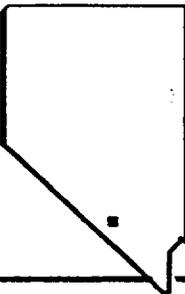


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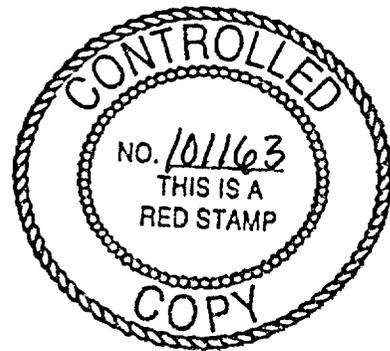


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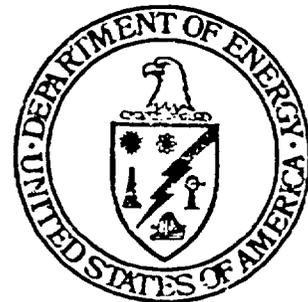
Document No. YMP/CM-0019
Revision 0
CI No. N/A
Date 7/14/93
WBS No. 1.2.1.2
QA Level Yes

PROJECT BASELINE DOCUMENT

EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS VOLUME 1



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



UNITED STATES DEPARTMENT OF ENERGY
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT OFFICE

Document Title:

Document Number:
YMP/CM- 0019

Exploratory Studies Facility Design Requirements (ESFDR)

The document identified in Blocks 1 and 2 has been changed. The changed pages attached to this DCN are identified in Block 3 opposite the latest DCN number in Block 3. The original issue of this document as modified by all applicable DCNs constitutes the current version of the document identified in Blocks 1 and 2.

3 DCN NO	4 CR NO.	5 DOCUMENT Rev./CN #	6 CR TITLE	7 AFFECTED PAGES	8 DATE
001	91/068	5/31/91*	Revision to ESFDR Document Minor editorial changes marked by bar Supplement Appendix B w/Testing Requirements Appendix C	Appendix B	5/31/91
* NOTE: Submitted as YMP/CC-0013, Revision 1. Change Control Board approved as date revision to accommodate dynamic changes to the document.					
002	91/076	7/01/91	Revision to ESFDR Document Minor editorial changes marked by bar Additional testing requirements added	Appendix B	7/01/91
003	91/095	7/29/91	Revision to ESFDR Document Changes to Appendix B marked by bar Add Appendix J	Appendix J	
004	92/098	7/02/92	Complete Revision to ESFDR Document Add TBD/TBV Log Delete Sec. 1.2.6.5.3 Delete Appendix H - Responsibility Matrix Add Appendix H - Requirements Traceability Matrix Oversized Drawing	TBD/TBV Log 6.5.3-1 to 6.5.3-2 H-1 to H-34 H-1 to H-27 All	7/22/92

Document Title:

Document Number:
YMP/CM-0019

Exploratory Studies Facility Design Requirements (ESFDR)

The document identified in Blocks 1 and 2 has been changed. The changed pages attached to this DCN are identified in Block 2 opposite the latest DCN number in Block 3. The original issue of this document as modified by all applicable DCNs constitutes the current version of the document identified in Blocks 1 and 2.

3 DCN NO.	4 CR NO.	5 DOCUMENT Rev./ICN #	6 CR TITLE	7 AFFECTED PAGES	8 CHANGE ADD DELETE	9 DATE
<p>* NOTE: A complete ESFDR Document was assigned Document Number YMP/CM-0019. The ESFDR was revised per CR 92/098 and again revised per CR 92/103. Therefore, the formal distribution being released at this time is a combination of Change Request 92/098 and 92/103.</p>						
005	92/103	7/02/92	ESFDR YMP/CC-0013	All	X	7/22/92
006	93/240	7/02/92 ICN-1	Surface Dust Suppression Water Not Tagged With Tracers.	6.0-4	X	3/29/93
			Removes the requirement for chemical tracers in surface dust suppression water.			
			Minor Editorial changes	6.2.2-2, E-3, E-3a, E-4, F.1-1, F.2-1, H-2, H-11, H-12, H-13, H-21, H-25	X	
007	93/316	7/02/92 ICN-2	Revision to ESFDR Document	6.2.2-2	X	4/30/93
			Fill compaction and general fill compaction water not tagged with chemical tracer.			
			Reinstate California Tunnel Safety Orders	Appendix E-2 6.0-11	X	
008	93/422	* Rev. 0	Revision to ESFDR Document	All		7/14/93
<p>* This revision replaces YMP/CM-0019, Rev. 7/02/92 ICN-2 in its entirety.</p>						

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT CHANGE DIRECTIVE (CD)

SECTION I. IDENTIFICATION

² Title of Change:

Exploratory Studies Facility Design Requirements Document

³ Change Classification:

- 0 2
 1 3

SECTION II. DISPOSITION

⁴ CR Disposition:

- Approved Approved with Conditions Disapproved

⁵ Conditions: (if applicable)

None.

(See Change Documentation Continuation Page)

⁶ Implementation Direction: (if applicable)

1. This CR for the Exploratory Studies Facility Design Requirements Document is approved as a Project Baseline Document and is assigned Document Number YMP/CM-0019, Revision 0.
2. The CCB Secretary shall ensure that the Cover and Title pages for Document Number YMP/CM-0019, Revision 0 are prepared.
3. Within 10 working days of the signature of this CD, the Document Custodian shall provide a print ready copy of the Document YMP/CM-0019, Revision 0

(See Change Documentation Continuation Page 2)

SECTION III. CONCURRENCE

All signatures below constitute procedural compliance. I have read, understood, and complied with Procedure QMP-02-03 Rev. 3, ICN # 3, in accomplishing my responsibilities in this procedure.

⁷ Quality Assurance Organization Concurrence

Name: R. E. Spence

(Print)

Org.: YMOAD

(Print)

Signature: 

Date: 7/14/93

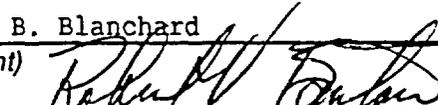
⁸ Disposition Authority

Name: M. B. Blanchard

(Print)

Title: CCB Chrprsn

(Print)

Signature: 

Date: 7/14/93

⁹ CD Effective Date

7/14/93

6 Implementation Direction (continued)

with the Document Number and revision date identified on each page of the publication ready copy.

4. The CCB Secretary shall ensure that the Document YMP/CM-0019, Revision 0, is prepared in accordance with this change directive. The CCB Secretary shall prepare a Controlled Document Issuance Authorization (CDIA) to transmit this CD and YMP/CM-0019, Revision 0 to the Project Document Control Center (DCC) in accordance with AP-1.5Q.
5. Per AP-3.3Q, each Project Office Division Director (DD) and Technical Project Officer (TPO) shall complete an Affected Document Notice (AND) as notification of completion of implementation for this CD. This review shall include all appropriate documents for which the DD or TPO are responsible, whether or not these documents are under CCB Control (e.g. Participant Procedures, Participant Analyses).

Each DD and TPO shall identify the personnel who perform the affected document review and ensure that these individuals are qualified to perform the review.

The documents reviewed shall be identified, the required changes for each document shall be identified or indication made that no change is required (see attachment #1) and a recommended schedule for implementing the changes to come into compliance with YMP/CM-0019 shall be proposed. A Preliminary impact analysis was performed and is documented in the CR which is provided with this Directive as guidance.

6. The CCB Secretary shall ensure that the Configuration Information System (CIS) and the CCB Register are updated to reflect the approved status change of this Document YMP/CM-0019, Revision 0.
7. Any changes to Document YMP/CM-0019, Revision 0 will require submittal of a CR to the Project CCB.
8. YMP/CM-0019, Revision 0, will be effective concurrent with YMP/CM-0022 (SBTFRD) in accordance with the effectivity requirements of DCP-56.
9. YMP/CM-0019 is approved for use for Design by this Directive and supersedes YMP/CM-0019. Implementation of such Design must be held pending effectiveness of YMP/CM-0019 in accordance with the requirements of DCP-56.

Document Reviewed	Reviewer	Description Req'd Chgs	Planned Implementation

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

EXPLORATORY STUDIES FACILITY

DESIGN REQUIREMENTS DOCUMENT

REVISION 0

JULY 1993

VOLUME 1

Prepared by

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

Prepared for the Yucca Mountain Site Characterization Project as part of the Civilian Radioactive Waste Management Program. The Yucca Mountain Site Characterization Project is managed by the Yucca Mountain Site Characterization Project Office of the U.S. Department of Energy. The Yucca Mountain Site Characterization Project work is sponsored by the U.S. Department of Energy Office of Civilian Radioactive Waste Management.

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

EXPLORATORY STUDIES FACILITY
DESIGN REQUIREMENTS DOCUMENT

for 

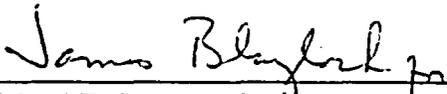
Carl P. Gertz, Project Manager
Yucca Mountain Site Characterization Project

7/6/93
Date



William B. Simecka, Director
Engineering & Development Division
Yucca Mountain Site Characterization Project

7/6/93
Date



Richard E. Spence, Director
Yucca Mountain Quality Assurance Division
Yucca Mountain Site Characterization Project

7/6/93
Date

EXPLORATORY STUDIES FACILITY
DESIGN REQUIREMENTS DOCUMENT

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YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

EXPLORATORY STUDIES FACILITY
DESIGN REQUIREMENTS DOCUMENT

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EXPLORATORY STUDIES FACILITY
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EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

TBD LOG

SECTION OR PARAGRAPH	RESPONSIBLE ORGANIZATION	SCHEDULED RESOLUTION DATE	BRIEF DESCRIPTION
3.1.B	YMPO	TBD	Personnel flow requirements.
3.1.C	YMPO	TBD	Material flow requirements.
3.2.1.H.2(c)ii	YMPO	TBD	Design to include means to protect SSC ITS against adverse effects.
3.2.1.M.3	YMPO	TBD	All substances and tracers to be reviewed for possible effect on site characterization and waste isolation.
3.2.1.M.4	YMPO	TBD	Use of hydrocarbons and solvents underground.
3.2.1.1.B	YMPO	TBD	Use of hydrocarbons and solvents shall be controlled to limit adverse chemical changes.
3.2.1.1.C.2	YMPO	TBD	Foundations not to create pathways that compromise repository performance.
3.2.1.4A	YMPO	TBD	Chemical content of blasting agents used underground.
3.2.1.4.B.1(b)	YMPO	TBD	Evaluate planned use of fluids and materials underground for impacts on site characterization.
3.2.1.4.B.2(a)	YMPO	TBD	Materials control program to be implemented in underground excavation.
3.2.1.4.B.2(b)	YMPO	TBD	Fluids and materials injected into rock to contain tracers.
3.2.1.4.C.1	YMPO	TBD	Design ground support system to limit impacts on waste isolation.

EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

TBD LOG (continued)

SECTION OR PARAGRAPH	RESPONSIBLE ORGANIZATION	SCHEDULED RESOLUTION DATE	BRIEF DESCRIPTION
3.2.1.4.C.2	YMPO	TBD	Select excavated dimensions to limit impacts on waste isolation.
3.2.1.4.C.3	YMPO	TBD	Design shaft and ramp liners to limit impacts on waste isolation.
3.2.1.4.C.4	YMPO	TBD	Design operational seals to limit impacts on waste isolation.
3.2.1.4.C.5	YMPO	TBD	Underground facility configuration vs. isolation capability of site.
3.2.1.4.D.1	YMPO	TBD	Rock support compatible with waste isolation.
3.2.1.4.D.2	YMPO	TBD	Rock support not to affect radionuclide containment or migration.
3.2.1.4.D.3	YMPO	TBD	Underground facility configuration vs. isolation capability of site.
3.2.1.4.E.1	YMPO	TBD	Select materials that do not produce geochemical effects if they burn.
3.2.1.5.G	YMPO	TBD	Selection of fire suppression agents must consider impacts on their use.
3.2.1.9.1.A	YMPO	TBD	ESF availability.
3.2.1.9.2.B	YMPO	TBD	ESF Equipment reliability requirements.
3.2.1.9.3.D.1	YMPO	TBD	Parts in inventory.
3.2.1.9.3.F.1	YMPO	TBD	Percent of detectable faults; percent LRUs.

EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

TBD LOG (continued)

SECTION OR PARAGRAPH	RESPONSIBLE ORGANIZATION	SCHEDULED RESOLUTION DATE	BRIEF DESCRIPTION
3.2.1.9.3.F.3	YMPO	TBD	Percent of component MTTR for FD/FI.
3.2.1.9.3.G.1(b)	YMPO	TBD	Reduction of maintenance requirements.
3.2.1.9.4.C.1	YMPO	TBD	Openings within the altered zone.
3.2.1.19.2.D	YMPO	TBD	Eliminating hazard through design selection.
3.2.1.25.8	YMPO	TBD	Records management.
3.2.2.1.I.2	YMPO	TBD	Foundations not to create pathways that compromise repository performance.
3.2.2.1.J.5	YMPO	TBD	Excess water shall be removed.
3.2.2.2.5.B	YMPO	TBD	Disposal of liquid wastes.
3.2.2.4.A.1(c)	YMPO	TBD	Elevation of main test level.
3.2.2.4.C.2	YMPO	TBD	Test location criteria
3.2.2.4.C.4	YMPO	TBD	Extent of performance confirmation testing to be provided for.
3.2.2.4.C.5	YMPO	TBD	Elevation of UDBR.
3.2.2.4.D.3	YMPO	TBD	Water intrusion into underground openings to be controlled.
3.2.2.4.E.1	YMPO	TBD	Size of temporary facilities for visitors.
3.2.2.4.H.3	YMPO	TBD	Volume of air required

EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

TBD LOG (continued)

SECTION OR PARAGRAPH	RESPONSIBLE ORGANIZATION	SCHEDULED RESOLUTION DATE	BRIEF DESCRIPTION
3.2.2.4.L.3	YMPO	TBD	Shaft centerline coordinates listed in RIB.
3.2.2.4.L.4	YMPO	TBD	Ramp portal coordinates listed in RIB.
3.2.2.4.L.5	YMPO	TBD	Diameter of accesses listed in RIB.
3.2.2.4.L.10	YMPO	TBD	Penetration of boreholes below TS _{w2} .
3.2.2.4.O.3	YMPO	TBD	Drainage not to impact site characterization
3.2.2.4.S.2	YMPO	TBD	Underground opening drainage compatible with potential repository grades.
3.2.2.4.S.5	YMPO	TBD	Water use in construction vs. percent saturation increase of repository horizon.
3.2.2.4.U.2(b)	YMPO	TBD	Maximum excavation overbreak.
3.2.2.4.U.6(a)	YMPO	TBD	Underground openings diametrical closure rate with no thermal load.
3.2.2.4.U.6(b)	YMPO	TBD	Underground openings diametrical closure rate with thermal load.
3.2.2.4.U.6(c)	YMPO	TBD	Size of rockfalls in unlined openings.
3.2.2.4.U.6(d)	YMPO	TBD	Access shall be maintainable.
3.2.2.4.V.1	YMPO	TBD	Subsurface facilities response to thermal effects is to meet performance objectives.

EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

TBD LOG (continued)

SECTION OR PARAGRAPH	RESPONSIBLE ORGANIZATION	SCHEDULED RESOLUTION DATE	BRIEF DESCRIPTION
3.2.2.4.V.3	YMPO	TBD	Provisions for thermally induced stresses in linings and excavation support system.
3.2.2.4.V.4	YMPO	TBD	Thermal and mechanical effects of operations and testing to not affect potential repository performance.
3.2.2.4.X.1	YMPO	TBD	Openings shall allow for future sealing so it does not become a preferential pathway.
3.2.2.4.X.2(a)	YMPO	TBD	Materials used in shaft collar and ramp portal construction shall not interfere with or prevent postclosure sealing.
3.2.2.4.X.2(b)	YMPO	TBD	Materials used at interface between PTn and TSw shall not interfere with or prevent postclosure sealing.
3.2.2.4.X.2(c)	YMPO	TBD	Materials used in the extension of the shaft or ramps shall not interfere with or prevent postclosure sealing.
3.2.2.4.X.3	YMPO	TBD	Materials and placement methods for seals shall not create preferential pathways or shall reduce radionuclide migration through existing pathways.
3.2.2.4.1.D	YMPO	TBD	Shaft collars and ramp portals elevation to be above the probable maximum flood as listed in RIB.
3.2.2.5.8.D	YMPO	TBD	Selection of fire suppression agents.
3.2.2.6.E.1	YMPO	TBD	Limit amount of water used in testing to limit effects on isolation capability of site.

EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

TBD LOG (continued)

SECTION OR PARAGRAPH	RESPONSIBLE ORGANIZATION	SCHEDULED RESOLUTION DATE	BRIEF DESCRIPTION
3.2.2.6.E.2	YMPO	TBD	Water use in testing vs. percent saturation increase of potential repository horizon.
3.2.2.6.E.5	YMPO	TBD	Excess water shall be removed.
3.2.3.3.C	YMPO	TBD	Size of temporary facilities for visitors.
3.2.5.2.6.D	YMPO	TBD	Tracers added to all compressed air used.
3.2.8.1	YMPO	TBD	ESF site designed to facilitate performance confirmation testing.
3.2.8.8.D	YMPO	TBD	Gaseous products shall not produce geochemical effects that impact waste isolation.
3.2.9.4.A.1	YMPO	TBD	Underground openings are to allow flexibility in closure so a seismic event does not affect isolation capability.
3.2.9.4.D.1	YMPO	TBD	Shaft, ramps and dedicated test area shall accommodate additional testing by NRC.
3.2.9.4.D.4	YMPO	TBD	Underground opening configuration to support performance confirmation testing.
3.2.9.5.A.1	YMPO	TBD	Components to accommodate additional testing required by NRC for site characterization and performance confirmation.
Appendix A.3	YMPO	TBD	ESF Sealing Requirements Imposed by Potential Repository Sealing Plan.

EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

TBD LOG (continued)

SECTION OR PARAGRAPH	RESPONSIBLE ORGANIZATION	SCHEDULED RESOLUTION DATE	BRIEF DESCRIPTION
Appendix A.4	YMPO	TBD	Thermal Design Basis Loads for the ESF.
Appendix A.5	YMPO	TBD	Seismic Design Basis Loads for the Exploratory Studies Facility.
The following are all in Appendix B			
B.2.3.4.C	YMPO	TBD	Zone of influence.
B.2.4.3.B	YMPO	TBD	Final test geometry and dimensions
B.2.4.3.C	YMPO	TBD	Requirements for design of block support system.
B.2.4.4.D	YMPO	TBD	Cutting test blocks.
B.2.4.4.E	YMPO	TBD	Zone of influence.
B.2.4.4.F	YMPO	TBD	Zone of influence.
B.2.5.4.E	YMPO	TBD	Zone of influence.
B.2.5.4.F	YMPO	TBD	Zone of influence.
B.2.6.4.E	YMPO	TBD	Zone of influence.
B.2.7.3.C	YMPO	TBD	Geometry of instrumentation holes.
B.2.10.3.F	YMPO	TBD	Chemical analysis procedures for traced water samples.
B.2.11.1	YMPO	TBD	MPBH design requirements and constraints.
B.2.11.2	YMPO	TBD	Functional Requirements
B.2.11.3	YMPO	TBD	Performance Criteria

EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

TBD LOG (continued)

SECTION OR PARAGRAPH	RESPONSIBLE ORGANIZATION	SCHEDULED RESOLUTION DATE	BRIEF DESCRIPTION
B.2.11.4	YMPO	TBD	Constraints
B.2.11.5	YMPO	TBD	Interface Requirements
B.2.12.4.F	YMPO	TBD	Zone of influence.
B.2.12.4.G	YMPO	TBD	Zone of influence.
B.2.13.4.F	YMPO	TBD	Zone of influence.
B.2.19.4.F	YMPO	TBD	Zone of influence
B.2.19.4.G	YMPO	TBD	Zone of influence.
B.2.23.4.F	YMPO	TBD	Zone of influence.
B.2.24.3.F	YMPO	TBD	Layout and dimensions of the demonstration breakout room.
B.2.24.4.G	YMPO	TBD	Zone of influence.
B.2.25.3.E	YMPO	TBD	Cross-sections and test layout.
B.2.25.4.E	YMPO	TBD	Zone of influence.
B.2.26.3.G	YMPO	TBD	Layout and configuration of test instrumentation.
B.2.27.3.E	YMPO	TBD	Layout and test instrument configuration.
B.2.28.3.D	YMPO	TBD	Test layout and instrument configuration.
B.2.29.3.D	YMPO	TBD	Test layout and instrumentation configuration.
B.2.30.3.E	YMPO	TBD	Test layout and instrument configuration.

EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

TBD LOG (continued)

SECTION OR PARAGRAPH	RESPONSIBLE ORGANIZATION	SCHEDULED RESOLUTION DATE	BRIEF DESCRIPTION
B.2.31.3.E	YMPO	TBD	Test layout and instrument configuration.
B.2.32.3.E	YMPO	TBD	Layouts, dimensions and instrument configuration.
B.2.35.3.D	YMPO	TBD	Layouts, dimensions and instrument configuration.
B.2.38.4.C	YMPO	TBD	IDS requirement.
B.2.38.4.D	YMPO	TBD	Interference envelope.
B.2.38.5	YMPO	TBD	Interface Requirements.
B.2.38.6	YMPO	TBD	Assumptions
B.2.39.4	YMPO	TBD	Performance constraints including rock support.
B.2.40.4.D	YMPO	TBD	Analysis objectives requiring stand-off zones dependent on test duration.
B.2.40.4.E	YMPO	TBD	Zone of influence.
B.2.40.4.F	YMPO	TBD	Zone of influence.
B.2.40.4.G	YMPO	TBD	Zone of influence.
B.2.40.4.H	YMPO	TBD	Zone of influence.
B.2.41.3.M	YMPO	TBD	Water requirements for infiltration studies.
B.2.41.4.F	YMPO	TBD	Stand-off and zone of influence determinations.
B.2.41.4.G	YMPO	TBD	Zone of influence.

EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

TBD LOG (continued)

SECTION OR PARAGRAPH	RESPONSIBLE ORGANIZATION	SCHEDULED RESOLUTION DATE	BRIEF DESCRIPTION
B.2.41.4.H	YMPO	TBD	Zone of influence.
B.2.41.4.I	YMPO	TBD	Zone of influence.
B.2.41.4.J	YMPO	TBD	Zone of influence.
B.2.42.4.G	YMPO	TBD	Zone of influence.
B.2.42.4.H	YMPO	TBD	Zone of influence.
B.2.42.4.I	YMPO	TBD	Zone of influence.
B.2.42.4.J	YMPO	TBD	Zone of influence.
B.3.1.4	YMPO	TBD	Constraints - Scientific Manpower Requirements for ESF Testing.
B.3.2.4	YMPO	TBD	Constraints - Laboratory/Office/ Storage Space Requirements
B.3.2.5	YMPO	TBD	Assumptions - Laboratory/Office/ Storage Space Requirements
B.3.3.3	YMPO	TBD	Performance Criteria - Electrical Power Requirements for ESF Testing
B.3.3.4	YMPO	TBD	Constraints - Electrical power Requirements for ESF Testing
B.3.4.3.C	YMPO	TBD	ESF water tracer requirements.
B.3.4.3.D	YMPO	TBD	Methods of monitoring and recording water usage.
B.3.5.3.A	YMPO	TBD	Compressed air system design requirements for ESF testing.
B.3.5.3.C	YMPO	TBD	Compressed air tracer requirements.

EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

TBD LOG (continued)

SECTION OR PARAGRAPH	RESPONSIBLE ORGANIZATION	SCHEDULED RESOLUTION DATE	BRIEF DESCRIPTION
B.3.6.4	YMPO	TBD	Common Sampling Design Requirements for ESF Testing.
B.3.7.3	YMPO	TBD	Communications system design requirements for ESF testing.
B.4.1.3.A.4	YMPO	TBD	SBTF uninterruptible power supply requirements.
B.4.1.3.A.5	YMPO	TBD	SBTF normal power distribution requirements.
B.4.1.3.B	YMPO	TBD	Individual DAS facility support requirements.
B.4.1.3.B.2	YMPO	TBD	DAS enclosure and environmental requirements.
B.4.1.3.D.3	YMPO	TBD	IDS underground repair facility UPS and normal power distribution system requirements.
Appendix C	YMPO	TBD	Government Furnished Equipment

EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

TBV LOG

SECTION OR PARAGRAPH	VERIFICATION/ VALIDATION ORGANIZATION	VERIFICATION/ VALIDATION DATE	BRIEF DESCRIPTION
3.1.3.4.A.1	YMPO	TBD	Shaft access
3.1.3.4.A.2	YMPO	TBD	Shaft station zones
3.1.3.4.B	YMPO	TBD	Ramp access
3.1.3.4.C	YMPO	TBD	Underground excavations
3.2.1.H.1(a)	YMPO	TBD	Altered zones in underground openings
3.2.1.4.B.2	YMPO	TBD	Use of concrete or cementitious materials
3.2.1.8.2.F	YMPO	TBD	Environmental and habitability requirements for surface personnel enclosures.
3.2.1.9.3.D.1	YMPO	TBD	Mean-Time-To-Repair
3.2.1.9.4.A	YMPO	TBD	Maintainable service life
3.2.1.9.4.B.1	YMPO	TBD	Life of liners for wastewater ponds and rock storage.
3.2.1.9.4.B.2	YMPO	TBD	Maintainable life of shaft collars and ramp portals.
3.2.1.9.4.B.3	YMPO	TBD	Maintainable life of sites for shaft collars and ramp portals.
3.2.1.9.4.B.4	YMPO	TBD	Maintainable life of permanent shaft and ramp features.
3.2.1.9.4.B.5	YMPO	TBD	Maintainable life of permanent ESF features.
3.2.1.9.4.B.6	YMPO	TBD	Maintainable life of nonpermanent ESF features.

EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

TBV LOG (continued)

SECTION OR PARAGRAPH	VERIFICATION/ VALIDATION ORGANIZATION	VERIFICATION/ VALIDATION DATE	BRIEF DESCRIPTION
3.2.1.9.4.C	YMPO	TBD	Maintainable life of ESF permanent systems, structures and components.
3.2.2.1.J.4	YMPO	TBD	Location of maximum credible flood in relation to MPBHs.
3.2.2.4.D.17(a)	YMPO	TBD	Drift Diameter.
3.2.2.4.E.2	YMPO	TBD	Number of underground visitors.
3.2.2.4.L.7	YMPO	TBD	Location of surface boreholes relative to underground openings.
3.2.2.4.M.2	YMPO	TBD	Proximity of excavation and drilling relative to repository block.
3.2.2.4.M.5	YMPO	TBD	Mining extraction ratio of 30 per cent.
3.2.2.4.P.1	YMPO	TBD	Detect and control anomalous geological conditions.
3.2.2.4.U.2(b)	YMPO	TBD	Overbreak limit of 12 inches.
3.2.2.4.X.2(d)	YMPO	TBD	No pressure grouting allowed within 50 feet of boundary of ESF Main Test Area.
3.2.2.5.8.A	YMPO	TBD	Fire protection system
3.2.2.6.D	YMPO	TBD	Number of scientific personnel in the main test area
3.2.3.3.C	YMPO	TBD	Facilities for visitors during ESF testing.
3.2.6.5.3.C	YMPO	TBD	Battery backup for emergency lighting.

EXPLORATORY STUDIES FACILITY DESIGN REQUIREMENTS

TBV LOG (continued)

SECTION OR PARAGRAPH	VERIFICATION/ VALIDATION ORGANIZATION	VERIFICATION/ VALIDATION DATE	BRIEF DESCRIPTION
Appendix A.1	YMPO	TBD	Potential Repository/ESF Interface Requirements.
Appendix A.2	YMPO	TBD	ESF - Potential Repository Interface Drawings
Appendix A.5	YMPO	TBD	Seismic Design Basis Loads for the ESF

1. SCOPE

1.1 IDENTIFICATION

This document establishes the requirements and basic constraints imposed on the development of an architectural and engineering design for Exploratory Studies Facilities (ESF) in support of the Civilian Radioactive Waste Management System (CRWMS) - Yucca Mountain Site Characterization Project (YMP).

The development and control of the Exploratory Studies Facility Design Requirements (ESFDR) document is quality affecting work and is subject to the Office of Civilian Radioactive Waste Management (OCRWM) Quality Assurance Requirements and Description (QARD), DOE/RW-0333P. As part of the technical requirements baseline, it is also subject to OCRWM Baseline Management Plan, DOE/RW-0381P, controls. The ESFDR has been prepared and managed in accordance with the Technical Document Preparation Plan for the Preparation of MGDS Design Requirements Documents.

1.2 PURPOSE OF DOCUMENT

The purpose of this requirements document is to establish the design requirements for facilities, underground openings, utilities, and services as part of the ESF required to support the subsurface in situ tests specified in the Site Design and Test Requirements Document (SD&TRD), YMP/CM-0021. The ESFDR includes requirements for both surface and underground construction, utilities, and services. This document captures the existing baseline requirements. As this new ESFDR and the other documents in the hierarchy (see Section 1.3) mature, some of the requirements may be identified as needing to be moved to a more appropriate document.

1.3 SYSTEM OVERVIEW

The OCRWM Program Management System Manual, DOE/RW-0043, establishes the technical document hierarchy for the program, as illustrated in Figure 1-1.

The ESFDR document provides the requirements for all systems and subsystems within the scope of the ESF. The applicable guidance and requirements contained in the technical requirements document hierarchy (Figure 1-1) were utilized and incorporated into the ESFDR. The flowdown from the higher tier documents runs from the Civilian Radioactive Waste Management Requirements Document (CRD), DOE/RW-0406P, into the Mined Geologic Disposal System Requirements Document (MGDS-RD), DOE/RW-0404P, into the SD&TRD and on into the ESFDR. The ESFDR also contains design interface requirement inputs from the Repository Design Requirements document and the Surface-Based Testing Facilities Requirements Document (SBTFRD).

1.4 DOCUMENT ORGANIZATION AND DESCRIPTION

1.4.1 DOCUMENT ORGANIZATION

This ESFDR is presented in two volumes. Volume 1 contains sections 1 through 6, and Volume 2 contains all of the appendices.

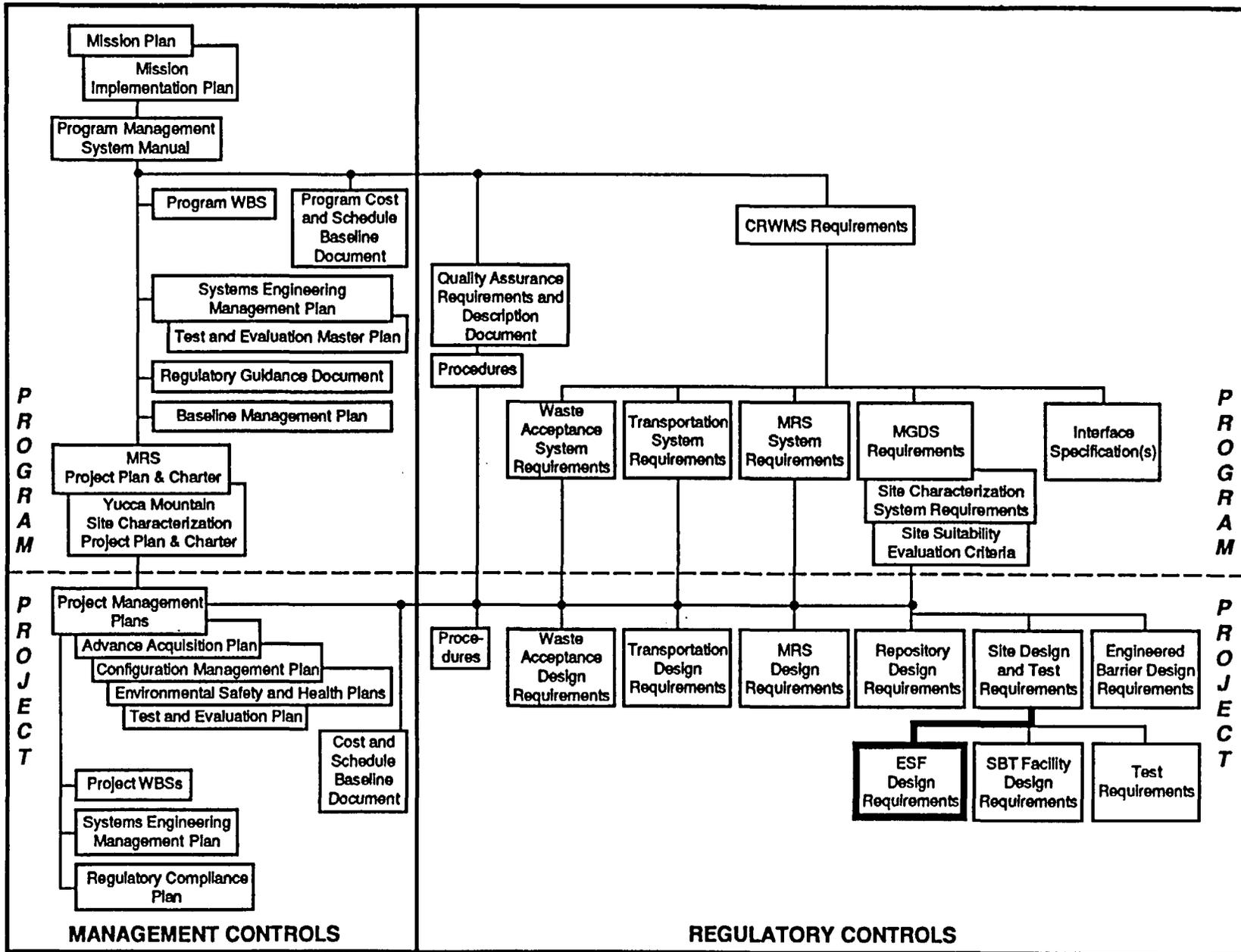


Figure 1-1 OCRWM Document Hierarchy

This ESFDR is organized as follows:

Volume 1

Section 1: Scope. This section presents an overview of the ESFDR and describes its role within the OCRWM document hierarchy.

Section 2: Applicable Documents. This section identifies documents that specifically relate to the various requirements of the ESFDR.

Section 3: Requirements. The mission of the ESF and its functions to be performed are described in Section 3.1. The performance characteristics and design criteria are presented in Sections 3.2 and 3.3. Specialty engineering, quality assurance (QA) and logistic requirements are also included in Section 3.2.

Section 4: Conformance Verification. This section addresses conformance verification and includes a cross-reference matrix to define verification of each requirement in Sections 3.2 and 3.3.

Section 5: Preparation for Operations. This section contains requirements for preparation of the system for acceptance and operations.

Section 6: Notes. This section contains explanatory material and is nonbinding on the ESFDR development. Cross-references to the SD&TRD as well as Chapter I, Title 10, Part 60, Code of Federal Regulations (10 CFR 60) are provided in this section.

Volume 2

Appendices: Data included in the appendices are binding with regard to ESFDR requirements. This document includes the following appendices:

Appendix A.1 Potential Repository/Exploratory Studies Facility Interface Constraints

Appendix A.2 Exploratory Studies Facility - Potential Repository Interface Drawings

Appendix A.3 Exploratory Studies Facility Sealing Requirements Imposed by Potential Repository Sealing Plan

Appendix A.4 Thermal Design Basis Loads for the Exploratory Studies Facility

Appendix A.5 Seismic Design Basis Loads for the Exploratory Studies Facility

Appendix B Facility Design Requirements for Exploratory Studies Facility Testing

Appendix C Government-Furnished Equipment

Appendix D Site Design and Test Requirements Document Traceability Matrix

Appendix E Applicable Regulations, Codes, Standards, and U.S. Department of Energy (DOE) Orders

Appendix F 10 CFR 60 Requirements Applicable to the Exploratory Studies Facility

Appendix G Reserved for Future use

Appendix H Reserved for Future use

Appendix I Performance Assessment Analysis

Appendix J Exploratory Studies Facility Environmental Requirements

1.4.2 REQUIREMENTS TRACEABILITY

Traceability of each requirement stated in Section 3.2 can be found in Section 6, Table 6-1 and Appendix D in Volume II.

1.4.3 REQUIREMENTS TO BE DETERMINED AND VERIFIED

Some of the requirements contained in Section 3 and the Appendices need to be determined [TBD] or to be verified [TBV].

Requirements needing a quantified value are TBD. Requirements are identified as TBD only if they are expected to be revised following determination of the quantity. If a requirement needs a quantified value, but the quantified value will be determined by the Design Organization (DO) without subsequent revision to the ESFDR, then the requirement is not identified as TBD.

TBV requirements have bounds, conditions or values that need verification, and must be verified by someone other than the DO.

1.4.4 VALUES STATED AS GOALS

Performance criteria and constraints expressed as goals are included to provide insight into the importance of parameters that are significant in satisfying the requirements specified in 10 CFR 60 (i.e., 3.2.2.4.M.5, 3.2.2.4.S.5, 3.2.2.4.U.2). In the design process, it is expected that analyses will be performed to test the validity of these goals. If such analyses predict that the identified goals cannot be met with reasonably available technology, it will be necessary to evaluate the predicted values to ensure that they are acceptable from the repository performance perspective. If the predicted values are acceptable, associated ESFDR goals will be revised accordingly.

2. APPLICABLE DOCUMENTS

This section, along with Appendices A, B, F and J, identify documents referenced as requirements for the ESFDR.

The ESF design shall comply with the latest version of all Federal Laws and Documents, State Laws and Documents, and Local Ordinances. For all Non-Government Documents, the issue in effect on the date of approval of the ESFDR forms a part of the requirements.

Omission of any applicable documents from this list shall not relieve the designer of the responsibility to meet those omitted requirements.

2.1 FEDERAL LAWS AND DOCUMENTS

2.1.1 U.S. CODE (USC) AND PUBLIC LAWS

	<u>Identifier</u>	<u>Title or Description</u>
A.	29 USC 651 et seq	Occupational Safety and Health Act
B.	42 USC 10101 et seq	Nuclear Waste Policy Amendments Act of 1987; Site Characterization Section
C.	49 USC 1501 et seq	Federal Aviation Act
D.	Public Law 97-425	Nuclear Waste Policy Act (NWPA) of 1982
E.	Public Law 100-203	Nuclear Waste Policy Amendments Act (NWPAA) of 1987

2.1.2 CODE OF FEDERAL REGULATIONS AND EXECUTIVE ORDERS

	<u>Identifier</u>	<u>Title or Description</u>
A.	10 CFR 60	Disposal of High-Level Radioactive Wastes in Geologic Repositories
B.	10 CFR 960	General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories
C.	27 CFR 55	Commerce in Explosives
D.	29 CFR 1910	Occupational Safety and Health Standards (OSHA)
E.	29 CFR 1926	Safety and Health Regulations for Construction (OSHA)
F.	29 CFR 1960	Basic Program Elements for Federal Employees Occupational Safety and Health Programs and Related Matters

G.	30 CFR 31	Diesel Mine Locomotives
H.	30 CFR 32	Mobile Diesel-Powered Equipment for Noncoal Mines
I.	30 CFR 36	Mobile Diesel-Powered Transportation Equipment for Gassy Noncoal Mines and Tunnels
J.	30 CFR 57	Safety and Health Standards - Underground Metal and Nonmetal Mines
K.	30 CFR Chapter I	Mine Safety and Health Administration (MSHA), Department of Labor
L.	33 CFR 323	Permits for Discharge of Dredged or Fill Material into Waters of the United States
M.	40 CFR 165	Regulations for the Acceptance of Certain Pesticides and Recommendation Procedures for the Disposal and Storage of Pesticides and Pesticides Containers
N.	41 CFR 101	Federal Property Management and Regulations
O.	49 CFR 177	Carriage by Public Highways
P.	Executive Order 11988	Office of the President, 1977a. "Floodplain Management," 42 Federal Register 101, Washington, D.C.
Q.	Executive Order 11990	Office of the President, 1977b. "Protection of Wetlands," 42 Federal Register 101, Washington, D.C.

2.1.3 OTHER DOCUMENTS, ORDERS, AND DIRECTIVES

	<u>Identifier</u>	<u>Title or Description</u>
A.	DOE Order 3790.1A	Federal Employees Occupational Safety and Health Program
B.	DOE Order 4330.4A	Real Property Maintenance Management
C.	DOE Order 4700.1	Project Management System
D.	DOE Order 5480.4	Environmental Protection, Safety and Health Protection Standards.
E.	DOE Order 5480.7A	Fire Protection
F.	DOE Order 6430.1A	General Design Criteria
G.	DOE/RW-0194	Record Management Policies and Requirements

H.	DOE/RW-0199	Site Characterization Plan
I.	DOE/RW-0333P	Quality Assurance Requirements and Description
J.	DOE/RW-0381P	OCRWM Baseline Management Plan
K.	DOE/RW-0404P	Mined Geologic Disposal System Requirements Document (MGDS-RD)
L.	DOE/RW-0406P	Civilian Radioactive Waste Management System Requirements Document (CRD)
M.	DOD-HDBK-743	Anthropometry of U.S. Military
N.	YMP/91-14	Reclamation Implementation Plan
O.	YMP/92-32	Repository Design Requirements
P.	YMP/93-02	Reference Information Base
Q.	YMP/CC-0009	Design Plan
R.	YMP/CM-0021	Site Design & Test Requirements Document
S.	YMP/CM-0022	Surface-Based Testing Facilities Requirements Document
T.	TDPP	Technical Document Preparation Plan For The Preparation of MGDS Design Requirements Documents
U.	MIL-STD-882B	System Safety Program Requirements
V.	MIL-STD-1388	Logistics Support Analysis
W.	MIL-STD-1472D	Human Engineering Design Criteria for Military Systems, Equipments, and Facilities
X.	UCRL 15673	Human Factors Design Guidelines for Maintainability of Department of Energy Nuclear Facilities
Y.	UCRL 15910	Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards, June 1, 1990
Z.	UCRL 53526	Natural Phenomena Hazards Modeling Project: Seismic Hazard Models for Department of Energy

- AA. NUREG 0700 Guidelines for Control Room Design Reviews
- AB. BLM Manual, Volume 34, Section 9113 - Roads
9100 Engineering
- AC. Administrative Procedure Interface Control
5.19Q
- AD. MOA, NS/RW 4/16/92 Memorandum of Agreement on Nuclear Safety
Requirements Between the Office of Civilian
Radioactive Waste Management and the Office of
Nuclear Safety

2.2 STATE LAWS AND DOCUMENTS

2.2.1 STATE OF NEVADA

<u>Identifier</u>	<u>Title or Description</u>
NAC 445/NRS 445	Nevada Water Pollution Control Law

2.2.2 OTHER STATES

<u>Identifier</u>	<u>Title or Description</u>
California Code of Regulations (CCR) Tunnel Safety Order	CCR "Title 8. Industrial Relations;" "Division 1. Department of Industrial Relations;" "Chapter 4. Division of Industrial Safety;" "Subchapter 20. Tunnel Safety Orders" (Required by DOE Order 5480.4) (8 CCR 8400 et seq)

2.3 LOCAL ORDINANCES

None were used for this document.

2.4 NON-GOVERNMENT DOCUMENTS

2.4.1 INDUSTRIAL AND PROFESSIONAL SOCIETY PUBLICATIONS

A. AMERICAN CONCRETE INSTITUTE (ACI)

<u>Identifier</u>	<u>Title or Description</u>
1. ACI 318	Building Code Requirements for Reinforced Concrete
2. ACI 349	Requirements for Nuclear Safety Related Concrete Structures

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

<u>Identifier</u>	<u>Title or Description</u>
1. ANSI/C2	National Electrical Safety Code
2. ANSI/ASTM D4256	Test Method for Determination of the Decontaminability of Coatings used in Light-Water Nuclear Power Plants
3. ANSI R15.16	Human Engineering Criteria for Handheld Robotics Controls
4. ANSI S-3.18	Evaluation of Human Exposures to Whole Body Vibration
5. ANSI/HSF 100-1988	Visual Display Terminal Workstations

C. AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

<u>Identifier</u>	<u>Title or Description</u>
ASCE 7-88	Minimum Design Loads for Buildings and Other Structures

D. INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS

1. Uniform Building Code (UBC)
2. Uniform Mechanical Code (UMC)
3. Uniform Plumbing Code (UPC)

E. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

1. NFPA 70 - National Electrical Code
2. NFPA 101 - Safety to Life from Fire in Buildings and Structures
3. NFPA 110 - Emergency in Standby Power Systems

F. MITRE CORPORATION (MTR)

Identifier

Title or Description

MTR 10090

Guidelines for Designing User Interface Software

G. CRANE MANUFACTURERS ASSOCIATION OF AMERICA

Specification for Overhead Traveling Cranes

3. REQUIREMENTS

3.1 EXPLORATORY STUDIES FACILITY DEFINITION

The ESF is defined as those systems, subsystems, and components used for site characterization and performance confirmation testing at depth that allows manned access to the test area(s). The data will be used to determine the suitability of the Yucca Mountain site for a potential repository of high-level nuclear waste. Specifically, the ESF shall consist of the following: ESF site, surface utilities, surface facilities, underground openings (ramp access, optional shaft access and other underground excavations), underground support systems, underground test support, and provisions for decommissioning and closure. Some or all of the ESF may be incorporated into a potential repository. The ESF will conduct only those subsurface activities necessary to characterize the Yucca Mountain Site to evaluate its suitability for an application to be submitted to the Nuclear Regulatory Commission (NRC) for construction authorization for a nuclear waste repository at the site. Subsurface lateral excavations and borings will be limited to those necessary to provide this data. The ESF also includes surface and underground facilities (including accesses and connecting drifts) and supporting systems required to support site characterization testing at depth.

The underground limits for ESF use (the main test area, drifts and ramps) are defined in the ESF potential repository interface drawings referenced in ESFDR Appendix A.2. The main test level (MTL) is defined as the ESF development within the planned repository horizon, which currently is the Topopah Spring welded unit 2 (TSw2) rock unit within the Topopah Spring Member of the Paintbrush Tuff. Radioactive wastes will not be handled, tested or stored at the ESF.

A. The mission of the ESF is to provide facilities for in situ site characterization for the MGDS, and to support in situ site characterization as required by DOE/OCRWM milestones and the Site Characterization Plan. The ESF also provides for the incorporation of subsurface and surface facilities into a potential repository. This section identifies and defines the functions the ESF will perform, provides the interrelationships of the functions, and it defines the architecture of the ESF and allocates the identified functions to this architecture. Table 3-1 provides a list of facilities to support subsurface testing. The specific functional requirements are presented below for each element of this architecture.

1. Provide Facilities to Support Subsurface Tests, ESF 1.4.1.2.1

Provide facilities for in situ site characterization for the MGDS and support in situ site characterization as required by DOE/OCRWM milestones and the SD&TRD.

Provide for incorporation of the ESF into a potential repository.

(a) Prepare Site(s) 1.4.1.2.1.1

Provide and prepare surface locations to support ESF activities.

Table 3-1 Exploratory Studies Facilities Functions

Function Title	Number
Provide Facilities to Support Subsurface Tests	1.4.1.2.1
Prepare Site(s)	1.4.1.2.1.1
Provide Access Roads	1.4.1.2.1.1.1
Provide Main Site(s)	1.4.1.2.1.1.2
Provide Auxiliary Site(s)	1.4.1.2.1.1.3
Provide Site Drainage	1.4.1.2.1.1.4
Provide Surface Utilities	1.4.1.2.1.2
Provide Power System	1.4.1.2.1.2.1
Provide Water System	1.4.1.2.1.2.2
Provide Sanitary System	1.4.1.2.1.2.3
Provide Communications System	1.4.1.2.1.2.4
Provide Surface Wastewater System	1.4.1.2.1.2.5
Provide Compressed Air System	1.4.1.2.1.2.6
Provide Solid Waste Disposal System	1.4.1.2.1.2.7
Provide Surface Facilities	1.4.1.2.1.3
Provide Site Preparation for Surface Structures	1.4.1.2.1.3.1
Provide Permanent Test Support Buildings	1.4.1.2.1.3.2
Provide Temporary Structures	1.4.1.2.1.3.3
Provide Communications/Data Building	1.4.1.2.1.3.4
Provide Warehouse Facilities	1.4.1.2.1.3.5
Provide Shop Facilities	1.4.1.2.1.3.6
Provide Storage Facilities	1.4.1.2.1.3.7
Provide Ventilation System	1.4.1.2.1.3.8
Provide Parking Areas	1.4.1.2.1.3.9
Provide Underground Openings	1.4.1.2.1.4
Provide Shaft	1.4.1.2.1.4.1
Provide Collar	1.4.1.2.1.4.2

Table 3-1 Exploratory Studies Facilities Functions (continued)

Function Title	Number
Provide Hoist System	1.4.1.2.1.4.3
Provide Ramps	1.4.1.2.1.4.4
Provide Portal	1.4.1.2.1.4.5
Provide Underground Excavations	1.4.1.2.1.4.6
Provide Lining	1.4.1.2.1.4.7
Provide Stations	1.4.1.2.1.4.8
Provide Furnishings	1.4.1.2.1.4.9
Provide Operations Support Area	1.4.1.2.1.4.10
Provide Sump	1.4.1.2.1.4.11
Provide Test Area	1.4.1.2.1.4.12
Provide Underground Support Systems	1.4.1.2.1.5
Provide Power Distribution	1.4.1.2.1.5.1
Provide Lighting	1.4.1.2.1.5.2
Provide Ventilation Distribution	1.4.1.2.1.5.3
Provide Water Distribution	1.4.1.2.1.5.4
Provide Underground Wastewater Collection	1.4.1.2.1.5.5
Provide Compressed Air Distribution	1.4.1.2.1.5.6
Provide Fire Protection	1.4.1.2.1.5.7
Provide Muck and Material handling	1.4.1.2.1.5.8
Provide Sanitary Facilities	1.4.1.2.1.5.9
Provide Monitoring and Warning	1.4.1.2.1.5.10
Provide Test Support	1.4.1.2.1.6
Provide for Data Collection	1.4.1.2.1.6.1
Provide Underground Test Support	1.4.1.2.1.6.2
Provide Decommissioning and Site Closure	1.4.1.2.1.7
Provide Decommissioning and Closure of Accesses and Underground Facilities	1.4.1.2.1.7.1
Provide Decommissioning and Closure of Surface Facilities	1.4.1.2.1.7.2

i. **Provide Access Roads 1.4.1.2.1.1.1**

Provide access roads to accommodate all anticipated services in a safe and effective manner.

ii. **Provide Main Site(s) 1.4.1.2.1.1.2**

Provide main site(s) of adequate size, shape and grade to support all anticipated structures, systems, and components that will be located near the accesses.

iii. **Provide Auxiliary Site(s) 1.4.1.2.1.1.3**

Provide auxiliary site(s) of adequate size and shape to support anticipated functions.

iv. **Provide Site Drainage 1.4.1.2.1.1.4**

Provide measures to control ESF Site drainage runoff.

(b) **Provide Surface Utilities 1.4.1.2.1.2**

Provide surface utility systems, subsystems, and facilities for the ESF, to support site preparation, construction, operations, and testing during site characterization.

i. **Provide Power System 1.4.1.2.1.2.1**

Provide an electrical system consisting of a standard electrical power distribution system, a standby electrical power system, and an uninterruptible power supply (UPS) system for the ESF.

ii. **Provide Water System 1.4.1.2.1.2.2**

Provide a water supply, storage, and distribution system for the ESF.

iii. **Provide Sanitary System 1.4.1.2.1.2.3**

Provide a sanitary system for the surface collection and disposal of underground and surface sanitary sewage during ESF activities.

iv. **Provide Communications System 1.4.1.2.1.2.4**

Provide a communications link internal and external to the ESF for use during construction, operation, and testing.

v. **Provide Surface Wastewater System 1.4.1.2.1.2.5**

Provide a surface wastewater system for collection, transfer, treatment, and disposal of nonsanitary underground water.

vi. **Provide Compressed Air System 1.4.1.2.1.2.6**

Provide compressed air production and distribution.

vii. **Provide Solid Waste Disposal System 1.4.1.2.1.2.7**

Provide for disposal of solid waste.

(c) **Provide Surface Facilities 1.4.1.2.1.3**

Provide surface buildings and/or supporting facilities for the ESF construction and operations.

Provide dust control and/or collection facilities.

Provide on-site transportation facilities for personnel, equipment, materials, and rock.

i. **Provide Site Preparation for Surface Structures 1.4.1.2.1.3.1**

Prepare sites with required services for surface structures.

ii. **Provide Permanent Test Support Buildings 1.4.1.2.1.3.2**

Provide test support facilities to meet the operational requirements of the principal investigators (PIs).

iii. **Provide Temporary Structures 1.4.1.2.1.3.3**

Provide temporary structures and their supporting equipment to support the ESF.

iv. **Provide Communications/Data Building 1.4.1.2.1.3.4**

Provide a communications/data building for the communications data collection and transmission equipment during the ESF operation and underground site characterization.

v. **Provide Warehouse Facilities 1.4.1.2.1.3.5**

Provide facilities for general warehousing in support of the ESF construction and operations.

vi. **Provide Shop Facilities 1.4.1.2.1.3.6**

Provide shop facilities and equipment for the routine maintenance, inspection, and repair of the ESF equipment, systems, structures, and components.

vii. Provide Storage Facilities 1.4.1.2.1.3.7

Provide storage for the anticipated equipment, supplies, and vehicles that will be used during construction and operation of the ESF.

viii. Provide Ventilation System 1.4.1.2.1.3.8

Provide a ventilation system to supply air to and exhaust air from the subsurface workings to meet the needs of construction and operation of the underground site characterization and testing program.

ix. Provide Parking Areas 1.4.1.2.1.3.9

Provide parking areas to support ESF construction, operation, and underground site characterization activities.

(d) Provide Underground Openings 1.4.1.2.1.4

Provide underground openings and accesses for the performance of in situ site characterization.

Provide for incorporation of underground openings into a potential repository.

i. Provide Optional Shaft (if required) 1.4.1.2.1.4.1

Provide an underground opening, in the configuration of a shaft, for in situ site characterization.

Provide for incorporation of the shaft into a potential repository.

ii. Provide Collar (if required) 1.4.1.2.1.4.2

Provide an adequate foundation for the headframe and accommodate penetrations and structural mountings for the optional shaft.

iii. Provide Hoist System (if required) 1.4.1.2.1.4.3

Provide for the transport of testing and construction personnel, materials, and construction equipment, and serve as an emergency egress during shaft construction, operation, and testing.

iv. Provide Ramps 1.4.1.2.1.4.4

Provide underground openings, in the configuration of a ramp, for in situ site characterization, and access to other underground excavations for the performance and support of in situ site characterization.

Provide for incorporation of the ramps into a potential repository.

v. **Provide Portal 1.4.1.2.1.4.5**

Provide adequate protection for ingress and egress and accommodate penetrations and structural mountings for the ramp.

vi. **Provide Underground Excavations 1.4.1.2.1.4.6**

Provide underground openings for in situ site characterization above, below, and at the potential repository horizon.

Provide for incorporation of the underground openings into a potential repository.

vii. **Provide Lining 1.4.1.2.1.4.7**

Provide structural and mechanical integrity, if required, for the optional shaft, and provide mounting for conveyance guide supports, utilities, and shaft instrumentation during construction and operations.

Provide structural and mechanical integrity for the ramp, if required, and mounting of conveyance supports, utilities, and ramp instrumentation during construction and operations.

viii. **Provide Stations 1.4.1.2.1.4.8**

Provide excavated space of adequate size and appropriate geometry to support underground construction and site characterization testing activities.

ix. **Provide Furnishings 1.4.1.2.1.4.9**

Provide structural support for the hardware (e.g., pipe, conduit, wiring, ventilation ducting) associated with the underground utility lines and other necessary underground services. These provisions are required during construction, operation and site characterization activities.

Provide for structural support and guides for the operation of the hoist conveyance.

x. **Provide Operations Support Area 1.4.1.2.1.4.10**

Provide excavated space of adequate size and appropriate geometry to support underground site characterization test activities on multiple levels.

xi. Provide Sump 1.4.1.2.1.4.11

Provide adequate space at or near the bottom of the optional shaft to accommodate in-shaft testing, shaft operation, and to collect and transfer wastewater to the underground wastewater collection system.

Provide adequate space within the ramp(s) to collect wastewater for transfer to the underground wastewater collection system.

xii. Provide Test Area 1.4.1.2.1.4.12

Provide excavated space of adequate size, appropriate layout, and appropriate opening geometry to conduct the necessary underground site characterization test activities, and house the necessary construction, test, and testing support equipment.

(e) Provide Underground Support Systems 1.4.1.2.1.5

Provide utilities for underground ESF construction, operations, in situ site characterization, and monitoring activities.

Provide facilities and equipment for the installation, operation, and maintenance of the underground services.

Provide underground transport services for personnel, equipment, and materials.

i. Provide Power Distribution 1.4.1.2.1.5.1

Provide a distribution system for electrical power to underground facilities.

ii. Provide Lighting 1.4.1.2.1.5.2

Provide a distribution system for underground lighting.

iii. Provide Ventilation Distribution 1.4.1.2.1.5.3

Provide a distribution system for ventilation air.

iv. Provide Water Distribution 1.4.1.2.1.5.4

Provide a water distribution system for underground facilities.

v. Provide Underground Wastewater Collection 1.4.1.2.1.5.5

Provide a system for underground wastewater collection and treatment, as required.

vi. **Provide Compressed Air Distribution 1.4.1.2.1.5.6**

Provide a system for the distribution of compressed air throughout the underground ESF facility.

vii. **Provide Fire Protection 1.4.1.2.1.5.7**

Provide for the detection, warning, and suppression of fires in the ESF underground.

viii. **Provide Muck and Material Handling 1.4.1.2.1.5.8**

Provide for transport of excavated rock, materials, and equipment between the ground surface and the underground.

ix. **Provide Sanitary Facilities 1.4.1.2.1.5.9**

Provide sanitary facilities for the work force at convenient locations throughout the underground.

x. **Provide Monitoring and Warning 1.4.1.2.1.5.10**

Provide monitoring and warning of underground environmental conditions dangerous to personnel.

(f) **Provide Test Support 1.4.1.2.1.6**

Provide the means for implementing characterization and performance confirmation testing plans.

i. **Provide for Data Collection 1.4.1.2.1.6.1**

Provide for incorporation of an Integrated Data System (IDS) into the ESF.

ii. **Provide Underground Test Support 1.4.1.2.1.6.2**

Provide adequate facilities to allow effective execution of tests.

(g) **Provide Decommissioning and Site Closure 1.4.1.2.1.7**

Provide for decommissioning and closure of the ESF.

i. **Provide Decommissioning and Closure of Accesses and Underground Facilities 1.4.1.2.1.7.1**

Provide for decommissioning and closure of the ESF accesses and underground facilities.

ii. **Provide Decommissioning and Closure of Surface Facilities**
1.4.1.2.1.7.2

Provide for decommissioning and closure of the ESF surface facilities.

- B. Personnel flow requirements will be defined by the tasks and performance criteria that are required by the ESF site characterization tests defined by the SD&TRD. [TBD]
- C. Material flow requirements will be defined by the tasks and performance criteria required by the ESF site characterization tests prescribed by the SD&TRD. [TBD]

3.1.1 FACILITY DRAWINGS

The ESF consists of surface facilities and underground excavations (illustrated conceptually in Figure 3-1). The surface facilities include such items as shops, a warehouse, offices and laboratories, an electric substation, IDS facility, wastewater treatment systems, and a muck storage area. The underground excavations consist of two ramps (one in the north, one in the south) constructed to the TSw2 level, where the potential repository horizon would be located. The bottoms of these ramps will be connected by a main drift in the TSw2 unit; additional drifts will be mined from this main drift. The MTL core area would also be located at the TSw2 level for both site characterization and performance confirmation testing.

The north and south ramps will both contain a turnout for ramps leading down to the Calico Hills (CH) unit; the bottoms of these ramps will be connected by a drift in the CH unit. Additional drifts may also be mined from this connecting drift. The current plan provides for an optional shaft in the north, the need for which will be determined during site characterization. The optional shaft will extend from the surface to the MTL.

3.1.2 INTERFACE DEFINITIONS

The ESF consists of both surface and underground facilities and associated support equipment to provide the required facilities for all underground site characterization testing. Physical interfaces exist between the ESF and both the potential repository and the surface-based testing facilities. Full compliance with the ESF design requirements necessitates an evaluation and understanding by the designer of these interfaces. The surface facilities, utilities, equipment and underground openings of the ESF will interface with the surface structures and equipment required by the potential repository and surface-based testing. The underground openings provided by the ESF will interface with, and may become an integral part of, the potential repository. Requirements to incorporate these interfaces into the design of the ESF are provided in Section 3.2.1.

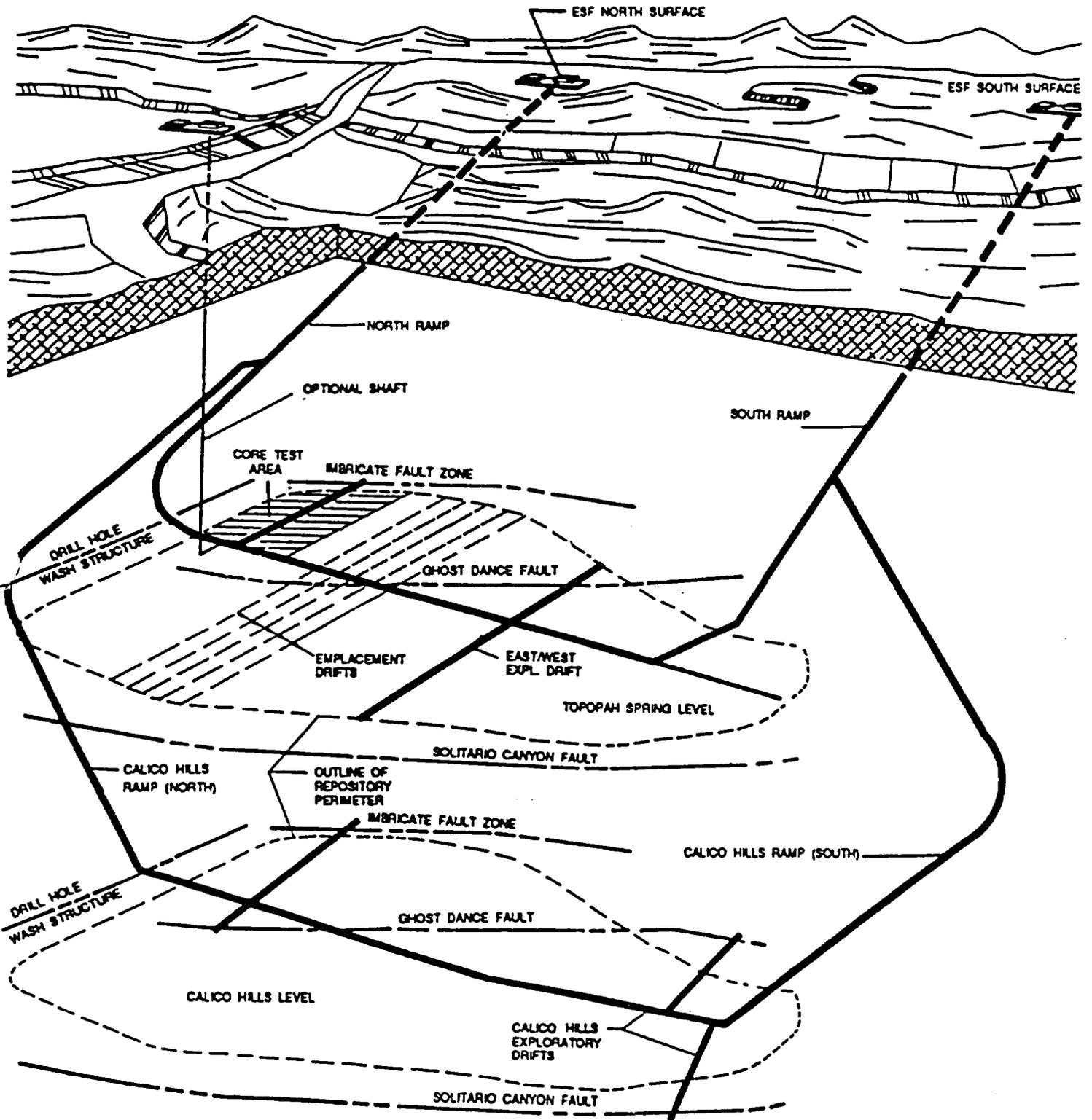


Figure 3-1 Conceptual Illustration of the Exploratory Studies Facility

3.1.3 MAJOR SUBSYSTEM AND COMPONENTS LIST

- A. The major subsystems of the ESF are:
- ESF Site(s)
 - Surface Utilities
 - Surface Facilities
 - Underground Openings
 - Underground Support Systems
 - Test Support
 - ESF Decommissioning and Closure
- B. Each of these subsystems consists of components which will be identified and described in the following paragraphs.

3.1.3.1 EXPLORATORY STUDIES FACILITIES SITE(S)

- A. ESF Sites - surface systems, subsystems and components located on Government-owned land necessary for the development of the surface and underground facilities, and supporting systems required to support site characterization testing at depth. Site systems, subsystems, and components are composed of general civil improvements and comprise the main site, auxiliary site, access roads, and site drainage.
1. Main site - located on the surface, accommodates structures, systems, and components for construction of ramps and/or shafts, but does not include initial construction and test support facilities.
 2. Auxiliary site - consists of the areas prepared for ESF purposes not fulfilled by the main site. Examples of the possible use of auxiliary sites include:
 - lay down area
 - explosives magazine
 - muck and rock storage
 - topsoil storage
 - batch plant
 - water tank
 - substation with standby generators
 - compressors
 - warehouse

and other areas defined as the design progresses.
 3. Access roads - all features needed to provide vehicular access, as required, to all surface areas designated to support the ESF.
 4. Site drainage system - items and measures utilized to control drainage and runoff water to preclude damage by erosion or flooding.

3.1.3.2 SURFACE UTILITIES

- A. **Surface utilities** - surface systems, subsystems, structures, and components necessary to meet the needs of Participant organizations in carrying out ESF activities. These include provisions for power, water, sewage, communications, mine wastewater, compressed air, and solid waste disposal.
1. **Power system** - systems, subsystems, components, and structures that supply electrical power to the ESF site. These systems include, but are not limited to: ESF site substation(s); distribution systems; extension and upgrading of the existing 69-kV overhead power line to 138-kV; secondary power lines to the muck conveying system and booster pump station; surface lighting; a stand-by power generation system; power distribution to the facilities; and a UPS system.
 2. **Water system** - systems, subsystems, and components that supply and distribute the potable and nonpotable water for the ESF.
 3. **Sanitary system** - systems, subsystems, and components that provide for the surface collection and disposal of underground and surface sanitary sewage for the support of ESF operations.
 4. **Communications system** - 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.
 5. **Surface wastewater system** - systems, subsystems, and components that provide surface equipment for collection, transfer, treatment, and disposal of liquid nonsanitary wastes generated underground in the ESF during construction and operation.
 6. **Compressed air system** - systems, subsystems, and components that provide the production and distribution of compressed air throughout the ESF.
 7. **Solid waste disposal system** - systems and subsystems required for collection, transport and disposal of nonhazardous solid waste during the ESF construction, operation, testing and closure activities.

3.1.3.3 SURFACE FACILITIES

- A. **Surface facilities** - temporary and permanent facilities, systems, and services for the surface buildings and temporary structures that are required for the support of ESF operations and in situ site characterization. Some of these facilities, such as the ventilation system and hoist house, are the surface portions of subsurface facilities.
1. **Ventilation system** - surface systems, subsystems, and components that supply fresh air, conditioned if required, to the ventilation distribution system, which in turn supplies fresh air to, and removes exhaust air from the ESF underground areas.

2. Test support facilities - surface facilities that accommodate the PIs' testing apparatus for equipment assembly, checkout, and repair; this may involve the use of temporary structures.
3. Site preparation for surface structures - sites prepared to receive surface structures by providing for necessary utilities at the sites. This includes all of the facilities, systems, and services required by the structures during construction and operation of the ESF. Surface structures to be provided for include all those covered by Section 3.1.3.3.
4. Parking areas - spaces and allowances for vehicle parking required to support construction, operation, and testing in the ESF.
5. Storage facilities - areas, structures, and supporting services intended to store equipment, supplies, and vehicles in a yard-type environment.
6. Shop - facilities, systems, and services for the routine maintenance and repair of the construction and testing equipment designated for the ESF, including ground maintenance and transportation equipment.
7. Warehouse - 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 of the Storage Facilities.
8. Other temporary structures - systems and services that will be utilized for the offices, change rooms, first aid and mine rescue apparatus center, and security offices; and space required (including site preparation) to support ESF construction, scientific operations, and maintenance personnel for the site characterization program.
9. Communications/data building - facilities, systems, and services for the communications, data collection, and transmissions that are required to support construction and testing.
10. Hoist house - accommodates the hoist, the necessary equipment and instrumentation for the hoist, air compressor system, control room, electrical and motor control centers, and an area for repairs and lay down.

3.1.3.4 UNDERGROUND OPENINGS

Underground openings include shaft access, ramp access and other underground excavations.

- A. Shaft access - systems, subsystems, and components which are comprised of:
 1. The vertical engineered opening within a circular zone whose radius is defined as the sum of the radius of the finished shaft, the lining thickness, and a nominal 1.5 meters (5 feet) beyond the lining, that connects the surface with the targeted horizons [TBV].

2. Shaft stations, including a zone extending a nominal 1.5 meters (5 feet) beyond the excavated station surfaces [TBV]. The system provides safe and controlled access to the targeted horizons for personnel, equipment, and underground service systems, as well as underground in-shaft testing operations. Under the current design, a shaft is optional.
 3. Collar - the foundation at the uppermost portion of the shaft used to support the headframe and shaft construction activities.
 4. Lining - components (e.g., concrete) which are provided to maintain the integrity of the intended opening.
 5. Stations - the initial underground openings at predetermined horizons adjacent to the shaft.
 6. Furnishings - structural steel sets consisting of buntons attached to fabricated brackets, which are fixed to the shaft wall or to other structural members. Also included are the shaft guides, fixed guide brackets and backers, conveyance chairs, crash beams, various enclosures or blockouts required to support instrumentation and cabling; and utility brackets to facilitate installation of shaft utilities such as electrical power, communications, compressed air, water, and wastewater removal.
 7. Hoist system - 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. The hoist system includes the rope winding equipment (hoist), conveyance, headframe, rope, dumping system, and hoist house.
 8. Sump - the area at the bottom of the shaft, below the adjacent horizontal excavation, that contains, collects, and transfers underground wastewater to the underground wastewater collection system.
- B. Ramp access - systems, subsystems, and components which are comprised of an engineered opening, including a zone extending a nominal 1.5 meters (5 feet) beyond the excavated surface, that connects the ground surface with the underground [TBV]. The system provides safe and controlled access to the targeted horizons for personnel, equipment, underground service systems, and materials required for development of the underground drifts and excavations, as well as underground testing operations. A ramp access will serve as the primary muck removal opening for test area development and will include site characterization testing activities. [TBV]**
1. Portal - the rock face and retaining structure at the surface entrance of the ramp. The structure provides ground and utility support and overhead protection for ingress and egress into the ramp during construction and operation.
 2. Lining - components (e.g., concrete) which are provided to maintain the integrity of the intended opening.

3. Furnishings - various enclosures or blockouts required to support instrumentation and cabling; and utility brackets to facilitate installation of shaft utilities such as electrical power, communications, compressed air, water, and wastewater removal.
 4. Sump - the area within the ramp, below the adjacent horizontal excavation, that contains, collects, and transfers underground wastewater to the underground wastewater collection system.
- C. **Underground excavations** - underground openings that extend more than 1.5 meters (5 feet) beyond the accesses and which comprise the excavations at the proposed test levels and the potential repository horizon, based on the need for underground site characterization. [TBV]
1. Furnishings - various enclosures or blockouts required to support instrumentation and cabling; and utility brackets to facilitate installation of shaft utilities such as electrical power, communications, compressed air, water, and wastewater removal.
 2. Operations support areas - the following underground openings: drift(s); refuge room(s); operations administration area; underground shop(s); lunch room(s); storage facility(ies); maintenance shop(s); areas for power distribution, fuel storage, and equipment storage; and other underground openings, but excluding those included in Test Areas.
 3. Test areas - openings excavated at the MTL, the CH level, and other areas as required for conducting underground site characterization tests at the potential repository horizon and the other geologic horizons.

3.1.3.5 UNDERGROUND SUPPORT SYSTEMS

- A. **Underground support systems, subsystems, and components** - the utilities and provisions for power, communications, lighting, ventilation, water, underground wastewater removal, compressed air, fire protection, materials and muck handling, sanitation, and safety monitoring and warning required to meet the needs of the underground site characterization testing program during construction and operation.
1. Power distribution system - systems, subsystems, and components that distribute electrical power to underground systems.
 2. Lighting system - systems, subsystems, and components that provide for the illumination of the ESF underground areas (shafts, ramps, stations, refuge chambers, alcoves, test areas, and shop areas).
 3. Ventilation distribution system - systems, subsystems, and components that allow fresh air, conditioned if required, to be supplied to, and exhaust air to be removed from, the underground areas to meet the needs of underground construction and site characterization testing.

4. Water distribution system - systems, subsystems, and components that distribute water within the underground facility.
5. Underground wastewater collection system - systems, subsystems, and components that collect, control, and transfer to the surface wastewater system, the wastewater that flows into the shafts/ramps and underground facilities.
6. Compressed air distribution system - systems, subsystems, and components that distribute compressed air throughout the underground ESF facility.
7. Fire protection system - systems, subsystems, and components that provide detection, warning, and suppression, as required, to extinguish fires within the underground facilities.
8. Muck and material handling systems - systems, subsystems, structures, equipment, and components that transport excavated rock (muck), materials (including supplies and fuel), and equipment between the ground surface and the underground to meet the needs of construction and underground site characterization testing. This includes any transferring at a shaft or ramp station. The material handling system includes material handling equipment, loading and unloading stations, transfer point structures, and buildings to accommodate all the necessary equipment and instrumentation; hydraulic power units; air compressor system; control room; electrical and motor control centers; and an area for repairs and lay down. The muck handling system includes the muck pockets, skip loaders, bottom cleanout systems, and the appropriate conveyances.
9. Sanitary facilities - the system that provides for human waste collection within the underground facilities.
10. Monitoring and warning systems - systems required to monitor underground environmental conditions (e.g., humidity, temperature, water accumulation, noise, dust, toxic and flammable gases, smoke, radon/radon daughters), and to alert on-site personnel of possible dangerous situations so as to ensure a safe and healthful working environment.

3.1.3.6 TEST SUPPORT

- A. **Test support** - activities associated with test equipment, including but not limited to, installation and maintenance, test execution, test data recording, and test analysis for in situ site characterization to be performed within the Yucca Mountain ESF.
 1. **IDS support** - hardware components and associated computer software necessary to acquire, store and disseminate data collected in connection with testing operations and construction, and operations monitoring in the ESF.
 2. **Underground test support** - test support for the various types of tests to be performed, such as geologic, hydrologic and fluid transport phenomena, geomechanical (including thermomechanical) and geochemical. Facility requirements for these tests are described in ESFDR Appendix B.

3.1.3.7 EXPLORATORY STUDIES FACILITY DECOMMISSIONING AND CLOSURE

- A. **Decommissioning and closure** - activities enacted to place the ESF facilities (systems and subsystems) into a permanently nonoperable and safe condition. Requirements in this section apply only if Yucca Mountain is determined to be unsuitable as a repository.
1. **Surface facilities** - temporary and permanent facilities, systems, and services for the surface buildings and temporary structures that are required for the support of ESF operations and in situ site characterization.
 2. **Accesses and underground facilities** - facilities, systems, and subsystems as described in previous sections: accesses, underground excavations, underground utility systems, and underground test support (excluding collar, hoist, and portal systems).

3.2 CHARACTERISTICS

The integrated performance and design requirements shall be allocated from, identical to, or in recognition of, the requirements established by the SD&TRD.

This section presents the design requirements which shall be applied by all ESF design areas, as applicable.

The ESF requirements specified in this section and its associated appendices satisfy all of the 10 CFR 60 requirements in U.S. Nuclear Regulatory Agency (NUREG) 1439. Appendix F identifies the location of all 10 CFR 60 requirements in this document that are specified in NUREG 1439.

ESF characteristics for the following disciplines are provided in Sections 3.2.1 through 3.3.1.6.

- General
- Civil/Mining
- Architectural
- Structural
- Mechanical
- Electrical
- Equipment
- Testing
- Flexibility and Expansion
- Security

These characteristics are provided for the ESF and each ESF supplement in subsequent paragraphs.

3.2.1 GENERAL

The ESF shall consist of the following:

- ESF site
- surface utilities
- surface facilities
- optional shaft access
- ramp access
- underground excavations
- underground support systems
- underground test support
- provisions for decommissioning and closure

The requirements in Section 3.2.1 are applicable to all segments of the ESF. General requirements which are applicable to specific ESF subsystems are presented in subsections 3.2.1.1 through 3.2.1.7 of this section.

[SD&TRD 3.7][MGDS-RD 3.7.1.3]

- A. The location of the ESF shall represent the features and conditions expected at the potential repository site.

[SD&TRD 3.7.B.1][10 CFR 60.15(b)]

- B. The thickness, lateral extent, physical and chemical properties, and composition of the host rock for the ESF shall represent the potential repository site.

[SD&TRD 3.7.B.1][10 CFR 60.15(b)]

- C. Drill core and/or the results of geologic, hydrologic, geochemical and geophysical investigations shall be used to establish and confirm specific location and design of the ESF accesses and underground openings.

[SD&TRD 3.7.B.1][10 CFR 60.15(b)]

- D. Underground openings shall be developed to meet the needs of in situ site characterization and performance confirmation, including basic needs for the initially planned tests and allowance for uncertainties in the test plans and underground conditions.

[SD&TRD 3.7.B.1][10 CFR 60.15(b)]

- E. The ESF shall be designed and constructed so that, to the extent practicable, equipment breakdowns during construction and operations will not adversely affect schedule or budget.

[SD&TRD 3.2.9.3.C.1, 3.2.9.5, 3.7.B.3][CRD 3.2.5.5.B][DOE Order 6430.1A]

- F. RESERVED

- G. The ESF design shall conform to applicable federal, state, and local codes and standards pertaining to natural hazards and foundation stability, such as the requirements specified in DOE Order 6430.1A, General Design Criteria.

[SD&TRD 3.3.1.C, 3.7.B.3][DOE Order 6430.1A]

- H. ESF structures, systems, and components (SSC) that will be incorporated into the potential repository shall be designed and constructed with the same criteria, standards, and QA as required for a repository, to the extent known at the time of ESF design.

[SD&TRD 3.2.7.1.B.1-3, 3.2.7.1.B.5-6, 3.7.B.1, 3.7.2.2.12][10 CFR 60.133]

1. The items listed below are the ESF permanent structures, systems, and components which shall be designed, procured, and constructed so they can be incorporated into a potential repository:
 - (a) Underground opening(s)--space created by mining or drilling, including those zones within the rock mass altered by that process to an extent which renders it unsuitable for construction of openings within the altered zone [TBV].
[SD&TRD 3.7.2.2.D, 3.7.B.1][10 CFR 60.15(c)(4)]
 - (b) Ramp and shaft lining(s)--all permanent components placed between the inside limits of the ramp and shaft and the accessible extent of the underground opening.
[SD&TRD 3.7.2.2.D, 3.7.B.1][10 CFR 60.15(c)(4)]
 - (c) Ground support--any means used to reinforce rock and/or control the movement of rock except for items of support which may be removed or replaced if the ESF is incorporated into the potential repository.
[SD&TRD 3.7.2.2.D, 3.7.B.1][10 CFR 60.15(c)(4)]
 - (d) Operational seal(s)--any engineered structure including the material placed in an underground opening and/or the peripheral rock for the purpose of controlling the flow of water and/or gas during the life of the ESF and through the preclosure phase of the potential repository.
[SD&TRD 3.7.2.2.D, 3.7.B.1][10 CFR 60.15(c)(4)]
2. The following potential repository design criteria, to the extent known at the time of ESF design, shall be considered for the ESF permanent SSC important to safety (ITS). These criteria will apply only during the period of the potential repository operations, and shall not interfere with ESF operations.
 - (a) The SSC ITS shall be designed so that natural phenomena and environmental conditions anticipated at the geologic repository operations area will not interfere with necessary safety functions.
[SD&TRD 3.2.7.1.B.2.a, 3.7.B.1][10 CFR 60.131(b)(1)]
 - (b) The SSC ITS 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 functions.
[SD&TRD 3.2.7.1.B.2.b, 3.7.B.1][10 CFR 60.131(b)(2)]
 - (c) The SSC ITS shall be designed to perform their safety functions during and after credible fires or explosions in the geologic repository operations area.
[SD&TRD 3.2.7.1.B.2.c, 3.7.2.2.13.c, 3.7.B.1][10 CFR 60.131(b)(3)(i)]

- i. To the extent practicable, the geologic repository operations area shall be designed to incorporate the use of noncombustible and heat resistant materials.
[SD&TRD 3.2.7.1.B.2.d, 3.7.B.1][10 CFR 60.131(b)(3)(ii)]
- ii. The geologic repository operations area shall be designed to include means to protect SSC ITS against the adverse effects [TBD] of either the operation or failure of the fire suppression systems.
[SD&TRD 3.2.7.1.B.2.f, 3.7.B.1][10 CFR 60.131(b)(3)(iv)]
- (d) The SSC ITS shall be designed to permit periodic inspection, testing, and maintenance, as necessary, to ensure their continued functioning and readiness.
[SD&TRD 3.2.7.1.B.3, 3.7.B.1][10 CFR 60.131(b)(6)]
- (e) Design and construction shall consider the Federal Mine Safety and Health Act of 1977. The design shall include provisions for worker protection necessary to provide reasonable assurance that all SSC ITS can perform their intended functions. Any deviation from relevant design requirements in 30 CFR, Chapter I, Subchapters D, E, [subchapters D and E are no longer used, they are now covered in parts 18-36] and N will give rise to rebuttable presumption that this requirement has not been met.
[SD&TRD 3.2.7.1.B.4, 3.7.B.1, 3.7.B.3][10 CFR 60.131(b)(9); 30 CFR Ch.I]
- i. If the subsurface facility is classified as a gassy mine by Yucca Mountain Site Characterization Project Office (YMPO), appropriate 29 CFR 1926, Subpart S and 30 CFR 57 (Category IV) requirements in effect at the time of design shall be applicable.
[SD&TRD 3.3.6.1.B, 3.7.B.3][29 CFR 1926, Subpart S; 30 CFR 57]

I. The ESF design and construction shall:

- 1. Support the performance confirmation program start-up during the site characterization phase.
[SD&TRD 3.2.7.3.A, 3.7.B.1][10 CFR 60.140(b)]
- 2. Provide facilities for in situ monitoring, laboratory and field testing, and in situ experiments.
[SD&TRD 3.2.7.3.B, 3.7.B.1][10 CFR 60.140(c)]
- 3. Provide for in situ testing of such features as borehole and shaft seals, backfill, and the thermal interaction effects of waste packages; backfill; rock; and groundwater.
[SD&TRD 3.2.7.3.C, 3.7.B.1][10 CFR 60.142(a)]
- 4. Provide for start of testing as early as is practical.
[SD&TRD 3.2.7.3.D, 3.7.B.1][10 CFR 60.142(b)]

5. Provide test sections to test the effectiveness of borehole and shaft seals before full-scale operation proceeds to seal boreholes and shafts.
[SD&TRD 3.2.7.3.E, 3.7.B.1][10 CFR 60.142(d)]
- J. The ESF shall be designed, constructed, and operated so that it does not preclude the MGDS's ability to meet the requirements of 10 CFR 60; in particular, those requirements listed below. Compliance with 10 CFR 60 will be demonstrated at the time of repository license application.
1. 10 CFR 60.21(c)(1)(ii)(E), Content of License Application: Safety Analysis Report; Assessment of Items Important to Safety.
[SD&TRD 3.7.B.1][10 CFR 60.21(c)(1)(ii)(E)]
 2. 10 CFR 60.111(a), Performance of the Geologic Repository Operations Area Through Permanent Closure: Protection Against Radiation Exposures and Releases of Radioactive Material.
[SD&TRD 3.7.B.1, 3.7.2.2.H][10 CFR 60.111(a)]
 3. 10 CFR 60.113(a)(1)(i), Performance of Particular Barriers after Permanent Closure: Engineered Barrier System.
[SD&TRD 3.7.B.1, 3.2.7.2.A, 3.2.7.2.B][10 CFR 60.113(a)(1)(i)]
 4. 10 CFR 60.113(a)(1)(ii)(A),(B), Performance of Particular Barriers after Permanent Closure: Engineered Barrier System.
[SD&TRD 3.2.7.2.C.1, 3.2.7.2.C.2, 3.7.B.1][10 CFR 60.113(a)(1)(ii)(A), 113(a)(1)(ii)(B)]
 5. 10 CFR 60.131(b)(4)(i), General Design Criteria for the Geologic Repository Operations Area: Structures, Systems, and Components Important to Safety; Emergency Capability.
[SD&TRD 3.7.B.1, 3.7.2.2.13.B][10 CFR 60.131(b)(4)(i)]
 6. 10 CFR 60.133(g), Additional Design Criteria for the Underground Facility: Underground Facility Ventilation.
[SD&TRD 3.7.B.1][10 CFR 60.133(g)]
 7. 10 CFR 60.133(h), Additional Design Criteria for the Underground Facility: Engineered Barriers.
[SD&TRD 3.7.B.1][10 CFR 60.133(h)]
 8. 10 CFR 60.140, Performance Confirmation Program: General Requirements.
[SD&TRD 3.7.B.1][10 CFR 60.140]
 9. 10 CFR 60.141, Performance Confirmation Program: Confirmation of Geotechnical and Design Parameters.
[SD&TRD 3.7.B.1][10 CFR 60.141]
 10. 10 CFR 60.142, Performance Confirmation Program: Design Testing.
[SD&TRD 3.7.B.1][10 CFR 60.142]

11. 10 CFR 60.151, Quality Assurance: Applicability.
[SD&TRD 3.7.B.1][10 CFR 60.151]
 12. 10 CFR 60.152, Quality Assurance: Implementation.
[SD&TRD 3.7.B.1][10 CFR 60.152]
 13. 10 CFR 60.111(b)(1), Performance Objectives: Preserve the Option of Waste Retrieval on a Reasonable Schedule.
[SD&TRD 3.2.7.1.B.1, 3.7.2.2.F, 3.7.2.2.G, 3.7.B.1][10 CFR 60.111(b)(1)]
 14. 10 CFR 60.111(b)(3), Performance Objectives: Definition of Reasonable Schedule.
[SD&TRD 3.7.B.1][10 CFR 60.111(b)(3)]
- K. Design and construction methods shall demonstrate that the potential repository can be licensed and constructed.
[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1)]
1. ESF accesses and other underground excavations shall be designed and constructed with reasonably available technology similar to or corresponding with the techniques planned for the potential repository. Technology used at the ESF site shall be reasonably available technology that exists and has been demonstrated, or for which the results of any necessary development, demonstration, or confirmatory testing will be available prior to its application to the ESF.
[Derived][10 CFR 960.5-2-9(d), 960.5-2-10(d), 960.5-2-11(d)]
- L. Applicability of state and local regulations shall be determined by DOE, with the exception of environmental requirements which are addressed in 3.2.1.24.A.
[Derived]
- M. Investigations to obtain the required information shall be conducted in such a manner as to limit adverse effects, to the extent practical, on the long-term performance of the geologic repository.
[SD&TRD 3.7.2.2.A, 3.7.B.1, 3.7.E][10 CFR 60.15(c)(1)]
1. Underground ESF construction shall not adversely affect in situ site characterization.
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
 2. All ESF activities shall be monitored frequently for the purpose of assessing the effects of those activities on the future suitability of the site for a potential repository.
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
 3. All substances and tracers intended to be added to water and compressed air to be used underground for such purposes as drilling and dust control, shall first be reviewed for potential to affect site characterization testing, performance

confirmation testing or monitoring, and waste isolation. Tracers may be used only following review, approval and receipt of the appropriate permits. [TBD]
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]

4. The use of hydrocarbons and solvents underground shall comply with criteria TBD by performance assessment. [TBD]
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
 5. Precautions shall be taken to avoid and/or control spills of hydrocarbons, solvents, and cementitious materials. Spills which do occur shall be cleaned up to the extent practicable. Spilled and contaminated material (including soil) shall be disposed of in accordance with federal and state requirements. Specifically, this means the following regarding cleanup:
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
 - (a) Liquid spills-- all puddles and soils that are nearly saturated with the spilled material shall be removed.
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
 - (b) Powder spills-- all spilled material shall be removed. Final cleanup from solid surfaces shall be by sweeping; final cleanup from soil surfaces shall include removal of soil in contact with the spilled material.
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
 6. ESF items and activities shall not affect overall system performance objectives for the MGDS as required by 10 CFR 60.112.
[SD&TRD 3.7.2.2.I, 3.7.B.1][10 CFR 60.112]
- N. 10 CFR 60.131 through 10 CFR 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 10 CFR 60.131 through 10 CFR 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 shall be consistent with the results of site characterization activities.
[SD&TRD 3.3.1.E, 3.7.B.1][10 CFR 60.130]
1. ESF design basis events shall be those natural, credible disruptive events likely to occur at the ESF site during both preclosure and postclosure periods. Natural, credible disruptive events shall be identified by the DO and reviewed and approved by the YMPO. Analysis shall conform to procedures for determining items ITS and to waste isolation. The magnitude, duration, and severity used for each of these design basis events shall be as described in the Reference Information Base (RIB), YMP/93-02.
[SD&TRD 3.7.B.1][10 CFR 60.131(b)(1)]
 2. ESF design basis accidents and operational occurrences shall be those credible disruptive events likely to occur at the ESF site during preclosure construction, operations, and testing. An initial comprehensive list of construction, operations and testing related credible disruptive events shall be identified by the DO and

reviewed and approved by the YMPO. Analysis shall conform to procedures for determining items ITS and to waste isolation.

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

(a) The magnitude, duration, and severity for each of these events shall be included in the design basis documentation.

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

O. Before proceeding to sink shafts for the ESF, the DOE shall submit a site characterization plan in accordance with 10 CFR 60.16.

[SD&TRD 3.7.B.1, 3.7.F][10 CFR 60.16]

P. All site survey, planning and design activities shall consider the criteria of DOE Order 6430.1A which do not pertain to areas under NRC jurisdiction.

[SD&TRD 3.3.1.A, 3.7.B.3][DOE Order 6430.1A]

Q. Unless specifically waived in writing by OCRWM, design and construction of all ESF facilities and equipment shall be accomplished using the criteria specified in the appropriate section of DOE Order 6430.1A. For facilities over which the NRC has regulatory authority, NRC requirements shall be the only controlling nuclear safety requirements. The following components are addressed in DOE Order 6430.1A:

1. General Requirements
2. Site and Civil Engineering
3. Concrete
4. Masonry
5. Metals
6. Woods and Plastics
7. Thermal and Moisture Protection
8. Doors and Windows
9. Finishes
10. Specialties
11. Equipment
12. Furnishings
13. Special Facilities
14. Conveying Systems
15. Mechanical
16. Electrical

[SD&TRD 3.3.1.B, 3.7.B.3][DOE Order 6430.1A]

R. State, county, municipal, and other local regulations, building and zoning codes, and ordinances shall be reviewed and incorporated, as appropriate, in the ESF design whenever those practices are not in conflict with the requirements of DOE Order 6430.1A.

[SD&TRD 3.3.1.C, 3.7.B.3][DOE Order 6430.1A]

S. Should conflicts exist between DOE Order 6430.1A and state, county, municipal, or local codes or regulations, a deviation shall be requested in accordance with Section 0101-2, Criteria Deviations, of DOE Order 6430.1A. NRC requirements or current

engineering practices which require deviations from DOE Order 6430.1A, must be documented.

[SD&TRD 3.3.1.D, 3.7.B.3][DOE Order 6430.1A, 0101-2]

- T. Standards or other DOE accepted documents identified as sufficient or more appropriate for the support of design, shall be used at the discretion of the designers provided there are no conflicts with the identified requirements of the ESF. Examples of this type of documentation are NUREGs, Regulatory Guides and other, similar, types of guidance provided by the NRC.

[SD&TRD 3.3.1.F][CRD 3.3.1.C]

- U. The ESF shall comply with environmental requirements (see ESFDR Appendix J).

[SD&TRD 3.7.D][10 CFR 960.3-4]

- V. RESERVED.

- W. The ESF shall be located, designed, constructed, operated, and decommissioned in a manner that protects the health and safety of the workers and the public, as specified in 10 CFR 60; 29 CFR 1910 and 29 CFR 1926; 8 CCR 8400 et seq; 30 CFR 57; DOE Order 5480.4; and other radiological and nonradiological standards.

[SD&TRD 3.3.6.1.A, 3.3.6.1.B, 3.3.6.3.A, 3.7.B.3][29 CFR 1910; 29 CFR 1926; 30 CFR 57][8 CCR 8400 et seq][29 USC 651 et seq][DOE Order 5480.4]

1. The definitions in 10 CFR 60.2 shall apply to the ESFDR.

[Derived][10 CFR 60.2]

2. Determination of specific permits and licenses to be obtained are established in programmatic planning documents. All technical requirements associated with obtaining these permits and licenses shall be considered in the design.

[SD&TRD 3.3.11.A][CRD 3.3.11.A]

- X. Facilities and utilities shall accommodate the number of personnel present during the ESF construction, operation, and testing phases. An ESF population study to determine the number of such personnel shall be performed by the DO and approved by the YMPO.

[SD&TRD 3.7.2.2.2, 3.7.2.2.3, 3.7.2.2.3.A][CRD 3.5.3.E]

- Y. In accordance with 10 CFR 60.21(c)(ii)(F)(11), the ESF design shall include a description of design considerations that are intended to facilitate permanent closure and decontamination or dismantlement of surface facilities.

[SD&TRD 3.7.2.2.11, 3.7.B.1][10 CFR 60.21(c)(11)]

- Z. Specific boundaries and interfaces between participating organizations' designs are identified in the YMP Interface Control Document(s). Boundaries and interfaces internal to a participating organization's design shall be controlled by the procedures of that organization. Full compliance of the ESF design with the requirements of this document necessitates an evaluation and understanding, by the designer, of the boundary and interface impacts of the requirements and criteria throughout this document, in accordance with approved YMP procedures.

[SD&TRD 3.2.7.A][CRD 3.3.1.A]

1. ESF design interfaces shall be maintained with all work performed by participating organizations and contractors including surface-based testing design, IDS, and potential repository design in compliance with Administrative Procedure 5.19Q, Interface Control.
[SD&TRD 3.2.7.1.B.5, 3.2.7.A, 3.7.B.1][10 CFR 60.133][CRD 3.3.1.A]
2. See ESFDR Appendix A.1 for potential repository/ESF interface constraints; and for potential repository/ESF interface drawings, see ESFDR Appendix A.2.
[SD&TRD 3.2.7.A][CRD 3.3.1.A]

AA. Types of Constraints on Construction and Operations of the ESF shall include:

1. Blast control (if blasting is used);
[SD&TRD 3.7.2.2.10.A, 3.7.B.1][10 CFR 60.15(c)(1), 60.15(c)(2), 60.15(c)(3)]
2. Control of fluids introduced in the ESF;
[SD&TRD 3.7.2.2.10.B, 3.7.B.1][10 CFR 60.15(c)(1), 60.15(c)(2), 60.15(c)(3)]
3. Control of dust, vibration, and traffic near sensitive environmental areas;
[SD&TRD 3.7.2.2.10.C, 3.7.B.1][10 CFR 60.15(c)(1), 60.15(c)(2), 60.15(c)(3)]
4. Use of phased construction and testing;
[SD&TRD 3.7.2.2.10.D, 3.7.B.1][10 CFR 60.15(c)(1), 60.15(c)(2), 60.15(c)(3)]
5. Sufficient separation distances to reduce the potential for interference;
[SD&TRD 3.7.2.2.10.E, 3.7.B.1][10 CFR 60.15(c)(1), 60.15(c)(2), 60.15(c)(3)]
6. Incorporate constraints from testing in ESF design;
[SD&TRD 3.7.2.2.10.F, 3.7.B.1][10 CFR 60.15(c)(1), 60.15(c)(2), 60.15(c)(3)]

Table 3-2 lists the applicable constraints for each of the ESF tests.

7. Evaluate the sensitivity of each experiment to operational considerations 1. through 6. above.
[SD&TRD 3.7.2.2.10.G, 3.7.B.1][10 CFR 60.15(c)(1), 60.15(c)(2), 60.15(c)(3)]

AB. Additional requirements from the various sources listed in Table 3-3 shall be imposed only to the extent that they actually impact the design or construction of the ESF.
[SD&TRD 3.7.B.3][29 CFR 1960, 30 CFR 31, 30 CFR 32, 30 CFR 36, 30 CFR Ch I, 40 CFR 165][UCRL 53526][ANSI R15.16][ANSI/ASTM D4256][CMAA 70]
[DOE Order 3790.1A, DOE/RW-0194, DOE/RW-0199]

AC. The design of the ESF shall be in accordance with the applicable parts of the regulations, codes, standards and DOE Orders listed in ESFDR Appendix E.

[Derived]

Table 3-2 Types of Constraints Imposed by Test Requirements on the Exploratory Studies Facility

ESFDR Section	Test	Sequencing	Physical Location	Construction Operations
B.2.1	Chloride and Chlorine-36 Measurements of Percolation at Yucca Mountain			
B.2.2	Matrix Hydrologic Properties Testing			
B.2.3	Intact-fracture Test in the ESF			
B.2.4	Percolation Tests in the ESF		X	X
B.2.5	Bulk Permeability Test in the ESF		X	X
B.2.6	Radial Borehole Tests in the ESF			
B.2.7	Excavation Effects Test in the ESF			
B.2.9	Perched Water Testing in the ESF			
B.2.10	Hydrochemistry Tests in the ESF			
B.2.12	Hydrologic Properties of Major Faults Encountered in the ESF		X	X
B.2.13	Diffusion Tests in the ESF		X	
B.2.14	Petrologic Stratigraphy of the Topopah Spring Member			
B.2.15	Mineral Distributions Between Host Rock and Accessible Environment			
B.2.16	Fracture Mineralogy			
B.2.17	History of Mineralogic and Geochemical Alteration of Yucca Mountain			
B.2.18	Biological Sorption and Transport			
B.2.19	Field-Scale Experiments to Study Radionuclide Transport at Yucca Mountain			
B.2.20	Underground Geologic Mapping			
B.2.21	Seismic Tomography/Vertical Seismic Profiling at the ESF			
B.2.22	Laboratory Tests (Thermal & Mechanical) Using Samples Obtained from the ESF			
B.2.23	Access Convergence Measurements	X		
B.2.24	Demonstration Breakout Rooms	X	X	X
B.2.25	Sequential Drift Mining	X	X	X

Table 3-2 Types of Constraints Imposed by Test Requirements on the Exploratory Studies Facility (continued)

ESFDR Section	Test	Sequencing	Physical Location	Construction Operations
B.2.26	Heater Experiment in TSw1	X		
B.2.27	Canister-Scale Heater Experiment		X	X
B.2.28	Heated Block Experiment		X	X
B.2.29	Thermal Stress Tests	X	X	X
B.2.30	Heated Room Experiment	X	X	X
B.2.31	Plate Loading Tests		X	
B.2.32	Rock Mass Response Test			
B.2.33	Evaluation of Mining Methods			
B.2.34	Monitoring of Ground Support Systems			
B.2.35	Monitoring Drift Stability			
B.2.36	Air Quality and Ventilation Experiment			
B.2.37	Overcore Stress Experiments in the ESF		X	X
B.2.38	Development and Demonstration of Required Equipment		TBD	TBD
B.2.39	In Situ Testing of Seal Components	TBD	TBD	TBD
B.2.40	Geomechanical Attributes of the Waste Package Environment			
B.2.41	Repository Horizon Near-Field Hydrologic Properties		X	X
B.2.42	Repository Horizon Rock-Water Interaction		X	X

Table 3-3 Additional ESF Requirements

29 CFR 1960	Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters
30 CFR Ch. I	Mine Safety and Health Administration
30 CFR 31	Diesel Mine Locomotives
30 CFR 32	Mobile Diesel-powered Equipment for Noncoal Mines
30 CFR 36	Mobile Diesel-powered Transportation Equipment for Gassy Noncoal Mines and Tunnels
40 CFR 165	Regulations for the Acceptance of Certain Pesticides and Recommended Procedures for the Disposal and Storage of Pesticides and pesticide Containers
DOE 3790.1A	Federal Employees' Occupational Safety and Health program
DOE/RW-0194	Records Management Policies and Requirements
DOE/RW-0199	Site Characterization Plan
ANSI/ASTM D4256	Test Method for Determination of Decontaminability of Coatings Used in Light-Water Nuclear Power Plants
ANSI R15.16	Human Engineering Criteria for Hand-Held Robotics Control
CMAA 70	Crane Manufacturers' Association of America Specification for Electric Overhead Traveling Cranes
UCRL 53526	Natural Phenomena Hazards Modeling Project: Seismic Hazard Models for Department of Energy

AD. Where possible, the following facilities and utilities shall be common with the surface-based testing facilities:

1. Test support facilities (service support facilities).
2. Warehouse (receiving and storage facilities).
3. Solid waste disposal system.
4. Water system (water supply).
5. Sanitary system (sanitation facilities).
6. Power system.
7. Communications system.

8. Access roads.
9. parking areas.
10. Storage facilities (equipment maintenance sheds).

[SD&TRD 3.2.7.A, 3.7C]

3.2.1.1 EXPLORATORY STUDIES FACILITY SITE(S)

The ESF site(s) shall provide, as a minimum, site civil improvements, the main site(s), auxiliary site(s), access roads, and site drainage necessary to conduct the site characterization phase.

[SD&TRD 3.7.2.2.1]

- A. In accordance with 10 CFR 60.15(c)(1), the location, design, construction, and operation of the main site and auxiliary sites shall incorporate aspects specifically directed at limiting the potential for adverse effects on the long-term performance of a potential repository.

[SD&TRD 3.2.7.1.A.1, 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]

- B. In accordance with 10 CFR 60.15(c)(1), the use of hydrocarbons, solvents, and chemicals shall be controlled during construction and operation of surface sites to limit adverse chemical changes. [TBD]

[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]

- C. In accordance with 10 CFR 60.133(f):

1. Site civil improvements for the permanent and nonpermanent 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 objectives as stated in the SD&TRD. Refer to ESFDR Appendix I, Analysis 5 for specific guidance.

[SD&TRD 3.7.B.1][10 CFR 60.133(f)]

2. The ESF equipment, buildings, and foundations for structures shall be designed and constructed so that their excavation does not lead to creation of pathways that compromise the potential repository's capability to meet the performance objective of 10 CFR 60.112. [TBD]

[SD&TRD 3.7.B.1][10 CFR 60.112, 60.133(f)]

- D. An auxiliary site storage area shall be capable of supporting the excavation allowance determined under 3.2.9.

[SD&TRD 3.7.2.2.1]

- E. The ESF designers shall interface with surface-based testing and repository designers on ESF site location and layout, and on permanent ESF structures, systems, and components. Section 3.2.1.Z.1 shall apply.

[SD&TRD 3.2.7.1.A.3, 3.7.B.1][10 CFR 60.15(c)(4)]

3.2.1.2 SURFACE UTILITIES

ESF surface utilities, which include as a minimum: power, water, sanitation, communications, surface wastewater, compressed air, and solid waste disposal, to support site characterization testing, shall be provided.

[SD&TRD 3.7.2.2.2.]

- A. YMPO shall interface with the Nevada Test Site (NTS) for telephone system and utility compatibility.

[SD&TRD 3.7.2.2.2]

- B. The ESF designers shall interface with surface-based testing and repository designers on ESF site location and layout, and on permanent ESF SSCs. Section 3.2.1.Z.1 shall apply.

[SD&TRD 3.2.7.1.A.3, 3.7.B.1][10 CFR 60.15(c)(4)]

3.2.1.3 SURFACE FACILITIES

The ESF shall provide surface facilities which include: a ventilation system, test support facilities, parking areas, storage facilities, a shop, a warehouse, communications/data building, and any other temporary structures necessary to support site characterization. This shall include site preparation and the necessary utilities to receive the surface structure(s).

[SD&TRD 3.7.2.2.3.A]

- A. The constructor shall furnish, as necessary, temporary construction support facilities (e.g., change house(s), office, shop, warehouse and storage, and first aid) during the initial stages of access construction.

[SD&TRD 3.7.2.2.3.A]

- B. Where feasible, the ESF support facilities shall be sized, designed and constructed to accommodate the requirements of both surface- and subsurface-based testing.

[SD&TRD 3.7.C][CRD 3.7.4.2.K.7]

- C. The ESF designers shall interface with surface-based testing and repository designers on ESF site location and layout, and on permanent ESF structures, systems, and components. Section 3.2.1.Z.1 shall apply.

[SD&TRD 3.2.7.1.A.3, 3.7.B.1][10 CFR 60.15(c)(4)]

3.2.1.4 UNDERGROUND OPENINGS

Underground openings shall include shaft access, ramp access and other excavations at the proposed test levels and preferred repository horizon based upon the need for underground site characterization.

The ESF shall provide underground openings, which include as a minimum: the collar, portal, lining, stations, furnishings, hoist, sump, test areas, and operations support area(s) necessary to conduct the site characterization phase.

[SD&TRD 3.7.2.2.6]

- A. The chemical content of the blasting agents and explosives shall be evaluated during their selection process to preclude adverse effects on in situ site characterization. The chemical content of the blast byproducts shall be sampled, recorded, and the data used as necessary to confirm that the blasts did not create adverse effects on in situ site characterization. [TBD]

[SD&TRD 3.7.2.2.A, 3.7.B.1, 3.7.E][10 CFR 60.15(c)(1)]

- B. 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 potential geologic repository, to the extent practicable.

[SD&TRD 3.7.A, 3.7.B.1, 3.7.B.3, 3.7.E][10 CFR 60.15(c)(1)][42 USC 10133(c)(1)]

1. Construction methods shall be planned 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.

[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]

- (a) The design, construction, and operation of underground excavations shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long-term performance of the potential repository.

[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]

- (b) All construction materials or substances to be used underground shall first be reviewed for potential effects on engineered barriers, waste isolation, and on-site characterization or other testing. These materials and substances are subject to established controls, and may only be used following review and approval, and only in those areas where use has been approved. Such materials or substances include, but are not limited to, the following [TBD]:

[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]

- i. Concrete and other cementitious materials, such as shotcrete and grout.

[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]

- ii. Ground support materials, including chemical/resin anchorages.

[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]

- iii. Water (Ph and organic content) and any additives to water for identification (tracers) or construction, operation, or testing.

[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]

- iv. Hydrocarbons and solvents.

[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]

- v. Organic materials.

[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]

- vi. Explosives and blasting ancillaries, including the introduction of pressurized drilling water into the rock, and chemical residues that are the products of blasting.
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
 - 2. To the extent practicable, the use of concrete and cementitious materials shall be limited, or avoided in or near geochemical test areas and emplacement locations.
[TBV]
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
 - 3. A materials control program shall be implemented to enable establishment of limits on the inventory of materials left after decommissioning. [TBD]
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
 - 4. Fluids, gases, and other materials used in underground 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. [TBD]
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
 - 5. The presence of combustible materials underground shall be controlled and limited such that testing in the ESF is not adversely affected.
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
- C. The necessary data to support the development of the Safety Analysis Report for license application shall be maintained according to OCRWM QARD, where appropriate. The Safety Analysis Report shall include an assessment of the effectiveness of engineered and natural barriers (including barriers that may not themselves be 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.
[SD&TRD 3.7.2.2.E, 3.7.B.1][10 CFR 60.21(c)(1)(ii)(D)]
- 1. The ground support system shall be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the ground support system is determined to be important to waste isolation, a comparative evaluation of alternatives shall be performed. [TBD]
[SD&TRD 3.7.B.1][10 CFR 60.21(c)(1)(ii)(D)]
 - 2. The excavated dimensions shall be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the dimensions are determined to be important to waste isolation, a comparative evaluation of alternatives shall be performed. [TBD]
[SD&TRD 3.7.B.1][10 CFR 60.21(c)(1)(ii)(D)]

3. The shaft and ramp liner shall 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. [TBD]

[SD&TRD 3.7.B.1][10 CFR 60.21(c)(1)(ii)(D)]

4. The operational seals shall (if required) 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. [TBD]

[SD&TRD 3.7.B.1][10 CFR 60.21(c)(1)(ii)(D)]

5. The underground facility layout shall 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. [TBD]

[SD&TRD 3.7.B.1][10 CFR 60.21(c)(1)(ii)(D)]

- D. 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.

[SD&TRD 3.2.7.1.B.5, 3.7.B.1][10 CFR 60.133(a)(1)]

1. Rock support and other structural anchoring materials shall be compatible with waste isolation. [TBD]

[SD&TRD 3.2.7.1.B.5, 3.7.B.1][10 CFR 60.133(a)(1)]

2. Rock support and other structural anchoring materials shall neither interfere with radionuclide containment nor enhance radionuclide migration. [TBD]

[SD&TRD 3.2.7.1.B.5, 3.7.B.1][10 CFR 60.133(a)(1)]

3. Underground facility configuration (access and drift location, diameter, orientation, geometry, separation, and depth) shall contribute to, or not detract from, the isolation capability of the site. [TBD]

[SD&TRD 3.2.7.1.B.5, 3.7.B.1][10 CFR 60.133(a)(1)]

- E. The underground facility shall be designed so that the effects of credible disruptive events (e.g., flooding, fires and explosions) during the period of operations, will not spread through the facility.

[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2)]

1. Materials shall be selected such that effects of fire do not produce geochemical effects that impact waste isolation capabilities of the site. [TBD]

[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1), 60.131(b)(3)]

- (a) The underground facility shall be designed such that effects of fire, which could produce geochemical effects that adversely affect potential repository operations, shall not spread.

[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1), 60.131(b)(3)]

- F. Activities associated with installation, operation, maintenance, and removal of furnishings shall be conducted in a manner that limits, to the extent practicable, adverse effects on the long-term performance of the potential geologic repository and on-site characterization testing.
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
- G. The hoist shall not be designed to convey radioactive waste unless specifically requested by the NRC for the purpose of site characterization testing.
[SD&TRD 3.7.2.1]
- H. The ESF designers shall interface with surface-based testing and repository designers on ESF site location and layout, and on permanent ESF structures, systems, and components, and shall make available all design information pertaining to the permanent ESF components. Section 3.2.1.Z.1 shall apply.
[SD&TRD 3.2.7.1.A.3, 3.7.B.1][10 CFR 60.15(c)(4)]

3.2.1.5 UNDERGROUND SUPPORT SYSTEMS

The ESF shall provide underground support systems, which include as a minimum: the power, communications, lighting, ventilation, water, underground wastewater removal, compressed air, fire protection, materials and rock and muck handling, sanitation, and safety monitoring and warning subsystems, required to meet the needs of the underground site characterization testing program during construction and operation.

[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

- A. 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.
[SD&TRD 3.7.2.2.A, 3.7.B.1, 3.7.E][10 CFR 60.15(c)(1)]
 - 1. The design, construction, and operation of the underground utilities shall incorporate aspects specifically directed at limiting, to the extent practicable, adverse effects on the potential repository's long-term performance.
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
- B. The following underground needs shall be met: power, communications, lighting, ventilation, water, wastewater removal, compressed air, fire protection, sanitation, materials (including supplies and fuel) and rock and muck handling, and safety monitoring and warning.
[SD&TRD 3.7.2.2.2]
- C. The service facilities and equipment required for maintaining and installing underground services shall be provided to support ESF operation and in situ site characterization, and shall be capable of supporting the uncertainty allowance defined in Section 3.2.9
[SD&TRD 3.2.12][CRD 3.2.8]

- D. Utility systems (i.e., electric power, air, water, etc.), when installed, shall not restrict foot, vehicular, or shaft and ramp conveyance traffic; obstruct ventilation; or cause safety hazards.
[SD&TRD 3.2.9.3.C.1.a-d, 3.7.B.3][DOE Order 6430.1A, 0110-99.0.4]
- E. 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.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2)]
1. Utility systems, including the water distribution and underground wastewater collection systems, shall operate safely in the event of seismic activity.
[SD&TRD 3.2.10.1.A, 3.7.B.1][10 CFR 60.133(a)(2)]
 2. The impact of underground utility system failures caused by credible disruptive events (e.g., fire, explosion, or seismic events) on site characterization and other testing, shall be controlled and limited.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2)]
- F. To the extent practicable, underground support (utility) systems and associated hardware (hangers, brackets, etc.) shall be removed following final use.
[SD&TRD 3.7.2.2.11, 3.7.B.3][DOE Order 6430.1A, 0110-99.0.4]
- G. Fire suppression agents shall be selected for compatibility with intended use. These agents shall be approved for use based on their impacts on underground safety (i.e., they do not produce adverse geochemical effects), the in situ site characterization testing program, and performance objectives as stated in 10 CFR 60.112. [TBD]
[SD&TRD 3.2.10.2.1.B, 3.7.B.1, 3.7.B.3][10 CFR 60.15(c)(1), 60.112; 30 CFR 57][8 CCR 8400 et seq]
- H. The ESF designers shall interface with surface-based testing and repository designers on ESF site location and layout, and on permanent ESF structures, systems, and components. Section 3.2.1.Z.1 shall apply.
[SD&TRD 3.2.7.1.A.3, 3.7.B.1][10 CFR 60.15(c)(4), 60.133]

3.2.1.6 TEST SUPPORT

The ESF test support shall include provisions for an IDS and underground test support facilities as a minimum. The test support facilities are defined as those facilities that accommodate the testing apparatus used for equipment assembly, checkout, and repair.
[SD&TRD 3.7.2.2.9.A]

- A. Support shall be provided for the IDS and for individual tests. See ESFDR Appendix B for a summary of requirements.
[SD&TRD 3.7.2.2.9.A]
- B. Facilities shall be provided, as defined in ESFDR Appendix B, to incorporate an IDS into the ESF.
[SD&TRD 3.7.2.2.9.A]

- C. Provide facilities, support, controls, access and test site configurations required for each test as described in ESFDR Appendix B.
[SD&TRD 3.7.2.2.9.A]
- D. For each test, comply with the requirements in ESFDR Appendix B.
[SD&TRD 3.7.2.2.9.A]
- E. The ESF designers shall interface with surface-based testing and repository designers on ESF site location and layout and on permanent ESF structures, systems, and components.
[SD&TRD 3.2.7.1.A.3, 3.7.B.1][10 CFR 60.15(c)(4)]
- F. The ESF designers shall interface with IDS and repository designers on ESF site locations and layout and on permanent ESF structures, systems, and components. Section 3.2.1.Z.1 shall apply.
[SD&TRD 3.2.7.1.A.3, 3.7.B.1][10 CFR 60.15(c)(4), 60.133]
- G. Interface control will be established between the following:
 - 1. The facility designers and the IDS designers for electrical and mechanical cable and terminating requirements between the instruments and the IDS.
[SD&TRD 3.7.2.2.9.A]
 - 2. The IDS designers and the facility designers for support requirements for the IDS facility.
[SD&TRD 3.7.2.2.9.A]

3.2.1.7 EXPLORATORY STUDIES FACILITY DECOMMISSIONING AND CLOSURE

Provisions shall be made for decommissioning and closure of the ESF if the site is found unsuitable as a repository. The ESF facilities (systems and subsystems) shall be placed into a permanently nonoperable and safe condition.

[SD&TRD 3.7.2.2.11]

- A. The ESF shall be designed, constructed, and operated, to not preclude meeting restoration requirements of applicable federal, Bureau of Land Management (BLM), state, and local codes.
[SD&TRD 3.7.2.2.11, 3.7.B.3][BLM Vol. 34]
- B. Decommissioning and closure shall be in accordance with the Reclamation Implementation Plan, YMP/91-14, Sections 2.6, 2.7 and 2.8.
[SD&TRD 3.7.2.2.11]
- C. Facilities shall be designed to be removable by the most practical and cost-effective methods.
[SD&TRD 3.7.2.2.11]
- D. Any significant adverse environmental impacts associated with the ESF decommissioning shall be minimized through the use of good engineering practices, reclamation guidelines, the Reclamation Implementation Plan, and any site specific

reclamation plans. The Reclamation Guidelines and the Reclamation Implementation Plan shall be implemented to the extent practicable.

[SD&TRD 3.3.11.B][10 CFR 960.3-4]

3.2.1.8 PHYSICAL CHARACTERISTICS

Selection of standards or guidelines to meet the requirements specified in this section shall be by engineering analysis and shall be documented in accordance with appropriate QA procedures.

[SD&TRD 3.2.8][CRD 3.2.4]

3.2.1.8.1 HABITABILITY

Some of the following statements contain references to two or more documents which provide acceptable guidance, the choice of which is left to design analysis. In addition to the specific requirements listed in this section, DOE Order 6430.1A shall apply to all underground operational areas.

[Derived]

A. Environmental Controls

Environmental controls shall be capable of maintaining an environment that provides comfortable and appropriate workspace temperature, humidity, personal storage, lavatory, and toilet facilities as required by 29 CFR 1910.141; 8 CCR 8400 et seq; and 30 CFR 57, Subparts D, G, P, and S. During construction operation, environmental controls shall be provided in accordance with 29 CFR 1926, Subparts D and S, for underground facilities.

[SD&TRD 3.2.8.1.1, 3.7.B.3][29 CFR 1910.141; 30 CFR 57]

B. Heating, Ventilation and Air Conditioning

Heating, Ventilation and Air Conditioning (HVAC) equipment shall be sized using the environmental requirements of 29 CFR 1910, Subpart G. MIL-STD-1472D Section 5.8.1, or the applicable American Society of Heating, Refrigerating, and Air Conditioning Engineers Standard may be used for reference (refer to ESFDR Appendix E for additional information). 29 CFR 1926 requirements for underground facilities shall be met.

[SD&TRD 3.2.8.1.2, 3.7.B.3][29 CFR 1910; 29 CFR 1926; 30 CFR 57]

C. Illumination

Lighting in working areas and other enclosures shall conform to 30 CFR 57, Subpart P. The applicable recommended practice of the Illuminating Engineering Society may be used for reference. The applicable requirements from 29 CFR 1926 shall be met for all underground facilities.

[SD&TRD 3.2.8.1.3, 3.7.B.3][29 CFR 1926; 30 CFR 57]

D. Acoustical Noise

Workspaces shall be provided with an acoustical environment that conforms to the requirements of 29 CFR 1910.95 and 30 CFR 57, Section 5050; MIL-STD-1472D

Section 5.8.3 may be used for reference. The requirements for underground facilities identified in 29 CFR 1926 shall be met.

[SD&TRD 3.2.8.1.4, 3.7.B.3][29 CFR 1910.95; 29 CFR 1926; 30 CFR 57]

E. Vibration

Facilities, buildings, and personnel enclosures shall be designed, located, or modified for vibration control. ANSI Standard S-3.18 or MIL-STD-1472D Section 5.8.4 may be used for reference.

[SD&TRD 3.2.8.1.5, 3.7.B.3][CRD 3.2.4.2.5][ANSI/S-3.18]

F. Underground Personnel Enclosures

Unless otherwise specified, underground personnel enclosures, including but not limited to those provided for offices, laboratories, break rooms and the like, shall, to the extent practicable, conform to the environmental and habitability requirements specified for surface personnel enclosures [TBV].

[SD&TRD 3.7.2.2.J][CRD 3.2.4.2.6]

3.2.1.9 SYSTEM QUALITY FACTORS

The quality factors for the ESF facilities are described in this section. These factors include Reliability, Maintainability, Inspectability, Availability, and Service Life. The ESF DO shall establish and execute a reliability, availability and maintainability (RAM) program to support Integrated Logistics Support and general engineering programs for the ESF.

[SD&TRD 3.2.9][CRD 3.2.5.1.B]

3.2.1.9.1 AVAILABILITY

A. Availability is defined as the degree, percent, or probability that the ESF is ready to operate at a random point in time. ESF availability is [TBD].

[SD&TRD 3.2.9.1.A]

B. The ESF shall allow for operation on a three-shift-per-day, seven-day-per-week schedule throughout both the ESF construction and operation phases.

[SD&TRD 3.2.9.1.B]

3.2.1.9.2 RELIABILITY

Design and construction reliability criteria are as follows:

A. The ESF shall:

1. Establish and execute a reliability program (MIL-STD-882 shall be considered in the design where applicable).

[SD&TRD 3.2.9.2.A.1][CRD 3.2.5.1]

2. Conduct failure mode and other analyses as part of the design process to determine critical functions and/or equipment, the failure of which, during operations, would result in situations which would:
 - [SD&TRD 3.2.9.2.A.2][CRD 3.2.5.1]
 - (a) be difficult to correct;
 - [SD&TRD 3.2.9.2.A.2.a][CRD 3.2.5.1]
 - (b) be costly in time lost or damaged property;
 - [SD&TRD 3.2.9.2.A.2.b][CRD 3.2.5.1]
 - (c) significantly impact the schedule;
 - [SD&TRD 3.2.9.2.A.2.c][CRD 3.2.5.1]
 - (d) detrimentally affect facility availability;
 - [SD&TRD 3.2.9.2.A.2.d][CRD 3.2.5.1]
 - (e) result in personal injury.
 - [SD&TRD 3.2.9.2.A.2.e][CRD 3.2.5.1]
3. Design and locate SSC ITS that will be incorporated into the potential repository so that when incorporated they continue to perform their safety functions effectively under credible fire and exposure conditions.
 - [SD&TRD 3.2.9.2.A.3, 3.7.B.1][10 CFR 60.131(b)(3)]

- B. Standard equipment shall be analyzed and rated according to manufacturer and industry reliability data. Equipment and systems shall be selected to meet ESF reliability requirements [TBD], and consideration shall be given to capital and maintenance costs.
 - [SD&TRD 3.2.9.2.B]

3.2.1.9.3 MAINTAINABILITY

Criteria for maintaining the ESF are as follows:

- A. Facility design shall provide access for routine maintenance.
 - [SD&TRD 3.2.9.3.A]
- B. Design shall take advantage of shutdowns and off-duty cycles to perform preventive maintenance necessary to lessen the downtime of equipment and facilities.
 - [SD&TRD 3.2.9.3.B, 3.7.B.1][10 CFR 60.131(b)(6)]
- C. Design for Maintainability:
 1. ESF shall be designed and constructed so that facilities are easily and economically maintained. Maintainability considerations shall include:
 - (a) Design (size and arrangement of interior corridors) to accommodate initial equipment installation and facility operations.
 - [SD&TRD 3.2.9.3.C.1.a, 3.7.B.3][DOE Order 6430.1A]

- (b) Use of easily maintained features and durable materials.
[SD&TRD 3.2.9.3.C.1.b, 3.7.B.3][DOE Order 4700.1, p. V-17, g]
- (c) Ease of replacement of installed equipment (i.e., without structure modifications).
[SD&TRD 3.2.9.3.C.1.c, 3.7.B.3][DOE Order 4700.1, p. V-17, g]
- (d) Accessibility of installed equipment and building systems for performance of maintenance.
[SD&TRD 3.2.9.3.C.1.d, 3.7.B.3][DOE Order 4700.1, p. V-17, g]
- (e) Life cycle costs in selection of features, systems, and finishes.
[SD&TRD 3.2.9.3.C.1.e, 3.7.B.3][DOE Order 4700.1, p. V-17, g]
- (f) Provisions of maintenance instructions and as-built drawings, especially the location of underground and otherwise concealed utility lines.
[SD&TRD 3.2.9.3.C.1.f, 3.7.B.3][DOE Order 4700.1, p. V-17, g]
- (g) Bringing test points to an easily accessible test connector to permit fault isolation without the need for completely or partially disassembling the equipment.
[SD&TRD 3.2.9.3.C.1.g, 3.7.B.3][DOE Order 6430.1A]

2. Engineered hardware shall be designed to be maintainable; University of California Research Laboratory (UCRL) 15673, shall be used as a reference. Should hardware require movement by personnel to provide accessibility for maintenance, requirements for portability shall be included in the design.
[SD&TRD 3.2.9.3.C.2][UCRL 15673]

3. The design of equipment and facilities shall use the maintainability requirements specified in UCRL 15673, Section 3, for areas to be incorporated into the potential repository.
[SD&TRD 3.2.9.3.C.3][UCRL 15673]

D. ESF facilities, subsystems, and equipment shall be designed with a mean downtime (MDT) that is consistent with the availability requirement specified in this document. The MDT shall include a mean time to repair (MTTR), disruptive preventive maintenance time, logistics delay time, administrative delay time (ADT), and safety delay time.
[SD&TRD 3.2.9.3.D]

1. The ESF MTTR shall be a maximum of six hours [TBV]. Sufficient [TBD] parts must be maintained in inventory for items to be repaired in place by qualified repair personnel with verified technical data to ensure the MTTR can be achieved.
[SD&TRD 3.2.9.3.D.1]

2. All commercial components MTTR must be integrated into the ESF MTTR.
[SD&TRD 3.2.9.3.D.2]

- E. Replacement equipment shall be provided as necessary for equipment that must be removed for repair to support the MTTR.
[SD&TRD 3.2.9.3.E]
1. The equipment must be accessible and transportable.
[SD&TRD 3.2.9.3.E.1]
 2. A lifting device having the capability to remove and install equipment that weighs more than the limits for human portability, shall be provided.
[SD&TRD 3.2.9.3.E.2]
 3. Replaceability shall be addressed for all equipment.
[SD&TRD 3.2.9.3.E.3]
- F. Fault detection and fault isolation (FD/FI) are important in addressing MTTRs. FD/FI shall be built into the system in terms of electronic detection, measurement point, etc., to the extent practical. All equipment used in the ESF shall comply with the following FD/FI requirements.
[SD&TRD 3.2.9.3.F]
1. The ESF systems shall detect [TBD] percent of all detectable faults. Of those faults detected [TBD] percent shall be isolated to one line replaceable unit (LRU), [TBD] percent to two LRUs and [TBD] percent to three or less LRUs.
[SD&TRD 3.2.9.3.F.1]
 2. Newly developed equipment shall satisfy the FD/FI requirements.
[SD&TRD 3.2.9.3.F.2]
 3. For commercial equipment FD/FI shall not take more than 25% of the component MTTR [TBD].
[SD&TRD 3.2.9.3.F.3]
- G. The design SSCs, construction, service, and utility equipment shall permit periodic testing, inspection, and maintenance, as necessary, to ensure their continued functional readiness.
[SD&TRD 3.2.9.3.G, 3.7.B.1][10 CFR 60.131(b)(6)]
1. On-line Maintenance.
 - (a) Facilities and equipment designs shall support the on-line maintenance concept that limits maintenance actions to those necessary to ensure safety, prevent system degradation, and restore security monitoring. This concept consists of remove and replace actions, minor servicing, minor repairs, or repair of items which cannot easily be removed from service for maintenance.
[SD&TRD 3.2.9.3.G.1.a]
 - (b) Maintenance shall be equipment intensive, rather than personnel intensive, and shall rely on technology to reduce maintenance requirements [TBD].
[SD&TRD 3.2.9.3.G.1.b]

- (c) Built-in test equipment (BITE) and automated test equipment (ATE) shall be used where it is already incorporated into the design of a system or equipment, but existing equipment should not be redesigned to accommodate BITE or ATE without specific authorization. Newly designed equipment or systems shall incorporate BITE and/or ATE only where it can be demonstrated to significantly reduce the on-site maintenance workload.

[SD&TRD 3.2.9.3.G.1.c]

- (d) Maintenance facilities, equipment, and tools shall be provided based on the criteria specified by DOE Order 4330.4A, I.3.5.

[SD&TRD 3.2.9.3.G.1.d]

- (e) The design of underground facilities shall ensure that provisions are made for maintenance of underground equipment in accordance with 29 CFR 1926, Subpart S; 30 CFR 57, Subpart M; and 8 CCR 8400 et seq.

[SD&TRD 3.2.9.3.G.1.e]

- 2. The ESF shall be designed to include means to test and maintain intrusion alarms, emergency alarms, communications equipment, physical barriers, and other security-related devices or equipment.

[SD&TRD 3.2.9.3.G.2],[CRD 3.2.5.1.D]

3. Intermediate Maintenance.

- (a) Intermediate maintenance shall provide failure detection, isolation, and replacement of shop-repairable or vendor-repairable units.

[SD&TRD 3.2.9.3.G.3.a]

- (b) Facilities, tools, and parts for shop-repairable items shall be provided at the site.

[SD&TRD 3.2.9.3.G.3.b]

- 4. Alarm systems shall be designed with provisions for calibration and for testing their operability.

[SD&TRD 3.2.9.3.G.4][10 CFR 60.131(a)(6)]

3.2.1.9.4 SERVICE LIFE/DESIGN LIFE/MAINTAINABLE LIFE

- A. The test support facilities shall be designed for a maintainable service life of at least 25 years. [TBV]

[SD&TRD 3.2.9.4.A]

- B. The design life for ESF systems, components, and structures shall be as follows:

- 1. Liners for wastewater ponds and rock storage areas shall be designed and constructed for a maintainable 25-year life. [TBV]

[SD&TRD 3.2.9.4.A]

2. Shaft collars and ramp portals shall be designed and constructed for a maintainable 100-year life. [TBV]
[SD&TRD 3.2.9.4.B]
 3. Sites prepared for shaft collars and ramp portals shall be designed and constructed for a maintainable 100-year life. [TBV]
[SD&TRD 3.2.9.4.C]
 4. Permanent shaft and ramp structures, systems, and components shall be designed and constructed for a maintainable 100-year life. [TBV]
[SD&TRD 3.2.9.4.A-C]
 5. Permanent ESF SSCs shall be designed and constructed for a 100-year maintainable life. [TBV]
[SD&TRD 3.2.9.4.A]
 6. The maintainable design life for those nonpermanent ESF structures, systems, and components which may be used for initial construction of a potential repository shall be 15 years. [TBV]
[SD&TRD 3.2.9.4.D]
- C. The items listed below are the "ESF permanent structures, systems, and components" which shall be designed, procured, and constructed so they can be incorporated into a potential repository. These items shall be designed to have a maintainable life of 100 years. [TBV]
[SD&TRD 3.2.9.4.A-C]
1. Underground Opening(s)--space created by mining or drilling, including those zones within the rock altered by that process. [TBD]
[SD&TRD 3.2.9.4.C]
 2. Ramp and Shaft Lining(s)--all permanent components placed between the inside limits of the ramp and shaft and the accessible extent of the underground opening.
[SD&TRD 3.2.9.4.C]
 3. Ground Support--any means used to reinforce rock and/or control the movement of rock except for items of support which may be removed or replaced if the ESF is incorporated into the potential repository.
[SD&TRD 3.2.9.4.C]
 4. Operational Seal(s)--any engineered structure including the material placed in an underground opening, and/or the peripheral rock for the purpose of controlling the flow of water and/or gas during the life of the ESF and through the preclosure phase of the potential repository.
[SD&TRD 3.2.9.4.C]

3.2.1.9.5 EFFECTS OF BREAKDOWN

The ESF shall be designed and constructed (to the extent practical) so that breakdowns during construction and operations will not adversely impact cost and schedule.

[SD&TRD 3.2.9.5]

3.2.1.9.6 OVERALL UTILIZATION

Appropriate overall utilization shall be considered in the design of the ESF to meet the site characterization schedule.

[SD&TRD 3.2.9.6][CRD 3.2.5.5.B]

3.2.1.10 ENVIRONMENTAL REQUIREMENTS**3.2.1.10.1 NATURAL ENVIRONMENTS**

The ESF shall be designed so that the effects of anticipated natural phenomena and environmental conditions will not interfere with necessary safety functions.

[SD&TRD 3.2.10.1, 3.7.B.1][10 CFR 60.131(b)(1)]

The ESF shall comply with the applicable design requirements for structural loads (static and dynamic) as described in DOE Order 6430.1A-1.

[SD&TRD 3.2.10.1]

A. Natural Conditions

Natural phenomena and environmental conditions considered in the design shall include events and conditions such as earthquakes, tornados, wind, lightning, floods, precipitation, humidity, temperature, sand and dust, and fungus, bacteria, and algae.

[SD&TRD 3.2.10.1.A][CRD 3.2.6.1.A]

B. Combinations

The ESF design basis shall be in accordance with requirements specified in DOE Order 6430.1A, 0111-2. The design basis shall also reflect consideration of the effects of natural phenomena, with margins taking into account the limitations of the data and the period of time in which the data have accumulated.

[SD&TRD 3.2.10.1.B, 3.7.B.3][DOE Order 6430.1A, 0111-2]

C. Tornado and Extreme Wind

The ESF shall be designed to comply with DOE Order 6430.1A, 0111-2.5 for tornado and extreme wind.

[SD&TRD 3.2.10.1.C, 3.7.B.3][DOE Order 6430.1A, 0111-2.5]

D. Load Combinations

Combining of loads, allowable stresses, and strength requirements for buildings and other structures shall be as stipulated in the UBC.

[SD&TRD 3.2.10.1.D, 3.7.B.3][DOE Order 6430.1A, 0111-2.10]

E. Design Earthquake

Earthquake design parameters for surface facilities shall be calculated in accordance with ESFDR Appendix A.5, with guidance presented in applicable sections of DOE Order 6430.1A, 0111-2.7.

[SD&TRD 3.2.10.1.E, 3.7.B.3][DOE Order 6430.1A, 0111-2.7]

F. Floods

The ESF design loads from flooding shall comply with UCRL 15910, Section 6.

[SD&TRD 3.2.10.1.F, 3.7.B.3][UCRL 15910]

G. Flood Protection

If, after compliance with the requirements of Executive Order 11988, new construction of structures or facilities are to be located in a flood plain, then:

1. Accepted flood-proofing and other flood protection measures shall be applied to new construction or rehabilitation.

[SD&TRD 3.2.10.1.G.1][Executive Order 11988, Section 2(b)]

2. To achieve flood protection, the design shall, wherever practicable, elevate structures above the base flood level rather than filling in land.

[SD&TRD 3.2.10.1.G.2][Executive Order 11988, Section 2(b)]

H. Earth and Groundwater

1. Every wall (foundation or otherwise) serving as a retaining structure shall be designed to resist, in addition to the vertical loads acting on it, the incident lateral earth pressures and surcharges, plus hydrostatic pressures corresponding to the maximum probable groundwater level.

[SD&TRD 3.2.10.1.H.1, 3.7.B.3][DOE Order 6430.1A, 0111-2.8.2]

2. Retaining walls shall be designed for earth pressures and potential groundwater levels producing the highest stresses and overturning moments. When a water-pressure-relief system is incorporated into the design, only earth pressures need to be considered. In cohesive soils, the long-term consolidation effects on the stability of the walls must be considered. Lateral earth pressures must be determined in accordance with accepted structural and geotechnical engineering practice.

[SD&TRD 3.2.10.1.H.2, 3.7.B.3][DOE Order 6430.1A, 0111-2.8.2]

I. Thermal Analysis

The design of structures shall include the effects of stresses and movements resulting from variations in temperature. The rise and fall in the temperature must be determined for the localities in which the structures are to be built. Structures must be designed for movement resulting from the maximum seasonal temperature change. The design must provide for the lags between air temperatures and the interior

temperatures of massive concrete members or structures. In cable-supported structures, changes in cable sag and tension must be considered.

[SD&TRD 3.2.10.1.I, 3.7.B.3][DOE Order 6430.1A, 0111-2.8.4]

J. Rain and Snowloads

Roof design for live load support shall comply with ASCE 7-88 which includes the minimum roof live loads, or snow loads and snow drifts, or possible rain loads, stipulated therein, whichever produces the more severe effect.

[SD&TRD 3.2.10.1.J, 3.7.B.3][DOE ORDER 6430.1A, 0111-2.3.2][ASCE 7-88]

3.2.1.10.2 INDUCED ENVIRONMENTS

A. Fire Protection

1. Surface facilities not in close proximity (100 feet) to the underground access facilities shall comply with the applicable fire protection requirements as identified in DOE Order 6430.1A, 0110-6.

[SD&TRD 3.2.10.2.1.A, 3.7.B.3][DOE Order 6430.1A, 0110-6]

- (a) Facilities shall comply with the applicable portions of the following:

- DOE Order 5480.4 Attachment 2, Section 2.C
- DOE Order 5480.7

[SD&TRD 3.2.10.2.1.A, 3.7.B.3][DOE Order 6430.1A, 0110-6; 5480.4; 5480.7]

- (b) Facilities shall also comply with 29 CFR 1926 and 29 CFR 1910. Except as required by other sections of these criteria, NFPA 101 shall apply where 29 CFR 1926 and 29 CFR 1910 do not apply or where NFPA 101 exceeds the requirements of 29 CFR 1926 and 29 CFR 1910.

[SD&TRD 3.2.10.2.1.A, 3.7.B.3][DOE Order 6430.1A, 0110-6]

- (c) Definitions, fire resistance ratings, and types of construction shall be those that are contained in the UBC.

[SD&TRD 3.2.10.2.1.A, 3.7.B.3][DOE Order 6430.1A, 0110-6]

- (d) Any materials with unusual fire characteristics, such as urethane foams, and any materials that develop significant quantities of toxic or other harmful products of combustion, shall not be used as interior finishes or for other interior applications without the approval of the cognizant DOE fire protection authority. The use of foamed plastics in construction shall be prohibited unless it fully complies with Factory Mutual (FM) 1-57.

[SD&TRD 3.2.10.2.1.A, 3.7.B.3][DOE Order 6430.1A, 0110-6]

2. Underground and surface facilities in close proximity (30.5 meters/100 feet) to the underground access facilities shall comply with fire protection requirements from 8 CCR 8400 et seq, 30 CFR 57, Subpart C, and 29 CFR 1926, Subpart S.

[SD&TRD 3.2.10.2.1.B, 3.7.B.3][30 CFR 57, Subpart C; 29 CFR 1926, Subpart S]

B. Fire Resistance

1. Surface facilities shall comply with requirements identified in DOE Order 6430.1A, 0110-6.3
[SD&TRD 3.2.10.2.2.A, 3.7.B.3][DOE Order 6430.1A, 0110-6.3]
2. Underground facilities and surface facilities in near proximity (30.5 meters/100 feet) to underground accesses shall comply with 30 CFR 57, Subpart C.
[SD&TRD 3.2.10.2.2.B, 3.7.B.3][DOE Order 6430.1A, 0110-6.3]

C. Vibration

Equipment supports shall be designed to avoid resonance resulting from the harmony between the natural frequency of the structure and the operating frequency of reciprocating or rotating equipment supported on the structure. The operating frequency of supported equipment must be determined from manufacturers' data prior to completion of structural design. Resonance must be prevented by designing equipment isolation supports to reduce the dynamic transmission of the applied load to as low a level as can be economically achieved in the design.

[SD&TRD 3.2.10.2.3, 3.7.B.3][DOE Order 6430.1A, 0111-2.8.1]

D. Creep and Shrinkage

Concrete and masonry structures shall be investigated for stresses and deformations induced by creep and shrinkage. The minimum linear coefficient of shrinkage must be assumed to be 0.0002 inch/inch, unless a detailed analysis is undertaken. The theoretical shrinkage displacement shall be computed as the product of the linear coefficient and the length of the member.

[SD&TRD 3.2.10.2.4, 3.7.B.3][DOE Order 6430.1A, 0111-2.8.5]

3.2.1.11 TRANSPORTABILITY/MODULARITY

To the extent practical, all temporary facilities shall be of either transportable or modular design. Specific requirements for temporary/modular facilities are provided in 3.2.3.3.8.

[SD&TRD 3.2.11][CRD 3.2.7]

3.2.1.12 FLEXIBILITY, EXPANSION, AND INTEGRATION

Site facilities shall be designed and constructed so as not to preclude the later addition, where appropriate, of facilities for offices and laboratories.

[SD&TRD 3.2.12][CRD 3.2.8]

3.2.1.13 PORTABILITY AND LOAD CARRYING

Equipment and components that must be moved over short distances for maintenance or other purposes shall:

- A. Not exceed 35 pounds in weight, if to be moved by one person;

[SD&TRD 3.2.13.A][CRD 3.2.9.A]

- B. Have suitable handgrips or lifting aids;
[SD&TRD 3.2.13.B][CRD 3.2.9.B]
- C. Have mechanical lifting and handling devices provided, if heavier than 70 pounds or impractical for 2-man carry.
[SD&TRD 3.2.13.C][CRD 3.2.9.C]

3.2.1.14 PHYSICAL SECURITY

3.2.1.14.1 PHYSICAL PROTECTION

The physical security systems and access controls shall be designed and constructed to satisfy the applicable security requirements of DOE Order 6430.1A, 0283, tailored to the application and focused on theft of high-value equipment and supplies.

[SD&TRD 3.2.14.1, 3.7.B.3][DOE Order 6430.1A, 0283]

3.2.1.14.2 PHYSICAL BARRIERS

- A. Physical barriers shall be designed and constructed to satisfy the applicable requirements of DOE Order 6430.1A, 0283.
[SD&TRD 3.2.14.2, 3.7.B.3][DOE Order 6430.1A, 0283]
- B. Where necessary to inhibit access, the ESF site shall be controlled by fencing.
[SD&TRD 3.2.14.2, 3.7.B.3][DOE Order 6430.1A, 0283]

3.2.1.14.3 ACCESS CONTROL

- A. Provide control for all points of personnel and vehicle access as specified in DOE Order 6430.1A, 0110-13.2 and 0283.
[SD&TRD 3.2.14.3, 3.7.B.3][DOE Order 6430.1A, 0110-13.2; 0283]
- B. Where necessary to inhibit access, the ESF site shall be controlled by a gate across the roadway.
[SD&TRD 3.2.14.3, 3.7.B.3][DOE Order 6430.1A, 0110-13.2; 0283]
- C. A system shall be provided to control access to underground openings as required by 30 CFR 57.11058, 29 CFR 1926.800(c), and 8 CCR 8400 et seq.
[SD&TRD 3.7.2.2.5, 3.7.B.3][29 CFR 1926; 30 CFR 57][8 CCR 8400 et seq]

3.2.1.15 ELECTROMAGNETIC RADIATION

- A. Critical communications and data circuits shall be protected or shielded from electromagnetic interference from sources within the ESF, and from external sources to the extent specified by manufacturers of sensitive data processing and communications equipment used in the system.
[SD&TRD 3.3.2.A, 3.7.B.3][DOE Order 6430.1A, 0200-99.8.1]
- B. Lighting fixture types and locations shall be coordinated with the equipment and functions of telecommunication, alarm, and automated data processing centers, to

provide the required illumination without creating electrical or electromagnetic interference detrimental to proper operation of equipment.

[SD&TRD 3.3.2.B, 3.7.B.3][DOE Order 6430.1A, 1655-99.8]

- C. Shielding shall be provided to protect magnetic recording equipment, magnetic tapes, and disk packs where an electromagnetic field of 10 microvolts or 50 Oersteds or greater can be expected.

[SD&TRD 3.3.2.C, 3.7.B.3][DOE Order 6430.1A, 0110-99.8.3]

- D. Provisions shall be made (in accordance with 30 CFR 57, Subpart E, and 8 CCR 8400 et seq) to prevent the possibility of electromagnetic transmitters inadvertently detonating blasting caps.

[SD&TRD 3.3.2.D][MGDS-RD 3.2.2.D]

3.2.1.16 NAMEPLATES AND MARKINGS

- A. Equipment and any parts of that equipment to be used by personnel shall be identified with appropriate labels. Equipment and equipment parts include, but are not limited to, system and subsystem component groupings; individual components; control positions or modes; display markings; instructions; procedure manuals; storage spaces; access panels; and tools.

[SD&TRD 3.3.3.A, 3.7.B.3][DOE Order 6430.1A, 1300-12.4.11]

- B. The label shall indicate, clearly and concisely, the function and purpose of the item being labeled; unnecessary information (e.g., information used only for manufacturing purposes) must not be included. Hierarchical labeling should be used to facilitate component location on control panels.

[SD&TRD 3.3.3.B, 3.7.B.3][DOE Order 6430.1A, 1300-12.4.11]

- C. The label information terminology shall have commonly accepted meaning for all users. Words, symbols, and other markings in a label or instruction shall be unambiguous and accurate.

[SD&TRD 3.3.3.C, 3.7.B.3][DOE Order 6430.1A, 1300-12.4.11]

- D. Label design shall be consistent and shall use abbreviations and acronyms minimally. Various equipment labels placed on the same or similar pieces of equipment and serving similar functions must use the same material, color, font type, relative location to component, general format, and other configuration features to promote simplicity and avoid clutter. The terminology used for equipment, procedures, and training materials must be the same for each case.

[SD&TRD 3.3.3.D, 3.7.B.3][DOE Order 6430.1A, 1300-12.4.11]

- E. Permanent labels shall be attached to the specific component or equipment in such a manner that environmental conditions or usage by personnel shall not remove or destroy the label.

[SD&TRD 3.3.3.E, 3.7.B.3][DOE Order 6430.1A, 1300-12.4.11]

- F. The identification markings and identification plates, tags, or labels, when used on equipment; systems; subsystems; assemblies; subassemblies; components and piece parts (if necessary); shall be permanent for the life of the item including withstanding

environmental conditions and cleaning requirements. These markings shall be accomplished using methods that shall not impact the life and use of the item.

[SD&TRD 3.3.3.F][CRD 3.3.3]

3.2.1.17 WORKMANSHIP

- A. Special processes, for SSC which are ITS, including welding; heat treating; and nondestructive testing; shall be controlled and performed by qualified personnel using approved procedures, and where applicable, in accordance with the QARD.

[SD&TRD 3.3.4.A, 3.7.B.3][QARD]

- B. Workmanship criteria shall reflect the currently applicable codes, standards, regulations, and architectural and engineering principles and practices specified in DOE Order 6430.1A (General Design Criteria) - 0109 Reference Standards and Guides, including:

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANS	American Nuclear Society
ANSI	American National Standards Institute
AREA	American Railway Engineering Association
ARI	Air Conditioning and Refrigeration Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrumentation Society of America
MBMA	Metal Building Manufacturers Association
NAAMM	National Association of Architectural Metal Manufacturers
NAPHCC	National Association of Plumbing-Heating-Cooling Contractors
NCMA	National Concrete Masonry Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology (formerly the National Bureau of Standards)
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute

[SD&TRD 3.3.4.B, 3.7.B.3][DOE Order 6430.1A, 0109]

3.2.1.18 INTERCHANGEABILITY

To the extent practicable, components such as pumps, motors, fans, transformers, etc., used for similar functions in various parts of the system shall be of identical manufacture and model. The objective is to simplify logistical support such as repair parts supply, training, and documentation.

[SD&TRD 3.3.5][CRD 3.3.5]

3.2.1.19 SAFETY**3.2.1.19.1 GENERAL REQUIREMENTS**

A. All workplaces shall be designed to be free from recognized hazards that cause or are likely to cause death or serious physical harm to employees.

[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]

B. All workplaces shall be designed to comply with occupational safety and health standards promulgated under 29 CFR 1910, 29 CFR 1926, 30 CFR 57 and 8 CCR 8400 et seq.

[SD&TRD 3.3.6.1.B, 3.7.B.3][29 CFR 1910; 29 CFR 1926; 30 CFR 57][8 CCR 8400 et seq]

1. Design shall include a check-in, check-out system which will provide an accurate record of persons in underground spaces as required by 30 CFR 57.11058 and 29 CFR 1926.800(c).

[SD&TRD 3.7.2.2.7.A, 3.7.B.3][29 CFR 1926.800(c); 30 CFR 57.11058]

3.2.1.19.2 SYSTEM SAFETY PRECEDENCE

The order of precedence for satisfying system safety requirements and resolving identified hazards (MIL-STD-882B may be used as a reference) shall be as follows:

A. The first priority of design shall be to eliminate hazards.

[SD&TRD 3.3.6.2.A][CRD 3.3.6.2.A]

B. If identified hazards cannot be eliminated, or their associated risk cannot be adequately reduced through design selection, that risk shall be reduced through the use of fixed, automatic, or other protective safety design features or devices. Provisions shall be made for periodic functional checks of safety devices, where applicable.

[SD&TRD 3.3.6.2.B][CRD 3.3.6.2.B]

C. When neither design nor safety devices can effectively eliminate identified hazards or adequately reduce associated risk, devices shall be used to detect the condition and to produce an adequate warning signal to alert personnel of the hazard. Warning signals and their application shall be designed to minimize the probability of incorrect personnel reaction to the signal and shall be standardized within like types of systems.

[SD&TRD 3.3.6.2.C][CRD 3.3.6.2.C]

- D. Only where it is impractical [TBD] to eliminate hazards through design selection, or adequately reduce the associated risk with safety and warning devices, may procedures and training be used.

[SD&TRD 3.3.6.2.D][CRD 3.3.6.2.D]

- E. This section (3.2.1.19) imposes requirements from 29 CFR 1910, 29 CFR 1926, 30 CFR 57 and 8 CCR 8400 et seq.

1. 30 CFR 57 and 8 CCR 8400 et seq shall apply only to subsurface facilities and equipment and to those mining-related surface facilities and equipment specifically addressed therein.

[SD&TRD 3.3.6.2.E.1, 3.7.B.3][30 CFR 57]

2. 29 CFR 1910 and 29 CFR 1926 shall apply to all other surface facilities and equipment. 29 CFR 1910 and 29 CFR 1926 shall also apply to subsurface facilities and equipment not addressed by 30 CFR 57 and 8 CCR 8400 et seq, and where safety hazard analysis following the precedence set in 3.2.1.19.2.A through 3.2.1.19.2.D deems it necessary.

[SD&TRD 3.3.6.2.E.2, 3.7.B.3][29 CFR 1910; 29 CFR 1926]

3. Subsurface construction, excavation, alteration, and repairs shall be governed by 8 CCR 8400 et seq.

[SD&TRD 3.3.6.2.E.3][8 CCR 8400 et seq]

3.2.1.19.3 FACILITIES, EQUIPMENT, AND MATERIALS PROTECTIVE MEASURES

The ESF shall be designed to meet the applicable requirements specified in 29 CFR 1910, NFPA 101, and the UBC for surface facilities, and 8 CCR 8400 et seq for subsurface facilities.

[SD&TRD 3.3.6.3.A, 3.7.B.3][29 CFR 1910][NFPA 101][UBC][8 CCR 8400 et seq]

- A. As a minimum, the design shall meet the following 29 CFR 1910 requirements:

1. Subpart D - Walking-Working Surfaces

[SD&TRD 3.3.6.3.A.1, 3.7.B.3][29 CFR 1910, Subpart D][NFPA 101][UBC]

2. Subpart E - Means of Egress

[SD&TRD 3.3.6.3.A.2, 3.7.B.3][29 CFR 1910, Subpart E]

3. Subpart G - Occupational Health and Environmental Control

[SD&TRD 3.3.6.3.A.3, 3.7.B.3][29 CFR 1910, Subpart G]

4. Subpart J - General Environmental Controls

[SD&TRD 3.3.6.3.A.4, 3.7.B.3][29 CFR 1910, Subpart J]

- B. Subsurface facilities shall be designed to meet the requirements of 30 CFR 57 and 8 CCR 8400 et seq.

[SD&TRD 3.3.6.3.B, 3.7.B.3][30 CFR 57][8 CCR 8400 et seq]

- C. Facilities for storing and handling hazardous gases and combustible and flammable liquids shall be designed and installed to meet the requirements of 29 CFR 1910, Subpart H and NFPA 70.
[SD&TRD 3.3.6.3.C, 3.7.B.3][29 CFR 1910, Subpart H][NFPA 70]
- D. Protection against electrical, mechanical, fluid, and toxic hazards shall be in accordance with the requirements of 29 CFR 1910, Subpart H. MIL-STD-1472D Section 5.13.7 may be used for reference.
[SD&TRD 3.3.6.3.D, 3.7.B.3][29 CFR 1910, Subparts H, O]

3.2.1.19.4 PERSONNEL PROTECTIVE EQUIPMENT

The following requirements shall be considered to the extent that they impact design.

- A. Protective equipment such as helmets, face shields, safety shoes, and respiratory protectors shall be selected in accordance with the applicable requirements of 29 CFR 1910, Subpart I; 29 CFR 1926, Subpart E; and 30 CFR 57, Subpart N.
[SD&TRD 3.3.6.4.A, 3.7.B.3][29 CFR 1910, Subpart I; 29 CFR 1926, Subpart E; 30 CFR 57, Subpart N]
- B. Hearing protection devices shall be provided as required by 29 CFR 1910.95.
[SD&TRD 3.3.6.4.B, 3.7.B.3][29 CFR 1910.95; 29 CFR 1926.101]
- C. Appropriate facilities that provide for convenient storage and for emergency issue of personal protective equipment shall be provided in accordance with 29 CFR 1910.132 and 8 CCR 8400 et seq.
[SD&TRD 3.3.6.4.C, 3.7.B.3][29 CFR 1910.132]

3.2.1.19.5 SAFETY LABELS AND PLACARDS

- A. Safety labels and placards shall be designed and displayed as required in 29 CFR 1910, Subpart J; 29 CFR 1926.59; and 29 CFR 1926.200. MIL-STD-1472D Section 5.13.2. may be used for reference.
[SD&TRD 3.3.6.5.A, 3.7.B.3][29 CFR 1910, Subpart J; 29 CFR 1926.59, 29 CFR 1926.200]
- B. Pipe, hose, and tube-line identification for liquids, gas, and steam shall be clearly and unambiguously labeled or coded as to contents, pressure, heat, cold, direction of flow, or other specific hazard information.
[SD&TRD 3.3.6.5.B][CRD 3.3.6.6.B]
- C. Alerting devices, emergency doors and exits, and equipment provided for use in hazard areas and the environment around surface workspaces, shall be designed in accordance with the requirements of 29 CFR 1910 and 29 CFR 1926, NFPA 101 and the UBC. MIL-STD-1472D Section 5.13.4. may be used for reference.
[SD&TRD 3.3.6.5.C, 3.7.B.3][29 CFR 1910; 29 CFR 1926][NFPA 101][UBC]

3.2.1.19.6 EMERGENCY LIGHTING

- A. Failure of the normal lighting systems shall not inhibit or degrade the operation of emergency lighting.
[SD&TRD 3.3.6.6.A][CRD 3.3.6.7.A]
- B. The emergency lighting system shall be designed to automatically actuate and shall be powered by batteries that are continuously charged by facility electrical power.
[SD&TRD 3.3.6.6.B][CRD 3.3.6.7.B]
- C. Emergency lighting systems shall comply with the requirements of NFPA 101, NFPA 110 and the recommended practices of the Illuminating Engineering Society.
[SD&TRD 3.3.6.6.C, 3.7.B.3][DOE Order 6430.1A, 1655-1]

3.2.1.19.7 EQUIPMENT RELATED HAZARDS

- A. Interlocks, alarms, access, hazard access, and edge rounding shall be provided and designed in accordance with the applicable requirements of 29 CFR 1910 and 29 CFR 1926 for surface equipment, or 30 CFR 57 and 8 CCR 8400 et seq for subsurface equipment. MIL-STD-1472D Section 5.13.5 may be used for reference.
[SD&TRD 3.3.6.7.A, 3.7.B.3][29 CFR 1910; 29 CFR 1926; 30 CFR 57][8 CCR 8400 et seq]
- B. To protect servicing and maintenance personnel, tag-out and lock-out fixtures shall be provided as required by 29 CFR 1910.147 and 29 CFR 1926 for surface machines and equipment, or 30 CFR 57.12016 and 8 CCR 8400 et seq for subsurface machines and equipment.
[SD&TRD 3.3.6.7.B, 3.7.B.3][29 CFR 1910.147; 29 CFR 1926; 30 CFR 57.12016]
[8 CCR 8400 et seq]
- C. Fixed machinery tools shall be selected, installed, and guarded as required by 29 CFR 1910, Subpart O and 29 CFR 1926 for surface machinery; or 30 CFR 57, Subpart M and 8 CCR 8400 et seq for subsurface machinery.
[SD&TRD 3.3.6.7.C, 3.7.B.3][29 CFR 1910, Subpart O; 29 CFR 1926; 30 CFR 57, Subpart M][8 CCR 8400 et seq]
- D. To the extent that they impact the ESF design, hand and portable power tools shall meet the applicable requirements specified by 29 CFR 1910, Subpart P and 29 CFR 1926.
[SD&TRD 3.3.6.7.D, 3.7.B.3][29 CFR 1910, Subpart P; 1926]
- E. To the extent that they impact ESF design, welding equipment and areas where welding operations will be performed shall meet the requirements specified by 29 CFR 1910, Subpart Q and 29 CFR 1926.
[SD&TRD 3.3.6.7.E, 3.7.B.3][29 CFR 1910, Subpart Q; 29 CFR 1926]

- F. Where the possibility exists for the eyes or body of any person to be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the immediate work area for emergency use in accordance with 29 CFR 1910.151 and 29 CFR 1926.51(f) for surface facilities, and 8 CCR 8400 et seq for underground facilities.
[SD&TRD 3.3.6.7.F, 3.7.B.3][29 CFR 1910.151(c); 1926.51(F)][8 CCR 8400 et seq]

3.2.1.19.8 WORK PLATFORMS

The following requirements shall be considered to the extent they impact design:

- A. Any powered platforms, manlifts, and vehicle-mounted work platforms shall be designed and constructed to comply with 29 CFR 1910, Subpart F and 29 CFR 1926. Underground applications shall comply with 30 CFR 57; 8 CCR 8400 et seq; and 29 CFR 1926, Subpart S.
[SD&TRD 3.3.6.8.A, 3.7.B.3][29 CFR 1910, Subpart F; 29 CFR 1926; 30 CFR 57][8 CCR 8400 et seq]
- B. Scaffolds, ladders, work platforms, stands, and bridges shall be provided with safety devices in accordance with the requirements of 29 CFR 1910, Subparts D and F and 29 CFR 1926. Underground applications shall comply with 30 CFR 57; 8 CCR 8400 et seq; and 29 CFR 1926, Subpart S. MIL-STD-1472D Section 5.13.6 may be used for reference.
[SD&TRD 3.3.6.8.B, 3.7.B.3][29 CFR 1910, Subparts D, F; 29 CFR 1926; 30 CFR 57][8 CCR 8400 et seq]

3.2.1.19.9 ELECTRICAL SAFETY

- A. Electrical systems and components shall be selected, designed, and installed as required by 29 CFR 1910, Subpart S; 29 CFR 1926, Subpart K; and for underground installations 29 CFR 1926, Subpart S; NFPA 70; and NFPA 70E. Underground electrical installations, and electrical installations where explosives and blasting agents are stored, shall comply with 30 CFR 57, Subparts E and K, and 8 CCR 8400 et seq.
[SD&TRD 3.3.6.9.A, 3.7.B.3][29 CFR 1910, Subpart S; 29 CFR 1926; 30 CFR 57][8 CCR 8400 et seq][NFPA 70, 70E]
- B. Provisions shall be incorporated into the design to make reliable and timely emergency power immediately available to instruments, utility service systems, central security systems and operating systems, including alarm systems ITS, in the event of a loss of primary power source or circuit. Backup power requirements for items not ITS are designed to applicable industry standards during the design development process.
[SD&TRD 3.3.6.9.B][10 CFR 60.131(b)(5)(iii)]
- C. Protection against electrical hazards shall also conform to the National Electrical Code (NFPA 70), the National Electrical Safety Code (ANSI Standard C2), and, for underground applications, 30 CFR 57, Subpart K.
[SD&TRD 3.3.6.9.C, 3.7.B.3][30 CFR 57, Subpart K][ANSI/C2][NFPA 70]

3.2.1.20 HUMAN FACTORS ENGINEERING

ESF design shall use the draft DOE Standard "Human Factors Engineering Design Criteria: Volume 1 General Criteria" and NUREG 0700 "Guidelines for Control Room Design Reviews" as references.

[SD&TRD 3.3.7][NUREG 0700]

A. Visual Display Terminal (VDT) Workstation

Human factors engineering of computer terminals, visual displays, and VDT workstations contributes to operator proficiency and lessens operator fatigue. Design, selection, and integration of VDT workstations shall use ANSI/HFS Std. No. 100-1988 Section 5 as a reference.

[SD&TRD 3.3.7.1, 3.7.B.3][CRD 3.3.7.9][ANSI/HFS 100-1988]

B. Anthropometry

Sizing and layout for equipment and facilities shall be compatible with the using personnel (use MIL-STD-1472D Section 5.6.3.2 as a reference, and see DOD-HDBK-743 for special populations).

[SD&TRD 3.3.7.2][CRD 3.3.7.10]

C. Remote Handling and Operation

The design, selection, and integration of equipment, controls, and indicators for remotely operated systems, if used, shall use MIL-STD-1472D Section 5.10 or applicable industry standards as a reference.

[SD&TRD 3.3.7.3][CRD 3.3.7.11]

D. Vehicles and Material Handling

The design, selection, and acquisition of operational and transportation vehicles and material handling equipment shall consider human interface requirements using MIL-STD-1472D Section 5.12.2 as a reference.

[SD&TRD 3.3.7.4][CRD 3.3.7.12]

E. Accessibility and Useability by the Physically Handicapped

1. All ESF buildings shall be designed and constructed to accommodate the physically handicapped as required by General Services Administration Uniform Federal Accessibility Standards.

[SD&TRD 3.3.7.5.A, 3.7.B.3][41 CFR 101-29.603]

2. The design, selection, and construction of all ESF facilities shall consider accessibility and useability of facilities and equipment by physically handicapped personnel, both visitors and employees. As a minimum, the criteria and requirements specified in DOE Order 6430.1A, 1300-13 shall be considered for all facility and equipment designs.

[SD&TRD 3.3.7.5.B][CRD 3.3.7.13]

F. User-Computer Software Interface

Design of computer software and firmware that provides an interface between users and computers shall use Guidelines for Designing User Interface Software, MTR 10090, as a reference for data entry and user input, data display, sequence control, user guidance and prompts, data transmission, and data protection.

[SD&TRD 3.3.7.6, 3.7.B.3][CRD 3.3.7.14][MTR 10090]

3.2.1.21 METHODS AND CONTROLS

A. Materials Management

ESF and equipment design shall consider the following, to the extent that they impact the design.

1. Materials, parts, and components, which are ITS and/or ITWI, shall provide identification and physical markings to ensure control and traceability of items. The identification and control of these materials, parts, and components shall be in accordance with the QARD.

[SD&TRD 3.3.8.1.A, 3.7.B.3][QARD]

2. Materials, parts, and components, which are ITS and/or ITWI, shall comply with the requirements of Section 8.0 of the QARD to ensure that only correct and accepted items are used or installed.

[SD&TRD 3.3.8.1.B][CRD 3.3.8.1.B]

3. Procurement of materials, parts, and components, which are ITS and/or ITWI, shall make use of procurement documents prepared in accordance with Section 4.0 of the QARD.

[SD&TRD 3.3.8.1.C][CRD 3.3.8.1.C]

4. Designs of ESF shall use standardization maximally when feasible.

[SD&TRD 3.3.8.1.D][CRD 3.3.8.1.D]

B. Inventory Control

ESF and equipment designs shall consider the following requirement to the extent that they impact the design:

An inventory management subsystem shall be implemented for the control of supplies and spare parts associated with the construction, operation, closure, and decommission of the ESF.

[SD&TRD 3.3.8.2][CRD 3.3.8.2]

3.2.1.22 GOVERNMENT FURNISHED PROPERTY

- A. The site for the ESF shall be provided by the U. S. Government.

[SD&TRD 3.3.9.A][CRD 3.3.9.A]

- B. Property required to be furnished by the U.S. Government is listed in Appendix C.
[SD&TRD 3.3.9.B][CRD 3.3.9.B]
- C. Requirements pertaining to the receipt, maintenance, operation and disposition of Government furnished property shall be specified as appropriate.
[SD&TRD 3.3.9.C][CRD 3.3.9.C]

3.2.1.23 COMPUTER RESOURCES

- A. ESF designs shall accommodate the use of computer resources when appropriate.
[SD&TRD 3.3.10.A][CRD 3.3.10.A]
- B. The design of ESF computer systems shall provide for the intercompatibility of resources, including hardware and software. The design goal is to allow for the common use of data bases and information with other CRWMS elements.
[SD&TRD 3.3.10.B][CRD 3.3.10.B]

3.2.1.24 ENVIRONMENTAL PROTECTION REQUIREMENTS

This section identifies and imposes requirements on the ESF to comply with federal laws and regulations to protect the environment.

- A. During design and construction, the ESF shall conform to the environmental protection requirements in Appendix J as a minimum, and shall add any applicable state and local environmental requirements.
[SD&TRD 3.3.11.A][CRD 3.3.11.A]
- B. During ESF construction, operation, and decommissioning, environmental impacts shall be mitigated to the extent practical.
[SD&TRD 3.3.11.B][10 CFR 960.3-4]

3.2.1.25 DOCUMENTATION

Technical data consists of the engineering, technical, and logistic data required to support operational and maintenance requirements. Measures shall be established to ensure that applicable regulatory requirements and the design basis are correctly translated into specifications, drawings, manuals, procedures and instructions.

3.2.1.25.1 SPECIFICATIONS

- A. All specifications for facility construction and for equipment development and procurement shall be prepared in accordance with the guidelines of the Construction Specification Institute format, tailored for the application.
[SD&TRD 3.4.1.A][CRD 3.4.1.B]
- B. Implementing documents shall be established to ensure that applicable requirements, as specified herein, are correctly translated into specifications. These implementing documents must ensure that appropriate quality standards are specified and included in design documents and that deviations from these standards are properly controlled.
[SD&TRD 3.4.1.B, 3.7.B.3][QARD]

- C. ESF DOs shall provide TBD/TBV/TBS logs for all information included as part of the design package. The logs shall take the form of summary tables that indicate the location of the TBD, TBV or TBS, and their description. The logs shall be located directly after the table of contents and directly before any change pages.

[SD&TRD 3.4.1.C]

3.2.1.25.2 DRAWINGS

Implementing documents shall be established to ensure that applicable regulatory requirements, design basis requirements, and other requirements as specified in this document, are correctly translated into drawings. These measures and procedures shall ensure that appropriate quality standards are specified and included in design documents and that deviations from these standards are properly controlled.

[SD&TRD 3.4.2, 3.7.B.3][QARD]

3.2.1.25.3 MAINTENANCE, OPERATOR'S, AND TECHNICAL MANUALS

Implementing documents shall be established to ensure that applicable requirements as specified herein are correctly translated into maintenance and technical manuals.

[SD&TRD 3.4.3, 3.7.B.3][QARD]

3.2.1.25.4 TEST PLANS AND PROCEDURES

The ESF projects shall establish a test and evaluation program to demonstrate conformance of the design to the system requirements as required in verification cross-reference Table 4-1.

[SD&TRD 3.4.4][CRD 3.4.4]

3.2.1.25.5 QUALITY ASSURANCE DOCUMENTATION

QA records shall be prepared, maintained, and stored in accordance with requirements specified in the OCRWM QARD, or an equivalent OCRWM-approved QA program.

[SD&TRD 3.4.5, 3.7.B.3][QARD]

3.2.1.25.6 CONSTRUCTION RECORDS

Construction records requirements for ESF activities, including as-built documentation, is specified below:

- A. All geotechnical information used to locate and design the ESF accesses and underground features (including seismic criteria) shall be consistent with information contained in the RIB, applicable YMP controlled documents, and/or applicable standard reference information sources (e.g., standard handbooks).

[SD&TRD 3.4.6.A][CRD 3.4.6.A]

- B. Records for areas of the ESF design, construction, operation and in situ testing, which will become part of the geologic repository operations area, shall be maintained to satisfy the requirements of 10 CFR 60.72 and Section 3.2.1.25.5.

[SD&TRD 3.4.6.B, 3.7.B.1, 3.7.B.3][10 CFR 60.72][QARD]

1. Surveys of the underground facility excavations, shafts, ramps, and boreholes referenced to readily identifiable features or monuments;
[SD&TRD 3.4.6.B, 3.7.B.1, 3.7.B.3][10 CFR 60.72][QARD]
2. A description of the materials encountered;
[SD&TRD 3.4.6.B, 3.7.B.1, 3.7.B.3][10 CFR 60.72][QARD]
3. Geologic maps and geologic cross-sections;
[SD&TRD 3.4.6.B, 3.7.B.1, 3.7.B.3][10 CFR 60.72][QARD]
4. Locations and amount of seepage;
[SD&TRD 3.4.6.B, 3.7.B.1, 3.7.B.3][10 CFR 60.72][QARD]
5. Details of equipment, methods, progress, and sequence of work;
[SD&TRD 3.4.6.B, 3.7.B.1, 3.7.B.3][10 CFR 60.72][QARD]
6. Construction problems;
[SD&TRD 3.4.6.B, 3.7.B.1, 3.7.B.3][10 CFR 60.72][QARD]
7. Anomalous conditions encountered;
[SD&TRD 3.4.6.B, 3.7.B.1, 3.7.B.3][10 CFR 60.72][QARD]
8. Instrument locations, readings, and analysis;
[SD&TRD 3.4.6.B, 3.7.B.1, 3.7.B.3][10 CFR 60.72][QARD]
9. Location and description of structural support systems;
[SD&TRD 3.4.6.B, 3.7.B.1, 3.7.B.3][10 CFR 60.72][QARD]
10. Location and description of dewatering systems;
[SD&TRD 3.4.6.B, 3.7.B.1, 3.7.B.3][10 CFR 60.72][QARD]
11. Details, methods of emplacement, and location of seals used.
[SD&TRD 3.4.6.B, 3.7.B.1, 3.7.B.3][10 CFR 60.72][QARD]

3.2.1.25.7 COMPUTER DOCUMENTATION

Analytical and computational models and software user documentation prepared for SSC which are ITS shall be prepared in accordance with the OCRWM QARD.

[SD&TRD 3.4.7, 3.7.B.3][QARD]

3.2.1.25.8 RECORDS MANAGEMENT

[TBD]

[SD&TRD 3.4.8][10 CFR 60.71(b)]

3.2.1.26 LOGISTICS

Logistics requirements established for the ESF are to provide a disciplined, unified, and iterative approach to development of support requirements for facilities, systems, and equipment. The systems, procedures, and measures developed to achieve these requirements will, in turn, ensure that the design, readiness and operational objectives of site characterization phase activities are met.

3.2.1.26.1 MAINTENANCE

The basic premise of the program maintenance concept is to minimize the likelihood of, and mitigate the effects of, SSC failures using preventive maintenance and inspections. When failures do occur, the goal is to provide the ability to restore full operational capability as quickly as possible through a proactive corrective maintenance program. Therefore, ESF facilities, systems, and components shall be designed to permit periodic testing, inspection, and maintenance, as necessary, to ensure their continued functioning and readiness.

[SD&TRD 3.5.1, 3.7.B.1][10 CFR 60.131(b)(6)]

A. Salvaging, Off-Site Repair and Vendor Repair

Items that cannot be repaired at the site shall be salvaged or returned to an off-site shop or to the vendor for repair. If impacts to the design from this requirement are identified as the design process evolves, these impacts will be incorporated and allocated appropriately. No design impacts have been identified for the ESF.

[SD&TRD 3.5.1.1][MGDS-RD 3.5.1.1.3]

B. Standardization

1. The ESF design shall allow maintenance to be performed, to the extent practical, using standard tools, lubricants, cleaners, test equipment, etc.

[SD&TRD 3.5.1.2.A][MGDS-RD 3.5.1.4.A]

2. The use of special tools and the number of standard tools required shall be minimized by selection of common fasteners, clamps, adapters, and connectors.

[SD&TRD 3.5.1.2.B][MGDS-RD 3.5.1.4.B]

3.2.1.26.2 SUPPLY

Based on projected logistics support requirements for design considerations an analysis shall be conducted iteratively to assess the capability of support available to the system. This Logistics Support Analysis (LSA) shall be conducted through all phases of the system or equipment life cycle to satisfy supportability objectives. The level of detail for the analyses and the timing of the task performance shall be tailored to each system and equipment item and shall be responsive to program schedules and milestones. An LSA program shall be established (see MIL-STD-1388 series or equivalent as reference).

[SD&TRD 3.5.2][CRD 3.5.2]

3.2.1.26.3 FACILITIES**A. Warehouse Requirements**

Warehouse space shall be provided for the storage of all spare parts and replaceable equipment in an environment conducive to their safekeeping and protection. If practical, the warehouse shall be common to ESF and surface-based testing.

[SD&TRD 3.5.3.1][CRD 3.5.3.C]

B. Shipping and Receiving Facilities

1. An ESF facility shall be provided for receipt of maintenance and repair materials and tools, and shipment and return receipt of items shipped off-site for repair. If practical, the receiving facility shall be common to ESF, and surface-based testing.

[SD&TRD 3.5.3.2.A][MGDS-RD 3.5.3.2.A]

2. Shipping and receiving facilities shall be designed with door openings, halls, and aisles adequate for movement of items to be shipped into and out of the facility.

[SD&TRD 3.5.3.2.B][MGDS-RD 3.5.3.2.B]

3. Shipping and receiving facility design shall be compatible with requirements for handling, storage, and shipment of items which are ITS as specified in Section 13.0 of the QARD.

[SD&TRD 3.5.3.2.C]

3.2.1.27 TRAINING

The ESF shall provide facilities and provisions for equipment, manuals and training aids to support training programs established for both DOE and contractor personnel. The training activities will include, but are not limited to, the following:

- A. Equipment maintenance training based on the criteria specified by DOE Order 4330.4A, I.3.1.4;

[SD&TRD 3.6.2.1.A, 3.7.B.3][DOE Order 4330.4A, I.3.1.4]

- B. Development of a training requirements document used for operations and maintenance training for the facilities, hardware and software;

[SD&TRD 3.6.2.1.B][CRD 3.6.2.1.A, D]

- C. Qualification and proficiency training, testing, and certification of personnel involved in activities ITS, as required by the QARD.

[SD&TRD 3.6.2.1.C][10 CFR 60.161]

3.2.1.28 PRECEDENCE

- A. The general order of precedence for ESF requirements shall be:
1. Federal Law and documents
 - (a) Laws, Statutes, United States Code, and Treaties
[SD&TRD 3.8.A.1.a][CRD 3.8.A]
 - (b) Codes of Federal Regulations and Executive Orders (including NRC Regulatory Guide and DOE Orders and Notices)
[SD&TRD 3.8.A.1.b][CRD 3.8.A]
 - (c) Other documents, orders, and directives
[SD&TRD 3.8.A.1.c][CRD 3.8.A]
 2. State Laws and Standards
 - (a) State of Nevada
[SD&TRD 3.8.A.2.a][CRD 3.8.A]
 - (b) State of California
[SD&TRD 3.8.A.2.b][CRD 3.8.A]
 3. Local Ordinances
[SD&TRD 3.8.A.3][CRD 3.8.A]
 4. National and International Standards
[SD&TRD 3.8.A.4][CRD 3.8.A]
- B. For requirements addressing nuclear safety, the NRC requirements (i.e., CFRs issued by the NRC) shall take precedence over DOE requirements (i.e., DOE Orders or CFRs issued by the DOE); however, DOE Orders, CFRs, or other standards may be used as a reference in meeting NRC requirements. In resolving questions of precedence involving CFRs, the requirements from NRC issued regulations shall take precedence.
[SD&TRD 3.8.B][MOA, NS/RW 4/16/92]
- C. The order of precedence between 29 CFR 1910 (Occupational Safety and Health Administration (OSHA)) and 30 CFR 57 (MSHA) shall be as described below:
[SD&TRD 3.8.C][CRD 3.8.C]
1. 30 CFR 57 shall apply only to subsurface facilities and equipment and to those mining related surface facilities and equipment specifically addressed in 30 CFR 57.
[SD&TRD 3.8.C.1][CRD 3.8.C]
 2. 29 CFR 1910 and 29 CFR 1926 shall apply to all other surface facilities and equipment. 29 CFR 1910 and 29 CFR 1926 shall also be applied to subsurface facilities and equipment not addressed by 30 CFR 57.
[SD&TRD 3.8.C.2][CRD 3.8.C]

3.2.1.29 QUALIFICATION/QUALITY ASSURANCE

All ESF quality affecting activities shall be conducted under a QA program accepted by the NRC to satisfy the provisions of Subpart G of 10 CFR 60. The applicable QA controls established by the OCRWM QARD shall be applied to quality affecting items and their associated activities based on the classification of the structure, system, or component.

[SD&TRD 3.7.B.3, 3.9][10 CFR 60, Subpart G][QARD]

3.2.2 CIVIL/MINING

A. RESERVED.

B. A minimum of two accesses shall be incorporated into the underground ESF to ensure adequate alternative routes of egress.

[SD&TRD 3.3.6.1.B, 3.3.6.2.E.2, 3.7.B.3][30 CFR 57.11050]

C. All coordinates shall be in accordance with the Nevada State Plane Coordinate System.

[SD&TRD 3.3.1.C, 3.7.B.3][DOE Order 6430.1A]

D. All project land surveys shall consider DOE Order 6430.1A and:

[SD&TRD 3.3.1.A][CRD 3.3.1.A]

1. Be traceable to existing first-order control points in or around Area 25;

[SD&TRD 3.3.1.A][CRD 3.3.1.A]

2. Comply with the accuracy requirements established by the requester of the surveying services;

[SD&TRD 3.3.1.A][CRD 3.3.1.A]

3. Be verifiable by the surveying organization that the survey originated from suitable control points and that accuracy requirements are satisfied.

[SD&TRD 3.3.1.A][CRD 3.3.1.A]

E. The number of exploratory boreholes and shafts (and ramps) shall be limited, to the extent practical, consistent with obtaining the information needed for site characterization.

[SD&TRD 3.7.2.2.B, 3.7.B.1][10 CFR 60.15(c)(2)]

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

[SD&TRD 3.7.2.2.C, 3.7.B.1][10 CFR 60.15(c)(3)]

- G. 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.

[SD&TRD 3.2.7.1.A.1, 3.2.7.1.A.3, 3.7.2.2.D, 3.7.B.1][10 CFR 60.15(c)(1), 60.15(c)(4)]

1. To the extent practicable, drilling with water into known large-aperture fractures shall be avoided.

[SD&TRD 3.2.7.1.A.1, 3.7.B.1][10 CFR 60.15(c)(1)]

H. Design of Seals for Shafts, Ramps and Boreholes

1. 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 objectives for the period following permanent closure.

[SD&TRD 3.7.B.2][10 CFR 60.134(a)]

2. Materials and placement methods for seals shall be selected to reduce, to the extent practicable, the potential for creating a preferential pathway for groundwater to contact the waste packages and/or for radionuclide migration through existing pathways.

[SD&TRD 3.7.B.2][10 CFR 60.134(b)]

3.2.2.1 EXPLORATORY STUDIES FACILITY SITE(S)

- A. Sites shall be surveyed and locations identified in sufficient detail for construction needs and to allow the conduct of an environmental analysis and assessment (archaeological, biological, radiological, and soil pre-activity surveys, etc.).

[SD&TRD 3.3.1.A][CRD 3.3.1.A]

- B. In accordance with 10 CFR 60.133(a)(2), ramp and ramp-portal and shaft and shaft-collar areas shall be located and/or graded to protect them, and to prevent water inflow to the underground facilities, from the probable maximum flood.

[SD&TRD 3.2.10.1.G.1, 3.7.B.1][10 CFR 60.133 (a)(2)]

- C. Sites shall be cleared of unusable roads, utilities, and structures that interfere with the ESF.

[SD&TRD 3.7.2.2.1]

- D. Roads, building sites, utility corridors, and storage areas for excavated rock shall be cleared, graded, and stabilized. Topsoil shall be stored in an environmentally acceptable manner (see ESFDR Appendix J).

[SD&TRD 3.7.D][10 CFR 960.3-4]

- E. New roads shall be constructed and existing roads shall be relocated or refurbished. Provisions for road access to the site shall be included, as required.

[SD&TRD 3.7.2.2.1]

- F. All storm water runoff shall be controlled in an environmentally acceptable manner (see ESFDR Appendix J).
[SD&TRD 3.3.11][NAC 445.070-.241][NRS 445.131-.399]
- G. Borrow areas shall be located as close to the ESF as practical.
[SD&TRD 3.7.2.2.1]
- H. The ground at each site shall be restored to a contour and revegetated compatible with its initial condition, as per ESFDR Appendix J. This restoration shall be done after site use is completed and all facilities have been removed.
[SD&TRD 3.7.D][10 CFR 960.3-4]
- I. In accordance with 10 CFR 60.133(f):
1. 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. Refer to ESFDR Appendix I, Analysis 5 for specific guidance.
[SD&TRD 3.2.7.1.B.5, 3.7.B.1][10 CFR 60.133]
 2. The ESF equipment, buildings, and foundations for structures shall be designed and constructed so that their excavation does not lead to creation of pathways that compromise the potential repository's capability to meet the performance objective of 10 CFR 60.112. [TBD]
[SD&TRD 3.2.7.1.B.5, 3.7.B.1][10 CFR 60.112, 60.133, 60.133(f)]
- J. In accordance with 10 CFR 60.15(c)(1):
1. The amount of water used in site preparation, construction and operations shall 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. Refer to ESFDR Appendix I, Analysis 1 for specific guidance.
[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1)]
 2. Surface sites shall be designed to avoid blockage of natural surface water drainage ways and to avoid creation of surface water impoundments that could impact postclosure performance.
[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1)]
 3. All surface-drilled exploratory boreholes associated with the ESF and located within the potential repository block, including multipurpose boreholes (MPBHs), if required, shall be drilled in compliance with SBTFRD requirements.
[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1)]
 4. If required, MPBHs drilled at the ESF site shall incorporate measures, as defined in the SBTFRD, to protect against the effects of maximum credible floods during

the period that MPBHs are accessible prior to borehole plugging and sealing. The location of the maximum credible flood in relation to MPBHs shall be determined by the DO. [TBV]

[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1)]

5. Excess water shall be removed. [TBD]

[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1)]

6. Management of water entering the ESF shall include quantity, location, and water balance inflow vs outflow.

[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1)]

7. Flood protection shall be utilized for appropriate surface facilities as applicable.

[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1)]

- K. Site preparation activities shall disturb only the amount of land necessary to support construction and operation.

[SD&TRD 3.7.D][10 CFR 960.3-4]

- L. RESERVED.

- M. Runoff and erosion during construction and operation and after decommissioning shall be controlled in accordance with applicable State of Nevada and local regulations (see ESFDR Appendix J).

[SD&TRD 3.7.D][10 CFR 960.3-4]

- N. Dust control shall be provided at potential dust-generation areas such as roads and earth-moving sites to minimize airborne particulates, as required by applicable federal, state, and local codes (see ESFDR Appendix J).

[SD&TRD 3.7.D][10 CFR 960.3-4]

- O. The site systems, subsystems, and components shall incorporate environmental impact considerations with respect to ground disturbance, dust control, etc.

[SD&TRD 3.7.D][10 CFR 960.3-4]

- P. The sites shall be sized and arranged to incorporate temporary facilities to support shaft and ramp construction.

[SD&TRD 3.7.2.2.1]

- Q. Rock excavated from the underground facilities shall be deposited at a location on the surface that is not visible from U.S. Highway 95.

[SD&TRD 3.7.2.2.1]

3.2.2.1.1 MAIN SITE(S)

- A. Analysis to determine which items should be included on the main site(s) shall consider the following:

1. Roads (muck haulage and access),
2. Shaft Access (plus standoff distances),

3. Ramp Access (plus standoff distances),
4. Permanent hoist house(s) (plus standoff distances),
5. Headframes and back legs and/or ramp construction facilities,
6. Muck-handling facilities,
7. Ventilation fans (plus standoff distances) as required,
8. Utilities (power, water, sewage, communications),
9. Access construction facilities,
10. Parking,
11. Communications/Data buildings (includes IDS),
12. MPBHs or surface-drilled exploratory boreholes,
13. Helicopter pad.

[SD&TRD 3.7.2.2.1]

- B. The layout of a main site shall facilitate the safe and efficient flow of material and personnel within working areas.

[SD&TRD 3.7.2.2.1]

- C. Buildings shall be spaced so as to allow sufficient room for construction and maintenance of the facilities.

[SD&TRD 3.7.2.2.1]

3.2.2.1.2 AUXILIARY SITE(S)

- A. Analysis to determine infrastructure on the auxiliary sites, shall include the following.

1. Construction Utilities:

- (a) Water
Piping
Water tanks
Booster station
Fire protection.
- (b) Power
Primary surface power
Secondary surface power
Substations(s)
Standby generators (including fuel tanks)
UPS.
- (c) Communications
Microwave support
Communications shelter
Telephone support.
- (d) Sewage.

- (e) Wastewater disposal.
- (f) Air compressor system.

[SD&TRD 3.7.2.2.1]

2. Construction surface storage:

- (a) Borrow material (fill)
- (b) Chemical and hazardous materials storage (if required)
- (c) Controlled material storage
- (d) Covered material storage
- (e) Explosives
- (f) Fuel and lubricants
- (g) Lay down areas
- (h) Muck and rock storage
- (i) Surface equipment
- (j) Surface transport vehicles.

[SD&TRD 3.7.2.2.1]

3. Construction support facilities:

- (a) Assembly yard
- (b) Batch plant
- (c) Shop(s)/warehouse
- (d) First aid station
- (e) Offices
- (f) Change house(s).

[SD&TRD 3.7.2.2.1]

4. Access to other facilities:

- (a) Roads.

[SD&TRD 3.7.2.2.1]

5. Site characterization surface storage:

- (a) Chemical and hazardous materials storage (if required)
- (b) Controlled material storage
- (c) Covered material storage
- (d) Sample storage provided by Sample Management Facility
- (e) Spare parts storage
- (f) Surface transport vehicles
- (g) Top soil storage.

[SD&TRD 3.7.2.2.1]

6. Site characterization support facilities:

- (a) Shop(s)/warehouse
- (b) First aid station
- (c) Offices

- (d) Change house(s)
- (e) Utilities.

[SD&TRD 3.7.2.2.1]

- B. All auxiliary sites shall be protected against the flood caused by a 100-year storm except as specified below:

[SD&TRD 3.2.10.1.F, 3.7.B.3][UCRL 15910]

1. Batch plant site, 10-year storm,
2. Booster pump building site, 50-year storm,
3. Compressor site, 50-year storm.

[SD&TRD 3.2.10.1.F, 3.7.B.3][UCRL 15910]

- C. The auxiliary site(s) shall facilitate the safe and efficient flow of material and personnel within and around their respective areas.

[SD&TRD 3.7.2.2.1]

- D. Surface explosives and cap storage magazines shall meet all requirements of 30 CFR 57, Subpart E; 29 CFR 1910.109; applicable state and local regulations; and DOE Orders 5480.4 and 6430.1A.

[SD&TRD 3.7.2.2.4.A, 3.7.B.3][29 USC 651 et seq][DOE Order 5480.4]

- E. The material-handling system(s) shall be capable of transporting and storing all excavated material in an environmentally acceptable manner (see ESFDR Appendix J).

[SD&TRD 3.7.D][10 CFR 960.3-4]

- F. The capacity of surface rock storage areas shall include allowance for overbreak and swell.

[SD&TRD 3.2.12][CRD 3.2.8]

- G. The muck storage site must provide equipment or facilities for dust control when muck storage begins.

[SD&TRD 3.7.D][10 CFR 960.3-4]

3.2.2.1.3 ACCESS ROADS

- A. Access roads shall meet the requirements of all anticipated service during the site characterization phase, including site security, safety, and anticipated loads during construction and operation.

[SD&TRD 3.7.2.2.1]

- B. The access roads shall include provisions for adequate drainage and flood control during inclement weather without sacrificing the structural integrity or safety of the road.

[SD&TRD 3.7.2.2.1]

- C. Existing roads shall be incorporated into the ESF if this incorporation can be shown to be cost effective and does not reduce the performance of the site or validity of the investigations.
[SD&TRD 3.7.2.2.1]
- D. Access roads used for hauling heavy loads shall be identified as such and shall be designed to not exceed alignment and grades that permit safe operation.
[SD&TRD 3.7.2.2.1]
- E. Access roads used by normal vehicle traffic to reach facilities and activity sites shall be identified as such and shall be designed to not exceed alignment and grades that permit safe operation.
[SD&TRD 3.7.2.2.1]
- F. Muck haulage in the vicinity of the main site shall be separated from personnel access for safety considerations.
[SD&TRD 3.7.2.2.1]
- G. The design for access roads shall include considerations to minimize dust and other environmental impacts.
[SD&TRD 3.7.D][10 CFR 960.3-4]
- H. Access to the USW G-4 borehole shall be preserved.
[SD&TRD 3.7.2.2.1]
- I. The access roads shall be designed to ensure and maintain proper provisions for drainage, including protection from runoff water.
[SD&TRD 3.7.D][10 CFR 960.3-4]
- J. Access roads on BLM and Air Force property shall comply with BLM requirements (BLM Manual Section 9113).
[SD&TRD 3.7.2.2.1, 3.7.B.3][BLM Vol. 34]

3.2.2.1.4 SITE DRAINAGE

In accordance with 10 CFR 60.122(c)(1), drainage shall be controlled to reduce the potential for flooding of the underground facility, whether resulting from the occupancy and modification of flood plains or from the failure of existing or planned man-made surface water impoundments.

[SD&TRD 3.7.D][10 CFR 60.122(c)(1)]

3.2.2.2 SURFACE UTILITIES

- A. Necessary utility services shall meet the requirements of ESF construction and operations.
[SD&TRD 3.7.2.2.2]
- B. A suitable system for treating, pumping, and disposing of credible water inflows into the ESF shall be provided.
[SD&TRD 3.7.2.2.2]

- C. When installed, surface utility systems shall not unnecessarily restrict foot, vehicular, or ramp portal and/or shaft collar traffic; obstruct ventilation; or cause health and safety concerns.
[SD&TRD 3.2.8.1.2, 3.7.2.2.2, 3.7.2.2.8.A, 3.7.B.3][29 CFR 1910; 29 CFR 1926]

- D. In accordance with 10 CFR 60.15(c)(1), the design, construction, and operation of the surface utilities, including wastewater ponds and the water-handling system, shall be specifically directed at limiting the potential for adverse impacts on the long-term performance of a potential repository, to the extent practicable. Refer to ESFDR Appendix I, Analysis 3 for specific guidance.
[SD&TRD 3.7.B.1, 3.7.E][10 CFR 60.15(c)(1)]

- E. Water storage tanks shall be located, or protection provided, to preclude water inflow to the ESF following a possible tank failure.
[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1)]

- F. Piping or other appropriate control measures shall limit possible water inflow to the ESF following a pipe rupture.
[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1)]

- G. In accordance with 10 CFR 60.15(c)(1), fluids recovered from sanitary uses or construction operations shall be disposed of in such a way as to avoid potential performance impacts. Refer to ESFDR Appendix I, Analysis 3 for specific guidance.
[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1)]

- H. Surface utilities shall be designed and constructed so that they do not affect the capability of the potential repository to meet the performance objective of 10 CFR 60.112.
[SD&TRD 3.7.B.1][10 CFR 60.112]

3.2.2.2.1 RESERVED

3.2.2.2.2 WATER SYSTEM

- A. The water supply, storage, and distribution systems, subsystems, and components shall have sufficient capacity to supply and distribute potable and nonpotable water in accordance with all anticipated needs and services for ESF construction, operation, and testing.
[SD&TRD 3.7.2.2.2]

- B. The water system shall supply water to the storage tank(s) in addition to services (tie-ins) to any suitable existing water main.
[SD&TRD 3.2.7.1.B.2.c, 3.7.2.2.2, 3.7.B.1][10 CFR 60.131(b)(3)]

- C. The water supply, storage, and distribution systems and subsystems shall meet the needs of fire protection during construction and operations under routine emergency and maximum credible firewater demand conditions.
[SD&TRD 3.7.2.2.2]

- D. A water tank shall have adequate volume for simultaneous normal peak usage and fire protection demands.
[SD&TRD 3.2.7.1.B.2.c, 3.7.B.1][10 CFR 60.131(b)(1), 60.131(b)(2), 60.131(b)(3)]
- E. The water system shall provide adequate resistance to water hammer and other destructive events as well as protective devices to prevent loss of water into the site.
[SD&TRD 3.2.7.1.B.2.c, 3.7.B.1][10 CFR 60.131(b)(1), 60.131(b)(2), 60.131(b)(3)]
- F. The potable water system shall provide water to the surface facilities and have adequate treatment systems to ensure that water quality is appropriate for its intended use.
[SD&TRD 3.7.2.2.2]
- G. The nonpotable water system shall provide water to the underground for construction, operation, and testing.
[SD&TRD 3.7.2.2.2]
- H. Protection shall be provided to ensure separation of potable and nonpotable water systems.
[SD&TRD 3.7.2.2.2]
- I. When practical, a single water storage and distribution system shall be employed for fire, industrial, and personnel needs.
[SD&TRD 3.7.2.2.2]
- J. The route of the water line shall be adequately marked to minimize the possibility of damage from future construction activities.
[SD&TRD 3.7.2.2.2]
- K. Nonpotable water lines shall be clearly marked to prevent consumption of the nonpotable water by personnel.
[SD&TRD 3.7.2.2.2]
- L. All water used during operation and construction of the ESF shall be provided with chemical tracers except for potable drinking water, water used for fill compaction and general surface construction, and water used for surface dust suppression. All tracers and substances added shall be approved, as specified in the Tracers, Fluids, and Materials Management Plan, YMP/91-23, to ensure that they will not significantly compromise site characterization testing, repository testing, or waste isolation.

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

[SD&TRD 3.7.2.2.2]

- M. The water systems and subsystems shall ensure that all of the water flows are measured to document total amounts of water used for various operations, and that addition of tracers can be accomplished, as required, for the site characterization testing.
[SD&TRD 3.7.2.2.2]
- N. Tracers added to the water system shall be of a composition and concentration such that potable water will not be contaminated.
[SD&TRD 3.7.2.2.2]
- O. Tracers added to the water system shall be of a composition and concentration compatible with the sanitary waste disposal system.
[SD&TRD 3.7.2.2.2]
- P. The water supply shall not detract from the performance of the site as described in 10 CFR 60.112.
[SD&TRD 3.7.B.1][10 CFR 60.112]

3.2.2.2.3 SANITARY SYSTEM

- A. Sewage effluent discharges shall not adversely affect site characterization activities.
[SD&TRD 3.7.D][10 CFR 960.3-4]
- B. The sanitary waste disposal system shall accommodate the sewage for ESF construction, operations and testing personnel.
[SD&TRD 3.7.D][10 CFR 960.3-4]
- C. Sanitary systems shall utilize an acceptable method of disposal (consistent with state or local codes) such as septic tanks or off-site disposal. Temporary and permanent systems shall comply with the appropriate sections of 29 CFR 1910 and 29 CFR 1926.
[SD&TRD 3.7.D, 3.7.B.3][10 CFR 960.3-4; 29 CFR 1910; 29 CFR 1926]
- D. Sanitary wastes shall be disposed of through collection piping from all buildings and trailers to a sanitary waste disposal system located beyond the perimeter of the potential repository subsurface facility. Refer to ESFDR Appendix I, Analysis 3 for specific guidance. The sanitary system shall not interfere with site characterization activities.
[SD&TRD 3.7.D][10 CFR 960.3-4]
- E. The sanitary system shall not detract from the ability of the site to meet performance objectives as stated in 10 CFR 60.112.
[SD&TRD 3.7.B.1][10 CFR 60.112]

3.2.2.2.4 RESERVED

3.2.2.2.5 SURFACE WASTEWATER SYSTEM

- A. A suitable surface wastewater system shall be provided for collection, transfer, pumping, treatment, and disposal of expected water and credible water inflows. The

underground wastewater collection system shall collect and pump all wastewater to the surface wastewater system, which shall receive underground wastewater and pump it off the potential repository block.

[SD&TRD 3.7.2.2.2]

- B. 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 or location. [TBD]

[SD&TRD 3.7.D][10 CFR 960.3-4]

- C. The surface wastewater collection system shall discharge to a wastewater pond consistent with location constraints. See ESFDR Appendix I, Analysis 3 for specific guidance. The surface wastewater system shall be designed, operated, and maintained in such a way as to prevent interference with the site characterization activities.

[SD&TRD 3.7.D][10 CFR 960.3-4]

- D. The surface wastewater system shall not detract from the ability of the site to meet the performance objectives as stated in 10 CFR 60.112.

[SD&TRD 3.7.B.1][10 CFR 60.112]

3.2.2.2.6 RESERVED

3.2.2.2.7 SOLID WASTE DISPOSAL SYSTEM

Provide for collection, transport, and disposal of nonhazardous solid waste in accordance with the requirements of ESFDR Appendix J.

[SD&TRD 3.7.2.2.2]

3.2.2.3 SURFACE FACILITIES

- A. Security facilities and equipment to protect the ESF in accordance with applicable DOE Orders shall be provided.

[SD&TRD 3.7.2.2.3.A]

- B. Surface explosive and cap storage magazines (if required) that meet the most stringent requirements of 27 CFR 55.201-211; 29 CFR 1910.109; 30 CFR 57, Subpart E; DOE Orders 5480.4 and 6430.1A; State of Nevada; and local regulations shall be provided.

[SD&TRD 3.7.2.2.4.A, 3.7.B.3][27 CFR 55][DOE Order 5480.4]

- C. Facilities for the storage of explosive materials shall be located in compliance with the regulations in 30 CFR 57, Subpart E and O; and 8 CCR 8400 et seq.

[SD&TRD 3.7.2.2.4.B, 3.7.B.3][27 CFR 55; 30 CFR 57, Subparts E, O][8 CCR 8400 et seq]

- D. Surface facilities and their locations shall facilitate the flow of material and personnel within the ESF site, and support adequate ESF site security, including controlled access and emergency response.

[SD&TRD 3.7.2.2.3.A]

- E. The facilities shall be complete with HVAC, compressed air, plumbing and sanitary facilities, power, lighting, communications, and fire protection systems as required for appropriate coverage.
[SD&TRD 3.7.2.2.3.A]
- F. Dust control/collection facilities at potential surface dust-generation areas, such as rock-handling transfer points (includes the muck storage pile) and processing areas, shall control airborne particulates as required by applicable federal, state, and local regulations.
[SD&TRD 3.3.11.A][CRD 3.3.11.A]
- G. Monitoring of the dust content in air at potential dust generating areas, such as rock-handling transfer points and processing areas, shall be conducted periodically.
[SD&TRD 3.3.11.A][CRD 3.3.11.A]
- H. Transportation facilities shall be of sufficient size to sustain ESF construction, operations, and testing.
[SD&TRD 3.7.2.2.3.A]
- I. To the extent practicable and economical, modular, relocatable, or portable structures shall be considered for surface facilities.
[SD&TRD 3.7.2.2.3.A]
- J. Structures exceeding 61 meters (200 feet) in height shall meet the safety provisions implemented under the Federal Aviation Act (49 USC 1501 et seq).
[SD&TRD 3.7.2.2.3.B, 3.7.B.3][49 USC 1501 et seq]
- K. The general layout of the surface facilities shall be designed to minimize environmental impacts to the site.
[SD&TRD 3.2.11, 3.3.11.A][CRD 3.2.7, 3.3.11.A]

3.2.2.3.1 RESERVED**3.2.2.3.2 TEST SUPPORT FACILITIES**

Provide the necessary areas where the test apparatus (for use in the ESF site characterization testing under the direction of the PIs) can be assembled, stored, repaired, tested, and disassembled. Refer to ESFDR Appendix B for specific guidance.
[SD&TRD 3.7.2.2.3.A]

3.2.2.3.3 SITE PREPARATION FOR SURFACE STRUCTURES

- A. Each site shall be furnished with available utility services appropriate to the structure. As a minimum, services included shall be power, water, fire protection, communications, sanitary waste, and parking allowances.
[SD&TRD 3.7.2.2.3.A]
- B. Provide water drainage at each site.
[SD&TRD 3.7.D][10 CFR 960.3-4]

3.2.2.3.4 PARKING AREAS

- A. As a minimum, the parking areas shall accommodate the following types of vehicles:
1. Automobiles,
 2. Vans,
 3. Buses,
 4. Haulage trucks,
 5. Tractor trailers (18 wheel and larger),
 6. Emergency vehicles (ambulance and underground rescue truck).
- [SD&TRD 3.7.2.2.3.A]
- B. Parking areas shall be sloped to allow water runoff control.
[SD&TRD 3.7.D][10 CFR 960.3-4]
- C. Parking area ease of access shall be ensured, while limiting the amount of surface area required.
[SD&TRD 3.7.2.2.3.A]
- D. All parking areas shall be located to ensure personnel safety and to prevent obstruction of the ESF construction and operational activities.
[SD&TRD 3.7.2.2.3.A]
- E. Dedicated parking for emergency vehicles shall be located such that the vehicles can be accessed quickly.
[SD&TRD 3.7.2.2.3.A]
- F. As a minimum, all parking areas shall utilize a compacted gravel base and surface.
[SD&TRD 3.7.2.2.3.A]
- G. Access to general parking areas from the working areas of the ESF, shall be controlled to prevent unauthorized removal of material and property.
[SD&TRD 3.7.2.2.3.A]

3.2.2.3.5 STORAGE FACILITIES

- A. Space and facilities shall be adequate to support the purchasing, storing, and equipment and materials dispensing functions, and shall be sized to accommodate the inventory needed for ESF operations and in situ site characterization. Storage facilities shall, as a minimum, accommodate the following:
1. General equipment,
 2. Pipe and pipe racks,
 3. Sheet steel and steel shapes,
 4. Lumber,
 5. Cement and admixtures,
 6. Coarse and fine aggregate,
 7. Reinforcing steel,
 8. Wire and cable reels,
 9. Compressed gas bottles,

- 10. Drilling rigs/construction equipment,
- 11. Heavy Construction Equipment.

[SD&TRD 3.7.2.2.3.A]

- B. The storage facilities shall provide adequate protection from the environment for designated stored equipment and supplies.

[SD&TRD 3.7.2.2.3.A]

- C. Provisions shall be made for the separate storage of private and DOE equipment.

[SD&TRD 3.7.2.2.3.A]

- D. Provisions shall be made for the separate storage of test equipment and construction/drilling equipment.

[SD&TRD 3.7.2.2.3.A]

3.2.2.3.6 RESERVED

3.2.2.3.7 RESERVED

3.2.2.3.8 RESERVED

3.2.2.3.9 COMMUNICATIONS/DATA BUILDING

Provision shall be made, adjacent to the communications building, for a microwave transmission tower.

[SD&TRD 3.7.2.2.9.A]

3.2.2.4 UNDERGROUND OPENINGS

- A. Unless the Nuclear Regulatory Commission (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.

[SD&TRD 3.7.B.1][10 CFR 60.15(b)]

- 1. Ramps shall provide access for site characterization activities to be performed at the planned waste emplacement horizon.

[SD&TRD 3.7.2.2.6]

- (a) Develop underground openings in welded high lithophysal/low lithophysal tuff for in situ site characterization construction, operations, and maintenance.

[SD&TRD 3.7.2.2.6]

- (b) The ESF MTL shall be constructed at the planned repository horizon, which is currently the TSw2 rock unit.

[SD&TRD 3.7.2.2.6]

- (c) Final selection of the horizon for the MTL shall be based on evaluation of stratigraphic information sources available before and during construction (e.g., from the geologic mapping of the ramp, and exploratory boreholes)

with respect to explicit horizon criteria. For initial design consideration, the MTL shall be located as identified in the RIB. [TBD]
[SD&TRD 3.7.2.2.6]

2. The ramp shall provide access into the CH unit without adversely affecting testing that may be ongoing. Such access shall consider aspects of underground utilities, ventilation, ground support, vehicular traffic, and muck handling.
[SD&TRD 3.7.2.2.6]
3. The underground design shall provide for drifts and rooms (alcoves) in the CH unit.
[SD&TRD 3.7.2.2.6]

B. The number of exploratory boreholes, underground excavations and accesses (shafts and ramps), shall be limited to the extent practical and consistent with obtaining the information needed for site characterization.
[SD&TRD 3.7.2.2.B, 3.7.B.1, 3.7.B.3][10 CFR 60.15(c)(2)][42 USC 10101 et seq]

1. The number of connections between the dedicated test area of the ESF and the potential repository shall be limited to as few as possible, consistent with access and ventilation needs.
[SD&TRD 3.7.B.1, 3.7.B.3][10 CFR 60.15(c)(2), 60.133(a)(1)][42 USC 10133(c)(1)]
2. The area of the ESF underground excavations shall be limited to that necessary for conducting the needed site characterization and performance confirmation tests.
[SD&TRD 3.7.2.2.B, 3.7.B.1][10 CFR 60.15(c)(2)]

C. Underground openings shall meet testing requirements.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

1. The testing requirements outlined in ESFDR Appendix B shall serve as the basis for test development.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]
2. Design and construction of the openings shall have the flexibility needed to ensure that the location, orientation, geometry, and configuration of each planned test can be modified, as necessary, to meet specific test location criteria, in response to and limited by actual site conditions encountered during construction.
[TBD]
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]
3. The configuration of openings shall be adequate to support present and (reasonably expected) future site characterization testing. This shall include an allowance to accommodate site specific conditions encountered without adversely affecting planned or ongoing testing.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

4. Underground design and construction shall provide for design and construction testing, performance confirmation testing, and in situ site characterization testing to the extent necessary [TBD].
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]
5. The upper demonstration breakout room (UDBR) shall be at an elevation [TBD].
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]
6. A station and test drifts shall be constructed as part of the selected ramp at the UDBR.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]
7. The shaft and ramp breakouts and the MTL 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 needed, in the dedicated test area; 3) allow development and testing in other areas as needed; and 4) limit interference between ESF construction and operation activities and testing activities.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]
8. Excavations shall provide for:
- access stations beyond initial breakout
 - muck storage
 - refuge chambers
 - power centers
 - shop and storage areas
 - fueling
 - sanitation
 - ventilation
 - utilities
 - drifts
 - test levels
 - test rooms and alcoves
 - communications
 - IDS
 - service
 - special functions, and other areas
- [SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]
9. Operations support areas shall include facilities for the administration and maintenance of ESF underground SSC, as well as space for underground testing equipment and instrumentation, equipment storage, power distribution, fuel storage and distribution, and lunch room.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]
10. Areas shall be provided for the storage of test equipment and of test support equipment such as forms, scaffolds, cable runs, support structures and utilities.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

11. The ramp roadway shall be designed to permit the inspection of ramp performance monitoring instrumentation, as well as inspection and maintenance activities.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

12. Routes for the material handling system shall be selected to avoid active test areas wherever possible.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

D. Underground construction and operations shall not adversely affect site characterization.
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]

1. RESERVED.

2. Probe or pilot holes shall be drilled, as appropriate, in advance of drifting to detect and control sudden water and/or gas intrusions into openings.
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]

3. Water intrusion, if any, into openings shall be monitored and controlled by suitable measures such that the effects of expected water inflows (i.e., water, heat, gases) will not endanger worker safety and in situ site characterization.
[TBD]
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]

4. Appropriate gravity drainage and/or pumping systems shall be incorporated for draining water away from testing and other work areas to suitable collection points for further treatment and/or disposal.
[SD&TRD 3.2.7.1.A.1, 3.7.B.1][10 CFR 60.15(c)(1)]

5. The amount of water used in construction and operations shall be limited to preclude interference with tests. Refer to ESFDR Appendix B and Appendix I, Analysis 2 for specific guidance.
[SD&TRD 3.2.7.1.A.1, 3.7.B.1][10 CFR 60.15(c)(1)]

6. Methods for dust control and cleaning of walls in the underground portion of the ESF shall be designed to limit adverse effects on the accuracy and reliability of information from site characterization.
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]

7. The use of blasting agents and explosives shall be controlled so that in situ site characterization is not adversely affected.
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]

8. The location of openings for rock handling shall be selected to minimize effects on testing.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

9. The openings required for handling excavated rock shall be of sufficient size to minimize interference of equipment movement with in situ site characterization.
[SD&TRD 3.7.B.1][10 CFR 60.133(e)(1)]

10. The ESF shall be designed so that ESF testing areas are separated from possible repository shop, training, operations, or waste emplacement areas, to limit adverse effects from activities in those areas on future testing, including performance confirmation in the main test area.
[SD&TRD 3.7.B.1][10 CFR 60.133(b)]

11. The openings required for rock handling and for support facilities (e.g., maintenance shops, electrical substations, pump stations, refuge chambers, lunch rooms, explosives magazines, and storage facilities for supplies and consumables) shall be located away from in situ site characterization testing to minimize interruptions.
[SD&TRD 3.2.7.3.B, 3.7.B.1][10 CFR 60.140(c)]

12. Openings for operating equipment shall be sized and equipment positioned to provide adequate clearance for maintenance, inspection, and repair or replacement of equipment.
[SD&TRD 3.2.9.3.C][CRD 3.2.5.5.B]

13. Underground maintenance facilities shall be designed and sized to maintain subsurface equipment, instrumentation, and systems.
[SD&TRD 3.7.2.2.6]

14. The maintenance areas/facilities shall be separated into a construction maintenance area and an underground test maintenance area.
[SD&TRD 3.7.2.2.6]

15. Test areas shall be separated so they are not affected by the excavation disturbed zone and any thermal, mechanical, chemical, and hydrological interactions. See ESFDR Appendix B for specifics.
[SD&TRD 3.7.2, 3.7.2.2.9.B, 3.7.2.2.9.C]
 - (a) The design layout shall consider the stand-off distance associated with each test described in ESFDR Appendix B. Stand-off distance surrounding each test is determined by the effects of zone(s) of influence (Table 3-4) associated with each test.
[SD&TRD 3.7.2, 3.7.2.2.9.C]

16. Instrumentation shall be protected from physical damage.
[SD&TRD 3.7.2.2.9.A]

Table 3-4 Categories of Effects Considered in Evaluating the Zone of Influence
for Each Site Characterization Test

ESFDR Section #	Test	Mechanical ¹	Thermal ²	Hydrologic ³	Chemical ⁴	No Effect ⁵
B.2.1	Chloride and Chlorine-36 Measurements of Percolation at Yucca Mountain					X
B.2.2	Matrix Hydrological Properties Testing					X
B.2.3	Intact-Fracture Test in the ESF	X				
B.2.4	Percolation Tests in the ESF	X		X		
B.2.5	Bulk Permeability Test in the ESF	X		X		
B.2.6	Radial Borehole Tests in the ESF			X		
B.2.7	Excavation Effects Test in the ESF					X
B.2.9	Perched-Water Test in the ESF					X
B.2.10	Hydrochemistry Test in the ESF					X
B.2.12	Hydrologic Properties of Faults Encountered in the ESF	X		X		
B.2.13	Diffusion Tests in the ESF				X	
B.2.14	Petrologic Stratigraphy of the Topopah Spring Member					X
B.2.15	Mineral Distributions Between Host Rock and Accessible Environment					X
B.2.16	Fracture Mineralogy					X
B.2.17	History of Mineralogic and Geochemical Alteration of Yucca Mountain					X
B.2.18	Biological Sorption and Transport					X
B.2.19	Field-Scale Experiments to Study Radionuclide Transport at Yucca Mountain	X		X		

Table 3-4 Categories of Effects Considered in Evaluating the Zone of Influence
for Each Site Characterization Test (continued)

ESFDR Section #	Test	Mechanical ¹	Thermal ²	Hydrologic ³	Chemical ⁴	No Effect ⁵
B.2.20	Underground Geologic Mapping					X
B.2.21	Seismic Tomography/Vertical Seismic Profiling at the ESF					X
B.2.22	Laboratory Tests (Thermal & Mechanical) using Samples Obtained from the ESF					X
B.2.23	Access Convergence Measurements	X				
B.2.24	Demonstration Breakout Rooms	X				
B.2.25	Sequential Drift Mining	X				
B.2.26	Heater Experiment in TS w1		X			
B.2.27	Canister-Scale Heater Experiment		X			
B.2.28	Heated Block Experiment	X	X			
B.2.29	Thermal Stress Tests	X	X			
B.2.30	Heated Room Experiment	X	X			
B.2.31	Plate Loading Tests	X				
B.2.32	Rock Mass Response Test	X				
B.2.33	Evaluation of Mining Methods					X
B.2.34	Monitoring of Ground Support Systems					X
B.2.35	Monitoring Drift Stability					X
B.2.36	Air Quality and Ventilation Experiment					X
B.2.37	Overcore Stress Experiments in the ESF					X
B.2.38	Development and Demonstration of Required Equipment					X

Table 3-4 Categories of Effects Considered in Evaluating the Zone of Influence
for Each Site Characterization Test (continued)

ESFDR Section #	Test	Mechanical ¹	Thermal ²	Hydrologic ³	Chemical ⁴	No Effect ⁵
B.2.39	In Situ Testing of Seal Components					X
B.2.40	Geomechanical Attributes of the Waste Package Environment	X	X	X	X	
B.2.41	Repository Horizon Near-Field Hydrologic Properties	X	X	X	X	
B.2.42	Repository Horizon Rock- Water Interaction	X	X	X	X	

1. Mechanical effects include stress alteration due to the drifting required for the test as well as to the test itself and to potential interferences from instrumentation arrangement. The effects do not explicitly include rock damage or stress alterations due to general construction in the ESF; these construction effects are considered in the discussions of constraints related to standoff from service drifts that provide access to the testing areas.
2. Thermal effects include coupled effects resulting from the addition of heat; e.g., vapor movement resulting from heating.
3. Hydrologic effects include only the effects from the fluids added to the formation by the test. Fluids used in construction are not included.
4. Chemical effects include only the effects from tracers in fluids or from chemicals used in construction.
5. If there are no areas indicated, no physical mechanism was identified that would cause additional perturbation to the natural condition (stress, temperature, moisture, etc.) from conducting this test. The test may be primarily observational or laboratory based with only sample collection activities in the underground excavations.

17. Location of accesses relative to each other shall be such that testing in any access will not be adversely affected by activities in others. Refer to ESFDR Appendix I, Analysis 2 for specific guidance.

[SD&TRD 3.2.7.3.B]

- (a) Twice the drift diameter shall be the minimum stand-off between drifts and between the ESF and the repository drifts to preclude interference due to mining [TBV].

[SD&TRD 3.7.2, 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

- E. Underground openings and operations shall meet personnel movement requirements.

[SD&TRD 3.7.2.2.6]

1. During ESF construction, temporary visitor facilities shall be provided as approved by the DOE. [TBD]

[SD&TRD 3.7.2.2.6]

2. During in situ site characterization testing, underground facilities shall be provided for at least 10 visitors at any one time. [TBV]

[SD&TRD 3.7.2.2.6]

- F. Underground openings shall meet equipment requirements.

[SD&TRD 3.7.2.2.6]

1. A ramp shall serve as the primary rock removal and construction support access.

[SD&TRD 3.7.2.2.6]

2. The ramp roadway shall be designed to sustain impact and heavy moving loads from equipment and material transport.

[SD&TRD 3.7.2.2.6]

3. The ramp and ramp roadway shall be provided with adequate width and clearance to permit the largest piece of equipment to be transported to and from the underground facility, and to minimize the interference with underground site characterization, to the extent practicable.

[SD&TRD 3.7.2.2.6]

4. The ramp and ramp roadway shall provide a slope suitable for excavation, safe vehicular traffic, and material-handling equipment requirements.

[SD&TRD 3.7.2.2.6]

- G. Underground openings shall meet utility requirements.

[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

- H. Underground openings shall meet ventilation requirements.

[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D][8 CCR 8400 et seq]

1. The size, shape, and construction of openings shall be adequate to supply and/or exhaust required volumes of air for underground construction, operations and

testing during normal and emergency conditions and shall minimize airborne dust during in situ site characterization.

[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D]
[8 CCR 8400 et seq]

2. Underground openings and their furnishings shall be designed to minimize air resistance to the extent practicable.
[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D]
[8 CCR 8400 et seq]
3. Underground openings shall be designed to handle required volumes of air [TBD] in order to cope with potential high temperatures from rock or waste-package simulation tests with heaters.
[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D]
[8 CCR 8400 et seq]
4. The ESF shall be designed so as not to preclude separate ventilation of potential repository excavation and waste emplacement in accordance with 10 CFR 60.133(g)(3).

[SD&TRD 3.7.B.1][10 CFR 60.133(g)(3)]

I. Underground openings shall meet safety requirements.

[SD&TRD 3.3.6.1.A, 3.7.2.2.6, 3.7.2.2.7.B, 3.7.B.3][29 USC 651 et seq]
[30 CFR 57, Subpart B][8 CCR 8400 et seq]

1. A ramp shall provide safe access between the ground surface and the underground to meet the needs of site characterization testing, emergency egress, ventilation intake and exhaust, major muck handling, fuel transfer, and primary transport of heavy equipment.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]
2. An optional shaft shall provide safe access between the ground surface and the underground portion of the ESF.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]
3. A ramp shall serve as emergency egress from the underground during ESF construction and underground testing and shall be capable of evacuating all underground personnel to safety within one hour.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]
4. The optional shaft shall connect to the MTL.
[SD&TRD 3.7.2.2.6]
5. Openings shall be excavated and supported using methods and materials based upon currently available construction technology for the dimension and depth under consideration. The need for a shaft and ramp lining shall be determined by a combination of analysis and observation during construction.
[SD&TRD 3.7.B.1][10 CFR 60.133(e)]

6. Accesses shall be separated to maintain reasonable distances for power and instrument cabling and water piping as well as to provide for redundancy in wastewater discharge.
[SD&TRD 3.7.2.2.6]
 7. The extent of drifting on the MTL and in the CH unit prior to connection of the accesses, shall be determined by a safety analysis.
[SD&TRD 3.7.2.2.6]
 8. The maintenance, refueling, and equipment storage areas shall be designed and located to minimize the fire and safety risks.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]
 9. A refuge chamber with sufficient capacity and facilities to accommodate personnel underground, and to meet all applicable MSHA requirements, shall be provided.
[SD&TRD 3.3.6.1.A, 3.7.B.3][30 CFR 57]
 10. Fuel storage areas shall comply with applicable federal, State of Nevada, and local requirements.
[SD&TRD 3.3.6.1.B][MGDS-RD 3.3.6.1.B]
 11. The stations shall be provided with landings complete with safety devices that shall include, as a minimum, signals; clear areas; barriers; and gates.
[SD&TRD 3.7.2.2.6]
- J. Shafts and ramps shall meet access requirements.
[SD&TRD 3.7.2.2.6]
1. Underground openings shall remain stable during operating and retrieval periods to meet personnel, equipment, and ventilation access requirements.
[SD&TRD 3.7.B.1][10 CFR 60.133(e)]
 2. Support facilities, utilities, and equipment shall accommodate the selected excavation method.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- K. Equipment shall meet construction needs.
[SD&TRD 3.3.1.B][CRD 3.3.1.B]
1. Surface rock and materials handling equipment and facilities shall meet required rates for excavation, rock removal, and backfilling of excavation; and the design of the facilities shall meet applicable requirements of DOE Orders 5480.4 and 6430.1A.
[SD&TRD 3.3.1.B, 3.7.B.3][CRD 3.3.1.B][DOE Order 5480.4]
 2. The excavation facilities and equipment required for handling excavated rock shall meet the needs of construction and testing activities and shall be capable of supporting the excavation allowances determined under Section 3.2.9.
[SD&TRD 3.3.1.B][CRD 3.3.1.B]

3. Excavated rock processing and storage capacity located underground prior to disposal shall be compatible with the required excavation and handling rates.
[SD&TRD 3.3.1.B][CRD 3.3.1.B]

4. In the event backfilling is required, underground handling capacity for processing, receiving, transporting, and, where necessary, emplacing backfill material, shall be adequate to handle these tasks.
[SD&TRD 3.3.1.B][CRD 3.3.1.B]

L. To the extent practical, shafts (and ramps) in the potential geologic repository operations area shall be located where shafts (and ramps) are planned for underground facility construction and operation, and exploratory boreholes shall be located where large unexcavated pillars are planned.
[SD&TRD 3.2.7.1.A.2, 3.7.B.1][10 CFR 60.15(c)(3)]

1. Ramps and shafts shall be located, to the extent practicable, where accesses are planned for the potential repository facility.
[SD&TRD 3.2.7.1.A.2, 3.7.B.1][10 CFR 60.15(c)(3)]

2. Borehole alignments and locations shall be monitored and surveyed, and the results included on all underground working maps.
[SD&TRD 3.2.7.1.A.2, 3.7.B.1][10 CFR 60.15(c)(3), 60.15(c)(4)]

3. The centerline coordinate location of the shaft shall be as listed in the RIB.
[TBD]
[SD&TRD 3.7.B.1][10 CFR 60.15(c)(4)]

4. The portal coordinate location of a ramp shall be as listed in the RIB. [TBD]
[SD&TRD 3.7.B.1][10 CFR 60.15(c)(4)]

5. The nominal finished inside dimension of accesses shall be as listed in the RIB.
[TBD]
[SD&TRD 3.7.B.1][10 CFR 60.15(c)(4)]

6. Exploratory boreholes drilled from the ground surface may intersect openings within the ESF main testing area which is defined in ESFDR Appendix A.2, subject to the following restrictions:
[SD&TRD 3.2.7.1.A.2, 3.7.B.1][10 CFR 60.15(c)(3)]

(a) The number of boreholes should be kept to the minimum required to perform the experiments needed.
[SD&TRD 3.2.7.1.A.2, 3.7.B.1][10 CFR 60.15(c)(3)]

(b) The location of any such boreholes must be identified by coordinates on the as-built maps of the ESF.
[SD&TRD 3.7.B.1][10 CFR 60.15(c)(4)]

7. Location of underground openings and exploratory boreholes shall be in coordination with the potential repository and surface-based test designs. In areas outside the ESF main test area, which is defined in ESFDR Appendix A.2,

no portion of any exploratory borehole drilled from the ground surface shall be located within 15 meters (49.2 feet) [TBV] of any underground opening. [TBV]
[SD&TRD 3.2.7.1.A.1, 3.7.B.1][10 CFR 60.15(c)(1)]

8. Horizontal boreholes, drilled from the MTL for installation of experiments or instrumentation systems that penetrate areas where waste could eventually be stored, shall not be permitted unless performance evaluations have been completed and approved indicating such holes shall be acceptable. Unless alternate constraints are approved, all such horizontal holes are subject to the following restrictions:

[SD&TRD 3.2.7.1.A.2, 3.7.B.1][10 CFR 60.15(c)(3)]

- (a) The holes shall be collared no less than 0.9 meters (3 feet) above the floor of the drift or alcove from which they are drilled.

[Derived][10 CFR 60.15(c)(3)]

- (b) The holes shall be biased upward from the collar sufficiently to assure that any liquid that may enter the hole will drain toward the hole collar.

[SD&TRD 3.2.7.1.A.2, 3.7.B.1][10 CFR 60.15(c)(3)]

- (c) All borehole alignments and locations shall be monitored, surveyed, and included on all underground as-built maps.

[SD&TRD 3.4.6.B, 3.7.B.1, 3.7.B.3][10 CFR 60.72][QARD]

9. MPBHs shall be located in unexcavated pillars, to the extent practicable.

[SD&TRD 3.2.7.1.A.2, 3.7.B.1][10 CFR 60.15(c)(3)]

10. Boreholes drilled from the MTL shall not penetrate significantly below the base of the TSw2 host rock, unless the impacts on the waste isolation performance of the site have been evaluated and found to be acceptable. [TBD]

[SD&TRD 3.2.7.1.A.2, 3.7.B.1][10 CFR 60.15(c)(3)]

- M. Subsurface exploratory drilling, excavation, and in situ testing before and during construction shall be planned and coordinated with potential geologic repository operations area design and construction.

[SD&TRD 3.2.7.1.A.3, 3.7.B.1][10 CFR 60.15(c)(4)]

1. The underground facility shall be located entirely 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.

[SD&TRD 3.2.7.1.A.3, 3.7.B.1][10 CFR 60.15(c)(4)]

2. The facilities constructed to support the experimental program on the MTL of the ESF, with the exception of the drifts driven laterally to investigate geological features, shall be within the boundary defined in ESFDR Appendix A.2. No drifting shall be closer than 23 meters (75 feet) from this boundary. Small-diameter boreholes are exempted, provided they meet the requirements pertaining to boreholes stated in this section. [TBV]

[SD&TRD 3.2.7.1.A.3, 3.7.B.1][10 CFR 60.15(c)(4)]

3. Openings, within the main test area as defined in ESFDR Appendix A.2, shall be maintained for future use during potential repository operation. (Future uses include utilization as waste emplacement support shops, ventilation airways, access to performance confirmation areas, etc.)
[SD&TRD 3.2.7.1.A.3, 3.7.B.1][10 CFR 60.15(c)(4)]
 4. Exploratory drifts outside the ESF main test area on the MTL shall be constructed such that they will not be precluded from use in a potential repository.
[SD&TRD 3.2.7.1.A.3, 3.7.B.1][10 CFR 60.15(c)(4)]
 5. The ESF shall be designed to be consistent with the potential repository design goal to limit the extraction ratio to less than 30 percent unless otherwise governed by test requirements. [TBV]
[SD&TRD 3.2.7.1.A.3, 3.7.B.1][10 CFR 60.15(c)(4)]
- N. 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.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(1)]
1. The MTL of the ESF shall be greater than 200 meters (656 feet) below the ground surface.
[Derived][10 CFR 960.4-2-5(d)]
 2. Adjacent ESF drifts shall be spaced no less than two drift diameters apart (using the maximum diameter of either opening and considering the closest proximity of any part of each opening) so as to obtain reliable and adequate information from site characterization, except where required otherwise by specific test requirements. Refer to ESFDR Appendix I, Analysis 2 for specific guidance.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(1), 60.133(e)(2)]
 3. The openings for handling muck shall be located and constructed to minimize effects on the integrity of any other openings.
[SD&TRD 3.7.B.1][10 CFR 60.133(e)(2)]
- O. The underground facility shall be designed so that the effects of credible disruptive events during the period of operations (e.g., flooding, fires and explosions) will not spread through the facility.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2)]
1. The ESF shall be designed so that the effects of credible disruptive events (e.g., flooding, fires, and explosions) shall not spread through the facility.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2)]

2. A shaft collar and ramp portal shall prevent significant water inflow from a flooding event during site characterization and the planned period of potential repository operation, such that testing in the underground portion of the ESF and waste emplacement are not adversely affected. Refer to ESFDR Appendix I, Analysis 4 for specific guidance.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2)]
3. The drainage plan for underground work shall: 1) be consistent with potential repository operations and postclosure sealing concerns; 2) be designed to control and limit the impact of a credible flood caused by construction and operations water on testing in the ESF; and 3) not impact the capability to characterize the site [TBD].
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2)]
- P. 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.
[SD&TRD 3.7.B.1][10 CFR 60.133(b)]
1. Methods shall be employed in advance of drifting, as appropriate, to detect and provide for control of possible anomalous geological conditions which may affect ESF development or ability to obtain data for site characterization. [TBV]
[SD&TRD 3.7.B.1][10 CFR 60.133(b)]
2. The ESF shall be designed so as not to interfere with the flexibility of the potential repository to accommodate specific site conditions.
[SD&TRD 3.7.B.1][10 CFR 60.133(b)]
- Q. The underground facility shall be designed to not preclude the retrieval of waste from the potential repository in accordance with 10 CFR 60.111.
[SD&TRD 3.7.B.1][10 CFR 60.111; 10 CFR 60.133(c)]
- R. Openings in the underground facility shall be designed so that operations can be carried out safely, and to not preclude the potential repository from maintaining the retrievability option.
[SD&TRD 3.7.B.1][10 CFR 60.133(e)(1)]
1. The characteristics of at least one ramp and the main drift on the MTL shall not preclude retrieval of waste canisters.
[SD&TRD 3.7.B.1][10 CFR 60.133(e)(1)]
- S. The design of the underground facility shall provide for control of water or gas intrusion.
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]
1. Facilities for plugging or grouting water inflow areas shall be available if water is known to exist in the vicinity of subsurface workings.
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]

2. The drainage plan for underground work shall be consistent with potential repository operations and postclosure sealing concerns; be designed to control and limit the impact of a credible flood caused by construction and operations water on testing in the ESF; and not impact the capability to characterize the site. Drainage shall be as defined in ESFDR Appendix A.2, and shall be compatible with potential repository grades. [TBD]
[SD&TRD 3.7.B.1][10 CFR 60.21(c)(11), 60.133(a)(1), 60.133(a)(2), 60.133(d)]
 3. The general drainage design for the main test area shall preclude water from the exploratory drifts or the ESF support area from flowing into the testing areas.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2), 60.133(d)]
 4. 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. Refer to ESFDR Appendix I, Analysis 2 for specific guidance.
[SD&TRD 3.2.7.1.B.5, 3.7.B.1][10 CFR 60.133(d)]
 5. Water use in construction shall be consistent with potential repository design goals to limit the increase in average percent saturation of the planned repository horizon to less than [TBD] percent, and to limit the increase in local percent saturation to less than [TBD] percent in waste emplacement areas. [TBD]
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]
 6. Management of water entering the ESF shall include quantity, location, and water balance (inflow versus outflow).
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]
 7. Operational seals shall be provided where necessary to control the intrusion of water into the facility. See ESFDR Appendix A.3 for additional information.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2), 60.133(d)]
 8. Methods to control sudden inflows of water shall be provided.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2), 60.133(d)]
- T. Openings in the underground facility shall be designed to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock that may create a pathway for radionuclide migration or that could impact the capability to adequately characterize the site.
[SD&TRD 3.7.B.1][10 CFR 60.133(e)(2)]
1. Underground excavated areas shall be designed for safe and maintainable ground support and control.
[SD&TRD 3.7.B.1][10 CFR 60.133(e)(1)]
 2. Facilities and equipment shall be available to deal effectively with subsurface ground control, including emergencies such as rock falls, rock bursts, and squeezing and swelling rock.
[SD&TRD 3.7.B.1][10 CFR 60.133(b), 60.133(e)(2)]

3. Underground structures shall withstand the effects of seismic events. Seismic criteria to be used in design are contained in ESFDR Appendix A.5. Additional information may be found in the RIB.
[SD&TRD 3.7.B.1][10 CFR 60.131(b)(1)]
 4. The MTL of the ESF shall limit overall response to excavation, including rock fall, considering all planned drifts and future drifting that may be constructed in the main test area, and consistent with obtaining adequate and reliable information from site characterization.
[SD&TRD 3.7.B.1][10 CFR 60.133(e)(2)]
 5. An adequate distance shall be provided between openings and accesses to limit potential mechanical and hydrological interference between the accesses, and to reduce the potential for deleterious rock movement so that the capability to reliably and adequately characterize the site is not impacted. Refer to ESFDR Appendix I, Analysis 2 for specific guidance.
[SD&TRD 3.7.B.1][10 CFR 60.133(e)]
 6. Underground openings and their supports in the ESF shall utilize pillar and opening geometries that limit stress concentration and changes in rock mass permeability and deformability to levels consistent with acquiring adequate and reliable information from site characterization.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)]
- U. 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.
[SD&TRD 3.7.B.1][10 CFR 60.133(f)]
1. Techniques used for excavation shall control overbreak of rock and minimize the disturbance to the integrity of adjoining rock mass while limiting blast-induced changes to permeability.
[SD&TRD 3.7.B.1][10 CFR 60.133(f)]
 2. Limitations on blast-induced changes and excavation overbreak are as follows. (These limitations are design goals which may be changed based on results of site characterization or future analyses.)
[SD&TRD 3.7.B.1][10 CFR 60.133(f)]
 - (a) Blast-induced changes to the average in situ permeability of the rock beyond one-half of the maximum opening dimension shall be less than one order of magnitude. Refer to ESFDR Appendix I, Analysis 5 for specific guidance.
[SD&TRD 3.7.B.1][10 CFR 60.133(f)]

- (b) Excavation overbreak is to average less than 30 centimeters (12 inches) with a maximum of [TBD]. This overbreak limit is in addition to the dimensional tolerances applied to the location and runout of the drill holes used for excavation explosives. This limit may be exceeded for short intervals where blast designs are being adjusted. [TBV]
[SD&TRD 3.7.B.1][10 CFR 60.133(f)]
3. Mechanical excavation methods using machines that break the rock with disc cutters or picks (e.g., tunnel boring machines, roadheaders, or variations of these machines), shall be used when feasible and practical. ESF ramps shall be constructed using a tunnel boring machine.
[SD&TRD 3.7.B.1][10 CFR 60.133(f)]
4. The construction of ramp stations, test alcoves, and other short drifts and secondary excavations in the ESF facility may not be amenable to use of mechanical excavation methods. Drill-and-blast excavation may be used in such circumstances if it is determined to be more effective (maneuverability, flexibility, schedule, or cost), and provided that pressurized drill water usage and the chemical byproducts of blasting do not disturb site characteristics related to waste isolation. Drill-and-blast excavation shall:
- (a) Limit the disturbance of the surrounding rock mass;
[SD&TRD 3.7.B.1][10 CFR 60.133(f)]
- (b) Provide fragmentation of tuff into sizes compatible with removal equipment;
[SD&TRD 3.7.B.1][10 CFR 60.133(f)]
- (c) Provide flexibility to compensate for changes in the lithophysal content of the tuff and in local joint patterns.
[SD&TRD 3.7.B.1][10 CFR 60.133(b), 60.133(f)]
5. If drill-and-blast construction techniques are used, controlled blasting shall be utilized to limit overbreak and damage to the surrounding rock mass, which could affect the adequacy or reliability of information from site characterization. Methods shall be designed to provide specific site characterization test requirements (e.g., limitations on the extent of excavation-induced damage, or the type of ground support that may be installed), and to facilitate investigation and monitoring of excavation effects during and after construction. Refer to ESFDR Appendix I, Analysis 5 for specific guidance.
[SD&TRD 3.7.B.1][10 CFR 60.133(f)]
6. The following are design goals relating to stability of underground openings. These design goals may be modified pending information obtained during site characterization or from future analyses:
[SD&TRD 3.7.B.1][10 CFR 60.133(e)]
- (a) In areas not affected by thermal load, diametrical closure rate should decrease at all times after construction activities in the vicinity have ceased.
[TBD]
[SD&TRD 3.7.B.1][10 CFR 60.133(e)]

(b) In areas affected by thermal load, the closure rate shall not preclude the opening from being stable, safe and usable. [TBD]
 [SD&TRD 3.7.B.1][10 CFR 60.133(e), 60.133(i)]

(c) In all accesses, not lined with concrete, rockfalls should be no greater than a size of [TBD].
 [SD&TRD 3.7.B.1][10 CFR 60.133(e)]

(d) Access shall be maintainable. [TBD]
 [SD&TRD 3.7.B.1][10 CFR 60.133(e)]

V. The underground facility shall be designed so that performance objectives will be met taking into account the predicted thermal and thermomechanical response of the host rock, surrounding strata, and groundwater system.
 [SD&TRD 3.7.B.1][10 CFR 60.133(i)]

1. Openings shall be designed considering the predicted thermal and thermomechanical response of the host rock, surrounding strata, and groundwater system to meet the performance objectives of the potential repository. Refer to ESFDR Appendix I, Analysis 6 for specific guidance.
 [TBD]
 [SD&TRD 3.7.B.1][10 CFR 60.133(i)]

2. The predicted loads imposed on openings by heating of the repository waste disposal formation, are defined in ESFDR Appendix A.4. These loads shall be considered in the analyses performed to predict the long-term response of the openings.
 [SD&TRD 3.7.B.1][10 CFR 60.133(i)]

3. Linings and excavation support systems shall withstand loads exerted along their length and around the entire perimeter under anticipated conditions, including reaction to thermally-induced stresses resulting from thermal loads. Refer to ESFDR Appendix I, Analysis 7 for specific guidance. The provisions for thermally-induced stresses can be installed at a later date. [TBD]
 [SD&TRD 3.7.B.1][10 CFR 60.133(i)]

4. The ESF shall be designed such that the thermal and thermomechanical effects of ESF operations and testing do not produce gross failure of intact rock, nor gross rock mass failure, along potential pathways from the potential repository to the accessible environment and do not significantly increase the saturation of the host rock in the waste emplacement area. [TBD]
 [SD&TRD 3.7.B.1][10 CFR 60.133(i)]

5. 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 Topopah Spring Welded Unit 3 (TSw3) or Calico Hills non-welded (CHn) units, compatible with the performance measure for the potential repository listed in the SD&TRD. Refer to ESFDR Appendix I, Analysis 8 for specific guidance.
 [SD&TRD 3.7.B.1][10 CFR 60.133(i)]

- W. Seals for shafts, 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 objectives of the period following permanent closure.
[SD&TRD 3.7.B.2][10 CFR 60.134(a)]
- X. Materials and placement methods for seals shall be selected to reduce, to the extent practicable, the potential for creating a preferential pathway for groundwater to contact the waste packages, or for radionuclide migration through existing pathways.
[SD&TRD 3.7.B.2][10 CFR 60.134(b)]
1. Design and construction shall allow for future sealing to ensure that an opening does not become a preferential pathway for groundwater or radioactive waste migration, and will meet the performance objectives as stated in 10 CFR 60.112. In addition, techniques used to seal aquifers during construction should not preclude the use, or reduce the effectiveness, of future access seals. [TBD]
[SD&TRD 3.7.B.1, 3.7.B.2][10 CFR 60.112, 60.134(a), 60.134(b)]
 2. Design and materials used in construction (e.g., epoxies and lean grouts which need to be evaluated prior to use) shall not significantly interfere with or prevent the eventual installation of the features required to effect postclosure sealing of a potential repository. To prevent complications of seal evaluations and emplacement, and to limit chemical alteration in future seal environments, no pressure grouting shall take place during or after the construction period at locations of potential seal testing or emplacement. Specifically, no pressure grouting shall be performed in the following locations:
[SD&TRD 3.7.B.2][10 CFR 60.134(a), 60.134(b)]
 - (a) Immediately below the shaft collar and ramp portal structures in the area where an anchor to bedrock seal is planned to be installed at the time of closure. [TBD]
[SD&TRD 3.7.B.2][10 CFR 60.134(a), 60.134(b)]
 - (b) At the interface between the nonwelded tuff and the Topopah Spring tuff. [TBD]
[SD&TRD 3.7.B.2][10 CFR 60.134(a), 60.134(b)]
 - (c) In the extension of the shaft or ramps below the main ESF test level. [TBD]
[SD&TRD 3.7.B.2][10 CFR 60.134(a), 60.134(b)]
 - (d) Within 15 meters (50 feet) of the boundary of the ESF main test area. [TBV]
[SD&TRD 3.7.B.2][10 CFR 60.134(a), 60.134(b)]
 - (e) Within fault zones.
[SD&TRD 3.7.B.2][10 CFR 60.134(a), 60.134(b)]

Note: The above limitations are not intended to restrict the locations of the radial borehole tests.

3. Materials and placement methods for shaft, ramp and borehole seals shall be selected to reduce, to the extent practicable, the potential for creating preferential pathways for groundwater to contact the waste packages, and to reduce radionuclide migration through existing pathways. [TBD]
[SD&TRD 3.7.B.2][10 CFR 60.134(a), 60.134(b)]
4. Any fill or other construction materials used in the floors of the drifts within the ESF in areas that may adversely impact implementation of postclosure sealing, shall be removable.
[SD&TRD 3.7.B.2][10 CFR 60.134(a), 60.134(b)]
5. Operational seals shall be provided where necessary to control the spread of water through the facility.
[SD&TRD 3.7.B.1, 3.7.B.2][10 CFR 60.133(d), 60.134(b)]
6. The ESF operational seals shall be designed, consistent with other goals of site characterization, to limit impacts on waste isolation. If the seals are determined to be important to waste isolation, a comparative evaluation of alternatives shall be performed.
[SD&TRD 3.2.7.1.A.1, 3.7.B.1, 3.7.2.2.A][10 CFR 60.15(c)(1)]

3.2.2.4.1 COLLAR AND PORTAL

- A. The collar shall provide support for the headframe and hoisting system over the entire range of hoisting system functions, operations, and requirements.
[SD&TRD 3.7.2.2.6, 3.7.2.2.7.B, 3.7.B.3][30 CFR 57, Subpart B][8 CCR 8400 et seq]
- B. The collar shall provide support for shaft construction equipment and construction stages over the range of conditions encountered during construction.
[SD&TRD 3.7.2.2.6, 3.7.2.2.7.B, 3.7.B.3][30 CFR 57, Subpart B][8 CCR 8400 et seq]
- C. The portal shall provide access and protection for the material handling system and equipment over the entire range of the handling system functions, operations, and requirements.
[SD&TRD 3.7.2.2.6, 3.7.2.2.7.B, 3.7.B.3][30 CFR 57, Subpart B][8 CCR 8400 et seq]
- D. The surface elevation at shaft collars and ramp portals shall be above the high-water mark of the probable maximum flood, as defined in the RIB. [TBD]
[SD&TRD 3.2.10.1.G][Executive Order 11988, Section 2(b)]
- E. Shaft collars and ramp portals shall be founded in rock.
[SD&TRD 3.7.2.2.6, 3.7.2.2.7.B, 3.7.B.3][30 CFR 57, Subpart B][8 CCR 8400 et seq]

3.2.2.4.2 LINING

- A. All concrete activities shall conform to the applicable ACI standards for furnishing, delivery, and placement of structural concrete.
[SD&TRD 3.7.B.3][ACI 318, 349]

- B. All forming and reinforcements utilized shall conform to applicable ACI and American Society for Testing and Materials standards. Refer to Section 2 and Appendix E for additional information.
[SD&TRD 3.7.B.3][ACI 318, 349]
- C. Linings shall be protected from damage due to blasting and other activities. To protect the shaft lining from blasting damage, the minimum distance between the shaft bottom and the lining shall be determined by the contractor with concurrence from the DO and the YMPO.
[SD&TRD 3.7.2.2.6]
- D. The lining placement shall be coordinated with scientific needs such as testing and mapping.
[SD&TRD 3.7.2.2.6]
- E. The capability to enhance postclosure performance by removing linings shall be retained.
[SD&TRD 3.7.2.2.11]

3.2.2.4.3 STATIONS

- A. The shaft stations shall allow sufficient room for unloading of personnel and materials.
[SD&TRD 3.7.2.2.6][8 CCR 8400 et seq]
- B. The shaft stations shall accommodate devices (e.g., forklift) for handling heavy and large materials.
[SD&TRD 3.7.2.2.6][8 CCR 8400 et seq]
- C. The design of the stations shall ensure unobstructed access to both sides of the shaft conveyance, complete with a protected walkway.
[SD&TRD 3.7.2.2.6][8 CCR 8400 et seq]
- D. The stations shall be provided with landings complete with safety devices that shall include, as a minimum, signals; clear areas; barriers; and gates.
[SD&TRD 3.3.6.1.B, 3.7.2.2.6, 3.7.B.3][29 CFR 1910; 29 CFR 1926; 30 CFR 57]
[8 CCR 8400 et seq]
- E. The stations shall ensure appropriate transition of utilities through the shaft stations to the continuation of the shaft below, as required.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- F. Stations shall ensure, if applicable, an adequate means of handling excavated rock.
[SD&TRD 3.7.2.2.6]
- G. Stations shall ensure adequate unobstructed room for ventilation air flow.
[SD&TRD 3.7.B.1][10 CFR 60.133(g)]
- H. The design of the shaft stations shall consider the physical characteristics of the material and equipment.
[SD&TRD 3.7.2.2.6]

- I. If an optional shaft is constructed, a shaft station shall be developed at the MTL.
[SD&TRD 3.7.2.2.6]

3.2.2.4.4 FURNISHINGS

- A. Brackets shall provide adequate support and isolation for all cables and other devices.
[SD&TRD 3.7.2.2.6]
- B. Furnishings shall be capable of being removed prior to permanent closure.
[SD&TRD 3.7.2.2.6]
- C. Furnishings shall be removable in a manner that will not restrict potential repository ventilation flow.
[SD&TRD 3.7.B.1][10 CFR 60.133(g)]

3.2.2.4.5 RESERVED

3.2.2.4.6 SUMP

- A. The size and depth of the shaft sump shall be sufficient to accommodate the required operation of the shaft equipment.
[SD&TRD 3.7.2.2.6]
- B. Provisions shall be made for cleaning the sumps.
[SD&TRD 3.7.2.2.6]
- C. The sumps shall be designed to prevent exfiltration.
[SD&TRD 3.7.2.2.6]
- D. The shaft sump shall not penetrate the CH unit unless authorization to do so is given by the YMPO.
[SD&TRD 3.7.2.2.6]

3.2.2.5 UNDERGROUND SUPPORT SYSTEMS

- A. The underground transport facilities shall be sufficiently sized to sustain construction, operations, and testing.
[SD&TRD 3.7.2.2.6]
- B. The transport system(s) shall have appropriate safety features, as required by analysis and applicable federal, State of Nevada, and local regulations.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]
- C. 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.
[SD&TRD 3.7.B.1][10 CFR 60.133(b)]

1. The underground utilities for the ESF shall not preclude monitoring and investigation of in situ conditions, and shall accommodate site-specific conditions, construction, and operation of the ESF.
[SD&TRD 3.7.B.1][10 CFR 60.133(b)]

- D. The design of the underground facility shall provide for control of water or gas intrusion.
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]

1. Appropriate gravity drainage and/or pumping systems shall be incorporated into the shaft, ramp, and underground facilities for draining water away from testing and other work areas, to suitable collection points for further treatment and/or disposal.
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]

2. Structures, systems, and components shall be provided for effective water and ground control.
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]

- E. Piping shall be designed to preclude or limit water inflow into the ESF following a pipe rupture.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2)]

- F. All joints in fluid-carrying columns shall be sealed and proof-tested.
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]

- G. Fluid-carrying piping shall be designed to prevent damage caused by water hammer.
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]

3.2.2.5.1 RESERVED

3.2.2.5.2 RESERVED

3.2.2.5.3 RESERVED

3.2.2.5.4 RESERVED

3.2.2.5.5 WATER DISTRIBUTION SYSTEM

- A. The water distribution system shall be of sufficient size and capacity to simultaneously provide for fire protection and process water throughout the ESF, in accordance with all anticipated needs and services for construction, testing, and operation of the ESF; and to preclude adverse effects on in situ site characterization testing or the ability of the site to meet performance objectives as stated in 10 CFR 60.112.
[SD&TRD 3.2.10.2.1.B, 3.7.2.2.A, 3.7.2.2.8, 3.7.B.1, 3.7.B.3, 3.7.E][10 CFR 60.15(c)(1); 10 CFR 60.112; 10 CFR 60.133(a)(2); 30 CFR 57]

- B. All water used underground during operation and construction of the ESF shall be provided with chemical tracers as required by testing.
[SD&TRD 3.7.B.1][10 CFR 60.112]

3.2.2.5.6 UNDERGROUND WASTEWATER COLLECTION SYSTEM

- A. The underground wastewater collection system shall provide for control, handling, collection, treatment (as required), and transfer of wastewater and groundwater inflow to the surface wastewater system.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- B. Gravity drainage, storage, and pumping systems, with adequate capacity and control measures, shall be designed and constructed for the control and transfer of underground water to the surface to ensure worker protection and to preclude adverse effects on in situ site characterization testing, or the ability of the site to meet performance objectives as stated in 10 CFR 60.112.
[SD&TRD 3.2.10.2.1.B, 3.7.2.2.A, 3.7.B.1, 3.7.B.3][10 CFR 60.15(c)(1); 10 CFR 60.112; 30 CFR 57]
1. Underground water handling and control, including pumping systems, 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.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
 2. Piping shall be provided to carry water from underground pump station(s) to the surface.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
 3. The underground wastewater collection system shall have full operating redundancy or shall have storage capacity to allow installation of spares in order to limit possible impacts on the isolation capability of the site.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- C. The underground wastewater collection system shall control standing water to reduce air/water contact surfaces where ventilation air will be flowing in order to control humidity in air and to maintain the quality of the ventilation air being supplied.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- D. The underground wastewater collection system shall utilize construction materials that are resistant to erosive and corrosive effects, if economically practicable; otherwise, suitable monitoring and treatment facilities for credible groundwater inflows shall be available to control possible contamination and to prevent damage to pumping/piping systems from erosion or corrosion by waterborne particulates.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- E. Fluids recovered during construction operations shall be disposed of in such a way as to avoid potential for performance impacts as stated in 10 CFR 60.112.
[SD&TRD 3.7.B.1][10 CFR 60.112]
- F. The drainage and pumping systems shall provide for measurement of the water as required.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

3.2.2.5.7 RESERVED**3.2.2.5.8 FIRE PROTECTION SYSTEM**

- A. The underground portion of the ESF shall incorporate a fire protection system to detect, warn, control and limit the impact of credible fires in the ESF. [TBV]
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2)]
- B. The fire suppression system shall be capable of operating automatically and/or manually.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2)]
- C. Portable extinguishers shall be located in the subsurface areas.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2)]
- D. Fire suppression agents shall be selected for compatibility with intended use. These agents shall be approved for use based on their impacts on underground safety (i.e., they do not produce adverse geochemical effects), the in situ site characterization testing program, and performance objectives as stated in 10 CFR 60.112. [TBD]
[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1), 60.112]
1. Water shall be used as the fire suppressing agent only after detailed analysis has been made of its effects on overall site characterization and individual testing activities.
[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1), 60.133(a)(2)]
- E. As a minimum, fire hose outlets shall be located at all shaft and/or ramp stations.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2)]
- F. A fire protection system shall be provided for the subsurface data building and IDS facility.
[SD&TRD 3.7.B.1][10 CFR 60.133(a)(2)]
- G. All fire protection systems shall meet applicable requirements of 29 CFR 1910, 29 CFR 1926, 30 CFR 57 and 8 CCR 8400 et seq.
[SD&TRD 3.3.6.2.E.2, 3.7.B.3][29 CFR 1910; 29 CFR 1926; 30 CFR 57][8 CCR 8400 et seq]

3.2.2.5.9 MUCK AND MATERIAL HANDLING SYSTEMS

- A. The muck handling system shall provide for collecting excavated rock at the shaft or ramp station, surge capacity, measuring, and loading the rock for conveyance.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- B. Muck and material handling systems shall be sized and designed for ESF construction and underground site characterization needs and shall minimize the spillage of excavated rock during handling. These systems shall provide capabilities for gathering and removing spillage.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

- C. Sufficient flexibility and redundancy for sustaining production shall be built into the muck handling system to cope with problems/breakdowns (e.g., equipment failure, material handling problems, etc.) in the underground development and operations activities.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- D. The conveyers and/or transport system shall incorporate fail-safe devices and be designed with adequate safety factors as per applicable requirements of 30 CFR 57, and State of Nevada and local regulations.
[SD&TRD 3.3.6.1.A, 3.7.B.3][30 CFR 57]
- E. The muck and material handling systems shall be designed, installed, tested, operated, and maintained in conformance with applicable regulations.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- F. If a repository is to be constructed, the muck and material handling systems shall be maintained to support initial construction of this potential repository until these can be replaced by the potential repository facilities.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

3.2.2.5.10 SANITARY FACILITIES

- A. Dry chemical, self-contained portable type toilets shall be provided underground to accommodate the collection of wastes from a maximum occupancy per shift.
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
- B. Toilet facilities shall be located at convenient, noninterfering locations relative to operations, site characterization testing, and monitoring.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- C. Underground sanitary waste shall be disposed of through the surface sanitary system provided in 3.2.1.2.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

3.2.2.6 TEST SUPPORT

- A. Experiments, tests, equipment, and monitoring and control systems shall be secure from unauthorized access.
[SD&TRD 3.7.2.2.9.A]
- B. Tests shall be located within the facility to ensure that thermal, mechanical, chemical and hydrological interactions will not endanger the structural stability of the ESF or adversely affect tests conducted in adjacent areas within the ESF. Refer to ESFDR Appendix B for further information.
[SD&TRD 3.7.2.2.D, 3.7.B.1][10 CFR 60.15(c)(4)]
- C. Instrumentation design; testing layout; and ventilation, personnel, and utility requirements shall be based on tests prioritization (sequence and schedule) by DOE.
[SD&TRD 3.2.7.3.B, 3.7.B.1][10 CFR 60.140(c)]

- D. Large scale testing in the main test area shall not be allowed, and the number of scientific personnel shall be limited, until two routes of egress or safe means of evacuation are available. [TBV]
[SD&TRD 3.3.6.1.B, 3.3.6.2.E.2, 3.7.B.3][30 CFR 57.11050]
 - 1. Tests or parts of tests which can be initiated prior to availability of the two routes of egress, shall be determined on the basis of the information contained in ESFDR Appendix B.
[SD&TRD 3.2.7.3.D, 3.7.B.1][10 CFR 60.142(b)]

- E. The design of the underground facility shall provide for control of water or gas intrusion.
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]
 - 1. The amount of water used in testing and operations shall be limited so as to lessen the effects on the containment and isolation capability of the site. [TBD]
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]
 - 2. Water use in testing shall be consistent with repository design goals to limit the increase in average percent saturation of the potential repository horizon to [TBD] percent, and to limit increase in the local percent saturation to [TBD] percent in areas of waste emplacement. [TBD]
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]
 - 3. MPBHs or other surface-drilled exploratory boreholes associated with the ESF shall be drilled dry.
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]
 - 4. Fluids recovered during testing operations shall be disposed of in such a way as to avoid potential for performance impacts.
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]
 - 5. Excess water shall be removed. [TBD]
[SD&TRD 3.7.B.1][10 CFR 60.133(d)]
 - 6. Any cleaning of ESF walls to facilitate photogrammetry, mapping, or other testing shall be done using compressed air/mist and control procedures to limit water saturation.
[SD&TRD 3.7.B.1][10 CFR 60.15(c)(1), 60.133(d)]

3.2.2.7 EXPLORATORY STUDIES FACILITY DECOMMISSIONING AND CLOSURE

3.2.2.7.1 SURFACE FACILITIES

- A. Near-term decommissioning of the surface facilities shall place the facilities in a permanently nonoperable and safe condition.
[SD&TRD 3.7.2.2.11]

- B. Permanent decommissioning of the surface facilities shall restore the ESF site and the immediate surrounding areas so they are compatible with their initial condition.
[SD&TRD 3.7.2.2.11]
- C. Portable and prefabricated buildings shall be emptied of their contents, dismantled, and removed from the site.
[SD&TRD 3.7.2.2.11]
- D. Systems and subsystems such as the hoist equipment (including the headframes), electric generators, electrical and water distribution systems, ventilation equipment, meteorological towers, and communications equipment, shall be dismantled and removed from the site.
[SD&TRD 3.7.2.2.11]
- E. Buried water, electrical, and sewage lines may be disconnected below the surface and left in the ground.
[SD&TRD 3.7.2.2.11]

3.2.2.7.2 ACCESS AND UNDERGROUND FACILITIES

- A. Near-term decommissioning of the ESF accesses and underground excavations shall place the facilities, systems, and subsystems in a permanently nonoperable and safe condition.
[SD&TRD 3.7.2.2.11]
- B. Facilities shall be removed by the most practical and cost-effective methods:
[SD&TRD 3.7.2.2.11]
 - 1. Horizontal and vertical drillholes extending from the ESF accesses and rooms shall be sealed.
[SD&TRD 3.7.2.2.11]
 - 2. Subsurface accesses, drifts, and rooms shall be backfilled with the material that was removed during excavation and/or with other suitable engineered material.
[SD&TRD 3.7.2.2.11]
 - 3. Equipment and structures shall be removed from ESF accesses.
[SD&TRD 3.7.2.2.11]
 - 4. ESF access liners may be left in place.
[SD&TRD 3.7.2.2.11]

3.2.3 ARCHITECTURAL

3.2.3.1 RESERVED

3.2.3.2 RESERVED

3.2.3.3 SURFACE FACILITIES

- A. Surface facilities shall be provided to support the following:
1. Administration,
 2. Operations and engineering staff,
 3. Training/Underground safety,
 4. Visitors,
 5. Environmental monitoring, health and safety,
 6. Security,
 7. Storage/warehouse,
 8. Shop/maintenance,
 9. Fire/emergency (and associated vehicles),
 10. Change room,
 11. Laboratory (as required),
 12. Sleeping quarters (as required),
 13. Mine ventilation fans, filters, cooling, and enclosures (as required),
 14. Compressed air,
 15. Computer control system/Data collection systems.
 16. Drill pads and mud ponds (as required),
 17. Shaft collars and ramp portals,
 18. Surface mobile equipment (as required),
 19. Electrical power,
 20. Treatment of underground water,
 21. Communications.
- [SD&TRD 3.7.2.2.3.A]
- B. Surface facilities shall support the administration of records, including those of construction, operations, site characterization, security, permitting, personnel, personnel training and certification, visitors, compliance with regulations, safety, etc.
- [SD&TRD 3.7.2.2.3.A]
- C. During ESF construction, temporary visitor facilities shall be approved by the DOE [TBD]. During ESF testing, facilities shall support a minimum capacity of 50 visitors on the surface and 10 visitors underground at any one time [TBV].
- [SD&TRD 3.7.2.2.3.A]
- D. Surface facilities shall combine functions when the combinations are cost effective and practicable. Similar functions (e.g., communications and computer control system) shall be combined wherever practicable.
- [SD&TRD 3.2.9.6, 3.7.2.2.3.A][CRD 3.2.5.5.B]
- E. The facilities shall be complete with HVAC, compressed air, plumbing and sanitary facilities, power, lighting, communications, and fire protection systems as required for appropriate coverage.
- [SD&TRD 3.7.2.2.2]
- F. The surface facilities shall be located away from potential dust generating areas to the extent practicable.
- [SD&TRD 3.3.6.1, 3.7.B.3][29 USC 651 et seq]

G. The surface buildings shall have a unified architectural theme that presents an aesthetic appearance.
[SD&TRD 3.7.2.2.3.A]

H. Each inhabited structure shall have restrooms, water heating, space heating, and air conditioning, as required for the intended use.
[SD&TRD 3.7.2.2.3.A]

3.2.3.3.1 RESERVED

3.2.3.3.2 RESERVED

3.2.3.3.3 RESERVED

3.2.3.3.4 RESERVED

3.2.3.3.5 RESERVED

3.2.3.3.6 SHOP

A. Shop facilities shall support the maintenance of roads, structures, grounds, and buildings.
[SD&TRD 3.7.2.2.3.A]

B. Shop facilities and equipment shall accommodate the following types of activities and services: routine equipment maintenance and repair, maintenance equipment storage, and operations spare parts storage.
[SD&TRD 3.7.2.2.3.A]

C. Shop facilities shall meet operational requirements as defined by the users.
[SD&TRD 3.7.2.2.3.A]

D. The shop shall include cranes and shop machinery which are consistent with maintenance needs.
[SD&TRD 3.7.2.2.3.A]

E. The shop shall provide for routine electrical generator repair and maintenance.
[SD&TRD 3.7.2.2.3.A]

F. The shop shall be a prefabricated metal building.
[SD&TRD 3.7.2.2.3.A]

G. The shop shall have, as a minimum, separate restrooms for men and women, an office, a service bay, storage space for maintenance supplies, and locker/change space. The need for multiple bays shall be determined by analysis.
[SD&TRD 3.7.2.2.3.A]

H. The shop shall be insulated and heated; in addition, the office area and restrooms shall be air conditioned.
[SD&TRD 3.7.2.2.2, 3.7.2.2.3.A]

- I. The shop facility shall include a concrete wash pad with suitable controls to ensure that wash water enters the proper sewage system and is treated accordingly.
[SD&TRD 3.7.2.2.3.A]
- J. The shop shall provide for separate storage of chemicals and flammable materials in accordance with applicable federal, State of Nevada, and local requirements.
[SD&TRD 3.7.2.2.3.A]

3.2.3.3.7 WAREHOUSE

- A. Space and equipment shall be adequate to support the receiving, storing, and equipment and materials dispensing functions, and shall sufficiently accommodate the inventory needed for ESF operations and site characterization.
[SD&TRD 3.5.3.1, 3.7.2.2.3.A][CRD 3.5.3.C]
- B. Temporary warehouse space shall be provided to support initial access construction and hoist and hoist house construction by the contractor.
[SD&TRD 3.7.2.2.3.A]
- C. The warehouse shall be a prefabricated metal building.
[SD&TRD 3.7.2.2.3.A]
- D. The warehouse shall contain restrooms and offices.
[SD&TRD 3.7.2.2.3.A]
- E. The warehouse shall be insulated and heated; in addition, the office areas and restrooms shall be air conditioned.
[SD&TRD 3.7.2.2.2, 3.7.2.2.3.A]
- F. The warehouse shall provide a chemical storage area which will comply with applicable federal, State of Nevada, and local requirements.
[SD&TRD 3.7.2.2.3.A]

3.2.3.3.8 OTHER TEMPORARY STRUCTURES

- A. Temporary structures and their supporting equipment provided under this section shall accommodate the following:
 - 1. Offices,
 - 2. Change rooms,
 - 3. First aid and underground rescue apparatus center,
 - 4. Scientific and test support personnel,
 - 5. Temporary IDS,
 - 6. Construction support functions, including training.

[SD&TRD 3.7.2.2.3.A]
- B. A change room facility shall be established (of sufficient size) to provide all necessary personnel and underground visitors with a place to bathe, change, and dry clothes. Separate change room facilities shall be provided for men and women.
[SD&TRD 3.7.2.2.3.A]

- C. Sufficient personnel office space, as defined by the users, shall be provided for test support functions, and for scientific, maintenance, and construction personnel.
[SD&TRD 3.7.2.2.3.A]
- D. Overhead baskets and locker facilities in the change room facility shall be sized to accommodate both personal and work-related clothing and equipment for the ESF operations, maintenance, and underground testing personnel.
[SD&TRD 3.7.2.2.3.A]
- E. A sufficient number of trailers shall be provided for test support functions.
[SD&TRD 3.7.2.2.3.A]
- F. The size of office spaces shall be based on a minimum of 9 square meters (100 square feet) per office as an average per DOE Order 6430.1A.
[SD&TRD 3.7.2.2.3.A]
- G. Each first aid structure shall provide at least 19 square meters (200 square feet) for the first aid facility, plus 4.6 square meters (50 square feet) for storage.
[SD&TRD 3.7.2.2.3.A]

3.2.3.3.9 COMMUNICATIONS/DATA BUILDING

- A. The building shall meet the operational requirements as defined by users.
[SD&TRD 3.7.2.2.3.A]
- B. The space within the building(s) shall be adequate to house the equipment.
[SD&TRD 3.7.2.2.3.A]
- C. The areas for housing IDS systems shall be equipped (as a minimum) as follows:
 - 1. Expandable power distribution system,
 - 2. Raised flooring,
 - 3. Acoustical treatment to reduce noise,
 - 4. Power failure lighting,
 - 5. Interior air cleaning/filtering,
 - 6. Air conditioning as required,
 - 7. UPS System, 120/208V, 3-phase capacity as required.
[SD&TRD 3.7.2.2.3.A]
- D. Facilities required for IDS equipment shall be provided with an HVAC system to maintain nominal temperature and humidity as required by the equipment specifications.
[SD&TRD 3.7.2.2.3.A]

3.2.3.4 UNDERGROUND OPENINGS

RESERVED.

3.2.3.5 UNDERGROUND SUPPORT SYSTEMS

3.2.3.5.1 RESERVED

3.2.3.5.2 RESERVED

3.2.3.5.3 RESERVED

3.2.3.5.4 RESERVED

3.2.3.5.5 RESERVED

3.2.3.5.6 RESERVED

3.2.3.5.7 RESERVED

3.2.3.5.8 RESERVED

3.2.3.5.9 RESERVED

3.2.3.5.10 RESERVED

3.2.3.5.11 MONITORING AND WARNING SYSTEMS

The central surface control room (for monitoring of underground systems) shall provide a central location for facility instrument readouts, alarms, equipment status, and automatic and/or manual override equipment controls. Monitor/control of the following equipment shall be incorporated into the design of the control room: water supply pumps, primary fans and doors, monitoring and warning system, conveyers, and underground wastewater collection system.

[SD&TRD 3.7.2.2.3.A]

3.2.4 STRUCTURAL

3.2.4.1 RESERVED

3.2.4.2 RESERVED

3.2.4.3 RESERVED

3.2.4.4 UNDERGROUND OPENINGS

3.2.4.4.1 RESERVED

3.2.4.4.2 LINING

A. The lining shall provide adequate bearing support for structural mounting of the conveyance system guide supports under both static and dynamic operational loading conditions.

[SD&TRD 3.7.2.2.6]

- B. The lining shall include provisions for instrumentation penetrations and data collection units. [SD&TRD 3.7.2.2.6]

3.2.4.4.3 RESERVED

3.2.4.4.4 FURNISHINGS

- A. The in-shaft structural steel supports shall carry the conveyance guides and absorb the maximum forces imposed on the conveyance when at rest and in motion. [SD&TRD 3.7.2.2.6]
- B. The shaft brackets, buntons, and attachments shall allow for final alignment of the sets and guides for the hoist conveyance to be used during ESF operation. [SD&TRD 3.7.2.2.6]
- C. All furnishings shall allow readily performed inspection and maintenance. [SD&TRD 3.7.2.2.6]
- D. Operational shaft guides shall be fixed and positioned to extend up to the underside of the crash beams. [SD&TRD 3.7.2.2.6]
- E. Shaft furnishings shall facilitate shaft sinking equipment and operations, in-shaft site characterization testing, and personnel activities. [SD&TRD 3.7.2.2.6]
- F. Ramp furnishings shall facilitate ESF underground construction and testing after ramp construction is complete. [SD&TRD 3.7.2.2.6]
- G. Furnishings shall provide for mounting the following utilities and cables underground:
 - 1. Electrical power,
 - 2. Compressed air,
 - 3. Water,
 - 4. Communications,
 - 5. Underground instrumentation,
 - 6. Instrumentation and IDS cabling,
 - 7. Underground wastewater handling system,
 - 8. Provision for ventilation.

[SD&TRD 3.7.2.2.6]

3.2.4.4.5 HOIST SYSTEM

A hoist foundation shall be provided to accommodate the hoist dimensions and mounting details, independent of the hoist house foundation. [SD&TRD 3.7.2.2.6]

3.2.4.4.6 RESERVED

3.2.5 MECHANICAL

- A. Sufficient facilities shall be provided which alert on-site personnel of possibly dangerous environmental and safety situations. Appendix J identifies the environmental requirements that apply to ESF activities.

[SD&TRD 3.2.7.1.B.2.e, 3.7.B.1][10 CFR 60.131(b)(1), 60.131(b)(3)]

1. Alarm systems shall indicate when the various monitored conditions exceed specified limits. Redundant systems shall be installed as required by applicable regulations, and shall include either whole systems or critical components within the system, to the extent practical.

[SD&TRD 3.2.7.1.B.2.e, 3.7.B.1][10 CFR 60.131(b)(3)]

2. Detection equipment for fires and explosions shall meet the requirements of DOE Orders 5480.7 and 6430.1A, Division 15, Mechanical; and any other applicable local, State of Nevada, and federal regulations.

[SD&TRD 3.2.10.2.1.A, 3.7.B.3][DOE Order 5480.7; 6430.1A]

- B. The facilities shall be complete with HVAC, compressed air, plumbing and sanitary facilities, power, lighting, communications, and fire protection systems as required for appropriate coverage.

[SD&TRD 3.7.2.2.2]

- C. The geologic repository operations area shall be designed to include explosion and fire detection alarm systems and appropriate suppression systems with sufficient capacity and capability to reduce the adverse effects of fires and explosions on structures, systems, and components ITS.

[SD&TRD 3.2.7.1.B.2.e, 3.7.2.2.13.A, 3.7.B.1][10 CFR 60.131(b)(3)(iii)]

- D. The design shall incorporate operability assessments which include RAM analysis. RAM analysis shall identify and mitigate operational problems in design. These analyses shall allocate systems performance objectives to subsystems and components.

[SD&TRD 3.2.9.2.A.1][CRD 3.2.5.1]

3.2.5.1 RESERVED**3.2.5.2 SURFACE UTILITIES**

Necessary utility services shall meet the requirements of ESF construction and operations.

[SD&TRD 3.7.2.2.2]

3.2.5.2.1 RESERVED**3.2.5.2.2 WATER SYSTEM**

The pumping systems shall include provisions for both manual and automatic operations.

[SD&TRD 3.7.2.2.2]

3.2.5.2.3 RESERVED

3.2.5.2.4 RESERVED**3.2.5.2.5 RESERVED****3.2.5.2.6 COMPRESSED AIR SYSTEM**

- A. The compressed air system shall provide compressed air throughout the designated areas of the ESF with flow rates and pressures to support construction and operations of the facilities, site characterization testing requirements, and drilling requirements including additional drift excavation.
[SD&TRD 3.7.2.2.2]
- B. Compressed air shall be conditioned as required and a quantity maintained to meet drilling and test apparatus requirements (see ESFDR Appendix B). Suitable filtering shall be provided where oil-free air is required.
[SD&TRD 3.7.2.2.2]
- C. The air compressor(s) shall be of a size to meet the requirements of ESF construction, testing, and operations. Modularity of the system to accommodate variable loads and system maintenance shall be considered.
[SD&TRD 3.7.2.2.2]
- D. All compressed air used during operation and construction of the ESF shall be provided with chemical tracers unless exempted by the ESF Test Coordinator. All tracers and substances added shall be approved per Section 3.2.1.M.3. [TBD]
[SD&TRD 3.7.2.2.2]
- E. As an energy conservation measure, designers will examine the use of electrical and/or electrohydraulic drives for underground construction equipment as an alternative to compressed air wherever possible and feasible.
[SD&TRD 3.7.2.2.2]

3.2.5.3 SURFACE FACILITIES**3.2.5.3.1 VENTILATION SYSTEM**

- A. The ventilation system shall supply and exhaust adequate quantities of air to and from underground working areas such that operator safety, health and productivity requirements are maintained.
[SD&TRD 3.7.2.2.2]
- B. All main ventilation systems shall contain safety features in accordance with 30 CFR 57, Subpart G; if the ESF is classified as gassy, the system shall comply with 30 CFR 57, Subpart T.
[SD&TRD 3.3.6.3.B, 3.7.2.2.5, 3.7.B.3][30 CFR 57]
- C. Anticipated noise levels, and noise reduction measures needed to provide personnel protection and enable required voice communications, shall be considered in the design specifications established for fan location and installation.
[SD&TRD 3.7.2.2.2]

- D. The ventilation system shall minimize leakage to the extent practicable.
[SD&TRD 3.7.2.2.2]
- E. The ventilation system shall be capable of supporting additional excavations beyond those planned, as indicated by the uncertainty allowance.
[SD&TRD 3.7.2.2.2]
- F. The ventilation system shall be designed to handle the required volume of air in order to cope with the in situ natural and induced heat sources. The system shall provide air cooling power equal to or greater than 260 W/m² of personnel skin surface area.
[SD&TRD 3.7.2.2.2]
- G. The ventilation system for the ESF and (subject to construction authorization) the initial development of a potential repository, shall not preclude design consideration being given to an underground location for the primary booster fan(s).
[SD&TRD 3.2.7.1.B.5, 3.7.2.2.2, 3.7.B.1][10 CFR 60.133]
- H. Monitoring of ventilated air shall comply with requirements of the monitoring and warning systems of the underground support system in this ESFDR.
[SD&TRD 3.7.2.2.2]

3.2.5.4 UNDERGROUND OPENINGS

3.2.5.4.1 RESERVED

3.2.5.4.2 RESERVED

3.2.5.4.3 RESERVED

3.2.5.4.4 RESERVED

3.2.5.4.5 HOIST SYSTEM

- A. Construction hoists shall be considered.
[SD&TRD 3.7.2.2.6]
- B. The hoisting system capacities shall be consistent with the requirements of shaft construction, operation, and site characterization and emergency egress needs.
[SD&TRD 3.3.6.3.A.2, 3.7.2.2.6, 3.7.B.3][29 CFR 1910][8 CCR 8400 et seq]
- C. The hoisting conveyance shall permit the inspection of shaft performance monitoring instrumentation, as well as other shaft inspection and maintenance activities.
[SD&TRD 3.7.2.2.6]
- D. The headframe shall elevate the hoist sheaves sufficiently above the collar level to provide room for normal conveyance unloading and over-travel allowances.
[SD&TRD 3.7.2.2.6]

- E. The headframe shall provide sufficient facilities for dumping buckets during shaft construction.
[SD&TRD 3.7.2.2.6]
- F. The headframe shall serve both shaft construction and test operations.
[SD&TRD 3.7.2.2.6]
- G. Clearances in the headframe directly above the collar shall accommodate the rigging of all anticipated underground equipment.
[SD&TRD 3.7.2.2.6]
- H. The hoisting systems (emergency egress systems) shall provide for the evacuation of all shaft personnel to safety within a one-hour time period.
[SD&TRD 3.3.6.1.B, 3.7.B.3][30 CFR 57.11050(b)]
- I. The hoisting and/or transport system shall incorporate fail-safe devices and be designed with adequate safety factors as per applicable requirements of 30 CFR 57, Subpart R, and State of Nevada and local regulations.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]
- J. The hoist shall accommodate the uncertainty allowance (see Section 3.2.9).
[SD&TRD 3.7.2.2.6]
- K. The hoist house control and operator's room shall be equipped with a heating and air conditioning system.
[SD&TRD 3.7.2.2.2]
- L. The hoisting system shall conform to applicable regulations.
[SD&TRD 3.7.2.2.6]
- M. The primary fire protection for hoist electrical gear shall not be a water flow or spray design.
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
- N. The sinking bucket, if used, shall be replaced with an enclosed conveyance for transporting non-shaft sinking personnel (i.e., visitors).
[SD&TRD 3.7.2.2.6]

3.2.5.4.6 SUMP

- A. The sump shall be equipped with wastewater collection and transfer facilities.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- B. The sump shall be equipped with underground wastewater collection facilities.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

3.2.5.5 UNDERGROUND SUPPORT SYSTEMS

- A. The utility services shall include minimal backup units for primary power lines, primary pumps, shaft and ramp conveyances, primary ventilation fans, and primary communications and testing equipment to allow testing continuity. Refer to ESFDR Appendix B for specific guidance.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- B. The underground support systems and service facilities shall be capable of supporting the uncertainty allowances as defined in Section 3.2.9.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- C. The distribution of utilities around the operations area of the MTL shall allow for flexibility in the siting and construction of the final testing locations.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- D. Utilities shall meet the needs of construction, operations, and in situ site characterization.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- E. The underground transport facilities shall be sufficiently sized to sustain construction, operations, and testing.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- F. The transport system(s) shall have appropriate safety features, as required by analysis and applicable federal, State of Nevada, and local regulations.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]
- G. The underground utilities for the ESF shall not preclude monitoring and investigation of in situ conditions, and shall accommodate site specific conditions, construction, and operation of the ESF.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- H. The underground utilities shall provide the flexibility needed to support the uncertainty in the design of the ESF.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- I. 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 underground water removal and ventilation exhaust to limit possible impacts on the capability to adequately characterize the site.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]

3.2.5.5.1 RESERVED**3.2.5.5.2 RESERVED****3.2.5.5.3 RESERVED**

3.2.5.5.4 VENTILATION DISTRIBUTION SYSTEM

- A. Underground ventilation shall dilute and/or remove particulate matter, blasting fumes (if drill-and-blast is used), and other flammable and noxious gases from the working areas, and shall divert exhaust air to the exhaust opening(s), all in conformance with applicable federal, state, and local regulations.
[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D][8 CCR 8400 et seq]
- B. The ventilation distribution system shall meet requirements for operator safety and productivity.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]
- C. The ventilation distribution system shall provide ventilating air using special ventilation devices, as required, to control airflow to the heated test areas and other specified underground areas during ESF underground construction, operations, and site characterization.
[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D][8 CCR 8400 et seq]
- D. Airflow distribution shall be controlled, as required, to supply air to all underground areas.
[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D][8 CCR 8400 et seq]
- E. The ventilation distribution system shall minimize leakage and undesirable recirculation, to the extent practicable.
[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D][8 CCR 8400 et seq]
- F. The ventilation distribution system shall supply adequate quantities of air (of acceptable temperature and humidity) to support all underground activities in accordance with applicable federal, state, and local regulations.
[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D][8 CCR 8400 et seq]
- G. Dust control/collection facilities shall be provided at potential underground dust-generation areas (e.g., working faces, rock-handling transfer points, processing areas, etc.) to minimize airborne particulates.
[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D][8 CCR 8400 et seq]
- H. The ventilation distribution system shall contribute to the control of the expected high free-silica and zeolite content dust, in conformance with applicable federal, state, and local regulations (see Section 2).
[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D][8 CCR 8400 et seq]
- I. Personnel working in the shaft and ramp shall not be exposed to ventilation air velocities exceeding those listed in the RIB.
[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D][8 CCR 8400 et seq]
- J. Ventilation air velocities in the active underground openings shall not be greater than those listed in the RIB, and the ventilation volume shall not be less than the quantity per person as listed in the RIB.
[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D][8 CCR 8400 et seq]

- K. The ventilation distribution system shall provide an air cooling power equal to or greater than 260 W/m² of personnel skin surface area.
[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D][8 CCR 8400 et seq]
- L. The subsurface data building ventilation system shall be compatible with the fire protection system.
[SD&TRD 3.2.7.1.B.2.c, 3.7.B.1][10 CFR 60.131(b)(1), 60.131(b)(2), 60.131(b)(3)]
- M. Shaft or ramp heaters, if required, shall conform to standard industry design.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- N. Maximum allowable noise levels produced by the underground ventilation distribution system shall allow the understanding of face-to-face and alarm-voice communications.
[SD&TRD 3.3.7, 3.7.B.3][29 USC 651 et seq]
- O. Ventilation capacity, shaft or ramp design, and air velocities in the shaft or ramp shall be optimized with respect to safety, design objectives, and cost.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]
- P. The ventilation distribution system shall be maintained to support initial construction of a potential repository until this can be replaced by the potential repository facilities.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

3.2.5.5.5 RESERVED

3.2.5.5.6 RESERVED

3.2.5.5.7 COMPRESSED AIR DISTRIBUTION SYSTEM

Compressed air shall be distributed at a quantity and pressure sufficient to meet all underground ESF construction, operations, and site characterization testing requirements.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

3.2.5.5.8 RESERVED

3.2.5.5.9 MUCK AND MATERIAL HANDLING SYSTEMS

- A. The muck handling system shall provide for collecting excavated rock at the shaft or ramp station, surge capacity, measuring, and loading the rock for conveyance.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- B. Muck and material handling systems shall be sized and designed for ESF construction and underground site characterization needs and shall minimize the spillage of excavated rock during handling. These systems shall provide capabilities for gathering and removing spillage.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

- C. Sufficient flexibility and redundancy for sustaining production shall be built into the muck handling system to cope with problems/breakdowns (e.g., equipment failure, material handling problems, etc.) in the underground development and operations activities.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- D. The muck handling system design shall accommodate handling of oversize material at the transfer points.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- E. The conveyers and/or transport system shall incorporate fail-safe devices and be designed with adequate safety factors as per applicable requirements of 30 CFR 57, and State of Nevada and local regulations.
[SD&TRD 3.3.6.1.B, 3.7.B.3][30 CFR 57]
- F. The muck and material handling systems shall be designed, installed, tested, operated, and maintained in conformance with applicable regulations.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- G. If a repository is to be constructed, the muck and material handling systems shall be maintained to support initial construction of this potential repository until they can be replaced by the potential repository facilities.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- H. The conveyers shall include smoke and heat detection systems.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]

3.2.5.5.10 RESERVED

3.2.5.5.11 MONITORING AND WARNING SYSTEMS

- A. The underground ventilation system shall be monitored, as a minimum, for the following:
- noise
 - dust
 - radon daughters
 - ammonia
 - nitrogen dioxide
 - nitrous oxides
 - sulfur dioxide
 - hydrogen sulfide
 - methane
 - oxygen
 - carbon monoxide
 - carbon dioxide
 - temperature

- humidity
- air velocity and volume flow,

as required by applicable federal, State of Nevada, and local regulations.

[SD&TRD 3.3.6.1.B, 3.7.B.3][29 CFR 1910; 29 CFR 1926; 30 CFR 57]

- B. Redundant components for all systems that monitor potential life threatening conditions shall be installed in accordance with applicable federal, State of Nevada, and local regulations.

[SD&TRD 3.3.6.1.B, 3.7.B.3][29 CFR 1910; 29 CFR 1926; 30 CFR 57]

- C. The ventilation monitoring systems for site characterization shall be separate and independent from the monitoring systems required for industrial hygiene and life safety support systems wherever this is feasible.

[SD&TRD 3.3.6.1.B, 3.7.B.3][29 CFR 1910; 29 CFR 1926; 30 CFR 57]

3.2.5.6 TEST SUPPORT

Test prioritization shall be the basis for instrumentation design; testing layout; and ventilation, personnel, and utility requirements.

[SD&TRD 3.2.7.3.B, 3.7.B.1][10 CFR 60.140(c)]

3.2.6 ELECTRICAL

3.2.6.1 RESERVED

3.2.6.2 SURFACE UTILITIES

- A. Necessary utility services shall meet the requirements of ESF construction and operations.

[SD&TRD 3.7.2.2.2]

- B. Safety and security lighting shall be available.

[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]

3.2.6.2.1 POWER SYSTEM

- A. Power distribution for the ESF, including the primary substation and secondary distribution systems, transmission lines, and feeder cables, shall have sufficient redundancy to meet load requirements at points of usage throughout the operations areas. Suitable switching and protective devices shall be provided in the electrical system to prevent damage to the equipment in case of power failure or faults. Metering shall be provided to establish the demand and consumption of power; and surge protection and a grounding system shall be provided to maximize personnel and equipment safety.

[SD&TRD 3.3.6.1.A, 3.7.2.2.2, 3.7.B.3][29 USC 651 et seq]

- B. Electrical power systems shall provide the necessary power, during both normal and peak demands, for the construction and operation of the ESF.

[SD&TRD 3.7.2.2.2]

- C. An overhead power line shall be routed from the nearest suitable power supply to the main substation(s) at the ESF site.
[SD&TRD 3.7.2.2.2]
- D. The electrical system shall include modifications that are required to accommodate tie-in of the proposed transmission line between the connection to the nearest suitable existing power supply and the main substation to be located at the ESF site.
[SD&TRD 3.7.2.2.2]
- E. The power distribution system shall provide services from the main ESF substation(s) to the surface and subsurface facilities.
[SD&TRD 3.7.2.2.2]
- F. The surface facilities power distribution system shall include the appropriate services to surface-mounted equipment. Surface-mounted equipment (permanent and temporary) includes, but is not limited to:
 - 1. hoists and controls,
 - 2. air compressor(s),
 - 3. ventilation fans, as required,
 - 4. communications equipment, as required,
 - 5. main water supply pump(s),
 - 6. shaft-work-deck winches and miscellaneous motors,
 - 7. temporary facilities,
 - 8. lights,
 - 9. muck discharge transport conveyers,
 - 10. ventilation air heaters (if required).
[SD&TRD 3.7.2.2.2]
- G. The electrical system shall withstand windblown dust and other natural phenomena.
[SD&TRD 3.2.10.1.C, 3.7.B.3][DOE Order 6430.1A, 0111-2.5]
- H. In the event of a power outage the standby power system shall provide all necessary power to systems and subsystems that are required to meet safety, operational, or security requirements, for the construction and operation of the ESF. This standby requirement includes those systems essential to evacuation, fire control, flood control, and critical in situ site characterization testing.
[SD&TRD 3.7.2.2.2]
 - 1. The standby power system shall include generators, fuel tanks, transfer switches, necessary fuel piping, conduit and wire, cutouts, concrete work, and weatherproof enclosures.
[SD&TRD 3.7.2.2.2]
 - 2. The standby power generators shall have sufficient output to provide power for the hoist to evacuate underground personnel within the one-hour time allowed; and to provide ventilation, area lighting, and to back up the UPS. The allowable delay time between the loss of primary power and the availability of standby power will be dictated by safety considerations of the underground operation.
[SD&TRD 3.7.2.2.2]

3. The minimum critical standby power requirements shall be determined by analysis. [SD&TRD 3.7.2.2.2]

I. A UPS system shall provide necessary power to systems and subsystems that cannot tolerate a loss of power incident. [SD&TRD 3.7.2.2.2]

1. A UPS system shall be provided to service, as a minimum, the monitoring systems (e.g., fire, smoke, gas), communications systems, data collection systems, and those instruments and tests requiring continuous power. [SD&TRD 3.2.7.3.B, 3.7.B.1][10 CFR 60.140(c)]

J. A utility-provided power supply shall be available as soon as possible but no later than the start of shaft and ramp construction. [SD&TRD 3.2.7.3.D, 3.7.2.2.2, 3.7.B.1][10 CFR 60.142(d)]

K. The normal supply of electrical power shall be provided by the main substation(s) to be constructed at the ESF site. Power for the main substation(s) shall be supplied from a connection to the nearest suitable existing power supply. [SD&TRD 3.7.2.2.2]

L. Existing YMP transformers and switchgear shall be incorporated to the extent practicable. [SD&TRD 3.3.5][CRD 3.3.5]

M. A UPS system shall consist of standby batteries and inverters. [SD&TRD 3.7.2.2.2]

N. The interconnection buss between the standby power and the main power distribution system shall allow the generating capacity of the standby system to be increased without modification to the interconnection buss. [SD&TRD 3.7.2.2.2]

3.2.6.2.2 RESERVED

3.2.6.2.3 RESERVED

3.2.6.2.4 COMMUNICATIONS SYSTEM

A. A hoist call-response signaling system and a battery powered telephone system shall be provided in each shaft station, shaft collar, bottom of shaft, and hoist operator's station. [SD&TRD 3.7.2.2.2]

B. A communications system shall be provided between the shaft cage and the hoist operator's station. [SD&TRD 3.7.2.2.2]

- C. Communications capability in and between the surface and the underground facilities (ramps, shafts, and underground openings) shall be established and suitable safety alarm systems shall be provided where required. Closed-circuit television monitoring shall be provided at critical locations.
[SD&TRD 3.7.2.2.2, 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- D. The system shall provide communications to NTS law enforcement, medical, fire-fighting, and emergency agencies in the local Nye County area.
[SD&TRD 3.3.6.1.B, 3.7.2.2.2, 3.7.B.3][29 CFR 1910; 29 CFR 1926; 30 CFR 57]
- E. The communications system shall provide adequate facilities for the transfer of data, via modem or other computer interface, from the ESF site to the outside communications network.
[SD&TRD 3.7.2.2.2]
- F. A public address system shall be provided for emergency announcements and general paging. This system shall have adequate speakers on the surface and in the underground to meet safety requirements and serve as an emergency notification system. Access should be from various points, but shall include, as a minimum, the control center, each shaft collar and ramp portal, and the telephone system.
[SD&TRD 3.7.2.2.2]
- G. Battery-powered phones shall be installed in all refuge stations, shops, and loading pockets.
[SD&TRD 3.7.2.2.2]
- H. At least one telephone shall be located in each building and trailer and each hoist operator station. These phones shall be capable of reaching off-site emergency numbers.
[SD&TRD 3.7.2.2.2]
- I. The ESF FM radio system shall be installed and integrated with the NTS FM radio system to provide communications to security and maintenance personnel and to serve as a backup communication system.
[SD&TRD 3.7.2.2.2]
- J. An intercom system shall have provisions for a multichannel connection as required in ESFDR Appendix B.
[SD&TRD 3.7.2.2.2]
- K. The communications system for the underground areas shall be tied into the hoisting system control room and ramp control buildings.
[SD&TRD 3.7.2.2.2]
- L. A telephone link shall be available to permit communication between any underground mine pager phone and the surface commercial telephone network, except for phones that require dedicated communications.
[SD&TRD 3.7.2.2.2]

- M. Phone jacks and phone service shall be provided as required for communication service as indicated in ESFDR Appendix B.
[SD&TRD 3.7.2.2.2]
- N. All electrical power wiring must be kept physically separated from data and communications wiring to prevent induced interference.
[SD&TRD 3.3.2.A, 3.7.B.3][DOE Order 6430.1A, 0200-99.8.1]
- O. The underground test areas shall have limited-access commercial service.
[SD&TRD 3.7.2.2.2]
- P. There shall be a phone jack in each intercom station.
[SD&TRD 3.7.2.2.2]
- Q. Inductive and radio communication systems in accesses/stations shall be restrictive to prevent "stray currents" from initiating premature detonation when blasting.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]

3.2.6.3 SURFACE FACILITIES

The facilities shall be complete with HVAC, compressed air, plumbing and sanitary facilities, power, lighting, communications, and fire protection systems as required for appropriate coverage.

[SD&TRD 3.7.2.2.2]

3.2.6.3.1 VENTILATION SYSTEM

The ventilation fan system shall have electrical standby power to retain full operational function when primary power is lost. A reduced level of ventilation necessary to support critical activities will be acceptable, since mining operations will be stopped during a power outage.

[SD&TRD 3.7.2.2.2]

3.2.6.3.2 RESERVED

3.2.6.3.3 SITE PREPARATION FOR SURFACE STRUCTURES

Each site shall be furnished with available utility services appropriate to the structure. As a minimum, services included shall be power, water, fire protection, communications, sanitary waste, and parking allowances.

[SD&TRD 3.7.2.2.2]

3.2.6.4 UNDERGROUND OPENINGS

Instrument and IDS cables and trunk cables shall be separated from power cables to minimize electrical interference, and shall be protected from damage.

[SD&TRD 3.3.2.A, 3.7.B.3][DOE Order 6430.1A, 0200-99.8.1]

3.2.6.4.1 RESERVED

3.2.6.4.2 RESERVED**3.2.6.4.3 STATIONS**

- A. The stations shall be provided with landings complete with safety devices that shall include, as a minimum: signals; clear areas; barriers; and gates.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]
- B. The stations shall ensure appropriate transition of utilities through the shaft stations to the continuation of the shaft below, as required.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

3.2.6.4.4 RESERVED**3.2.6.4.5 HOIST SYSTEM**

- A. Area floodlighting, obstruction lighting, and lightning protection shall be provided atop the shaft headframe.
[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D][8 CCR 8400 et seq]
- B. The hoist shall have an independent power feeder from the primary switchgear and a dedicated standby power feeder.
[SD&TRD 3.7.2.2.8.B, 3.7.B.3][29 CFR 1910.94; 30 CFR 57, Subpart D][8 CCR 8400 et seq]

3.2.6.4.6 RESERVED**3.2.6.5 UNDERGROUND SUPPORT SYSTEMS**

- A. The following underground needs shall be met: power, communications, lighting, ventilation, water, wastewater removal, compressed air, fire protection, sanitation, materials (including supplies and fuel) and rock and muck handling, and safety monitoring and warning.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- B. The utility services shall include minimal backup units for primary power lines, primary pumps, shaft and ramp conveyances, primary ventilation fans, and primary communications and testing equipment to allow testing continuity. Refer to ESFDR Appendix B for specific guidance.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- C. Effective communications capability in and between the surface and the underground facilities shall be established, and suitable safety alarm systems shall be provided where required. Closed-circuit television monitoring shall be provided at critical locations.
[SD&TRD 3.2.2.8.A][MGDS-RD 3.7.1.3]
- D. The underground support systems and service facilities shall be capable of supporting the uncertainty allowances as defined in Section 3.2.9.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]

- E. The distribution of utilities around the operations area of the MTL shall allow for flexibility in the siting and construction of the final testing locations.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- F. Utilities shall meet the needs of construction, operations, and in situ site characterization.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- G. Utility systems (i.e., electric power, air, water, etc.), when installed, shall not restrict foot, vehicular, or shaft and ramp conveyance traffic, obstruct ventilation, or cause safety hazards.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]
- H. Utility systems, including the water distribution and underground wastewater collection systems, shall operate safely in the event of seismic activity.
[SD&TRD 3.2.7.1.B.2.a, 3.7.B.1][10 CFR 60.131(b)(1)]
- I. The impact of underground utility system failures caused by credible disruptive events (e.g., fire, explosion, or seismic events) on site characterization and other testing, shall be controlled and limited.
[SD&TRD 3.7.2.2.A, 3.7.B.1][10 CFR 60.15(c)(1)]
- J. The underground utilities for the ESF shall not preclude monitoring and investigation of in situ conditions, and shall accommodate site specific conditions, construction, and operation of the ESF.
[SD&TRD 3.7.A, 3.7.B.3][42 USC 10133(c)(1)]
- K. The underground utilities shall provide the flexibility needed to accommodate the uncertainty in the design of the ESF.
[SD&TRD 3.2.12][CRD 3.2.7]

3.2.6.5.1 POWER DISTRIBUTION SYSTEM

- A. The underground electrical power system shall provide the necessary power, during both the normal and peak demands, for construction, operation, and site characterization requirements of the subsurface facility.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- B. Underground power distribution for the ESF, including the transformers and primary and secondary feeder cables, shall be adequately designed with sufficient redundancy to meet the load requirements at points of usage for the construction and operations areas of the facility.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- C. Stand-by power to the underground systems shall provide all necessary power to systems and subsystems that are required to operate in the event of a power outage, based on safety or operational requirements for the construction and operation of the ESF.
[SD&TRD 3.3.6.1.A, 3.7.B.3][29 USC 651 et seq]

- D. The underground UPS system(s) shall ensure continuity of power to the IDS, sensor systems, safety instruments and controls, communications, and all systems and subsystems that cannot tolerate a power interruption (see ESFDR Appendix B).
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- E. The underground power distribution system shall have one primary power feed (steel or wire armored) and one alternate power feed (steel or wire armored). One power feed shall be installed in each access, as necessary, and adequate switching shall be provided.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- F. Underground feeders shall have a ground check circuit to continuously monitor the grounding circuit to ensure continuity.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- G. Underground substations supplying power to 480V, 3-phase loads shall be resistance grounded.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- H. The UPS system(s) shall consist of batteries and inverters and shall be in a location separate from the main power distribution center.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- I. Utility lines, steel supports, and other conducting structures supporting electrical systems, shall be electrically bonded and reliably connected to the surface electrical safety grounding network.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- J. The power distribution system shall be shielded to minimize interference with testing activities.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

3.2.6.5.2 RESERVED

3.2.6.5.3 LIGHTING SYSTEM

- A. Lighting shall be provided at each testing area and alcove, refuge chamber, and at the shaft and ramp station areas. Lighting shall also be provided in the mechanical, electrical, and utility shops.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- B. Temporary lighting shall be provided for special needs such as mapping, photography, and work lights near instrumentation junction boxes.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- C. Exit lighting with battery backup shall be provided to identify direction of evacuation to refuge chambers, and/or shaft and ramp stations. [TBV]
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

- D. Emergency lighting with battery backup shall be provided in each shop, testing area, refuge chamber, and shaft and ramp station areas.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- E. The lighting provided in each testing area shall be based upon specific test requirements for that area.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- F. The lighting in the shop areas shall be based on specific maintenance requirements.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]
- G. Lighting fixtures for test areas shall be selected for low electrical noise, as applicable.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

3.2.6.5.4 RESERVED

3.2.6.5.5 RESERVED

3.2.6.5.6 RESERVED

3.2.6.5.7 RESERVED

3.2.6.5.8 RESERVED

3.2.6.5.9 MUCK AND MATERIAL HANDLING SYSTEM

The muck and material handling systems shall be designed with a power feeder that is separate from the power distribution system.

[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

3.2.6.5.10 RESERVED

3.2.6.5.11 MONITORING AND WARNING SYSTEM

- A. When monitored conditions exceed predetermined limits, an alarm system shall give warning of the hazardous conditions, and notify the responsible personnel on the surface and all personnel underground.
[SD&TRD 3.3.6.3.B][8 CCR 8400 et seq]
- B. A life safety alarm system shall be provided between the underground and surface.
[SD&TRD 3.3.6.3.B][8 CCR 8400 et seq]
- C. The central surface control room (for monitoring of the underground systems) shall provide a central location for facility instrument readouts, alarms, equipment status, and automatic and/or manual override equipment controls. Monitor/control of the following equipment shall be incorporated into the design of the control room: water supply pumps, primary fans and doors, monitoring and warning system, conveyers, and underground wastewater collection system.
[SD&TRD 3.7.2.2.8.A][MGDS-RD 3.7.1.3]

- D. The air quality monitoring system shall have the capability to sample, measure, and analyze physical and chemical conditions consistent with the requirements of applicable federal, State of Nevada, and local regulations.

[SD&TRD 3.3.11.B][10 CFR 960.3-4]

- E. Concentrations of radon daughters in underground work areas shall be monitored in accordance with 30 CFR 57.5037.

[SD&TRD 3.3.6.1.B, 3.3.6.3.B, 3.7.B.3][30 CFR 57.5037]

F. RESERVED

G. RESERVED

- H. Monitoring systems shall utilize the IDS as often as possible.

[SD&TRD 3.7.2.2.9.A]

3.2.6.6 TEST SUPPORT

A UPS system shall be available (as required) to ensure continuous operation of equipment and instrumentation related to critical testing, as determined by the YMP through analysis.

[SD&TRD 3.7.2.2.9.A]

3.2.7 EQUIPMENT

To the extent practicable and consistent with procurement regulations, surplus government equipment shall be considered for fulfilling the requirements of the ESF facilities, support services, and equipment.

[SD&TRD 3.3.9.B][CRD 3.3.9.B]

3.2.7.1 RESERVED

3.2.7.2 RESERVED

3.2.7.3 RESERVED

3.2.7.4 RESERVED

3.2.7.5 UNDERGROUND SUPPORT SYSTEMS

In the selection of equipment that will require maintenance, consideration shall be given to the availability and cost of replacement materials and parts, and the need for equipment manufacturer's technical services.

[SD&TRD 3.2.9.2.B]

3.2.8 TESTING

Testing instrumentation shall be removed, to the extent practicable, after its final use.

[SD&TRD 3.7.2.2.9.A]