of the site to isolate waste.

1.2.5.2 (1.2.6.5PC2b.i) The exploratory shafts shall be located, to the extent practicable, where shafts are planned for the repository facility.

1.2.6 Underground excavation

1.2.6.1 (1.2.6.6PC2b.i) Exploratory boreholes shall be located so that they do not intersect any underground openings.

1.2.6.2 (1.2.6.6PC2b.ii) For sealing purposes, exploratory boreholes shall be located a minimum distance of 15 m from any underground opening.

1.2.6.3 (1.2.6.6PC2b.iii.c) Borehole alignments and location shall be monitored, surveyed, and the results included on all underground working maps.

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1.2.8 Underground testing

1.2.8.1 (1.2.6.8CD.i) MPBH boreholes shall be located in pillars to the extent practicable.

1.2.8.2 (1.2.6.8CD.iii) Boreholes drilled from the underground portion of the ESF shall not penetrate significantly below the base of the TsW2 host rock, unless the impacts of doing so, on the waste isolation performance of the site, have been evaluated and found to be acceptable.

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1.3 Requirement: 60.21(c)(1)(ii)(D). The assessment shall contain - The effectiveness of engineered and natural barriers, including barriers that may not be themselves a part of the geologic repository operations area, against the release of radioactive material to the environment. The analysis shall also include a comparative evaluation of alternatives to the major design features that are important to waste isolation, with particular attention to the alternatives that would provide longer radionuclide containment and isolation.

1.3.4 First shaft

(I-2) 1.3.4.1 The exploratory shaft locations should be selected, consistent with other goals of site characterization, to limit impacts on isolation.

(I-2) 1.3.4.2 The exploratory shaft ground support system should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed.

(I-2) 1.3.4.3 The exploratory shaft diameter should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the diameter is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed.

(I-2) 1.3.4.4 The exploratory shaft liner should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the liner is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed.

(I-2) 1.3.4.5 The exploratory shaft operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed.

1.3.5 Second shaft

(I-2) 1.3.5.1 The exploratory shaft locations should be selected, consistent with other goals of site characterization, to limit impacts on isolation.

(I-2) 1.3.5.2 The exploratory shaft ground support system should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed.

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(I-2) 1.3.5.3 The exploratory shaft diameter should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the diameter is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed.

(I-2) 1.3.5.4 The exploratory shaft liner should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the liner is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed.

(I-2) 1.3.5.5 The exploratory shaft operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed.

1.3.6 Underground excavation

(I-2) 1.3.6.1 The Exploratory Shaft Underground Facility layout, including drift size, should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the layout is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed.

(I-2) 1.3.6.2 The Exploratory Shaft Underground Facility support system should be designed, consistent with the other goals of site characterization, to limit the impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed.

(I-2) 1.3.6.3 The Exploratory Shaft Underground Facility operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed.

1.4 Requirement: 60.21(c)(11). The Safety Analysis Report shall include: A description of design consideration that are intended to facilitate permanent closure and decontamination or dismantlement of surface facilities.

1.4.1 Site

1.4.1.1 (1.2.6.1CB) The pad shall be designed to permit the ground to be restored to a contour compatible with its initial conditions.

1.4.4 First shaft

1.4.4.1 (1.2.6.4.2CD) The shaft liner shall be designed to be removable prior to permanent closure.

1.4.4.2 (1.2.6.4PC2k.ii) To prevent complications of seal evaluations and emplacement and limit chemical alteration in future seal environments, no pressure grouting shall take place during the construction period of the shaft at locations of potential seal testing or emplacement. Specifically, no pressure grouting shall be performed within 50 feet of the original ground surface and within 50 feet (above and below) the contact of the Pah Canyon and Topopah Spring tuffs.

1.4.4.3 (1.2.6.4.4CC) Furnishings in the shafts shall be designed to be removable, if necessary, prior to permanent closure.

1.4.5 Second shaft

1.4.5.1 (1.2.6.5.2CC) Shaft liners shall be designed to be removable prior to permanent closure.

1.4.5.2 (1.2.6.5PC2k.ii) To prevent complications of seal evaluations and emplacement and limit chemical alteration in future seal environments, no pressure grouting shall take place during the construction period of the shaft at locations of potential seal testing or emplacement. Specifically, no pressure grouting shall be performed within 50 feet of the original ground surface and within 50 feet (above and below) the contact of the Pah Canyon and Topopah Spring tuffs.

1.4.5.3 (1.2.6.5.4CC) Furnishings in the shafts shall be designed to be removable, if necessary, prior to permanent closure.

1.4.6 Underground excavation

1.4.6.1 (1.2.6.6PC2h.ii) The drainage plan for the ESF and long exploratory drifts should be consistent with postclosure sealing concerns.

1.4.6.2 (1.2.6.7CH) Nonpermanent components in the underground openings shall be designed to be removable, if necessary, prior to permanent closure.

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1.4.9 Decommissioning

(I-2) 1.4.9.1 The first shaft, second shaft, all underground excavations, and all boreholes shall be constructed to allow backfilling and sealing as necessary to limit the release of radioactive material to the environment.

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1.5 Requirement: 60.74 (a) DOE shall perform, or permit the Commission to perform, such tests as the Commission deems appropriate or necessary for the administration of the regulations in this part. These may include tests of: (1) Radioactive waste, (2) the geologic repository including its structures, systems, and components, (3) radiation detection and monitoring instruments, and (4) other equipment and devices used in connection with the receipt, handling, or storage of radioactive waste. (b) The tests required under this section shall include a performance confirmation program carried out in accordance with Subpart F of this part.

1.5.8 Underground testing

(TP) 1.5.8.1 The testing program and underground layout shall be designed with sufficient flexibility that tests that are deemed appropriate by the NRC can be performed. Prior to incorporating such tests, an evaluation of potential impacts on waste isolation shall be performed.

(TP) 1.5.8.2 Performance confirmation testing shall be carried out to meet the requirements of 10 CFR 60, Subpart F. Prior to incorporating such tests, an evaluation of potential impacts on waste isolation shall be performed.

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1.6 Requirement: 60.112 The geologic setting shall be selected and the engineered barrier system and the shafts, boreholes and their seals shall be designed to assure that releases of radioactive materials to the accessible environment following permanent closure conform to such generally applicable environmental standards for radioactivity as may have been established by the Environmental Protection Agency with respect to both anticipated processes and events and unanticipated processes and events. *

1.6.1 Site

1.6.1.1 (1.2.6.1CC.iii) The Exploratory Shaft Facility pad shall be designed and constructed so that it does not lead to creation of pathways that compromise the repository's capability to meet the performance objective of 10 CFR Part 60.112.

1.6.2 Surface Utilities

1.6.2.1 (1.2.6.2CF) The surface utilities shall be designed and constructed so that they do not affect the capability of the repository to meet the Performance Objective of 10 CFR 60.112.

1.6.4 First shaft

1.6.4.1 (I-4) The shaft opening shall be designed and constructed so that, following permanent closure, it does not become a pathway that compromises the repository's ability to meet the performance objectives of 10 CFR Part 60.112.

1.6.5 Second shaft

1.6.5.1 (I-4) The shaft opening shall be designed and constructed so that, following permanent closure, it does not become a pathway that compromises the repository's ability to meet the performance objectives of 10 CFR Part 60.112.

1.6.6 Underground excavation

1.6.6.1 (I-4) The Exploratory Shaft Facility underground excavation shall be designed and constructed so that, following permanent closure, it does not become a pathway that compromises the repository's ability to meet the performance objective of 10 CFR Part 60.112.

1.6.7 Underground Utilities

1.6.7.1 (I-4) The underground utilities shall be designed and constructed so that they do not affect the capability of the repository to meet the Performance Objective of 10 CFR 60.112.

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1.6.8 Underground testing

(TP) 1.6.8.1 The testing program shall not affect the capability of the underground repository to meet the performance objective of 10 CFR 60.112.

(TP) 1.6.8.2 Borehole openings shall be designed so that, following permanent closure, they do not become pathways that compromise the repository's ability to meet the performance objectives of 10 CFR Part 60.112.

1.6.9 Decommissioning

(I-4) 1.6.9.1 The first shaft, second shaft, all underground excavations, and all boreholes shall be constructed to allow backfilling and sealing as necessary to limit the release of radioactive material to the environment.

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1.7 Requirement 60.113(a)(1)(i): The engineered barrier system shall be designed so that, assuming anticipated processes and events: (A) Containment of HLW will be substantially complete during the period when radiation and thermal conditions in the engineered barrier system are dominated by fission product decay; and (B) any release of radionuclides from the engineered barrier system shall be a gradual process which results in small fractional releases to the geologic setting over long times.

1.7.6 Underground excavation

(I-4) 1.7.6.1 The underground excavation shall be designed to assist or not detract from the capability of the repository to ensure substantially complete containment and a release of radionuclides that is a gradual process after the containment period, and construction and operation of the underground excavation shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure substantially complete containment and a release of radionuclides that is a gradual process after the containment period.

1.7.7 Underground utilities

(I-4) 1.7.7.1 The underground utilities shall be designed to assist or not detract from the capability of the repository to ensure substantially complete containment and a release of radionuclides that is a gradual process after the containment period, and construction of the underground utilities shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure substantially complete containment and a release of radionuclides that is a gradual process after the containment period.

1.7.8 Underground testing

(TP) 1.7.8.1 The underground testing program shall be designed to assist or not detract from the capability of the repository to ensure substantially complete containment and a release of radionuclides that is a gradual process after the containment period, and construction and operation of the underground testing program shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure substantially complete containment and a release of radionuclides that is a gradual process after the containment period.

1.8 Requirement 60.113(a)(1)(ii)(A): Containment of HLW within the waste packages will be substantially complete for a period determined by the commission taking into account the factors specified in 60.113 (b) provided that such period shall not be less than 300 years nor more than 1000 years after the permanent closure of the repository. *

1.8.6 Underground excavation

(I-4) 1.8.6.1 The underground excavation shall be designed to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository, and construction and operation of the underground excavation shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository.

1.8.7 Underground utilities

(I-4) 1.8.7.1 The underground utilities shall be designed to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository, and construction of the underground utilities shall be performed in a manner intended to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository.

1.8.8 Underground testing

(TP) 1.8.8.1 The underground testing program shall be designed to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository, and implementation and operation of the underground testing program shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository.

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1.9 Requirement 60.113(a)(1)(ii)(B): The release rate of any radionuclide from the engineered barrier system following the containment period shall not exceed one part in 100,000 per year of the inventory of that radionuclide calculated to be present at 1000 years following permanent closure. *

1.9.6 Underground excavation

(I-4) 1.9.6.1 The underground excavation shall be designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure, and construction and operation of the underground excavation shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure.

1.9.7 Underground utilities

(I-4) 1.9.7.1 The underground utilities shall be designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure, and construction of the underground utilities shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure.

1.9.8 Underground testing

(TP) 1.9.8.1 The underground testing program shall be designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure, and construction and operation of the underground excavation

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shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure.

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1.10 Requirement: 60.130: Sections 60.131 through 60.134 specify minimum criteria for the design of the geologic repository operations area. These design criteria are not intended to be exhaustive, however. Omissions in §§ 60.131 through 60.134 do not relieve DOE from any obligation to provide such safety features in a specific facility needed to achieve the performance objectives. All design bases must be consistent with the results of site characterization activities.

1.10.1 Site

1.10.1.1 (1.2.6.1CE) Pad operation and construction should limit adverse chemical changes by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.4 First shaft

1.10.4.1 (1.2.6.4PC2a.ii) (1.2.6.4PC2a.iii) Shaft operation and construction should limit adverse chemical changes (type, quantity and location) particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.4.2 (1.2.6.4PC2a.ii.a) (1.2.6.4PC2a.ii.b) The usage of cement, shotcrete, and grout for bolt anchors or other rock mass support for shaft construction and operations should not exceed requirements for proper construction or safety considerations.

1.10.4.3 (1.2.6.4PC2a.ii) The chemistry of any water used in shaft construction, or operation should be compatible with postclosure requirements to isolate and contain waste.

1.10.4.4 (1.2.6.4PC2a.ii.c) Fluids and materials planned for use in the shaft shall be evaluated with respect to intended use for possible effects on the capability of the site to isolate waste, and appropriate controls instituted.

1.10.4.5 (1.2.6.4PC2a.iv) A materials control program should be implemented to enable establishment of limits on the inventory of materials left after decommissioning.

1.10.4.6 (1.2.6.4.2CD) The capability to enhance postclosure performance by removing shaft liners shall be retained.

1.10.4.7 (1.2.6.4PC2a.v) The shaft shall be designed with construction controls that enable flexibility in closure, such as the location of seals, so that a seismic event is unlikely to compromise the ability of the facility to isolate wastes.

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1.10.4.8 (1.2.6.4PC2a.ii) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.5 Second shaft

1.10.5.1 (1.2.6.5PC2a.ii) (1.2.6.5PC2a.iii) Shaft operation and construction should limit adverse chemical changes (type, quantity and location) particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.5.2 (1.2.6.5PC2a.ii.a) (1.2.6.5PC2a.ii.b) The usage of cement, shotcrete, and grout for bolt anchors or other rock mass support shaft construction and operations should not exceed requirements for proper construction or safety considerations.

1.10.5.3 (1.2.6.5PC2a.ii) The chemistry of any water used in shaft construction, or operation should be compatible with postclosure requirements to isolate and contain waste.

1.10.5.4 (1.2.6.5PC2a.ii.c) Fluids and materials planned for use in the shaft shall be evaluated with respect to intended use for possible effects on the capability of the site to isolate waste, and appropriate controls instituted.

1.10.5.5 (1.2.6.5PC2a.iv) A materials control program should be implemented to enable establishment of limits on the inventory of materials left after decommissioning.

1.10.5.6 (1.2.6.5.2CC) The capability to enhance postclosure performance by removing shaft liners shall be retained.

1.10.5.7 (1.2.6.5PC2a.v) The shaft shall be designed with construction controls that enable flexibility in closure, such as the location of seals, so that a seismic event is unlikely to compromise the ability of the facility to isolate wastes.

1.10.5.8 (1.2.6.5PC2a.ii) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.6 Underground excavation

1.10.6.1 (1.2.6.6PC2c.i) The ESF shall be designed with a minimum distance of 75 feet between the centerlines of the adjacent ESF and waste emplacement drifts.

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1.10.6.2 (1.2.6.6PC2a.ii) Underground facility operation and construction should limit adverse chemical changes (type, quantity and location) particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.6.3 (1.2.6.6PC2a.ii.a) (1.2.6.6PC2a.ii.b) Underground facility construction and operation should limit cement, shotcrete, and grout for bolt anchors or other rock mass support to that required for proper construction.

1.10.6.4 (1.2.6.6PC2a.ii) The chemistry of any water used in underground excavation construction or operation should be compatible with postclosure requirements to isolate and contain waste.

1.10.6.5 (1.2.6.6PC2a.ii.c) Fluids and materials planned for use in the underground excavation shall be evaluated with respect to intended use for possible effects on the capability of the site to isolate waste, and appropriate controls instituted.

1.10.6.6 (1.2.6.6PC2a.iii) A materials control program should be implemented to enable establishment of limits on the inventory of materials left after decommissioning.

1.10.6.7 (1.2.6.6PC2a.iv) The underground excavation shall be designed with construction controls that permit flexibility in closure, such as the location of seals, so that a seismic event is unlikely to compromise the ability of the facility to isolate wastes.

1.10.6.8 (1.2.6.6PC2a.ii) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.7 Underground utilities

1.10.7.1 (1.2.6.7CD.i) Utility systems, including the water distribution and mine wastewater collection systems, shall be designed so that, in the event of seismic activity, the ability of the facility to isolate waste will not be compromised.

1.10.8 Underground testing

1.10.8.1 (1.2.6.8CE.i) Fluids and materials planned for use in the shaft shall be evaluated with respect to intended use for possible effects on the capability of the site to isolate waste, and appropriate controls instituted.

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(TP) 1.10.8.2 The testing program should limit adverse chemical changes (type, quantity and location) particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

(TP) 1.10.8.3 The testing program should be executed in a manner that contributes to or does not detract from the isolation capability of the site; for example, by limiting organics in drilling fluids and explosive residues from blasting.

(TP) 1.10.8.4 The chemistry of any water used in the testing program should be compatible with isolation and containment objectives.

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1.11 Requirement: 60.133(a)(1) The orientation, geometry, layout, and depth of the underground facility, and the design of any engineered barriers that are part of the underground facility shall contribute to the containment and isolation of radionuclides.

1.11.4 First shaft

(1.2.6.4PC2d.iii)	1.11.4.1	The shaft configuration (shaft location, shaft diameter, shaft separation, and shaft depth) should contribute to or not detract from the isolation capability of the site.

1.11.5 Second shaft

(1.2.6.5PC2d.iii)	1.11.5.1	The shaft configuration (shaft location, shaft diameter, shaft separation, and shaft depth) should contribute to or not detract from the isolation capability of the site.

1.11.6 Underground excavation

(1.2.6.6PC2e.v)	1.11.6.1	The underground facility configuration (drift location, orientation, geometry, and drift sizes) should contribute to or not detract from the capability of the site to isolate and contain waste.
(1.2.6.6PC2e.i)	1.11.6.2	Overburden above the potential repository horizon must be > 200m.
(1.2.6.6PC1a.ii)	1.11.6.3	If possible, confine Main Test Level facility to TsW2, although TsW1 can be considered.
(1.2.6.6PC2c.i)	1.11.6.4	Location of underground facility should stay within the conceptual perimeter drift boundary, except as needed to characterize areas outside that boundary, taking into account any potential impacts on the waste isolation capabilities of the site.
(1.2.6.6PC2b.ii)	1.11.6.5	The distance of underground facility openings from exploratory boreholes drilled from the surface should be at least 15m.
(1.2.6.6PC2e.ii)	1.11.6.6	The spacing between adjacent ESF drifts shall be a minimum of two drift diameters (using the maximum diameter of either opening, and considering the closest proximity of any part of each opening).
(1.2.6.6PC1b.i)	1.11.6.7	The number of interconnections between the dedicated test area and the repository should be limited to as few as possible, consistent with access and ventilation needs.

1.11.6.8 (1.2.6.6PC2h.ii) The drainage plan for the ESF and long exploratory drifts should be consistent with repository operations and postclosure sealing concerns. Specifically, drainage in the dedicated test area should be toward ES-1 and drainage in long drifts should be compatible with repository grades.

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1.12 Requirement: 60.133(a)(2) The underground facility shall be designed so that the effects of credible disruptive events during the period of operations, such as flooding, fires and explosions, will not spread through the facility.

1.12.1 Site

1.12.1.1 (1.2.6.1PC1b) The areas around the shaft collar shall be designed and constructed to prevent water inflow from the probable maximum flood.

1.12.2 Surface Utilities

1.12.2.1 (1.2.6.2CC) Water storage tanks should be located, or protection provided to preclude water inflow to ESF following a possible tank failure.

1.12.2.2 (1.2.6.2CD) Piping shall be designed to preclude or limit possible water inflow to the ESF following a pipe rupture.

1.12.4 First shaft

1.12.4.1 (1.2.6.4PC2e.i) The exploratory shaft shall be designed so that the effects of credible disruptive events (e.g., flooding, fires, and explosions) shall be limited from spreading through the facility.

1.12.5 Second shaft

1.12.5.1 (1.2.6.5PC2e.i) The exploratory shaft shall be designed so that the effects of credible disruptive events (e.g., flooding, fires, and explosions) shall be limited from spreading through the facility.

1.12.6 Underground excavation

1.12.6.1 (1.2.6.6PC2f.i) The Exploratory Shaft Underground Facility shall be designed so that the effects of credible disruptive events (e.g., flooding, fires, and explosions) shall be limited from spreading through the facility.

1.12.6.2 (1.2.6.6PC2f.iv) The drainage plan for the ESF and long exploratory drifts should be designed to ensure that the effects of flooding shall be limited from spreading through the facility.

1.12.6.3 (1.2.6.6PC2f.ii) Materials should be selected such that effects of fire do not produce geochemical effects that impact waste isolation capabilities of the site.

1.12.6.4 (1.2.6.6PC2f.iii) The underground facility should be designed to limit any spread of fire, which could produce geochemical effects that impact waste isolation capabilities of the site.

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1.12.6.5 (1.2.6.6PC2h.vii) Operational seals shall be provided where necessary to control the spread of water through the facility.

1.12.7 Underground utilities

1.12.7.1 (1.2.6.7CJ) Water lines in ESF should be outfitted to limit water inflow to ESF following a possible line rupture.

1.12.7.2 (1.2.6.7.6PC1b.v) Effective redundant minewater discharge systems should be provided to limit possible impacts on the isolation capability of the site.

1.12.7.3 (1.2.6.7.8CA) Fire suppression agents shall be selected such that they do not produce geochemical effects that adversely impact waste isolation capabilities of the site.

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1.13 Requirement: 60.133(b) The underground facility shall be designed with sufficient flexibility to allow adjustments where necessary to accommodate specific site conditions identified through in situ monitoring, testing, or excavation.

1.13.6 Underground excavation

1.13.6.1 (1.2.6.6PC2g.ii)	The ESF should be designed so as not to interfere with the flexibility of the repository to accommodate specific site conditions.
1.13.6.2 (1.2.6.6PC1b.i)	The number of interconnections between the dedicated test area and the repository should be limited to as few as practicable.
1.13.6.3 (1.2.6.6PC1b.ii)	The area of the ESF underground excavations shall be limited to that necessary for conducting the needed site characterization and performance confirmation tests.

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1.14 Requirement: 60.133(d) The design of the underground facility shall provide for control of water or gas intrusion.

1.14.1 Site

1.14.1.1 (1.2.6.1CF.i) The amount of water used in construction, and operations, of the main pad should be limited so as to limit the effects on the containment and isolation capability of the site.

1.14.1.2 Deleted Water use in pad construction shall not adversely impact goals to limit the average saturation of the repository horizon to <75% and limit the local saturation to 90%.

1.14.1.3 (1.2.6.1CF.ii) Construction of the main pad shall be performed in a manner to avoid blockage of natural surface water drainageways and avoid creation of surface water impoundments that could impact post-closure performance.

1.14.1.4 (1.2.6.1CF.iii) MPBHs or other surface drilled exploratory boreholes associated with the ESF shall be drilled dry.

1.14.1.5 (1.2.6.1CF.iv) MPBHs shall incorporate a standpipe or other measures appropriate and adequate for protection against the effects of maximum credible floods during the period when MPBHs are accessible prior to borehole plugging and sealing.

1.14.1.6 (1.2.6.1CF.i) Construction water shall be limited to that required for dust control and proper equipment operation consistent with performance objectives.

1.14.1.7 (1.2.6.1CF.v) Construction procedures shall enable removal of excess water.

1.14.1.8 (1.2.6.1CO) Operating procedures shall be developed to ensure water entering the ESF is managed appropriately, including quantity, location, and water balance.

1.14.2 Surface Utilities

1.14.2.1 (1.2.6.2CE) Fluids recovered from sanitary uses or during construction operations should be disposed of in such a way as to avoid potential for performance impacts, for example in lined ponds.

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1.14.4 First Shaft

1.14.4.1 (1.2.6.4PC2g.i) The amount of water used in construction and operations, should be limited so as to limit the effects on the containment and isolation capability of the site.

1.14.4.2 (1.2.6.4PC2g.ii) Water use in shaft construction should be generally consistent with repository design goals to limit the average saturation of the repository horizon to <75% and limit the local saturation to <90% in waste emplacement areas.

1.14.4.3 (1.2.6.6PC2h.ii) The drainage plan for the ESF and long exploratory drifts should be consistent with repository operations and postclosure sealing concerns. Specifically, drainage in the dedicated test area should be toward ES-1, and drainage in long drifts should be compatible with repository grades.

1.14.4.4 (1.2.6.4PC1i.iii) The shafts should be separated to maintain reasonable distances for power and instrument cabling and water piping as well as to provide for redundancy in mine water discharge.

1.14.4.5 (1.2.6.4PC1d.ii) Appropriate gravity drainage and/or pumping systems shall be incorporated into the shaft and underground facilities for draining water away from testing and other working areas to suitable collections point(s) for further treatment and/or disposal.

1.14.4.6 (1.2.6.4PC2g.iii) Operating procedures shall be developed to ensure water entering the ESF is managed appropriately, including quantity, location, and water balance.

1.14.4.7 (1.2.6.4PC2g.i) Construction water shall be limited to that required for dust control and proper equipment operation.

1.14.4.8 (1.2.6.4PC1d.i) Construction procedures shall enable removal of excess water.

1.14.4.9 (1.2.6.4PC2g.iv) Operational seals shall be provided where necessary to control the intrusion of water into the facility.

1.14.5 Second shaft

1.14.5.1 (1.2.6.5PC2g.ii) The amount of water used in construction and operations, should be limited so as to limit the effects on the containment and isolation capability of the site.

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1.14.5.2 (1.2.6.5PC2g.iii) Water use in shaft construction should be generally consistent with repository design goals to limit the average saturation of the repository horizon to <75% and limit the local saturation to <90% in waste emplacement areas.

1.14.5.3 (1.2.6.5PC2g.i) The drainage plan for the ESF and long exploratory drifts should be consistent with repository operations and postclosure sealing concerns. Specifically, drainage in the dedicated test area should be toward ES-1 and drainage in long drifts should be compatible with repository grades.

1.14.5.4 (1.2.6.5PC1d.ii) Appropriate gravity drainage and/or pumping systems shall be incorporated into the shaft and underground facilities for draining water away from testing and other working areas to suitable collections point(s) for further treatment and/or disposal.

1.14.5.5 (1.2.6.5PC2g.iv) Operating procedures shall be developed to ensure water entering the ESF is managed appropriately, including quantity, location, and water balance.

1.14.5.6 (1.2.6.5PC2g.ii) Construction water shall be limited to that required for dust control and proper equipment operation consistent with performance goals.

1.14.5.7 (1.2.6.5PC1d.i) Construction procedures shall enable removal of excess water.

1.14.5.8 (1.2.6.5PC2g.v) Operational seals shall be provided where necessary to control the intrusion of water into the facility.

1.14.6 Underground excavation

1.14.6.1 (1.2.6.6PC2h.iv) The amount of water used in construction and operations, should be limited so as to limit the effects on the containment and isolation capability of the site.

1.14.6.2 (1.2.6.6PC2h.v) Water used in construction and operations should not adversely impact the repository design goals to limit the average saturation of the repository horizon to <75% and limit local saturation to <90% in areas of waste emplacement.

1.14.6.3 (1.2.6.6PC2h.ii) The drainage plan for the ESF and long exploratory drifts should be consistent with repository operations and postclosure sealing concerns. Specifically, drainage in the dedicated test area should be toward ES-1 and drainage in long drifts should be compatible with repository grades.

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1.14.6.4 (1.2.6.6PC2h.iv) Construction and operating water shall be limited to that required for dust control and proper equipment operation consistent with performance goals.

1.14.6.5 (1.2.6.6PC1d.iv) Construction procedure shall enable removal of excess water.

1.14.6.6 (1.2.6.6PC1d.v) Appropriate gravity drainage and/or pumping systems shall be incorporated into the shaft and underground facilities for draining water away from testing and other working areas to suitable collections point(s) for further treatment and/or disposal.

1.14.6.7 (1.2.6.6PC2h.vi) Operating procedures shall be developed to ensure water entering the ESF is managed appropriately, including quantity, location and water balance.

1.14.6.8 (1.2.6.6PC2h.vii) Operational seals shall be provided where necessary to control the intrusion of water into the facility.

1.14.7 Underground utilities

1.14.7.1 (1.2.6.7CF.i) Appropriate gravity drainage and/or pumping systems shall be incorporated into the shaft and underground facilities for draining water away from testing and other working areas to suitable collections point(s) for further treatment and/or disposal.

1.14.7.2 (1.2.6.7.6PC1b.i) The groundwater collection and control system shall be designed to include possible inflow from penetrations of fault structures during geologic drifting or from perched water horizons during shaft sinking and facility development, in addition to expected inflows.

1.14.7.3 (1.2.6.7.6PC1b.ii) The storage and pumping system shall be designed to provide the capacity to handle emergency situations such as unexpected inflow of water or water line breakage at a peak rate of 250 GPM, or a steady flow of 20 GPM.

1.14.8 Underground testing

1.14.8.1 (1.2.6.8CE.ii) The amount of water used in testing and operations, should be limited so as to limit the effects on the containment and isolation capability of the site.

1.14.8.2 (1.2.6.8CE.iii) Water use in testing should be generally consistent with repository design goals to limit the average saturation of the repository horizon to <75% and limit the local saturation to <90% in waste emplacement areas.

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1.14.8.3	(1.2.6.8CE.iv)	MPBHs or other surface drilled exploratory boreholes associated with the ESF shall be drilled dry.
1.14.8.4	(1.2.6.8CE.ii)	Testing water should be limited to that required for dust control and proper test operation consistent with performance goals.
1.14.8.5	(1.2.6.8CE.vi)	Testing procedures shall require removal of excess water.
1.14.8.6	(1.2.6.8CE.vii)	Any cleaning of ESF walls to facilitate photogrammetry, mapping, or other testing shall be done using compressed air/mist using control procedures.
1.14.8.7	(1.2.6.8CE.viii)	Test procedures must be developed to ensure water entering the ESF is managed appropriately, including quantity, location, and water balance.
1.14.8.8	(1.2.6.8CE.ix)	Gaseous products used in characterization should not produce geochemical effects that impact waste isolation capabilities of site.

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1.15 Requirements: 60.133(e)(2) Openings in the underground facility shall be designed to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock.

1.15.4 First shaft

1.15.4.1 (1.2.6.4PC2i.ii) The shaft shall be designed to provide stability and to reduce the potential for deleterious rock movement or fracturing that may create a pathway for radionuclide migration.

1.15.4.2 (1.2.6.4PC2h.ii) An adequate distance between shafts should be provided to reduce potential mechanical interference between the two shafts.

1.15.5 Second shaft

1.15.5.1 (1.2.6.5PC2i.ii) The shaft should be designed to provide stability and to reduce the potential for deleterious rock movement or fracturing that may create a pathway for radionuclide migration.

1.15.5.2 (1.2.6.5PC2h.ii) An adequate distance between shafts should be provided to reduce potential mechanical interference between the two shafts.

1.15.6 Underground excavation

1.15.6.1 (1.2.6.6PC2j.ii) The underground excavation be designed to provide stability and to minimize the potential for deleterious rock movement or fracturing that may create a pathway for radionuclide migration.

1.15.6.2 (1.2.6.6PC2i.v) (1.2.6.6PC2j.ii) The design of underground openings and their supports shall utilize pillar and opening geometries that limit stress concentration to acceptable levels, so as to minimize the potential for deleterious rock movement or fracturing that may create a pathway for radionuclide migration.

1.15.6.3 (1.2.6.6PC2e.ii) The spacing between adjacent ESF drifts shall be a minimum of two drift diameters (using the maximum diameter of either opening, and considering the closest proximity of any part of each opening).

1.15.6.4 (1.2.6.6PC2c.ix) The ESF shall be designed to be consistent with the repository design goal to limit the extraction ratio to less than 30%.

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1.16 Requirement: 60.133(f) The design of the underground facility shall incorporate excavation methods that will limit the potential for creating a preferential pathway for groundwater to contact the waste packages or radionuclide migration to the accessible environment.

1.16.1 Site

1.16.1.1 (1.2.6.1CC.ii) Excavation techniques used for pad construction shall control overbreak of rock and limit disturbance to the integrity of the adjoining rock mass.

1.16.4 First shaft

1.16.4.1 (1.2.6.4PC2i.viii) The exploratory shaft construction method should be selected, consistent with other goals of site characterization, to limit impacts on isolation.

1.16.4.2 (1.2.6.4PC2i.i) Excavation techniques used for shaft and station construction shall control overbreak of rock and limit disturbance to the integrity of the adjoining rock mass.

1.16.4.3 (1.2.6.4PC2i.vi) Drill and blast specifications should include controls related to types and amounts of explosives, shot patterns, and hole depth in order to limit the magnitude and extent of blast-induced permeability.

1.16.4.4 (1.2.6.4PC2i.v.a) The excavation methods should be compatible with repository design goals to limit permeability changes beyond 3 m from the walls of the excavation to less than one order of magnitude.

1.16.5 Second shaft

1.16.5.1 (1.2.6.5PC2i.viii) The exploratory shaft construction method should be selected, consistent with other goals of site characterization, to limit impacts on isolation.

1.16.5.2 (1.2.6.5PC2i.i) Excavation techniques used for shaft and station construction shall control overbreak of rock and limit disturbance to the integrity of the adjoining rock mass.

1.16.5.3 (1.2.6.5PC2i.vi) Drill and blast specifications should include controls related to types and amounts of explosives, shot patterns, and hole depth in order to limit the magnitude and extent of blast-induced permeability.

1.16.5.4 (1.2.6.5PC2i.v.a) The excavation methods should be compatible with repository design goals to limit permeability changes beyond 3 m from the walls of the excavation to less than one order of magnitude.

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1.16.6 Underground excavation

1.16.6.1 (1.2.6.6PC2j.i) Excavation techniques used for ESF construction shall control overbreak of rock and limit disturbance to the integrity of the adjoining rock mass.

1.16.6.2 (1.2.6.6PC2j.x) Drill and blast specifications shall include controls related to types and amounts of explosives, shot patterns, and hole depth in order to limit the magnitude and extent of blast-induced permeability.

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1.17 Requirement: 60.133(h) Engineered barriers. Engineered barriers shall be designed to assist the geologic setting in meeting the performance objectives for the period following permanent closure.

1.17.4 First shaft

(I-2) 1.17.4.1 Engineered barriers in the shafts shall assist the geologic setting in limiting the release of radionuclides to the accessible environment.

1.17.5 Second shaft

(I-2) 1.17.5.1 Engineered barriers in the shafts shall assist the geologic setting in limiting the release of radionuclides to the accessible environment.

1.17.6 Underground excavation

(I-2) 1.17.6.1 The engineered barriers in the underground excavation must be designed such that other systems, structures, and components of the ESF and the candidate repository do not eventually become ground-water flow paths and do not promote the release of radionuclides to the accessible environment.

(I-2) 1.17.6.2 The engineered barriers in the underground excavation shall not preclude the repository from creating a waste package environment that favorably controls chemical reactions affecting waste package performance.

1.17.9 Decommissioning

(I-2) 1.17.9.1 The first shaft, second shaft, all underground excavations, and all boreholes shall be constructed to allow backfilling and sealing as necessary to limit the release of radioactive material to the environment.

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1.18 Requirement: 60.133(i) The underground facility shall be designed so that the performance objectives will be met taking into account the predicted thermal and thermomechanical response of the host rock, and surrounding strata, groundwater system.

1.18.4 First shaft

1.18.4.1 (1.2.6.4PC2j.iii) The shaft liner shall withstand pressures exerted along its length and around the entire perimeter under anticipated conditions, including reaction to thermally induced stresses resulting from thermal loads.

1.18.5 Second shaft

1.18.5.1 (1.2.6.5PC2j.iii) The shaft liner shall withstand pressures exerted along its length and around the entire perimeter under anticipated conditions, including reaction to thermally induced stresses resulting from thermal loads.

1.18.6 Underground excavation

1.18.6.1 (1.2.6.6PC2k.i) The ESF shall be designed, taking into account the predicted thermal and thermomechanical response of the host rock and surrounding strata so that the performance objectives of the repository can be met.

1.18.6.2 (1.2.6.6PC2k.iii) The ESF shall be designed such that the thermal and thermomechanical effects of ESF operations and testing do not produce failure of intact rock, nor gross rock mass failure, along potential pathways from the repository to the accessible environment.

1.18.6.3 (1.2.6.6PC2k.iii) The ESF shall be designed so that the thermal and thermomechanical effects of ESF operations and testing on the groundwater system, do not significantly increase the saturation of the host rock in the waste emplacement area.

1.18.6.4 (1.2.6.6PC2k.iv) The underground excavation support system shall be designed to withstand pressures under anticipated conditions, including reaction to thermally induced stresses resulting from thermal loads.

1.18.8 Underground testing

1.18.8.1 (1.2.6.6PC2k.iii) The ESF shall be designed such that the thermal and thermomechanical effects of ESF testing does not produce failure of intact rock, nor gross rock mass failure, along potential pathways from the repository, to the accessible environment.

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1.18.8.2 (1.2.6.6PC2k.iii) The ESF shall be designed so that the thermal and thermomechanical effects of ESF testing on the groundwater system, do not significantly increase the saturation of the host rock in the waste emplacement area.

1.18.8.3 (1.2.6.6PC2k.v) The ESF shall be designed so that the thermal effects of ESF testing do not result in temperatures in excess of 115°C in either the TsW3 or CHn units.

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1.19 Requirement: 60.137 The geologic repository operations area shall be designed so as to permit implementation of a performance confirmation program that meets the requirements of Subpart F of this part.

1.19.6 Underground excavation

1.19.6.1 The underground excavations shall be designed to accommodate the performance confirmation tests required by 60.141 and 60.142, and taking into account any potentially adverse impacts these excavations could have on the waste isolation capabilities of the site. (1.2.6.6CB.i)

1.19.8 Underground testing

1.19.8.1 The testing program shall accommodate the performance confirmation tests required by 60.141 and 60.142, and taking into account any potentially adverse impacts these tests could have on the waste isolation capabilities of the site. (TP)

1.20 Requirement 60.140(d): The program shall be implemented so that: (1) it does not adversely affect the ability of the natural and engineered elements of the geologic repository to meet the performance objectives. *

1.20.8 Underground testing

(TP) 1.20.8.1 The design of the performance confirmation testing program shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and implementation of the performance confirmation testing program and operation of the facility shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository.

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* The approach adopted for evaluation of the adequacy of this 10 CFR Part 60 Requirement involves consideration of criteria developed under other 10 CFR Part 60 Requirements. Rather than listing each of those criteria here, a matrix indicating those criteria that were considered in the evaluation of this 10 CFR Part 60 Requirement is presented in the Figure Appended to this Document.

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NRC CONCERN NO: 2

The ESF design, construction, and operations should not compromise the ability to characterize the site.

2.1 Requirement: 60.74 (a) DOE shall perform, or permit the Commission to perform such tests as the Commission deems appropriate or necessary for the administration of the regulations in this part. These may include tests of: (1) Radioactive waste, (2) the geologic repository including its structures, systems, and components, (3) radiation detection and monitoring instruments, and (4) other equipment and devices used in connection with the receipt, handling, or storage of radioactive waste. (b) The tests required under this section shall include a performance confirmation program carried out in accordance with Subpart F of this part.

2.1.4 First shaft

2.1.4.1 (1.2.6.4CA.i) The structures, systems, components and operation of the exploratory shafts shall be designed to accommodate additional tests that may be required by the NRC for site characterization and performance confirmation.

2.1.5 Second shaft

2.1.5.1 (1.2.6.5CA.i) The structures, systems, components and operation of the exploratory shafts shall be designed to accommodate additional tests that may be required by the NRC for site characterization and performance confirmation.

2.1.6 Underground excavation

2.1.6.1 (1.2.6.6CA.i) The dedicated test area should include adequate allowance for additional testing that may be required by the NRC.

2.1.6.2 (1.2.6.6CA.i) The dedicated test area shall be designed to support such additional testing as may be required by the NRC without disruption of or interference with testing in progress or planned testing.

2.1.7 Underground Utilities

2.1.7.1 (1.2.6.7CC.i) The structures, systems, components, and operation of the shaft breakouts and main test level of the ESF shall be designed to accommodate additional tests that may be required by the NRC for site characterization and performance confirmation.

2.1.8 Underground testing

2.1.8.1 (TP) The underground test program shall be designed to accommodate the requirements of 10 CFR Part 60.74.

2.1.8.2 (TP) The testing program shall be designed to be able to accommodate additional testing that may be deemed appropriate by the Commission.

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(TP) 2.1.8.3 Prior to initiation of additional tests requested by the Commission, an analysis of the potential for the tests to affect the ability of the site to be characterized shall be performed.

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2.2 Requirement 60.130: Sections 60.131 through 60.134 specify minimum design criteria for the design of the geologic repository operations area. These design criteria are not intended to be exhaustive, however. Omissions in ¶ 60.131 through 134 do not relieve the DOE from any obligation to provide such safety features in a specific facility needed to acheive the performance objectives. All design bases must be consistent with the results of site characterization.

2.2.4 First Shaft

2.2.4.1 (1.2.6.4PC1d.vi) Fluids and materials planned for use in the shaft shall be evaluated with respect to intended use and possible effects on site characterization or other testing, and appropriate controls will be implemented.

2.2.5 Second Shaft

2.2.5.1 (1.2.6.5PC1d.vi) Fluids and materials planned for use in the shaft shall be evaluated with respect to intended use and possible effects on site characterization or other testing, and appropriate controls will be implemented.

2.2.6 Underground Excavation

2.2.6.1 (1.2.6.6PC1d.ix) Fluids and materials planned for use in the ESF underground facility shall be evaluated with respect to intended use and possible effects on site characterization or other testing, and appropriate controls will be implemented.

2.2.8 Underground Tests

2.2.8.1 (1.2.6.8CE.i) Fluids and materials planned for use in testing in the ESF shall be evaluated with respect to intended use and possible effects on site characterization or other testing, and appropriate controls will be implemented.

2.3 Requirement: 60.133(a)(2) The underground facility shall be designed so that the effects of credible disruptive events during the period of operations such as flooding, fires and explosions, will not spread through the facility.

2.3.1 Site

2.3.1.1 (1.2.6.1PC1b) The areas around the shaft collar shall be designed and constructed to prevent water inflow from the probable maximum flood such that testing in the underground portion of the ESF is not adversely affected.

2.3.4 First Shaft

2.3.4.1 (1.2.6.4PC2e.ii) The exploratory shaft collar shall be designed to prevent significant water inflow from a maximum credible flooding event during site characterization and the planned period of repository operation, such that testing in the underground portion of the ESF is not adversely affected.

2.3.5 Second shaft

2.3.5.1 (1.2.6.5PC2e.ii) The exploratory shaft collar shall be designed to prevent significant water inflow from a maximum credible flooding event during site characterization and the planned period of repository operation, such that testing in the underground portion of the ESF is not adversely affected.

2.3.6 Underground Excavation

2.3.6.1 (1.2.6.6PC1d.iii) (1.2.6.6PC1d.iv) (1.2.6.6PC2f.i) The Exploratory Shaft Underground Facility shall be designed so that the effects of credible disruptive events shall be limited from spreading through the facility and affecting characterization.

2.3.6.2 (1.2.6.6PC2f.iv) The drainage plan for the ESF and long exploratory drifts should be designed to ensure that the effects of flooding shall be limited from spreading through the facility and affecting characterization.

2.3.6.3 (1.2.6.6PC1d.xi) The presence of combustible materials in the underground facility shall be controlled and limited such that testing in the ESF is not adversely affected.

2.3.7 Underground utilities

2.3.7.1 (1.2.6.7.6PC1b.v) The ESF shall have redundant mine water discharge systems to control and limit the impact of water intrusion on testing in the ESF.

2.3.7.2 (1.2.6.7.8PC1a) The underground portion of the ESF shall incorporate a fire protection system to control and limit the impact of a credible fire on testing in the ESF.

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2.3.7.3
(1.2.6.7CD.ii)

The underground utility system shall be designed to control and limit the impact,of utility system failures caused by credible disruptive events such as fire, explosion, or seismic events, on site characterization and other testing.

2.3.7.4
(1.2.6.7.6PC1b.i)

The mine water collection, control, and removal system shall be designed with capacity for emergency situations such as unexpected inflow or water line breakage, inflow from penetrations of fault structures during drifting, or from perched water encountered during shaft sinking and ESF development, such that the capability to adequately characterize the site is maintained.

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2.4 Requirement: 60.133(b) The underground facility shall be designed with sufficient flexibility to allow adjustments where necessary to accommodate specific site conditions identified through in situ monitoring, testing, or excavation.

2.4.4 First shaft

2.4.4.1 (1.2.6.4PC1c.ii) The configuration of the shaft shall be adequate to support site characterization testing, and future testing that may be reasonably expected for site characterization. This shall include an allowance to accommodate site specific conditions encountered in the shaft without adversely affecting testing that is planned or ongoing.

2.4.4.2 (1.2.6.4PC1a.iv) The design of ES-1 shall include flexibility to deepen the shaft to at least 1,500 feet, or approximately 100' deeper than the Topopah Spring/Calico Hills unit contact, without adversely affecting other testing that may be ongoing. Such flexibility shall consider aspects of hoisting capacity, underground utilities, ground support, and muck handling.

2.4.5 Second shaft

2.4.5.1 (1.2.6.5PC1c.ii) The configuration of the shaft shall be adequate to support site characterization testing, and future testing that may be reasonably expected for site characterization. This shall include an allowance to accommodate site specific conditions encountered in the shaft without adversely affecting testing that is planned or ongoing.

2.4.6 Underground excavation

2.4.6.1 (1.2.6.6PC1d.xiv) The ESF shall be designed so that testing areas are separated from possible repository shop, training, operations, or waste emplacement areas, to limit adverse effects from activities in these areas on future testing, including performance confirmation, in the dedicated test area.

2.4.6.2 (1.2.6.6PC1c.iv) The design of the shaft breakouts and main test level of the ESF shall: (1) limit the extent of interference between tests and (2) limit interference between ESF construction and operation activities and testing activities.

2.4.6.3 (1.2.6.6PC1c.iv) The design of the shaft breakouts and main test level shall have sufficient flexibility to: (1) relocate experiments as necessary to limit interference between tests and aid in ensuring that test location acceptance criteria are met, (2) incorporate additional tests, as

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needed, in the dedicated test area, (3) allow development and testing in other areas as needed (e.g. southern portion of repository block or Calico Hills Tuff), and (4) accommodate schedule changes as needed.

2.4.6.4 (1.2.6.6PC2g.iii) A contingency plan shall be established for underground excavation to accommodate unexpected or site specific conditions that may be encountered, such as highly fractured zones, lithophysae-rich zones, perched water, or pathways for significant water movement.

2.4.6.5 (1.2.6.6PC1c.iii) The ESF underground excavation shall be of adequate size to support site characterization testing and future testing that may be reasonably expected for site characterization. This shall include an allowance to accommodate site specific conditions encountered in the dedicated test area, and capacity to extend an exploratory drift from the main test level, if necessary, up to approximately 10,000 feet to other parts of the repository block.

2.4.7 Underground utilities

2.4.7.1 (1.2.6.7CE.i) The design of underground utilities for the ESF shall be capable of supporting expansion of the main test level for additional testing and an exploratory drift from the main test level, if necessary, up to approximately 10,000 feet to other parts of the repository block.

2.4.7.2 (1.2.6.7CE.ii) The underground utilities for the ESF shall not preclude monitoring and investigation of in situ conditions, and shall be designed to accommodate site specific conditions, construction, and operation of the ESF.

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2.5 Requirement: 60.133(d) The design of the underground facility shall provide for control of water or gas intrusion.

2.5.4 First shaft

2.5.4.1 (1.2.6.4PC1d.iii) The amount of water used in the construction and operation of the shaft should be limited to preclude interference with tests.

2.5.4.2 (1.2.6.4PC1d.i) Shaft construction and operating procedures shall require the removal of excess water to preclude interference with tests.

2.5.4.3 (1.2.6.4PC1i.iii) The shafts should be separated to maintain reasonable distances for power and instrument cabling and water piping as well as to provide for redundancy in mine water discharge to preclude interference with tests.

2.5.5 Second shaft

2.5.5.1 (1.2.6.5PC1d.iii) The amount of water used in the construction and operation of the shaft should be limited to preclude interference with tests.

2.5.5.2 (1.2.6.5PC1d.i) Shaft construction and operating procedures shall require the removal of excess water to preclude interference with tests.

2.5.6 Underground excavation

2.5.6.1 (1.2.6.6PC1d.vi) The amount of water used in construction and operations of the underground facility should be limited to preclude interference with tests.

2.5.6.2 (1.2.6.6PC1d.iv) Underground facility construction and operating procedures shall require the removal of excess water to preclude interference with tests.

2.5.6.3 (1.2.6.6PC1d.v) (1.2.6.6PC2h.ii) The drainage plan for the ESF and long exploratory drifts should be consistent with repository operations and not impact the capability to characterize the site. Specifically, drainage in the dedicated test area should be toward ES-1 and that in long drifts should be compatible with repository grades.

2.5.6.4 (1.2.6.6PC1d.viii) Construction methods shall be designed and implemented so that the effects of fluids, gases, or other materials used do not adversely affect the adequacy or reliability of information from site characterization.

2.5.6.5 (1.2.6.6PC1d.vii) Methods for dust control and cleaning of walls in the underground portion of the ESF shall be designed to limit adverse effects on the adequacy and reliability of information from site characterization.

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2.5.6.6 (1.2.6.6PC1d.x) Fluids,gases, and other materials used in ESF construction and operations, and/or injected into the rock mass, shall be appropriately tagged. Selection of tracers shall consider, but not be limited to: (1) the possible future need to account for the mobility and disposition of all such materials as part of site characterization, and (2) the effects of tracers on site characterization.

2.5.7 Underground utilities

2.5.7.1 (1.2.6.7.6PC1b.i) The mine water collection, control, and removal system shall be designed to accommodate inflow from penetrations of fault structures during drifting, or from perched water encountered during shaft sinking and ESF development such that the capability to adequately characterize the site is maintained. The mine water control system shall be designed with capacity for emergency situations such as unexpected inflow or water line breakage.

2.5.7.2 (1.2.6.7CF.iii) The design of the ESF underground utility system, including ventilation, shall facilitate monitoring of moisture influx to the ESF from the rock mass and from ventilation, and moisture efflux from mine water removal and ventilation exhaust to limit possible impacts on the capability to adequately characterize the site.

2.5.8 Underground Testing

2.5.8.1 (1.2.6.8CE.i) The amount of water used in testing in the shaft should be limited to preclude interference with tests.

2.5.8.2 (1.2.6.8CE.vi) Test procedures shall require the removal of excess water.

2.5.8.3 (1.2.6.8CE.viii) Test procedures shall be developed to ensure that water entering the ESF is managed appropriately, including quantity, location, and water balance.

2.6 Requirement: 60.133(e)(2) Openings in the underground facility shall be designed to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock.

2.6.4 First Shaft

2.6.4.1 (1.2.6.4PC2i.ii) The shaft shall be designed to provide stability and to reduce the potential for deleterious rock movement or fracturing that could impact the capability to reliably and adequately characterize the site.

2.6.4.2 (1.2.6.4PC2h.ii) An adequate distance between shafts shall be provided to limit potential mechanical and hydrological interference between the two shafts to the extent that it could impact the capability to reliably and adequately characterize the site.

2.6.5 Second Shaft

2.6.5.1 (1.2.6.5PC2i.ii) The shaft shall be designed to provide stability and to reduce the potential for deleterious rock movement or fracturing that could impact the capability to reliably and adequately characterize the site.

2.6.5.2 (1.2.6.5PC2h.ii) An adequate distance between shafts shall be provided to limit potential mechanical and hydrological interference between the two shafts to the extent that it could impact the capability to reliably and adequately characterize the site.

2.6.6 Underground excavation

2.6.6.1 (1.2.6.6PC2i.iv) The main test level of the ESF shall be designed to limit overall response to excavation, including rock fall, considering all planned drifts and future drifting that may be performed in the dedicated test area, consistent with obtaining adequate and reliable information from site characterization.

2.6.6.2 (1.2.6.6PC2i.v) **The design of underground openings and their supports in the ESF shall utilize pillar and opening geometries that limit stress concentration, changes in rock mass permeability, and changes in rock mass deformability to levels consistent with acquiring adequate and reliable information from site characterization.**

2.6.6.3 (1.2.6.6PC2e.ii) **The spacing between adjacent ESF drifts shall be a minimum of two drift diameters (using the maximum diameter of either opening and considering the closest proximity of any part of each opening) consistent with obtaining reliable and adequate information from site characterization.**

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2.6.8 Underground testing

2.6.8.1 (1.2.6.6.2CA) The ESF shall be designed to limit mechanical, hydrologic, or geochemical interference between underground tests that may be associated with damage to the rock mass caused by excavation.

2.7 Requirement: 60.133(f) The design of the underground facility shall incorporate excavation methods that will limit the potential for creating a preferential pathway for groundwater to contact the waste packages or radionuclide migration to the accessible environment.

2.7.1 Site

2.7.1.1 (1.2.6.1CC.ii) The main pad shall be constructed using excavation methods that will limit damage to the underlying rock mass to the extent that it could affect the adequacy or reliability of information from site characterization. Methods shall be designed to facilitate investigation and monitoring of such effects during and after construction.

2.7.4 First Shaft

2.7.4.1 (1.2.6.4PC2i.vii) The shaft and shaft stations of the exploratory shaft shall be constructed using controlled blasting methods, to limit overbreak and damage to the surrounding rock mass, which could affect the adequacy or reliability of information from site characterization. The methods shall be designed to facilitate investigation and monitoring of such effects during and after construction.

2.7.5 Second shaft

2.7.5.1 (1.2.6.5PC2i.vii) The shaft and shaft stations of the exploratory shaft shall be constructed using controlled blasting methods, to limit overbreak and damage to the surrounding rock mass, which could affect the adequacy or reliability of information from site characterization. The methods shall be designed to facilitate investigation and monitoring of such effects during and after construction.

2.7.6 Underground excavation

2.7.6,1 (1.2.6.6PC2j.x) The shaft breakouts and main test level of the ESF shall be constructed using controlled blasting methods, to limit overbreak and damage to the surrounding rock mass, which could affect the adequacy or reliability of site characterization. The methods shall be designed to provide for the requirements of specific site characterization tests, such as limitations on the extent of excavation-induced damage, or the type of ground support that may be installed. The methods shall be designed to facilitate monitoring and investigation of excavation effects during and after construction.

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2.8 Requirement: 60.137 The geologic repository operations area shall be designed so as to permit implementation of a performance confirmation program that meets the requirements of Subpart F of this part.

2.8.1 Site

2.8.1.1 (1.2.6.1CD) The ESF site shall be designed to facilitate appropriate performance confirmation measurement and monitoring to obtain adequate and reliable information about the site. The performance confirmation program shall include measurement and monitoring of the performance of the ESF site to the extent that aspects of the site are part of the geologic setting that could contribute to the waste isolation performance of a repository.

2.8.4 First shaft

2.8.4.1 (1.2.6.4CB.ii) The configuration of the shaft shall be adequate to support performance confirmation testing, and future performance confirmation testing that may be reasonably expected for site characterization. This shall include an allowance to accommodate site specific conditions encountered in the shaft without adversely affecting testing that is planned or ongoing.

2.8.4.2 (1.2.6.4CB.iii) The shafts of the ESF shall be designed to facilitate performance confirmation testing to obtain adequate and reliable information about the site, during and after construction, as required for the geologic repository by 10 CFR 60, Subpart F.

2.8.4.3 (I-5) The shafts of the ESF shall be designed so that baseline performance confirmation data can be acquired, pertaining to parameters and natural processes that may be significantly altered by site characterization. In addition, the ESF shall be designed to facilitate monitoring of changes to the baseline condition of parameters that could affect performance of a geologic repository.

2.8.5 Second shaft

2.8.5.1 (1.2.6.5PCB.ii) The configuration of the shaft shall be adequate to support site performance confirmation testing, and future performance confirmation testing that may be reasonably expected for site characterization. This shall include an allowance to accommodate site specific conditions encountered in the shaft without adversely affecting testing that is planned or ongoing.

2.8.5.2 (1.2.6.5CB.iii) The shafts of the ESF shall be designed to facilitate performance confirmation testing to obtain adequate and reliable information about the site, during and after construction, as required for the geologic repository by 10 CFR 60, Subpart F.

2.8.5.3 (I-5) The shafts of the ESF shall be designed so that baseline performance confirmation data can be acquired, pertaining to parameters and natural processes that may be significantly altered by site characterization. In addition, the ESF shall be designed to facilitate monitoring of changes to the baseline condition of parameters that could affect performance of a geologic repository.

2.8.6 Underground excavation

2.8.6.1 (1.2.6.6CB.iii) The shaft breakouts and main test level of the ESF shall be designed to facilitate performance confirmation testing, during and after construction, as required for the geologic repository by 10 CFR 60, Subpart F.

2.8.6.2 (I-5) The shaft breakouts and main test level of the ESF shall be designed so that baseline performance confirmation data can be acquired, pertaining to parameters and natural processes that may be significantly altered by site characterization. In addition, the ESF shall be designed to facilitate monitoring of changes to the baseline condition of parameters that could affect performance of a geologic repository.

2.8.6.3 (1.2.6.6CB.ii) The ESF underground excavation shall be of adequate size to support performance confirmation testing and future testing that may be reasonably expected for performance confirmation. This shall include an allowance to accommodate site specific conditions encountered in the dedicated test area.

2.8.6.4 (1.2.6.6PC1c.iv) The design of the shaft breakouts and main test level of the ESF shall: limit the extent of interference between characterization tests, performance confirmation tests and ESF construction and operation activities.

2.8.6.5 (1.2.6.6PC1c.iv) The design of the shaft breakouts and main test level shall have sufficient flexibility to: (1) relocate experiments as necessary to limit interference between tests, (2) incorporate additional performance confirmation tests, as needed, in the dedicated test area, and, (3) accommodate schedule changes as required.

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2.8.7 Underground Utilities

2.8.7.1 (1.2.6.7CG.i) The design of underground utilities for the ESF shall be capable of supporting the performance confirmation testing.

2.8.7.2 (1.2.6.7CE.ii) The underground utilities for the ESF shall not preclude monitoring and investigation of in situ conditions, and shall be designed to accommodate site specific conditions, construction, and operation of the ESF.

2.8.8 Underground testing

2.8.8.1 (TP) Performance confirmation testing shall be conducted in the ESF during and after construction, to meet the requirements which pertain to such testing in the geologic repository as stated in 10 CFR 60, Subpart F.

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NRC CONCERN NO: 3

The ESF design, construction, and operations should provide representative data.

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3.1 Requirement: 60.15(b) Unless the Commission determines with respect to the site described in the application that it is not necessary, site characterization shall include a program of in situ exploration and testing at the depths that wastes would be emplaced.

3.1.4 First shaft

3.1.4.1 (1.2.6.4PC1a.i) Shaft design and construction shall provide access for site characterization activities to be performed at the planned waste emplacement horizon.

3.1.4.2 (1.2.6.4PC1a.iii) Selection of the horizon for the main test level shall be based on evaluation of stratigraphic information sources available during construction (e.g., from the MPBH activity, geologic mapping of the shafts, and a probe corehole drilled ahead of the shaft face in portions of the shaft) with respect to explicit horizon criteria.

3.1.5 Second shaft

3.1.5.1 (1.2.6.5PC1a.i) Shaft design and construction shall provide access for site characterization activities to be performed at the planned waste emplacement horizon.

3.1.5.2 (1.2.6.5PC1a.iii) Selection of the horizon for the main test level shall be based on evaluation of stratigraphic information sources available during construction (e.g., from the MPBH activity, geologic mapping of the shafts, and a probe corehole drilled ahead of the shaft face in portions of the shaft) with respect to explicit horizon criteria.

3.1.6 Underground excavation

3.1.6.1 (1.2.6.6PC1a.ii) The ESF main test level shall be constructed at the planned repository horizon.

3.1.8 Underground testing

3.1.8.1 (TP) Underground testing shall be conducted in a facility constructed at the planned repository horizon.

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3.2 Requirement: 60.15(d)(2) The number of exploratory boreholes and shafts shall be limited to the extent practical consistent with obtaining the information needed for site characterization.

3.2.4 First Shaft

3.2.4.1 (1.2.6.4PC1b) The number and depth of exploratory shafts shall be consistent with obtaining needed information for site characterization, while contributing to acquisition of representative data.

3.2.5 Second Shaft

3.2.5.1 (1.2.6.5PC1b) The number and depth of exploratory shafts shall be consistent with obtaining needed information for site characterization, while contributing to acquisition of representative data.

3.2.8 Underground testing

3.2.8.1 (TP) The number and length of exploratory and monitoring boreholes drilled from the underground portion of the ESF shall be consistent with obtaining the needed information for site characterization.

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3.3 Requirement: 60.15(d)(3) To the extent practical, exploratory boreholes and shafts in the geologic repository operations area shall be located where shafts are planned for underground facility construction and operation or where large unexcavated pillars are planned.

3.3.8 Underground testing

(TP) 3.3.8.1 Exploratory, monitoring and testing boreholes shall be located where pillars are planned in the repository underground facility to the extent practicable. Implementation of this criterion within the designated test area of the ESF shall be consistent with obtaining the needed information for site characterization.

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3.4 Requirement 60.74 (a) DOE shall perform, or permit the Commission to perform such tests as the commission deems appropriate or necessary for the administration of the regulations in this part. These may include tests of: (1) Radioactive waste, (2) the geologic repository including its structures, systems, and components, (3) radiation detection and monitoring instruments, and (4) other equipment and devices used in connection with the receipt, handling, or storage of radioactive waste. (b) The tests required under this section shall include a performance confirmation program carried out in accordance with Subpart F of this part.

3.4.8 Underground testing

(TP) 3.4.8.1 The area set aside for future site characterization and performance confirmation testing, shall be representative of the overall designated test area with respect to rock characteristics that control acceptability of test locations.

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3.5 Requirement: 60.133(b) The underground facility shall be designed with sufficient flexibility to allow adjustments where necessary to accommodate specific site conditions identified through in situ monitoring, testing, or excavation.

3.5.4 First shaft

3.5.4.1 (1.2.6.4PC1c.i) The shaft design shall have the flexibility needed to ensure that the location, orientation, geometry, and configuration of each test can be modified, as necessary to meet specific test location acceptance criteria for each test in the shaft, in response to actual site conditions encountered during construction.

3.5.5 Second shaft

3.5.5.1 (1.2.6.5PC1c.i) The shaft design shall have the flexibility needed to ensure that the location, orientation, geometry, and configuration of each test can be modified, as necessary to meet specific test location acceptance criteria for each test in the shaft, in response to actual site conditions encountered during construction.

3.5.6 Underground excavation

3.5.6.1 (1.2.6.6PC1c.ii) The design of the shaft breakouts, and the layout of the main test level of the ESF, shall have the flexibility to ensure that the location, orientation, geometry, and configuration of each planned test can be modified, as necessary, to meet specific test location acceptance criteria, in response to actual site conditions encountered during construction.

3.5.7 Underground utilities

3.5.7.1 (1.2.6.7CE.iii) The design of the underground utilities shall provide the flexibility needed to support required flexibility in the design of the shafts, shaft breakouts, and the layout of the main test level of the ESF.