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Physical System Requirements -

Exploratory Studies Facility

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Prepared for

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by

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ENCLOSURE 6

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- Part 1

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1.0 INTRODUCTION

1.1 BACKGROUND

The Nuclear Waste Policy Act (NWPA) of 1982 assigned to the Department of Energy (DOE) the responsibility for managing the disposal of spent nuclear fuel and high-level radioactive waste and established the Office of Civilian Radioactive Waste Management (OCRWM) for that purpose. The Secretary of Energy, in his November 1989 report to Congress (DOE/RW-0247), announced three new initiatives for conduct of the Civilian Radioactive Waste Management (CRWM) program. One of these initiatives was to establish improved management structure and procedures. In response, OCRWM performed a management study and the Director subsequently issued the Management Systems Improvement Strategy (MSIS) on August 10, 1990, calling for a rigorous implementation of systems engineering principles with a special emphasis on functional analysis.

A primary objective of OCRWM's MSIS is to establish a consistent set of program requirements, including requirements for the physical systems that will ultimately comprise the Waste Management System, requirements for the program that must bring this system into being, and requirements for the test facilities that will be used to demonstrate that the selected site and engineered systems will comply with their ultimate requirements.

The functional analysis approach establishes a framework for integrating the program management efforts with the technical requirements analysis into a single, unified, and consistent program. This approach recognizes that just as the facilities and equipment comprising the physical waste management system must perform certain functions, so must certain programmatic and management functions be performed within the program in order to successfully bring the physical system into being.

Thus, two separate but coordinated systems engineering efforts have been undertaken: (1) a functional analysis of the physical system and; (2) a functional analysis of the program. The physical system functional analysis is intended to:

- Identify the functions that must be performed by the physical system to fulfill the waste disposal mission;
- Identify the corresponding requirements imposed on each of the functions; and

- Identify the conceptual architecture that will be used to satisfy the requirements.

The principal purpose of this requirements document is to present the results that were obtained from the conduct of a physical system functional analysis effort for the "Conduct Subsurface-Based Activities" mission. The primary basis for this functional analysis is the ESF Mission Analysis results (Appendix G). The requirements for the Dispose of Waste function from the "Physical System Requirements - Dispose of Waste" document were also considered during this effort. The Physical System Requirements/Functional Analysis Management Plan, defines the criteria and activities for the preparation, review, and approval of this report. The document hierarchy when finalized will be shown in one of the OCRWM programmatic documents.

1.2 OBJECTIVE

The objective of this document is to establish the essential functions, requirements, interfaces, and system architecture for the "Conduct Subsurface-Based Activities" mission. This document will be baselined and the technical requirements contained herein will be the basis for future stages of design (Title II) of an Exploratory Studies Facility (ESF). This document contains system level requirements for the ESF and will lead to the preparation of more detailed ESF specification documents.

1.3 APPROACH

A comprehensive functional analysis of the physical system begins with a statement of the mission, from which all essential functions that the system must perform are derived. The functional analysis process is sequential. Thus, there are several distinct steps, each leading to three important pieces of information:

- Functions,
- Requirements, and
- Architecture.

Functions are simple statements of purpose, defining what the system must do; requirements indicate how well the function must be accomplished; and architecture represents a piece of the actual physical system that satisfies a corresponding requirement. This triad of functions (F), requirements (R), and architecture (A)

is needed to completely describe and understand the physical system at each level and to set the stage for the next lower level.

Figure 1 illustrates the sequential F-R-A approach that was implemented by a team of technical experts from across the OCRWM program, in accordance with the Physical System Requirements/Functional Analysis Management Plan. These experts were supported by a regulatory review team who extracted all potentially relevant physical system requirements from the source documents identified in Table 1.

Beginning with the mission statement, the technical experts assigned a set of applicable requirements from those provided by the regulatory review team, and provided an architectural concept. At this point, the mission statement became the parent function which the technical experts decomposed into a set of functions that are both necessary and sufficient to satisfy the parent. Physical system requirements were assigned and architectural concepts provided for each function, establishing the basis for further decomposition. Eventually, a level of detail is reached within the function hierarchy that cannot be supported with either specific requirements or specific architecture, until an ESF design is prepared. This can lead to some differences in the level of detail for functions, requirements, and architecture contained within this document.

1.4 MISSION

Based upon the Nuclear Waste Policy Act, the mission of DOE's "Conduct Subsurface-Based Activities" in the Exploratory Studies Facility can be stated succinctly as:

> **to conduct subsurface exploration and testing, in support of site suitability determination and license application, in a manner that protects the environment and nuclear waste isolation capabilities of the site.**

1.5 SCOPE

1.5.1 Scope of Functional Analysis

The functional analysis process must eventually consider all phases of a system's life cycle. However, it should begin with an analysis of that phase having the greatest impact on the satisfaction of the mission. For the "Conduct Subsurface-Based

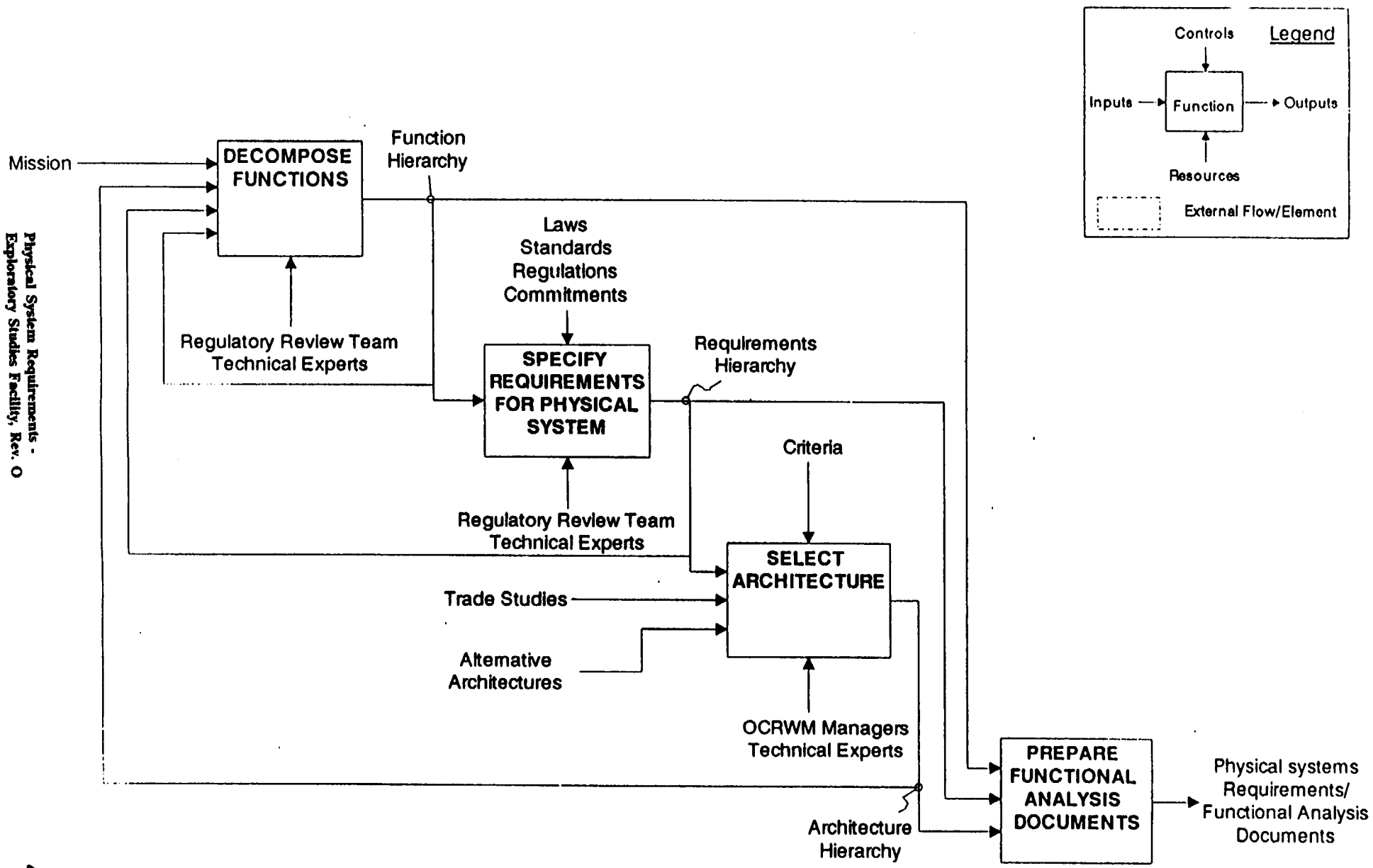


Figure 1. Physical System Functional Analysis Approach

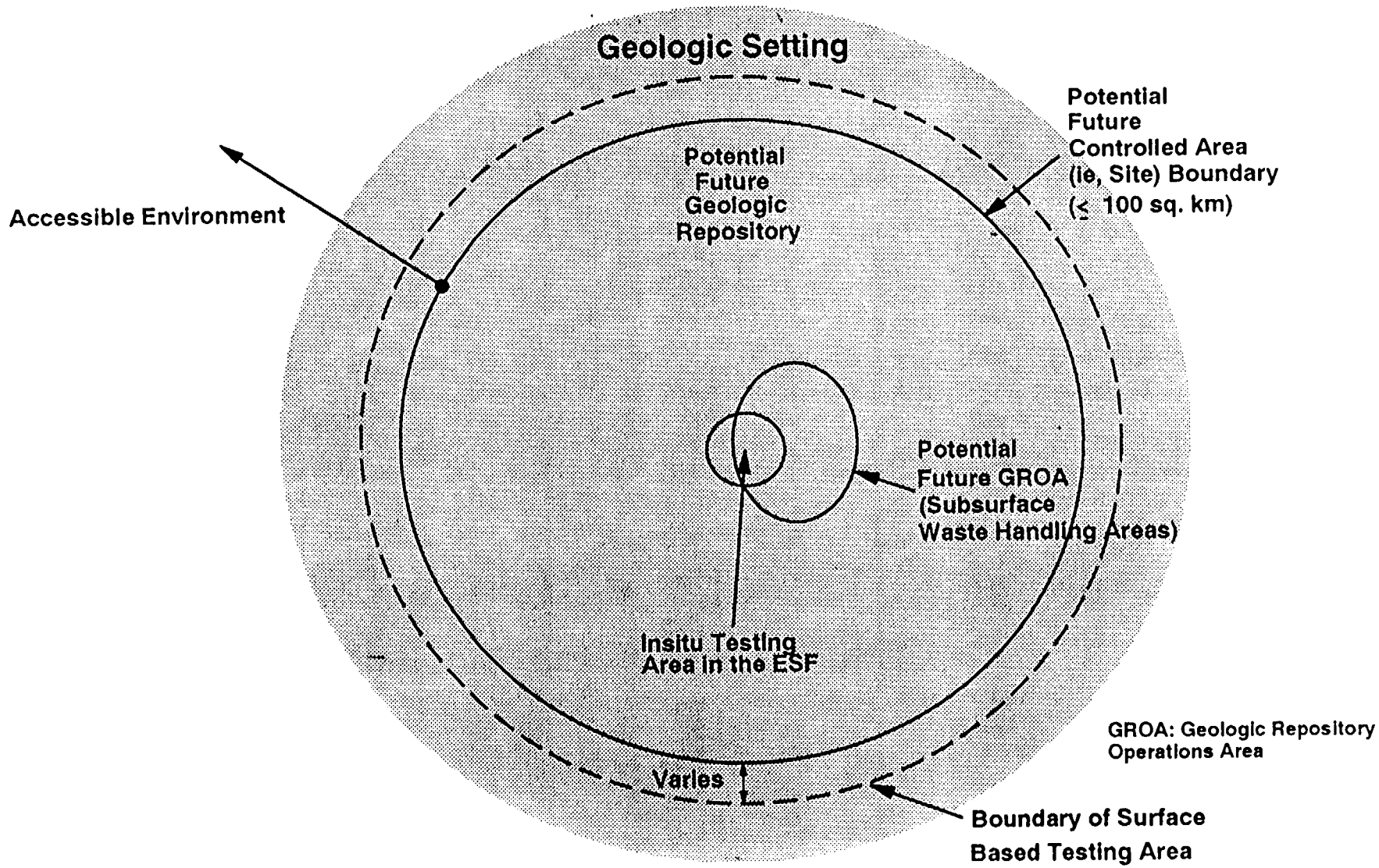
Table 1. Source Documents Containing Requirements in this Exploratory Studies Facility Document

Document Identifier	Document Description
29 USC 651 et seq.	Occupational Safety and Health Act
30 USC 801 et seq.	Mine Safety and Health
33 USC 1251 et seq.	Clean Water Act
42 USC 300f et seq.	Safe Drinking Water Act
NWPA-42 USC 10101 et seq.	Nuclear Waste Policy Act
10 CFR 60	Disposal of High-Level Radioactive Wastes in Geologic Repositories
10 CFR 960	General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories
30 CFR 57	Safety and Health Standards - Underground Metal and Nonmetal Mines*
33 CFR 322	Permits for Structures or Work in or Affecting Navigable Waters of the United States
40 CFR 191	Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes (Note: Included only by implication through 10 CFR 60)
DOE/RW-0214	Quality Assurance Requirements Document
DOE ORDER 3790.1A	Federal Employee Occupational Safety and Health Program
DOE ORDER 5480.1B	Environment, Safety, and Health Program for Department of Energy Operations
DOE ORDER 5480.11	Radiation Protection for Occupational Workers
YMP/CM-0011	Site Characterization Program Baseline
MOU Between DOE/DOL	Memorandum of Understanding Between DOE and DOL

* Not all requirements that may be applicable to an ESF have been included from 30 CFR 57.

Activities" mission, that phase was determined to begin with ESF construction, continue through site testing, and end either at the Presidential recommendation for a geologic repository or, if determined to be unsuitable as a geologic repository, at ESF closure. The ESF physical system mission is defined to end as stated, but if the system is later used for other purposes, e.g., additional pre-licensing testing following the period of site characterization as defined in 10 CFR 60, the functional analysis may require updating.

The boundaries for the "Conduct Subsurface-Based Activities" function are shown within the context of the "Dispose of Waste" boundaries in Figure 2. Although the ESF is not now considered to be a part of a geologic repository, the assumption is that this analysis should not preclude the possibility of the ESF eventually becoming a part of a geologic repository. Thus, it is possible that at least a portion of the underground excavations constructed for the ESF may become a part of a future geologic repository operations area should the site be found suitable.



*per 40 CFR 191.12 (g)

Figure 2. "Conduct Subsurface-Based Activities " Boundary (Including Potential Future Dispose of Waste Boundaries)

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1.5.2 Organization of Document

Section 2.0 of this document contains an explicit description for each of the "Conduct Subsurface-Based Activities" subfunctions; an identification of the key interfaces (inputs/outputs) between these functions; and a specification of the corresponding requirements (constraints, performance and interface). All of this information is presented in the form of a single table for each function.

Section 3.0 contains individual architectural description tables for each physical system element of an Exploratory Studies Facility. These tables present the rationale justifying the need for, or the selection of, a particular architecture and a brief description of the concept along with the requirements satisfied by the architecture.

Section 4.0 contains a more illustrative description of the important interfaces that have been identified within the "Conduct Subsurface-Based Activities" mission. This includes interfaces between the lower level functions and between a function and the external environment. Two types of diagrams are used to illustrate these interfaces: N-square charts and functional flow diagrams.

A number of appendices are included in this document. Appendix A is a glossary of terms that are used throughout the functional analysis effort; Appendix B, a Bibliography of reference documents used in this effort; Appendix C, Decision Documentation, indicates the basis for any DOE/OCRWM decisions that have been made in support of this effort; Appendix D, a list of the Acronyms that are used throughout this document; Appendix E, Interfaces, contains a list of the important inputs and outputs from the "Conduct Subsurface-Based Activities" functions; Appendix F, an indentured list of "Conduct Subsurface-Based Activities" functions; Appendix G, the results of the ESF Mission Analysis; and Appendix H, which provides the Traceability of ESF Mission to "Dispose of Waste" Requirements.

2.0 FUNCTIONS AND REQUIREMENTS

Figure 3 displays the functions deemed necessary to fulfill the "Conduct Subsurface-Based Activities" mission which is shown to be a subfunction of the more extensive "Conduct Geoscientific Investigations" and "Investigate Yucca Mountain Site for a Repository" functions. These upper level functions are included in the hierarchy only to place the ESF mission into the proper overall context. Since these additional functions are beyond the scope of this functional analysis effort, no attempt has been made to provide a comprehensive treatment of them in terms of requirements and interfaces. As indicated, the numbering scheme which uniquely identifies function titles is based on using a 3. at the first level, a 3.X at the second level, a 3.X.Y at the third level, etc. The focus of this document is on function 3.2.2 and its subfunctions. Additional functions are shown in Figure 3 to place the subsurface-based activities within the scope of the entire site investigation function. Presently there are no plans to extend this functional analysis to these additional functions. Furthermore, within the context of the overall function analysis, (sub)functions beginning with 1. pertain to the primary functions: Manage Waste Disposal, Accept Waste, Transport Waste, Store Waste, and Dispose of Waste. Programmatic (sub)functions begin with a number 2. This scheme, which permits traceability between functions and subfunctions, is used throughout the physical system functional analysis.

Table 1 contains a list of source documents from which the regulatory requirements (i.e., constraints) contained in this document were extracted. Although additional source documents have been, and will continue to be, reviewed, it was determined that the scope and detail contained in the documents referenced in Table 1 are sufficient to specify an initial set of requirements in the Exploratory Studies Facility document.

Tables F3. through F3.2.2.4.2 contain descriptions for each of the functions, including an identification of inputs to, and outputs from, each of the functions. A compilation of key inputs and outputs is provided in Appendix E, and an indentured list of all "Conduct Subsurface-Based Activities" functions is provided in Appendix F. Tables F3. through F3.2.2.4.2 also include a compilation of the corresponding requirements that are determined to be appropriate for each function. In general, if a requirement is applicable to all functions at a given level in the hierarchy, it is assigned to their parent function in order to avoid unnecessary repetition. These requirements satisfied by each architecture are listed in the architecture tables in Section 3.0.

Requirements can be one of three types: **constraints**, which are requirements imposed on the function by sources external to OCRWM (e.g., Congress, Environmental Protection Agency, Nuclear Regulatory Commission, other DOE Offices); **performance requirements** which are imposed on the function by OCRWM; and **interface requirements** which apply to the inputs to, or outputs from, the functions and may be imposed either by external sources or by OCRWM. The numbering convention used for the identification of requirements in these tables is as follows:

For example,

3.2.2.2C1:	The first constraint (C) assigned to function 3.2.2.2.
3.2.2.2P1:	The first performance requirement (P) assigned to function 3.2.2.2; and
3.2.2.2O1a:	The first interface requirement assigned to output (O) 1 from function 3.2.2.2.

Each requirement that has been extracted from a source document has the appropriate reference noted. All performance and interface requirements without an explicit reference are based on the results of the ESF Mission Analysis in Appendix G. Other requirements that have not yet been firmly decided are noted as "TBD" or "Requirements at this level to be specified". Some requirements specified are administrative in nature which support the operating phase. Note that any reference to an appendix, a different section number, or a paragraph number within a particular requirement refers to the appendix, a section, or paragraph in the source itself.

OCRWM recognizes that this initial version of the Exploratory Studies Facility requirements document contains a limited number of performance requirements. Furthermore, many of the interfaces currently have no requirements specified, pending future decisions to be made by OCRWM. These decisions will be based on the results of both prior and future systems studies. Subsequent revisions to this document will include additional specific requirements as they are identified and resolved. To be included, performance and interface requirements tied to quality affecting activities must be developed and documented in accordance with an approved Quality Assurance (QA) program which meets the requirements of 10 CFR 50 Subpart B and NQA-1.

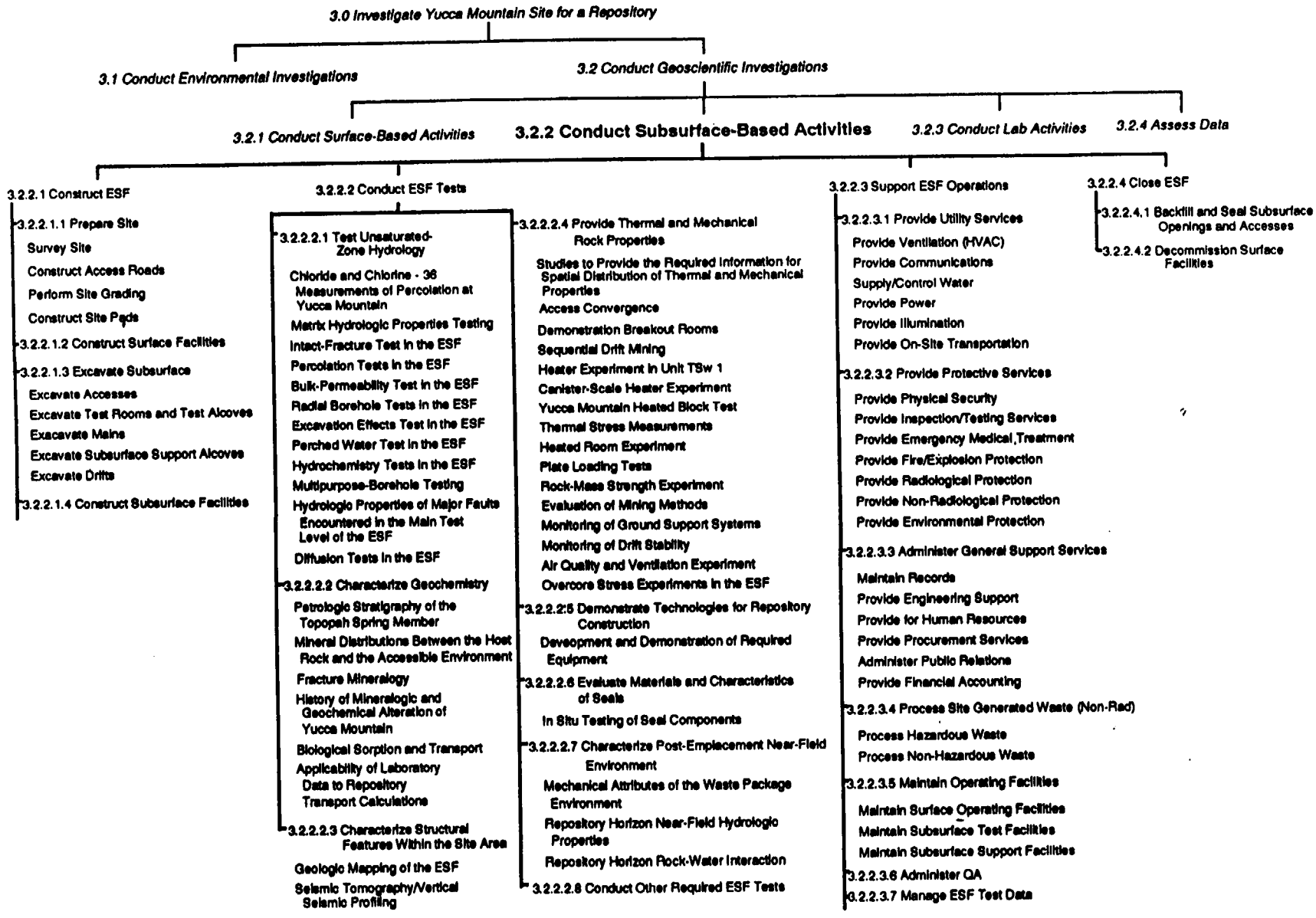

Figure 3. Conduct Subsurface-Based Activities Function Hierarchy

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Table F3.0 Function Description: Investigate Yucca Mountain Site for a Repository

I. Function ID Number: 3.0

II. Function Title: Investigate Yucca Mountain Site for a Repository

III. Function Definition:

To investigate the suitability of the Yucca Mountain site for a licensed repository using the general guidelines specified in 10 CFR 960. This includes performing a coordinated series of in-situ and regional tests, investigations, and analyses, grouped as either environmental investigations or as geoscientific investigations.

The tests included under Geoscientific Investigations establish the geologic conditions and the ranges of the parameters of a candidate site relevant to the location of a repository.

The term "Yucca Mountain site" means the candidate site in the State of Nevada recommended by the Secretary to the President under section 112(b)(1)(B) on May 27, 1986. (NWPA Sec 2(30))

The "Yucca Mountain site" refers to the candidate site in the State of Nevada recommended by the Secretary of Energy to the President on May 27, 1986 (Nuclear Waste Policy Amendments Act of 1987 [NWPAA]). In order to determine whether the candidate site is suitable for recommendation as a repository, the Secretary is directed by the NWPAA to "carry out...appropriate site characterization activities at the Yucca Mountain site." Such investigations, also required by 10 CFR Part 60, consist primarily of surface-based field studies, the construction of an ESF, and the tests conducted in that facility (SCPB, 1988).

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints:

3.C1 The Secretary may conduct at the Yucca Mountain site only such site characterization activities as the Secretary considers necessary to provide the data required for evaluation of the suitability of such site for an application to be submitted to the Commission for a construction authorization for a repository at such site, and for compliance with the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.).

[NWPA Sec 113 (c)(1)]

3.C2 A site shall be disqualified at any time during the siting process if the evidence supports a finding by the DOE that a disqualifying condition exists or the qualifying condition of any system or technical guideline cannot be met.

[10 CFR 960.3-4]

B. Performance: None specified at this time

C. Interface: None specified at this time

Table F3.1 Function Description: Conduct Environmental Investigations

I. Function ID Number: 3.1

II. Function Title: Conduct Environmental Investigations

III. Function Definition:

To conduct environmental investigations to determine and mitigate significant adverse impacts to the environment from the site characterization, site selection and repository development process. The NWPAA directs the Secretary of Energy to conduct site characterization activities in a manner that minimizes significant adverse impacts to the environment. While the Environmental Assessment for the Yucca Mountain site (a document required by the Nuclear Waste Policy Act of 1982 and the NWPAA) identified no potentially significant adverse environmental impacts, the DOE is committed to conducting its operations in an environmentally safe and sound manner, and will comply with applicable environmental statutes and regulations. Further, the SCP states that "In conducting the site characterization program, care will be taken to reduce adverse environmental and socioeconomic impacts." Site characterization activities will be monitored and, to the extent practicable, mitigation measures will be implemented, if necessary.

Several environmental investigations have already commenced at the site (air quality, meteorology, water availability, and radionuclides in air, soil, plants, and animals), with many others planned. Evidence of environmental monitoring plans is required by the State of Nevada for consideration and approval of permits, without which site characterization cannot proceed. Nongeologic data provided by such studies is needed for determining the suitability of the site, and may ultimately be used in support of the Environmental Impact Statement (EIS) (required by the National Environmental Policy Act of 1969) which must accompany any recommendation to the President for approval of a repository site. (NWPAA)

Environmental impacts shall be considered by the DOE throughout the site characterization, site selection, and repository development process. [10 CFR 960.3-4]

IV. Interfaces:

A. Inputs:

3.1I1 Existing Yucca Mountain Site **From:** Outside System Boundary

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints:

3.1C1 (a) Qualifying Condition. The site shall be located such that present projected effects from nearby industrial, transportation, and military installations and operations, including atomic energy defense activities, (1) will not significantly affect repository siting, construction, operation, closure, or decommissioning or can be accommodated by engineering measures and (2), when considered together with emissions from repository operation and closure, will not be likely to lead to radionuclide releases to an unrestricted area greater than those allowable under the requirements specified in Sec. 960.5-1(a)(1).

(d) Disqualifying Condition. A site shall be disqualified if atomic energy defense activities in proximity to the site are expected to conflict irreconcilably with repository siting, construction, operation, closure, or decommissioning.

[10 CFR 960.5-2-4]

3.1C2 (a) Qualifying Condition. The site shall be located such that (1) the quality of the environment in the affected area during this and future generations will be adequately protected during repository siting, construction, operation, closure, and decommissioning, and projected environmental impacts in the affected area can be mitigated to an acceptable degree, taking into account programmatic, technical, social, economic, and environmental factors; and (2) the requirements specified in Sec. 960.5-1(a)(2) can be met.

(d) Disqualifying Conditions. Any of the following conditions shall disqualify a site: (1) During repository siting, construction, operation, closure, or decommissioning the quality of the environment in the affected area could not be adequately protected or projected environmental impacts in the affected area could not be mitigated to an acceptable degree, taking into account programmatic, technical, social, economic, and environmental factors.

[10 CFR 960.5-2-5]

B. Performance: Requirements at this level to be specified.

C. Interface: Requirements at this level to be specified

Table F3.2 Function Description: Conduct Geoscientific Investigations

I. Function ID Number: 3.2

II. Function Title: Conduct Geoscientific Investigations

III. Function Definition:

To conduct geoscientific investigations including a program of exploration and research, both in the laboratory and in the field, undertaken to establish the geologic conditions and the ranges of parameters of the Yucca Mountain site.

The term "site characterization" means--

activities, whether in the laboratory or in the field, undertaken to establish the geologic condition and the ranges of the parameters of a candidate site relevant to the location of a repository, including borings, surface excavations, excavations of exploratory shafts, limited subsurface lateral excavations and borings, and in situ testing needed to evaluate the suitability of a candidate site for the location of a repository, but not including preliminary borings and geophysical testing needed to assess whether site characterization should be undertaken. (NWPA Sec 2(21)(B))

This function begins at T_o = Presidential approval of Yucca Mountain site for characterization (5/27/86), and ends at T_f = Presidential recommendation, or Secretarial determination of unsuitability as a geologic repository, whichever comes first.

IV. Interfaces:

A. Inputs:

3.2I1	Existing Yucca Mountain Site	**From:**	Outside System Boundary

B. Outputs:

3.2O1	Records	**To:**	Outside System Boundary
3.2O2	Samples	**To:**	Outside System Boundary
3.2O3	Data	**To:**	Outside System Boundary
3.2O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints:

3.2C1 (a) In general.- The Secretary shall carry out, in accordance with the provisions of this section, appropriate site characterization activities at the Yucca Mountain site. The Secretary shall consider fully the comments received under subsection (b)(2) and section 112(b)(2) [42 U.S.C. 10132(b)(2)] and shall, to the maximum extent practicable and in consultation with the Governor of the State of Nevada, conduct site characterization activities in a manner that minimizes any significant adverse environmental impacts

identified in such comments or in the environmental assessment submitted under section 112(b)(1).

(b) Commission and States (1) Before proceeding to sink shafts at the Yucca Mountain site, the Secretary shall submit for such candidate site to the Commission and to the Governor or legislature of the State of Nevada, for their review and comment -

(A) a general plan for site characterization activities to be conducted at such candidate site, which plan shall include -

(ii) a description of such site characterization activities, including the following: the extent of planned excavations, plans for any onsite testing with radioactive or nonradioactive material, plans for any investigation activities that may affect the capability of such candidate site to isolate high-level radioactive waste and spent nuclear fuel, and plans to control any adverse, safety-related impacts from such site characterization activities;

(iii) plans for the decontamination and decommissioning of such candidate site, and for the mitigation of any significant adverse environmental impacts caused by site characterization activities if it is determined unsuitable for application for a construction authorization for a repository;

(iv) criteria to be used to determine the suitability of such candidate site for the location of a repository, developed pursuant to section 112(a)[42 U.S.C. 10132(a)]; and

(3) During the conduct of site characterization activities at the Yucca Mountain site, the Secretary shall report not less than once every 6 months to the Commission and to the Governor and legislature of the State of Nevada, on the nature and extent of such activities and the information developed from such activities.

(c) Restrictions (1) The Secretary may conduct at the Yucca Mountain site only such site characterization activities as the Secretary considers necessary to provide the data required for evaluation of the suitability of such site for an application to be submitted to the Commission for a construction authorization for a repository at such site, and for compliance with the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.).

(2) In conducting site characterization activities -

(A) the Secretary may not use any radioactive material at a site unless the Commission concurs that such use is necessary to provide data for the preparation of the required environmental reports and an application for a construction authorization for a repository at such site; and

(B) if any radioactive material is used at a site -

(i) the Secretary shall use the minimum quantity necessary to determine the suitability of such site for a repository, but in no event more than the curie equivalent of 10 metric tons of spent nuclear fuel; and

(ii) such radioactive material shall be fully retrievable.

[NWPA Sec. 113]

3.2C2 (B) The Secretary shall make grants to the State of Nevada and any affected unit of local government for purposes of enabling such State or affected unit of local government--

(iii) to engage in any monitoring, testing, or evaluation activities with respect to site characterization programs with regard to such site;

[NWPA Sec 116(c)(1)]

3.2C3 (c) The program of site characterization shall be conducted in accordance with the following:

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

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

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

[10 CFR 60.15]

3.2C4 (c) The Safety Analysis Report shall include:

(1) A description and assessment of the site at which the proposed geologic repository operations area is to be located with appropriate attention to those features of the site that might affect geologic repository operations area design and performance. The description of the site shall identify the location of the geologic repository operations area with respect to the boundary of the accessible environment.

(ii) The assessment shall contain:

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

(E) An analysis of the performance of the major design structures, systems, and components, both surface and subsurface, to identify those that are important to safety. For the purposes of this analysis, it shall be assumed that operations at the geologic repository operations area will be carried out at the maximum capacity and rate of receipt of

radioactive waste stated in the application.

(11) A description of design considerations that are intended to facilitate permanent closure and decontamination or dismantlement of surface facilities.

[10 CFR 60.21]

3.2C5 The evidence required to support the recommendation of a candidate site for the development of a repository, after the completion of characterization activities at such site, shall consist of the information specified in Section 114(a) of the Act for the comprehensive statement of the basis for such recommendation and Section 114(f) of the Act for the environmental impact statement. This evidence shall be obtained by the characterization of such site, according to the requirements specified in Section 113(b) of the Act and in 10 CFR 60.11, and by nongeologic data gathering.

[10 CFR 960.3-1-4-4]

3.2C6 Environmental impacts shall be considered by the DOE throughout the site characterization, site selection, and repository development process. The DOE shall mitigate significant adverse environmental impacts, to the extent practicable, during site characterization and repository construction, operation, closure, and decommissioning.

[10 CFR 960.3-4]

3.2C7 (d) Disqualifying Condition. A site shall be disqualified if the pre-waste-emplacement ground-water travel time from the disturbed zone to the accessible environment is expected to be less than 1,000 years along any pathway of likely and significant radionuclide travel.

[10 CFR 960.4-2-1]

3.2C8 (a) Qualifying Condition. The site shall be located in a geologic setting where future tectonic processes or events will not be likely to lead to radionuclide releases greater than those allowable under the requirements specified in Sec. 960.4-1. In predicting the likelihood of potentially disruptive tectonic processes or events, the DOE will consider the structural, stratigraphic, geophysical, and seismic evidence for the nature and rates of tectonic processes and events in the geologic setting during the Quaternary Period.

(d) Disqualifying Condition. A site shall be disqualified if, based on the geologic record during the Quaternary Period, the nature and rates of fault movement or other ground motion are expected to be such that a loss of waste isolation is likely to occur.

[10 CFR 960.4-2-7]

3.2C9 (d) Disqualifying Conditions. A site shall be disqualified if-- (1) Previous exploration, mining, or extraction activities for resources of commercial importance at the site have created significant pathways between the projected underground facility and the accessible environment; or (2) Ongoing or likely future activities to recover presently valuable natural

mineral resources outside the controlled area would be expected to lead to an inadvertent loss of waste isolation.

[10 CFR 960.4-2-8-1]

3.2C10 (a) Qualifying Conditions - (2) Environment, Socioeconomics, and Transportation. During repository siting, construction, operation, closure, and decommissioning the public and the environment shall be adequately protected from the hazards posed by the disposal of radioactive waste.

[10 CFR 960.5-1]

3.2C11 (a) Qualifying Conditions - (3) Ease and Cost of Siting, Construction, Operation, and Closure. Repository siting, construction, operation, and closure shall be demonstrated to be technically feasible on the basis of reasonably available technology, and the associated costs shall be demonstrated to be reasonable relative to other available and comparable siting options.

[10 CFR 960.5-1]

B. Performance:

3.2P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.17 The site characterization plan shall contain -

(a) A general plan for site characterization activities to be conducted at the area to be characterized, which general plan shall include:

(2) A description of such site characterization activities, including the following --

(iv) Plans to control any adverse impacts from such site characterization activities that are important to safety or that are important to waste isolation;

[DOE letter dated 2/27/90]

3.2P2 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.131 (a) Radiological protection. The geologic repository operations area shall be designed to maintain radiation doses, levels, and concentrations of radioactive material in air in restricted areas within the limits specified in Part 20 of this chapter. Design shall include:

(1) Means to limit concentrations of radioactive material in air;

(2) Means to limit the time required to perform work in the vicinity of radioactive materials, including, as appropriate, designing equipment for ease of repair and replacement and providing adequate space for ease of operation;

(3) Suitable shielding;

(4) Means to monitor and control the dispersal of radioactive contamination;

(5) Means to control access to high radiation areas or airborne radioactivity areas; and

(6) A radiation alarm system to warn of significant increases in radiation levels, concentrations of radioactive material in air, and of increased radioactivity released in effluent. The alarm system shall be designed with provisions for calibration and for testing its operability.

[DOE letter dated 2/27/90]

C. Interface:

3.2I1 Requirements at this level to be specified

3.2O1a Effluent limitations

(a) Except as in compliance with this section and sections 1312, 1316, 1317, 1328, 1342, and 1344 of this title, the discharge of any pollutant by any person shall be unlawful.

(f) Notwithstanding any other provisions of this chapter it shall be unlawful to discharge any radiological, chemical, or biological warfare agent any high-level radioactive waste or any medical waste, into the navigable waters.

[33 USC 1251 et seq., Sec. 1311]

3.2O1b National standards of performance

(d) Protection from more stringent standards

Notwithstanding any other provision of this chapter, any point source the construction of which is commenced after October 18, 1972, and which is so constructed as to meet all applicable standards of performance shall not be subject to any more stringent standard of performance during a ten-year period beginning on the date of completion of such construction or during the period of depreciation or amortization of such facility for the purposes of section 167 or 169 (or both) of title 26 whichever period ends first.

[33 USC 1251 et seq., Sec. 1316]

3.2O2 Requirements at this level to be specified

3.2O3a DOE shall consider the following requirement in ESF design activities:

10 CFR 60.24 (a) The application shall be as complete as possible in the light of information that is reasonably available at the time of docketing.

[DOE letter dated 2/27/90]

3.203b 8.1 SAMPLES

Samples shall be identified and controlled in a manner consistent with the samples' intended uses. Such controls shall define the responsibilities, including interfaces between technical specialties and organizations for:

a. Collection, identification, and traceability of samples including archival samples.

b. Test or experiment allocation.

c. Disposition of samples.

d. Generation of associated records.

[DOE/RW - 0214 page A-2]

3.203c 8.2 SAMPLE IDENTIFICATION

Samples shall be identified by placing identification directly on the samples when possible, on the samples' containers, or on labels or tags attached to the samples or the samples' containers. Sample identification shall be verified and documented prior to release for testing or analysis.

[DOE/RW - 0214 page A-2]

3.203d 13.2 GEOTECHNICAL SAMPLE HANDLING AND SHIPPING

Samples shall be controlled during handling, storage, and shipment to preclude damage or loss and minimize deterioration. Controls shall be established for appropriate packaging, handling, and modes of transportation, with consideration being given to type of containers, time constraints on perishable materials (that is, shelf life), and any other environmental or safety considerations applicable to the samples. Measures shall be taken to avoid sample contamination during handling and shipment. Where multiple organizations are involved, appropriate procedures shall describe interface and custody responsibilities. Sample identification shall be verified and maintained when samples are handled, transported, or transferred from one organization's responsibility to another.

[DOE/RW - 0214 page A-3]

3.204 Requirements at this level to be specified

Table F3.2.1 Function Description: Conduct Surface-Based Activities

I. Function ID Number: 3.2.1

II. Function Title: Conduct Surface-Based Activities

III. Function Definition:

To conduct surface exploration and testing in support of site suitability determination and license application in a manner that protects the environment and isolation capabilities of the site.

T_o = Submittal of SCP, T_f = Presidential recommendation, or Secretarial determination of unsuitability as a geologic repository, whichever comes first.

IV. Interfaces:

A. Inputs:

3.2.1I1 Existing Yucca Mountain Site	**From:**	Outside System Boundary

B. Outputs:

3.2.1O1 Records	**To:**	Outside System Boundary
3.2.1O2 Samples	**To:**	Function 3.2.3/Outside System Boundary
3.2.1O3 Data	**To:**	Function 3.2.4

V. Function Requirements:

A. Constraints:

3.2.1C1 (a) Qualifying Condition. The site shall be located such that (1) any significant adverse social and/or economic impacts induced in communities and surrounding regions by repository siting, construction, operation, closure, and decommissioning can be offset by reasonable mitigation or compensation, as determined by a process of analysis, planning, and consultation among the DOE, affected State and local government jurisdictions, and affected Indian tribes; and (2) the requirements specified in Sec. 960.5-1(a)(2) can be met.

(d) Disqualifying Condition. A site shall be disqualified if repository construction, operation, or closure would significantly degrade the quality, or significantly reduce the quantity, of water from major sources of offsite supplies presently suitable for human consumption or crop irrigation and such impacts cannot be compensated for, or mitigated by, reasonable measures.

[10 CFR 960.5-2-6]

3.2.1C2 (a) Qualifying Condition. The site shall be located such that, considering the surface characteristics and conditions of the site and surrounding area, including surface-water systems and the terrain, the requirements specified in Sec. 960.5-1(a)(3) can

be met during repository siting, construction, operation, and closure.

[10 CFR 960.5-2-8(a)]

3.2.1C3 Interim regulation of underground injection

(b) Well operations permits; publication in Federal Register; notice and hearing; issuance or denial; conditions for issuance

(1) During the period beginning on the date an area is designated under subsection (a) ... and ending on the date the applicable underground injection control program covering such area takes effect, no new underground injection well may be operated in such area unless the Administrator has issued a permit for such operation.

(3) The Administrator may issue a permit for the operation of a new underground injection well in an area designated under subsection (a) only if he finds that the operation of such well will not cause contamination of the aquifer of such area so as to create a significant hazard to public health.

[42 USC 300f et seq., Sec. 300h-3]

Note: Underground injection applies to the use of tracers during construction and testing, not to radioactive waste disposal.

B. Performance: Requirements at this level to be specified

C. Interface: Requirements at this level to be specified

Table F3.2.2 Function Description: Conduct Subsurface-Based Activities

I. Function ID Number: 3.2.2

II. Function Title: Conduct Subsurface-Based Activities

III. Function Definition:

To conduct subsurface exploration and testing at depth in support of site suitability determination and license application, in a manner that protects the environment and nuclear waste isolation capabilities of the site.

To perform exploratory testing by personnel access underground to depths at which wastes would be emplaced and locations where underground facility construction is planned.

T_o = initiation of MPBH drilling/ESF collar/portal construction.

T_f = Presidential recommendation, or Secretarial determination of unsuitability, as a geologic repository, whichever comes first.

IV. Interfaces:

A. Inputs:

3.2.2I1 Existing Yucca Mountain Site	**From:**	Outside System Boundary

B. Outputs:

3.2.2O1 Records	**To:**	Outside System Boundary
3.2.2O2 Samples	**To:**	Outside System Boundary/ Function 3.2.3
3.2.2O3 Data	**To:**	Function 3.2.4
3.2.2O4 Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints:

3.2.2C1 (a) Each employer - (1) shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or likely to cause death or serious physical harm to his employees; (2) shall comply with occupational safety and health standards promulgated under this chapter. (b) Each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this chapter which are applicable to his own actions and conduct.

[29 USC 651 et seq.,(654 (a)(b))]

3.2.2C2 Interim regulation of underground injection

(b) Well operations permits; publication in Federal Register; notice and hearing; issuance or denial; conditions for issuance

(1) During the period beginning on the date an area is designated under subsection (a) ... and ending on the date the applicable underground injection control program covering such area takes effect, no new underground injection well may be operated in such area unless the Administrator has issued a permit for such operation.

(3) The Administrator may issue a permit for the operation of a new underground injection well in an area designated under subsection (a) only if he finds that the operation of such well will not cause contamination of the aquifer of such area so as to create a significant hazard to public health.

[42 USC 300f et seq., Sec. 300h-3]

Note: Underground injection applies to the use of tracers during construction and testing, not

to radioactive waste disposal.

3.2.2C3 (a) Compliance with Federal, State, and local requirements, etc.; scope of applicability of compliance requirements, etc.; liability for civil penalties

Each Federal agency (1) having jurisdiction over any federally owned or maintained public water system or (2) engaged in any activity resulting, or which may result in, underground injection which endangers drinking water (within the meaning of section 300h(d)(2) shall be subject to and comply with, all Federal, State, and local requirements, administrative authorities, and process and sanctions respecting the provision of safe drinking water and respecting any underground injection program in the same manner, and to the same extent, as any nongovernmental entity. The preceding sentence shall apply

(A) to any requirement whether substantive or procedural (including any recordkeeping or reporting requirement, any requirement respecting permits, and any other requirement whatsoever),

(B) to the exercise of any Federal, State, or local administrative authority,

[42 USC 300f et seq., Sec.300j-6]

3.2.2C4 Unless the Commission determines with respect to the site described in the application that it is not necessary, site characterization shall include a program of in situ exploration and testing at the depths that wastes would be emplaced.

[10 CFR 60.15(b)]

3.2.2C5 The program of site characterization shall be conducted in accordance with the following: ...

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

[10 CFR 60.15(c)]

3.2.2C6 Before proceeding to sink shafts at any area which has been approved by the President for site characterization, DOE shall submit to the Director, for review and comment, a site characterization plan for such area. DOE shall defer the sinking of such shafts until such time as there has been an opportunity for Commission comments thereon to have been solicited and considered by DOE.

[10 CFR 60.16]

3.2.2C7 (c) The Safety Analysis Report shall include:

(11) A description of design considerations that are intended to facilitate permanent closure

and decontamination or dismantlement of surface facilities.

[10 CFR 60.21]

3.2.2C8 (a) Protection against radiation exposures and releases of radioactive material. The geologic repository operations area shall be designed so that until permanent closure has been completed, radiation exposures and radiation levels, and releases of radioactive materials to unrestricted areas, will at all times be maintained within the limits specified in Part 20 of this chapter and such generally applicable environmental standards for radioactivity as may have been established by the Environmental Protection Agency.

[10 CFR 60.111]

3.2.2C9 (b) Retrievability of waste.

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

(3) For purposes of this paragraph, a reasonable schedule for retrieval is one that would permit retrieval in about the same time as that devoted to construction of the geologic repository operations area and the emplacement of wastes.

[10 CFR 60.111]

3.2.2C10 The geologic repository operations area shall be designed so as to permit implementation of a performance confirmation program that meets the requirements of Subpart F of this part.

[10 CFR 60.137]

3.2.2C11 The quality assurance program applies to all systems, structures and components important to safety, to design and characterization of barriers important to waste isolation and to activities related thereto. These activities include: site characterization, facility and equipment construction, facility operation, performance confirmation, permanent closure, and decontamination and dismantling of surface facilities.

[10 CFR 60.151]

3.2.2C12 DOE shall implement a quality assurance program based on the criteria of Appendix B of 10 CFR Part 50 as applicable, and appropriately supplemented by additional

criteria as required by Section 60.151.

[10 CFR 60.152]

3.2.2C13 The DOE shall mitigate significant adverse environmental impacts, to the extent practicable, during site characterization ....

[10 CFR 960.3-4]

3.2.2C14 7. Policy. It is Department policy to:

a. Assure the protection of the environment and the health and safety of the public.

b. Assure safe and healthful workplaces and conditions of employment for all employees of DOE and DOE contractors as described in paragraph 6, above.

d. Assure compliance with applicable statutory requirements affecting Federal facilities and operations and where possible, consistent with the Department"s mission and supported by appropriate cost/benefit analysis, reduce identified environment, safety, and health risks, even though not mandated by specific requirements.

e. Assure that quality assurance is pursued (i.e. that research, development, demonstration, and production activities are performed in a controlled manner; that components, systems, and processes are designed, developed, constructed,tested, operated, and maintained according to industry accepted engineering standards, quality practices, and Technical Specifications/Operational Safety Requirements; and that resulting technology data are valid and retrievable).

[DOE Order 5480.1B p 06]

3.2.2C15 The design objectives for personnel exposure from external sources of radiation in continuously occupied controlled areas are ALARA and not exceeding 0.5 mrem (5 microsieverts) per hour on average. The design objectives for exposure rates for potential exposure to a radiation worker where occupancy is generally not continuous are ALARA and not exceeding 20 percent of the applicable standard in paragraphs 9b(1) and (2).

[DOE Order 5480.11(9)(j)(1)(b)]

Note: Controlled Area: Any area to which access is controlled in order to protect individuals from exposure to radiation and radioactive materials. [DOE Order 5480.11]

3.2.2C16 The following MSHA standards are relevant to underground operations conducted by the OCRWM program:

30 CFR Parts 31, 32, 36, 48, 49 and 57.

In addressing these standards, DOE may encounter situations in which DOE considers that an alternative approach to that specified in the standards is required. In those instances, DOE will consult with MSHA to arrive at a mutually agreeable solution.

[MOU Between DOE and DOL]

B. Performance:

3.2.2P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.17 (a) A general plan for site characterization activities to be conducted at the area to be characterized, which general plan shall include:

(2) A description of such site characterization activities, including the following -

(iv) Plans to control any adverse impacts from such site characterization activities that are important to safety or that are important to waste isolation;

[DOE letter dated 2/27/90]

3.2.2P2 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.134 (a) General design criterion. Seals for shafts 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 or the period following permanent closure.

(b) Selection of materials and placement methods. Materials and placement methods for seals shall be selected to reduce, to the extent practicable:

(1) The potential for creating a preferential pathway for groundwater to contact the waste packages or

(2) For radionuclide migration through existing pathways.

[DOE letter dated 2/27/90]

C. Interface:

3.2.2I1 Requirements at this level to be specified

3.2.2O1 Records and reports; inspections

(a)(1)(A) the Administrator shall require the owner or operator of any point source to (i) establish and maintain such records, (ii) make such reports, (iii) install, use, and maintain such monitoring equipment or methods (including where appropriate, biological monitoring methods), (iv) sample such effluent (in accordance with such methods, at such

locations, at such intervals, and in such manner as the Administrator shall prescribe), and (v) provide such other information as he may reasonably require;

[33 USC 1251 et seq., Sec. 1318]

3.2.2O2 Requirements at this level to be specified

3.2.2O3 Requirements at this level to be specified

3.2.2O4 Requirements at this level to be specified

Table F3.2.2.1 Function Description: Construct ESF

I. Function ID Number: 3.2.2.1

II. Function Title: Construct ESF

III. Function Definition:

To construct the ESF surface facilities and subsurface exploratory openings including: surface to underground accesses, drifts, test areas, rooms and alcoves as well as drilling boreholes.

T_o is start of construction of surface and subsurface facilities.

T_f is when the last planned test excavation is finished.

IV. Interfaces:

A. Inputs:

3.2.2.1I1	Existing Yucca Mountain Site	**From:**	Outside System Boundary

B. Outputs:

3.2.2.1O1	ESF	**To:**	Function 3.2.2.2/3.2.2.4
3.2.2.1O2	Construction Records	**To:**	Outside System Boundary
3.2.2.1O3	Muck	**To:**	Outside System Boundary/Function 3.2.2.3
3.2.2.1O4	Effluents	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints:

3.2.2.1C1 Sections 60.131 through 60.134 specify minimum criteria for the design of the geologic repository operations area. These design criteria are not intended to be exhaustive, however. Omissions in 60.131 through 60.134 do not relieve DOE from any obligation to provide such safety features in a specific facility needed to achieve the performance objectives. All design bases must be consistent with the results of site characterization activities.

[10 CFR 60.130]

3.2.2.1C2 (b) Structures, systems, and components important to safety -- (1) Protection against natural phenomena and environmental conditions. The structures, systems, and components important to safety shall be designed so that natural phenomena and environmental conditions anticipated at the geologic repository operations area will not interfere with necessary safety functions.

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

(3) Protection against fires and explosions. (i) The structures, systems, and components important to safety shall be designed to perform their safety functions during and after credible fires or explosions in the geologic repository operations area.

(ii) To the extent practicable, the geologic repository operations area shall be designed to incorporate the use of noncombustible and heat resistant materials.

(iii) 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 important to safety.

(iv) The geologic repository operations area shall be designed to include means to protect systems, structures, and components important to safety against the adverse effects of either the operation or failure of the fire suppression systems.

(4) Emergency capability.

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

(6) Inspection, testing, and maintenance. The structures, systems, and components important to safety shall be designed to permit periodic inspection, testing, and maintenance, as necessary, to ensure their continued functioning and readiness.

(9) Compliance with mining regulations. To the extent that DOE is not subject to the Federal Mine Safety and Health Act of 1977, as to the construction and operation of the

geologic repository operations area, the design of the geologic repository operations area shall nevertheless include such provisions for worker protection as may be necessary to provide reasonable assurance that all structures, systems, and components important to safety can perform their intended functions. Any deviation from relevant design requirements in 30 CFR, Chapter I, Subchapters D, E, and N will give rise to a rebuttable presumption that this requirement has not been met.

[10 CFR 60.131]

B. Performance:

3.2.2.1P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.131 (b) Structures, systems, and components important to safety --

(4) Emergency capability.

(ii) The geologic repository operations area shall be designed to include onsite facilities and services that ensure a safe and timely response to emergency conditions and that facilitate the use of available offsite services (such as fire, police, medical and ambulance service) that may aid in recovery from emergencies.

(8) Instrumentation and control systems. The design shall include provisions for instrumentation and control systems to monitor and control the behavior of systems important to safety over anticipated ranges for normal operation and for accident conditions.

(10) Shaft conveyances used in radioactive waste handling.

(i) Hoists important to safety shall be designed to preclude cage free fall.

(ii) Hoists important to safety shall be designed with a reliable cage location system.

(iii) Loading and unloading systems for hoists important to safety shall be designed with a reliable system of interlocks that will fail safely upon malfunction.

(iv) Hoists important to safety shall be designed to include two independent indicators to indicate when waste packages are in place and ready for transfer.

[DOE letter dated 2/27/90]

C. Interface:

3.2.2.1I1 Requirements at this level to be specified

3.2.2.1O1 Requirements at this level to be specified

3.2.2.1O2a (d) Accident investigations; records.

All accidents, including unintentional roof falls (except in any abandoned panels or in areas which are inaccessible or unsafe for inspections), shall be investigated by the operator or his agent to determine the cause and the means of preventing a recurrence. Records of such accidents and investigations shall be kept and the information shall be made available to the Secretary (of Labor) or his authorized representative and the appropriate State agency. Such records shall be open for inspection by interested persons. Such records shall include man-hours worked and shall be reported at a frequency determined by the Secretary (of Labor), but at least annually.

[30 USC 801 et seq., Section 813]

3.2.2.1O2b (h) Records and reports; compilation and publication; availability.

In addition to such records as are specifically required by this chapter, every operator of a coal or other mine shall establish and maintain such records, make such reports, and provide such information, as the Secretary (of Labor) or the Secretary of Health and Human Services may reasonably require from time to time to enable him to perform his functions under this chapter.

[30 USC 801 et seq., Section 813]

3.2.2.1O2c (a) DOE shall maintain records of construction of the geologic repository operations area in a manner that ensures their useability for future generations in accordance with Section 60.51(a)(2).

(b) The records required under paragraph (a) shall include at least the following:

1) Surveys of the underground facility excavations, shafts, and boreholes referenced to readily identifiable surface features or monuments;

2) A description of the materials encountered;

3) Geologic maps and geologic cross sections;

4) Locations and amount of seepage;

5) Details of equipment, methods, progress, and sequence of work;

6) Construction problems;

7) Anomalous conditions encountered;

8) Instrument locations, readings, and analysis;

9) Location and description of structural support systems;

10) Location and description of dewatering systems; and

11) Details, methods of emplacement, and location of seals used.

[10 CFR 60.72]

3.2.2.1O3 Requirements at this level to be specified

3.2.2.1O4a Effluent limitations

(a) Except as in compliance with this section and sections 1312, 1316, 1317, 1328, 1342, and 1344 of this title, the discharge of any pollutant by any person shall be unlawful.

(f) Notwithstanding any other provisions of this chapter it shall be unlawful to discharge any radiological, chemical, or biological warfare agent any high-level radioactive waste or any medical waste, into the navigable waters.

[33 USC 1251 et seq., Sec. 1311]

3.2.2.1O4b National standards of performance

(d) Protection from more stringent standards

Notwithstanding any other provision of this chapter, any point source the construction of which is commenced after October 18, 1972, and which is so constructed as to meet all applicable standards of performance shall not be subject to any more stringent standard of performance during a ten-year period beginning on the date of completion of such construction or during the period of depreciation or amortization of such facility for the purposes of section 167 or 169 (or both) of title 26 whichever period ends first.

[33 USC 1251 et seq., Sec. 1316]

3.2.2.1O4c Records and reports; inspections

(a)(1)(A) the Administrator shall require the owner or operator of any point source to (i) establish and maintain such records, (ii) make such reports, (iii) install, use, and maintain such monitoring equipment or methods (including where appropriate, biological monitoring methods), (iv) sample such effluent (in accordance with such methods, at such locations, at such intervals, and in such manner as the Administrator shall prescribe), and (v) provide such other information as he may reasonably require;

[33 USC 1251 et seq., Sec. 1318]

Table F3.2.2.1.1 Function Description: Prepare Site

I. Function ID Number: 3.2.2.1.1

II. Function Title: Prepare Site

III. Function Definition:

To prepare the site for construction activities and to provide and prepare surface locations to support the ESF activities. Prepare Site comprises general area improvements for ESF surface facilities and includes surveying the site, construction of ESF site access roads, site grading and grubbing, water control, top soil and spoils management, and site pads preparation.

IV. Interfaces:

A. Inputs:

3.2.2.1.1I1	Existing Yucca Mountain Site	**From:**	Outside System Boundary

B. Outputs:

3.2.2.1.1O1	Topsoil	**To:**	Function 3.2.2.4
3.2.2.1.1O2	Spoils	**To:**	Function 3.2.2.4
3.2.2.1.1O3	Construction Records	**To:**	Outside System Boundary
3.2.2.1.1O4	Effluents	**To:**	Outside System Boundary/Function 3.2.2.3
3.2.2.1.1O5	Prepared Site	**To:**	Function 3.2.2.1.2/3.2.2.1.3

V. Function Requirements: Requirements at this level to be specified.

Table F3.2.2.1.1.1 Function Description: Survey Site

I. Function ID Number: 3.2.2.1.1.1

II. Function Title: Survey Site

III. Function Definition:

To survey the site in preparation of site construction activities and to provide location control of site facilities. Surveys include but are not limited to: archaeological, biological, soil pre-activity surveys, topographical, and construction control.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified.

Table F3.2.2.1.1.2 Function Description: Construct Access Roads

I. Function ID Number: 3.2.2.1.1.2

II. Function Title: Construct Access Roads

III. Function Definition:

To construct all ESF surface-related access roads for vehicular traffic required to support ESF facilities and activities.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified.

Table F3.2.2.1.1.3 Function Description: Perform Site Grading

I. Function ID Number: 3.2.2.1.1.3

II. Function Title: Perform Site Grading

III. Function Definition:

To perform ESF site grading and grubbing for ESF surface facilities. To collect and store for reclamation, all surface soil removed from the ESF site and to establish spoils control

and disposal.

IV. Interfaces:

A. Inputs:	None identified at this time
B. Outputs:	None identified at this time
V. Function Requirements:	Requirements at this level to be specified.

Table F3.2.2.1.1.4 Function Description: Construct Site Pads

I. Function ID Number:	3.2.2.1.1.4
II. Function Title:	Construct Site Pads

III. Function Definition:

To construct general civil improvements consisting of main site(s) pads and auxiliary pad(s).

IV. Interfaces:

A. Inputs:	None identified at this time
B. Outputs:	None identified at this time
V. Function Requirements:	Requirements at this level to be specified.

Table F3.2.2.1.2 Function Description: Construct Surface Facilities

I. Function ID Number:	3.2.2.1.2
II. Function Title:	Construct Surface Facilities

III. Function Definition:

To construct all temporary and permanent ESF surface facilities that are required for the

support of ESF operations and in situ site characterization.

IV. Interfaces:

A. Inputs:

3.2.2.1.2I1	Prepared Site	**From:**	Function 3.2.2.1.1

B. Outputs:

3.2.2.1.2O1	Construction Records	**To:**	Outside System Boundary
3.2.2.1.2O2	Effluents	**To:**	Outside System Boundary
3.2.2.1.2O3	Surface Facilities	**To:**	Function 3.2.2.4

V. Function Requirements: Requirements at this level to be specified.

Table F3.2.2.1.3 Function Description: Excavate Subsurface

I. Function ID Number: 3.2.2.1.3

II. Function Title: Excavate Subsurface

III. Function Definition:

To excavate all ESF subsurface openings, including borings, shaft(s), ramp(s), test rooms, test support alcoves, and underground mains and drifts.

IV. Interfaces:

A. Inputs:

3.2.2.1.3I1	Prepared Site	**From:**	Function 3.2.2.1.1

B. Outputs:

3.2.2.1.3O1	Construction Records	**To:**	Outside System Boundary
3.2.2.1.3O2	Effluents	**To:**	Outside System Boundary
3.2.2.1.3O3	Muck	**To:**	Outside System Boundary
3.2.2.1.3O4	Pretest Site	**To:**	Function 3.2.2.2
3.2.2.1.3O5	Accesses/Mains/Drifts/ Test Rooms/Alcoves	**To:**	Function 3.2.2.1.4

V. Function Requirements:

A. Constraints:

3.2.2.1.3C1 (a) General criteria for the underground facility.

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

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

[10 CFR 60.133]

3.2.2.1.3C2 (b) Flexibility of design. 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.

[10 CFR 60.133]

3.2.2.1.3C3 (c) Retrieval of waste. The underground facility shall be designed to permit retrieval of waste in accordance with the performance objectives of Section 60.111.

[10 CFR 60.133]

3.2.2.1.3C4 (d) Control of water and gas. The design of the underground facility shall provide for control of water or gas intrusion.

[10 CFR 60.133]

3.2.2.1.3C5 (e) Underground openings.

(1) Openings in the underground facility shall be designed so that operations can be carried out safely and the retrievability option maintained.

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

[10 CFR 60.133]

3.2.2.1.3C6 (f) Rock excavation. 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.

[10 CFR 60.133]

3.2.2.1.3C7 (h) Engineered barriers. Engineered barriers shall be designed to assist the geologic setting in meeting the performance objectives for the period following permanent closure.

[10 CFR 60.133]

3.2.2.1.3C8 (i) Thermal loads. The underground facility shall be designed so that the performance objectives will be met taking into account the predicted thermal and thermomechanical response of the host rock, and surrounding strata, groundwater system.

[10 CFR 60.133]

3.2.2.1.3C9 (d) Disqualifying Condition. The site shall be disqualified if site conditions do not allow all portions of the underground facility to be situated at least 200 meters below the directly overlying ground surface.

[10 CFR 960.4-2-5]

3.2.2.1.3C10 (d) Disqualifying Condition. A site shall be disqualified if, based on expected ground-water conditions, it is likely that engineering measures that are beyond reasonably available technology will be required for exploratory-shaft construction or for repository construction, operation, or closure.

[10 CFR 960.5-2-10]

3.2.2.1.3C11 (d) Disqualifying Condition. A site shall be disqualified if, based on the expected nature and rates of fault movement or other ground motion, it is likely that engineering measures that are beyond reasonably available technology will be required for exploratory-shaft construction or for repository construction, operation, or closure.

[10 CFR 960.5-2-11]

B. Performance: Requirements at this level to be specified.

C. Interface:

3.2.2.1.3I1a The geologic setting shall be selected and the engineered barrier system and the shafts, boreholes and their seals shall be designed to assure that releases of radioactive materials to the accessible environment following permanent closure conform to such generally applicable environmental standards for radioactivity as may have been established by the Environmental Protection Agency with respect to both anticipated processes and events and unanticipated processes and events.

[10 CFR 60.112]

3.2.2.1.3I1b DOE shall consider the following requirement in ESF design activities:

10 CFR 60.113(a)(2) Geologic setting. The geologic repository shall be located so that pre-waste-emplacement groundwater travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment shall be at least 1,000 years or such other travel time as may be approved or specified by the Commission.

[DOE letter dated 2/27/90]

3.2.2.1.3I1c DOE shall consider the following requirement in ESF design activities:

10 CFR 60.113(b) On a case-by-case basis, the Commission may approve or specify some other radionuclide release rate, designed containment period or pre-waste-emplacement groundwater travel time, provided that the overall system performance objective, as it relates to anticipated processes and events, is satisfied. Among the factors that the Commission may take into account are: ...

(2) The age and nature of the waste, and the design of the underground facility, particularly as these factors bear upon the time during which the thermal pulse is dominated by the decay heat from the fission products;

(3) The geochemical characteristics of the host rock, surrounding strata and groundwater; and

(4) Particular sources of uncertainty in predicting the performance of the geologic repository.

[DOE letter dated 2/27/90]

3.2.2.1.3O1 Requirements at this level to be specified

3.2.2.1.3O2 Requirements at this level to be specified

3.2.2.1.3O3 Rock dust and gas hazards; controls.

The dust resulting from drilling in rock shall be controlled by the use of permissible dust collectors, or by water or water with a wetting agent, or by ventilation, or by any other method or device approved by the Secretary (of Labor) which is at least as effective in controlling such dust. Respiratory equipment approved by the Secretary (of Labor) and the Secretary of Health and Human Services shall be provided persons exposed for short periods to inhalation hazards from gas, dusts, fumes or mist. When the exposure is for prolonged periods, other measures to protect such persons or to reduce the hazard shall be taken.

[30 USC 801 et seq., Section 844]

3.2.2.1.3O4a (a) General provisions --

(1) Engineered barrier system.

(i) The engineered barrier system shall be designed so that assuming anticipated

processes and events:

(A) Containment of HLW will be substantially complete during the period when radiation and thermal conditions in the engineered barrier system are dominated by fission product decay; and

(B) any release of radionuclides from the engineered barrier system shall be a gradual process which results in small fractional releases to the geologic setting over long times. For disposal in the saturated zone, both the partial and complete filling with groundwater of available void spaces in the underground facility shall be appropriately considered and analyzed among the anticipated processes and events in designing the engineered barrier system.

[10 CFR 60.113]

3.2.2.1.3O4b (a) General provisions --

(1) Engineered barrier system.

(ii) In satisfying the preceding requirement, the engineered barrier system shall be designed, assuming anticipated processes and events, so that:

(A) Containment of HLW within the waste packages will be substantially complete for a period to be determined by the Commission taking into account the factors specified in Section 60.113(b) provided, that such period shall be not less than 300 years nor more than 1,000 years after permanent closure of the geologic repository; and

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

[10 CFR 60.113]

3.2.2.1.3O4c Furthermore, engineered barriers shall not be used to compensate for an inadequate site; mask the innate deficiencies of a site; disguise the strengths and weaknesses

of a site and the overall system; and mask differences between sites when they are compared.

[10 CFR 960.3-1-5]

3.2.2.1.3O5 Requirements at this level to be specified

Table F3.2.2.1.3.1 Function Description: Excavate Accesses

I. Function ID Number: 3.2.2.1.3.1

II. Function Title: Excavate Accesses

III. Function Definition:

To excavate accesses from surface to underground mains.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints:

3.2.2.1.3.1C1 Escapeways and refuges.

(a) Every mine shall have two or more separate, properly maintained escapeways to the surface from the lowest levels which are so positioned that damage to one shall not lessen the effectiveness of the others. A method of refuge shall be provided while a second opening to the surface is being developed. A second escapeway is recommended, but not required, during the exploration or development of an ore body.

(b) In addition to separate escapeways, a method of refuge shall be provided for every employee who cannot reach the surface from his working place through at least two separate escapeways within a time limit of one hour when using the normal exit method. These refuges must be positioned so that the employee can reach one of them within 30 minutes from the time he leaves his workplace.

[30 CFR 57.11050]

B. Performance: Requirements at this level to be specified.

C. Interface: Requirements at this level to be specified.

Table F3.2.2.1.3.2 Function Description: Excavate Test Rooms and Test Alcoves

I. Function ID Number: 3.2.2.1.3.2

II. Function Title: Excavate Test Rooms and Test Alcoves

III. Function Definition:

To excavate test rooms, alcoves and drill boreholes for testing activities and for IDS.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs:

3.2.2.1.3.2O1 (Pretest site) **To:** Function 3.2.2.2

V. Function Requirements:

3.2.2.1.3.2O1 Requirements specified by pretest site input requirements for individual tests defined under Function 3.2.2.2.

Table F3.2.2.1.3.3 Function Description: Excavate Mains

I. Function ID Number: 3.2.2.1.3.3

II. Function Title: Excavate Mains

III. Function Definition:

To excavate the underground main drifts which will connect shaft(s) and/or ramp(s) to the test alcoves, support alcoves and other underground drifts (non-mains).

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified.

Table F3.2.2.1.3.4 Function Description: Excavate Subsurface Support Alcoves

I. Function ID Number: 3.2.2.1.3.4

II. Function Title: Excavate Subsurface Support Alcoves

III. Function Definition:

To excavate underground support alcoves which will house utility equipment, pumping systems, storage areas, etc. which will not be used as testing alcoves.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified.

Table F3.2.2.1.3.5 Function Description: Excavate Drifts

I. Function ID Number: 3.2.2.1.3.5

II. Function Title: Excavate Drifts

III. Function Definition:

To excavate underground drifts other than those designated as mains.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified.

Table F3.2.2.1.4 Function Description: Construct Subsurface Facilities

I. Function ID Number: 3.2.2.1.4

II. Function Title: Construct Subsurface Facilities

III. Function Definition:

To construct ESF subsurface operational support facilities that are required for the support of ESF operations and in-situ site characterization.

IV. Interfaces:

A. Inputs:

3.2.2.1.4I1	Accesses/Mains/Drifts/ Alcoves	**From:**	Function 3.2.2.1.3

B. Outputs:

3.2.2.1.4O1	Construction Records	**To:**	Outside System Boundary
3.2.2.1.4O2	Effluents	**To:**	Outside System Boundary/Function 3.2.2.3
3.2.2.1.4O3	Subsurface Facilities	**To:**	Function 3.2.2.4

V. Function Requirements: Requirements at this level to be specified.

Table F3.2.2.2 Function Description: Conduct ESF Tests

I. Function ID Number: 3.2.2.2

II. Function Title: Conduct ESF Tests

III. Function Definition:

To conduct the tests already identified for the ESF-related activities in section 4.0, Appendix G - ESF Mission Analysis and any additional tests that may be defined by the DOE or the NRC (10 CFR 60.74) to be performed within the ESF facility. Directly pertaining to the ESF and derived from 10 CFR 960, subpart C, eight (8) categories of investigations have been identified. These investigations are important in developing and exercising models which can be used to assess the suitability of Yucca Mountain for a repository.

IV. Interfaces:

A. Inputs:

3.2.2.2I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2O1	Effluents	**To:**	Outside System Boundary/ Function 3.2.2.3
3.2.2.2O2	Data	**To:**	Function 3.2.2.1 (Control)/Function 3.2.2.3
3.2.2.2O3	Samples	**To:**	Outside System Boundary/ Function 3.2.2.3
3.2.2.2O4	Characterized Site	**To:**	Outside System Boundary/ Function 3.2.2.4
3.2.2.2O5	Records	**To:**	Function 3.2.2.3

V. Function Requirements:

A. Constraints

3.2.2.2C1 (a) DOE shall perform, or permit the Commission to perform, such tests as the Commission deems appropriate or necessary for the administration of the regulations in this part. These may include tests of:

(1) Radioactive waste,

(2) The geologic repository including its structures, systems, and components,

(3) Radiation detection and monitoring instruments, and

(4) Other equipment and devices used in connection with the receipt, handling, or storage of radioactive waste.

(b) The tests required under this section shall include a performance confirmation program carried out in accordance with Subpart F of this part.

[10 CFR 60.74]

3.2.2.2C2 (b) The program shall have been started during site characterization and it will continue until permanent closure.

(c) The program shall include in situ monitoring, laboratory and field testing, and in situ experiments, as may be appropriate to accomplish the objective as stated above.

(d) The program shall be implemented so that:

(1) It does not adversely affect the ability of the natural and engineered elements of the geologic repository to meet the performance objectives.

[10 CFR 60.140]

3.2.2.2C3 (a) During repository construction and operation, a continuing program of surveillance, measurement, testing, and geologic mapping shall be conducted to ensure that geotechnical and design parameters are confirmed and to ensure that appropriate action is taken to inform the Commission of changes needed in design to accommodate actual field conditions encountered.

(b) Subsurface conditions shall be monitored and evaluated against design assumptions.

(c) As a minimum, measurements shall be made of rock deformations and displacement, changes in rock stress and strain, rate and location of water inflow into subsurface areas, changes in groundwater conditions, rock pore water pressures including those along fractures and joints, and the thermal and thermomechanical response of the rock mass as a result of development and operations of the geologic repository.

(d) These measurements and observations shall be compared with the original design bases and assumptions. If significant differences exist between the measurements and observations and the original design bases and assumptions, the need for modifications to the design or in construction methods shall be determined and these differences and the recommended changes reported to the Commission.

(e) In situ monitoring of the thermomechanical response of the underground facility shall be conducted until permanent closure to ensure that the performance of the natural and engineering features are within design limits.

[10 CFR 60.141]

3.2.2.2C4 (a) During the early or developmental stages of construction, a program for in situ testing of such features as borehole and shaft seals, backfill, and the thermal interaction effects of the waste packages, backfill, rock, and groundwater shall be conducted.

(b) The testing shall be initiated as early as is practicable.

(c) A backfill test section shall be constructed to test the effectiveness of backfill placement and compaction procedures against design requirements before permanent backfill placement is begun.

(d) Test sections shall be established to test the effectiveness of borehole and shaft seals before full-scale operation proceeds to seal boreholes and shafts.

[10 CFR 60.142]

B. Performance:

3.2.2.2P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.17 (b) A description of the possible waste form or waste package for the high-level radioactive waste to be emplaced in such geologic repository, a description (to the extent practicable) of the relationship between such waste form or waste package and the host rock at such area, and a description of the activities being conducted by DOE with respect to such possible waste form or waste package or their relationship; and

(c) A conceptual design for the geologic repository operations area that takes into account likely site-specific requirements.

[DOE letter dated 2/27/90]

3.2.2.2P2 DOE shall consider the following requirement in ESF design activities:10 CFR 60.143 (a) A program shall be established at the geologic repository operations area for monitoring the condition of the waste packages. Waste packages chosen for the program shall be representative of those to be emplaced in the underground facility.

(b) Consistent with safe operation at the geologic repository operations area, the environment of the waste packages selected for the waste package monitoring program shall be representative of the environment in which the wastes are to be emplaced.

(c) The waste package monitoring program shall include laboratory experiments which focus on the internal condition of the waste packages. To the extent practical, the environment experienced by the emplaced waste packages within the underground facility during the waste package monitoring program shall be duplicated in the laboratory experiments.

(d) The waste package monitoring program shall continue as long as practical up to the time of permanent closure.

[DOE letter dated 2/27/90]

3.2.2.2P3 No radioactive waste tests shall be conducted in the ESF.

[SCPB Section 8.7.1]

C. Interface:

3.2.2.2I1 Requirements at this level to be specified

3.2.2.2O1 Records and reports; inspections

(a)(1)(A) the Administrator shall require the owner or operator of any point source to (i) establish and maintain such records, (ii) make such reports, (iii) install, use, and maintain such monitoring equipment or methods (including where appropriate, biological monitoring methods), (iv) sample such effluent (in accordance with such methods, at such locations, at such intervals, and in such manner as the Administrator shall prescribe), and (v) provide such other information as he may reasonably require;

[33 USC 1251 et seq., Sec. 1318]

3.2.2.2O2 Requirements at this level to be specified

3.2.2.2O3 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2O4 Requirements at this level to be specified

Table F3.2.2.2.1 Function Description: Test Unsaturated-Zone Hydrology

I. Function ID Number: 3.2.2.2.1

II. Function Title: Test Unsaturated-Zone Hydrology

III. Function Definition:

To test the hydrologic properties of the unsaturated zone in order to provide a sufficient set of data to develop models of the UZ hydrologic system at Yucca Mountain which can be used to determine compliance with the requirements of 10 CFR 60 and 40 CFR 191 for radionuclide release. Development of these models requires an understanding of the manner in which water and gases move through the UZ including

the directions, paths, and rates in which flow occurs.

IV. Interfaces:

A. Inputs:

3.2.2.2.1I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.1O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.1O2	Samples	**To:**	Outside System Boundary/ Function 3.2.2.3
3.2.2.2.1O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.1O4	Characterized Site	**To:**	Outside System Boundary/ Function 3.2.2.4

V. Function Requirements: Requirements at this level to be specified

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Table F3.2.2.2.1.1 Function Description: Conduct Chloride and Chlorine-36 Measurements of Percolation at Yucca Mountain

I. Function ID Number: 3.2.2.2.1.1

II. Function Title: Conduct Chloride and Chlorine-36 Measurements of Percolation at Yucca Mountain

III. Function Definition:

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

IV. Interfaces:

A. Inputs:

3.2.2.2.1.1I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.1.1O1	Data	To:	Function 3.2.2.3
3.2.2.2.1.1O2	Samples	To:	Function 3.2.2.3
3.2.2.2.1.1O3	Records	To:	Function 3.2.2.3
3.2.2.2.1.1O4	Characterized Site	To:	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.1.1P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

> (24) Potential for the movement of radionuclides in a gaseous state through air-filled pore spaces of an unsaturated geologic medium to the accessible environment.

[DOE letter dated 2/27/90]

3.2.2.2.1.1P2 Bulk samples and core samples shall be collected from several locations representative of the formations in the ESF.

3.2.2.2.1.1P3 Water samples shall be collected whenever perched water is encountered.

3.2.2.2.1.1P4 Geologic maps, photographs, test locations, and test records including field description of the samples shall be prepared.

C. Interface:

3.2.2.2.1.1I1a Water usage shall be minimized in the test area.

3.2.2.2.1.1I1b If blasting is used, the blast produced chemicals shall not contaminate the pretest condition of samples to be collected.

3.2.2.2.1.1O1 No field data produced. Samples will be analyzed in the laboratory to obtain chlorine isotope age dates.

3.2.2.2.1.1O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.1.1O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.1.1O4 The condition of the site after this activity shall be unchanged, except for the sample collection (e.g. core holes).

Table F3.2.2.2.1.2 Function Description: Conduct Matrix Hydrologic Properties Testing

I. Function ID Number: 3.2.2.2.1.2

II. Function Title: Conduct Matrix Hydrologic Properties Testing

III. Function Definition:

To conduct matrix hydrologic properties in order to develop a comprehensive data base on matrix flux properties in the unsaturated-zone tuffs at Yucca Mountain. This activity includes collecting bulk and/or core samples, taken from the ESF. The collected samples will be packaged, labeled, and sent to an off-site laboratory for various analyses.

Samples are required from various geologic formations intercepted during the construction of accesses to the Topopah Spring Member and excavations made in the Topopah Spring Member and CHn formation.

IV. Interfaces:

A. Inputs:

3.2.2.2.1.2I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.1.2O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.1.2O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.1.2O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.1.2O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.1.2P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (b) Favorable conditions.

(8) For disposal in the unsaturated zone, hydrogeologic conditions that provide --

(i) Low moisture flux in the host rock and in the overlying and underlying hydrogeologic units;

[DOE letter dated 2/27/90]

3.2.2.2.1.2P2 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (b) Favorable conditions.

(8) For disposal in the unsaturated zone, hydrogeologic conditions that provide --

(iii) A laterally extensive low-permeability hydrogeologic unit above the host rock that would inhibit the downward movement of water or divert downward moving water to a location beyond the limits of the underground facility;

[DOE letter dated 2/27/90]

3.2.2.2.1.2P3 Bulk and/or core samples (some large enough not to pass a 1-ft mesh) shall be collected from various geologic formations intercepted during the construction of accesses to, and excavations of, the Topopah Spring member, and CHn formation.

3.2.2.2.1.2P4 Geologic maps, location maps, photographs, and installation records shall be prepared.

3.2.2.2.1.2P5 Core holes shall be drilled dry.

3.2.2.2.1.2P6 Water contamination of any bulk samples shall be minimized.

C. Interface:

3.2.2.2.1.2I1a Water used in the ESF shall contain non-chlorine tracers to indicate change in pretest site conditions due to construction activity.

3.2.2.2.1.2I1b Existing accesses in TSw1 and drifts in TSw2 shall be provided for this activity.

3.2.2.2.1.2O1 Requirements at this level to be specified.

3.2.2.2.1.2O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.1.2O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.1.2O4 The condition of the site after this activity shall be unchanged, except for the drilled holes.

Table F3.2.2.2.1.3 Function Description: Conduct Intact-Fracture Test in the ESF

I. Function ID Number: 3.2.2.2.1.3

II. Function Title: Conduct Intact-Fracture Test in the ESF

III. Function Definition:

To conduct intact-fracture test which will be used to evaluate fluid-flow and chemical transport properties and mechanisms in relatively undisturbed and variably stressed fractures to enhance understanding of physics of flow and for flow modeling.

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

IV. Interfaces:

A. Inputs:

3.2.2.2.1.3I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.1.3O1	Samples	**To:**	Function 3.2.2.3
3.2.2.2.1.3O2	Records	**To:**	Function 3.2.2.3
3.2.2.2.1.3O3	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.1.3P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (b) Favorable conditions.

(8) For disposal in the unsaturated zone, hydrogeologic conditions that provide --

(iv) A host rock that provides for free drainage;

[DOE letter dated 2/27/90]

3.2.2.2.1.3P2 Drilling and overcoring shall be done using dry methods.

3.2.2.2.1.3P3 Sample locations shall be chosen by the principal investigator after mapping information is available.

3.2.2.2.1.3P4 The samples shall be collected from different rock types, locations, and orientations in the unsaturated zone.

3.2.2.2.1.3P5 Geologic maps, location maps, photographs and test records shall be prepared.

C. Interface:

3.2.2.2.1.3I1a Flexibility shall be provided for the principal investigator to select the sampling locations.

3.2.2.2.1.3I1b If permanent liners are to be installed, blockouts shall be provided to be able to extract samples of the intact fractures.

3.2.2.2.1.3O1 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.1.3O2 Records shall be provided to the appropriate records processing center.

3.2.2.2.1.3O3 The condition of the site after this activity shall be unchanged except for the removed core samples.

Table F3.2.2.2.1.4 Function Description: Conduct Percolation Tests in the ESF

I. Function ID Number: 3.2.2.2.1.4

II. Function Title: Conduct Percolation Tests in the ESF

III. Function Definition:

To conduct percolation tests which will be used to observe and measure fluid flow through a network of fractures under controlled in situ conditions in order to characterize and quantify important flow processes in fractured welded tuff. The test is planned to use a large, isolated block of rock of approximately 6 ft. on a side. The block will be instrumented to detect fluid flow under physical conditions that can be mechanically controlled and systematically varied. Tracer-tagged water will be introduced from a trickle system/sand bed on the surface of the block.

This test will be performed at the Topopah Spring Member.

IV. Interfaces:

A. Inputs:

3.2.2.2.1.4I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.1.4O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.1.4O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.1.4O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.1.4O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.1.4P1 Water used in this activity shall contain a tracer.

3.2.2.2.1.4P2 This activity shall be conducted in the TSw2.

3.2.2.2.1.4P3 Geologic maps, location maps, photographs, and test records shall be prepared.

C. Interface:

3.2.2.2.1.4I1a A large, isolated block of rock approximately 6 ft. on a side shall be provided in TSw2 for this activity.

3.2.2.2.1.4I1b Two parallel drifts shall be excavated so that the block can be cut from

the pillar between the drifts.

3.2.2.2.1.4I1c Flexibility shall be provided for the principal investigator to locate the block.

3.2.2.2.1.4I1d Excavation methods shall not excessively damage the test block.

3.2.2.2.1.4I1e Connection to the IDS shall be provided at the test location.

3.2.2.2.1.4O1 Field measurements shall include water flow rates through the test block.

3.2.2.2.1.4O2 Samples shall bé packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.1.4O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.1.4O4 The zone of hydrologic or geochemical influence shall not extend beyond the isolated test block.

Table F3.2.2.2.1.5 Function Description: Conduct Bulk-Permeability Test in the ESF

I. Function ID Number: 3.2.2.2.1.5

II. Function Title: Conduct Bulk-Permeability Test in the ESF

III. Function Definition:

To conduct bulk-permeability tests which will be used to assess the fluid transport properties in relatively large volumes of minimally disturbed tuff. Tests are planned at various separate locations in the ESF, selected on the basis of detailed fracture maps. At each location, small-diameter holes will be air-cored and logged. Air permeability will then be measured in packed-off intervals. If the rock is deemed suitable for the test based on the preliminary results, three additional holes, sub-parallel (frustrum configuration) to the first, will be air-cored, logged, and instrumented.

Cross-hole air permeability (injection) tests will be conducted. Pressure, temperature, and humidity sensors will be installed in experiment boreholes. Selected holes will then be pressurized, and the air movement outward to sensors in the other holes will be monitored. The measurements will be repeated as required by using positive or negative pressures in the boreholes.

This test will be conducted at various locations in the ESF at Calico Hills formation

nonwelded unit and at the lower breakout zone in the Topopah Spring welded unit.

IV. Interfaces:

A. Inputs:

3.2.2.2.1.5I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.1.5O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.1.5O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.1.5O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.1.5O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.1.5P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (b) Favorable conditions.

(8) For disposal in the unsaturated zone, hydrogeologic conditions that provide --

(iv) A host rock that provides for free drainage;

[DOE letter dated 2/27/90]

3.2.2.2.1.5P2 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(24) Potential for the movement of radionuclides in a gaseous state through air-filled pore spaces of an unsaturated geologic medium to the accessible environment.

[DOE letter dated 2/27/90]

3.2.2.2.1.5P3 Air permeability measurements shall be conducted between air-drilled holes (frustrum configuration) in both the Calico Hills formation nonwelded unit and the lower breakout zone in TSw2.

3.2.2.2.1.5P4 Geologic maps, photographs, test locations, borehole logs, and test records shall be prepared.

3.2.2.2.1.5P5 Air used in this activity shall contain a tracer.

C. Interface:

3.2.2.2.1.5I1a Water usage shall be minimized in the test area.

3.2.2.2.1.5I1b Connection to the IDS shall be provided at each test location.

3.2.2.2.1.5I1c Flexibility shall be provided to the principal investigator to locate the tests.

3.2.2.2.1.5O1 Field measurements shall include humidity, barometric pressure; borehole locations; fracture dimensions; fracture orientation; hydraulic head and in situ temperature.

3.2.2.2.1.5O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.1.5O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.1.5O4 The condition of the site after this activity shall be unchanged, except for the long (up to 150 ft) boreholes and air tracers.

Table F3.2.2.2.1.6 Function Description: Conduct Radial Borehole Tests in the ESF

I. Function ID Number: 3.2.2.2.1.6

II. Function Title: Conduct Radial Borehole Tests in the ESF

III. Function Definition:

To conduct radial borehole tests which will investigate vertical and lateral movement of gas, water, and vapor on and across hydrogeologic contacts and within the various units, and evaluate near-field excavation effects on hydrologic properties.

Radial borehole tests will be conducted at geologic contacts. At each contact location coreholes will be drilled using air as the drilling fluid. Orientation of the radial boreholes at each location will be determined by analyzing fracture data collected during access wall mapping. Core will be collected, packaged, labeled, and transported to an off-site laboratory for hydrologic analyses (fracture and matrix properties). The holes will be logged and surveyed for fracture and moisture data. Air-permeability tests in packed-off intervals will be conducted to obtain gas permeability data. Across

stratigraphic contacts, cross-hole permeability tests will be run with both gas and water. Long-term monitoring of matrix water potential, pressure, and temperature will also be conducted; formation gases will be sampled periodically.

In the radial borehole tests, test holes are drilled radially outward from the accesses to the Topopah Spring Member and Calico Hills formation.

IV. Interfaces:

A. Inputs:

3.2.2.2.1.6I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.1.6O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.1.6O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.1.6O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.1.6O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.1.6P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (b) Favorable conditions.

(8) For disposal in the unsaturated zone, hydrogeologic conditions that provide --

(i) Low moisture flux in the host rock and in the overlying and underlying hydrogeologic units;

[DOE letter dated 2/27/90]

3.2.2.2.1.6P2 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (b) Favorable conditions.

(8) For disposal in the unsaturated zone, hydrogeologic conditions that provide --

(iii) A laterally extensive low-permeability hydrogeologic unit above the host rock that would inhibit the downward movement of water or divert downward moving water to a location beyond the limits of the underground facility;

[DOE letter dated 2/27/90]

3.2.2.2.1.6P3 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (b) Favorable conditions.

(8) For disposal in the unsaturated zone, hydrogeologic conditions that provide --

(iv) A host rock that provides for free drainage;

[DOE letter dated 2/27/90]

3.2.2.2.1.6P4 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(24) Potential for the movement of radionuclides in a gaseous state through air-filled pore spaces of an unsaturated geologic medium to the accessible environment.

[DOE letter dated 2/27/90]

3.2.2.2.1.6P5 Radial borehole tests shall be dry drilled in the accesses to the Topopah spring member and Calico Hills formation.

3.2.2.2.1.6P6 This test shall be initiated as soon as possible after construction.

3.2.2.2.1.6P7 Air permeability tests in packed-off intervals shall be conducted to obtain gas permeability data.

3.2.2.2.1.6P8 Across stratigraphic contacts, cross-hole permeability tests shall be conducted with both gas (nitrogen) and water.

3.2.2.2.1.6P9 Long-term monitoring of matrix water potential, pressure and temperature shall be conducted; formation gases shall be sampled periodically.

3.2.2.2.1.6P10 Geologic maps, photographs, test locations, borehole logs and test records shall be prepared.

C. Interface:

3.2.2.2.1.6I1a Test alcoves shall be provided to allow periodic access to the test locations.

3.2.2.2.1.6I1b Connection to the IDS shall be provided at each test location.

3.2.2.2.1.6I1c Flexibility shall be provided to the principal investigator to locate the tests.

3.2.2.2.1.6O1 Field measurements shall include barometric pressure, fracture dimensions,

in situ temperature, and hydraulic head.

3.2.2.2.1.602 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.1.603 Records shall be provided to the appropriate records processing center.

3.2.2.2.1.604 The condition of the site after this activity shall be unchanged, except for the boreholes, test alcoves, and tracers.

Table F3.2.2.2.1.7 Function Description: Conduct Excavation Effects Test in the ESF

I. Function ID Number: 3.2.2.2.1.7

II. Function Title: Conduct Excavation Effects Test in the ESF

III. Function Definition:

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

This test requires multiple small-diameter holes drilled parallel or sub-parallel to the unexcavated opening wall but set back at a selected distance from it. All holes are planned to be air drilled/cored, logged, and surveyed; some of the holes will be instrumented to monitor stress changes and some to monitor permeability changes as the excavation is advanced. Stress and permeability data will be taken in drill holes extended beyond the excavation. Long-term permeability measurements will be made and temperature and moisture data collected. Additional holes may be drilled to handle the instrumentation packages if they are determined to be necessary during prototype testing.

This test will be performed in TSw2.

IV. Interfaces:

A. Inputs:

3.2.2.2.1.7I1 Pretest Site **From:** Function 3.2.2.1

B. Outputs:

3.2.2.2.1.7O1	Data	To:	Function 3.2.2.3
3.2.2.2.1.7O2	Samples	To:	Function 3.2.2.3
3.2.2.2.1.7O3	Records	To:	Function 3.2.2.3
3.2.2.2.1.7O4	Characterized Site	To:	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.1.7P1 This activity shall measure stress changes in the near-field wall-rock as the ESF is excavated and air-permeability changes resulting from the stress redistribution.

3.2.2.2.1.7P2 Multiple small-diameter holes shall be air drilled.

3.2.2.2.1.7P3 This activity shall be conducted in the highly lithophysal zone in the access and in TSw2.

3.2.2.2.1.7P4 Geologic maps, location maps, photographs and installation history records shall be prepared.

C. Interface:

3.2.2.2.1.7I1 Flexibility for locating drill holes shall be provided.

3.2.2.2.1.7O1 Field measurements shall include borehole locations, characteristics; fracture dimensions; fracture orientation; in situ stress, magnitude, orientation; and moisture content, fault zones.

3.2.2.2.1.7O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.1.7O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.1.7O4 The condition of the site after this activity shall be unchanged, except for the drilled holes.

Table F3.2.2.2.1.8 Function Description: Conduct Perched Water Test in the ESF

I. Function ID Number: 3.2.2.2.1.8

II. Function Title: Conduct Perched Water Test in the ESF

III. Function Definition:

To conduct perched-water test the purpose of which is to detect the occurrence, and delineate the lateral and vertical extent, of perched-water zones (if encountered) during excavation, to identify perching mechanism(s), and to sample the water for chemical analyses. Because there is significant uncertainty regarding the likelihood of encountering perched water, the perched-water test is categorized as a "contingency test."

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

This test will be performed wherever in the ESF perched water is encountered, including the CHn.

IV. Interfaces:

A. Inputs:

3.2.2.2.1.8I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.1.8O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.1.8O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.1.8O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.1.8O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.1.8P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(20) Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts.

[DOE letter dated 2/27/90]

3.2.2.2.1.8P2 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(23) Potential for existing or future perched water bodies that may saturate portions of the underground facility or provide a faster flow path from an underground facility located in the unsaturated zone to the accessible environment.

[DOE letter dated 2/27/90]

3.2.2.2.1.8P3 If perched water is encountered during excavation, one or more small diameter hole(s) shall be dry drilled to enhance drainage, facilitate collection of water samples, and allow flow and/or pressure measurements to be made.

3.2.2.2.1.8P4 The holes shall be instrumented and sealed during testing to obtain data on hydraulic pressure and water potential over time.

3.2.2.2.1.8P5 Geologic maps, location maps, photographs and test records shall be prepared.

C. Interface:

3.2.2.2.1.8I1 Construction activity shall be stopped if moisture is visible.

3.2.2.2.1.8O1 Field measurements shall include hydraulic head.

3.2.2.2.1.8O2 Perched water samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.1.8O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.1.8O4 The condition of the site after this activity shall be unchanged, except for the drilled holes.

I. Function ID Number: 3.2.2.2.1.9

II. Function Title: Conduct Hydrochemistry Tests in the ESF

III. Function Definition:

The hydrochemistry tests will determine the chemical composition, reactive mechanisms, and age of water and gas in pores, fractures, and perched-water zones within the unsaturated tuffs accessible from the ESF and/or affiliated core holes. The ESF will provide access for the collection of gas, rock and possibly perched-water samples.

Samples for this test will be collected from the Radial Borehole tests (performed in accesses, the Topopah Spring Member, and the CHn) and from mine rubble or cores from the unsaturated zone.

IV. Interfaces:

A. Inputs:

3.2.2.2.1.9I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.1.9O1	Samples	**To:**	Function 3.2.2.3
3.2.2.2.1.9O2	Records	**To:**	Function 3.2.2.3
3.2.2.2.1.9O3	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.1.9P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (b) Favorable conditions.

(8) For disposal in the unsaturated zone, hydrogeologic conditions that provide --

(i) Low moisture flux in the host rock and in the overlying and underlying hydrogeologic units;

[DOE letter dated 2/27/90]

3.2.2.2.1.9P2 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may

affect isolation within the controlled area.

(7) Groundwater conditions in the host rock, including chemical composition, high ionic strength or ranges of Eh-pH, that could increase the solubility or chemical reactivity of the engineered barrier system.

[DOE letter dated 2/27/90]

3.2.2.2.1.9P3 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(9) Groundwater conditions in the host rock that are not reducing.

[DOE letter dated 2/27/90]

3.2.2.2.1.9P4 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(20) Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts.

[DOE letter dated 2/27/90]

3.2.2.2.1.9P5 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(24) Potential for the movement of radionuclides in a gaseous state through air-filled pore spaces of an unsaturated geologic medium to the accessible environment.

[DOE letter dated 2/27/90]

3.2.2.2.1.9P6 This test shall determine the chemical composition, reactive mechanisms, and age of water and gas in pores, fractures and perched-water zones within the unsaturated tuffs accessible from the ESF and/or affiliated core holes.

3.2.2.2.1.9P7 Large rock samples and dry core for this test shall be collected from the Radial Borehole Tests (Function 3.2.2.2.1.6) performed in the access and TSw2 and from the mine rubble or cores from the unsaturated zone.

3.2.2.2.1.9P8 Geologic maps and location maps shall be prepared.

C. Interface:

3.2.2.2.1.9I1a Water used in the ESF shall contain non-chloride tracers prior to completion of Cl-36 sample collection (Function 3.2.2.2.1.1).

3.2.2.2.1.9I1b All compressed air used in coring and drilling shall contain sulfur hexafluoride (SF_6) as a tracer.

3.2.2.2.1.9I1c Access shall be provided for the collection of gas, rock and possibly perched-water samples.

3.2.2.2.1.9O1 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.1.9O2 Records shall be provided to the appropriate records processing center.

3.2.2.2.1.9O3 The condition of the site after this activity shall be unchanged, except for the sample collections.

Table F3.2.2.2.1.10 Function Description: Conduct Multipurpose-Borehole Testing

I. Function ID Number: 3.2.2.2.1.10

II. Function Title: Conduct Multipurpose-Borehole Testing

III. Function Definition:

To conduct multipurpose-borehole testing in which one or more multi-purpose boreholes will be constructed using dry-drilling and spot-coring techniques, to the extent practicable. The borehole(s) would be located such that they do not penetrate within a distance of two diameters, as appropriate, of any underground openings. The borehole(s) would be drilled to depths approximately equal to the corresponding opening, with walls as smooth as practical to maximize the quality of geophysical logging and provide adequate packers seats. The drilling activities are planned to be completed and monitoring begun before ESF construction.

Exact location of the boreholes is yet to be established.

IV. Interfaces:

A. Inputs:

3.2.2.2.1.10I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.1.10O1	Samples	**To:**	Function 3.2.2.3
3.2.2.2.1.10O2	Records	**To:**	Function 3.2.2.3
3.2.2.2.1.10O3	Characterized Site	**To:**	Outside System Boundary
3.2.2.2.1.10O4	Effluents	**To:**	Outside System Boundary/ Function 3.2.2.3
3.2.2.2.1.10O5	Drill Cuttings	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.1.10P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (b) Favorable conditions.

(8) For disposal in the unsaturated zone, hydrogeologic conditions that provide --

(i) Low moisture flux in the host rock and in the overlying and underlying hydrogeologic units;

[DOE letter dated 2/27/90]

3.2.2.2.1.10P2 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (b) Favorable conditions.

(8) For disposal in the unsaturated zone, hydrogeologic conditions that provide --

(iv) A host rock that provides for free drainage;

[DOE letter dated 2/27/90]

3.2.2.2.1.10P3 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(24) Potential for the movement of radionuclides in a gaseous state through air-filled pore spaces of an unsaturated geologic medium to the accessible environment.

[DOE letter dated 2/27/90]

3.2.2.2.1.10P4 One or more multipurpose boreholes shall be constructed using dry-drilling and spot-coring techniques, to the extent practicable.

3.2.2.2.1.10P5 Drilling shall be completed prior to initiation of ESF excavation.

3.2.2.2.1.10P6 Boreholes shall be located such that they will not penetrate within a distance of two diameters of any planned underground openings.

3.2.2.2.1.10P7 Geophysical logs, lithological logs, locations, photographs, and drilling history reports shall be prepared.

C. Interface:

3.2.2.2.1.10I1 Requirements at this level to be specified

3.2.2.2.1.10O1 Core samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.1.10O2 Records shall be provided to the appropriate records processing center.

3.2.2.2.1.10O3 The condition of the site after this activity shall be unchanged, except for the drilled holes and tracers.

3.2.2.2.1.10O4 Requirements at this level to be specified

3.2.2.2.1.10O5 Requirements at this level to be specified

Table F3.2.2.2.1.11 Function Description: Determine Hydrologic Properties of Major Faults Encountered in the Main Test Level of the ESF

I. Function ID Number:	3.2.2.2.1.11
II. Function Title:	Determine Hydrologic Properties of Major Faults Encountered in the Main Test Level of the ESF

III. Function Definition:

To determine hydrologic information in parallel with a portion of SCPB Activity 8.3.1.4.2.2.4 (geologic mapping of the ESF). All faults encountered in the ESF will be characterized geologically under the geologic mapping activity. Hydraulic properties of major faults encountered in the ESF will be determined in this activity. The major faults or fault zones expected to be tested are the Ghost Dance fault, a suspected fault in Drill Hole Wash, the imbricate fault zone, and the Solitario Canyon fault. Other faults will be tested if flow is observed.

On the basis of the identification of major faults by the geologic mapping activity, a hydrologic testing program will be implemented. This program will consist primarily of tests conducted in boreholes drilled through fault zones and tests on core collected. Air permeability tests will be conducted between boreholes to determine the permeability to air of the fault zones. Some boreholes will be instrumented to determine in situ conditions of the rock mass and monitored for any changes in these conditions over time. Other sets of boreholes will be used for cross-hole water-injection tests. There will be one borehole at each location used for geothermal measurements. All water used for injection will be tagged with a tracer. Core recovered from the holes will be tested to provide a water-content profile across the fault zone. This profile may provide information relative to any recent moisture occurrence in the fault zone.

This test will be conducted wherever faults with flow are observed in the ESF and in major suspected faults in the Topopah Spring and Calico Hills formation such as Ghost Dance Fault, Imbricate Fault, Solitario Canyon.

IV. Interfaces:

A. Inputs:

3.2.2.1.11I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.1.11O1	Data	**To:**	Function 3.2.2.3
3.2.2.1.11O2	Samples	**To:**	Function 3.2.2.3
3.2.2.1.11O3	Records	**To:**	Function 3.2.2.3
3.2.2.1.11O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.1.11P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (b) Favorable conditions.

(8) For disposal in the unsaturated zone, hydrogeologic conditions that provide --

(iv) A host rock that provides for free drainage;

[DOE letter dated 2/27/90]

3.2.2.2.1.11P2 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(20) Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts.

[DOE letter dated 2/27/90]

3.2.2.2.1.11P3 This activity shall determine the hydrologic properties of all major faults encountered in the ESF, including the Ghost Dance fault, a suspected fault in Drill Hole Wash, the Imbricate fault zone, and the Solitario Canyon fault.

3.2.2.2.1.11P4 Air permeability tests shall be conducted between boreholes to determine the permeability of the fault zone.

3.2.2.2.1.11P5 Water used for injection shall contain a tracer.

3.2.2.2.1.11P6 One near horizontal borehole shall be air cored at each location for geothermal measurements at approximately 45 degrees to the opening, as soon as possible after identification of the fault.

3.2.2.2.1.11P7 The hydrologic boreholes shall not be drilled until the principal investigator has determined the effects of ventilation in the geothermal borehole at that location.

3.2.2.2.1.11P8 Geologic maps, locations, photographs and test records shall be prepared.

3.2.2.2.1.11P9 Some boreholes shall be instrumented to determine in situ conditions of the rock mass and monitored for any changes in these conditions over time.

C. Interface:

3.2.2.2.1.11I1a Connection to the IDS shall be provided at each location.

3.2.2.2.1.11I1b Water usage shall be minimized in the test area.

3.2.2.2.1.11O1 Field measurements shall include atmospheric moisture, humidity; fracture dimensions; fracture orientation; hydraulic head; and in situ temperature.

3.2.2.2.1.11O2 Core samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the

Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.1.1103 Records shall be provided to the appropriate records processing center.

3.2.2.2.1.1104 The condition of the site after this activity shall be unchanged, except for the drilled holes.

Table F3.2.2.2.1.12 Function Description: Conduct Diffusion Tests in the ESF

I. Function ID Number: 3.2.2.2.1.12

II. Function Title: Conduct Diffusion Tests in the ESF

III. Function Definition:

To conduct diffusion tests which will take place in specially constructed alcoves in the zeolitic and the vitric zones of the Calico Hills formation. Each test will require boreholes dry-drilled, vertically downward, or subhorizontally in each alcove. The bottom of each hole will serve as a source region for the tracer diffusion tests. The core removed from the bottom of each hole will be examined for fractures. In addition, the boreholes will be examined for fractures using a downhole borescope.

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

The results of the diffusion experiments will be used to estimate the effective diffusion coefficients of conservative radionuclides in the unsaturated zone. There will be two sets of experiments performed for each zone (vitric and zeolitic) in the Calico Hills formation. The initial experiment (3 months) will be performed to establish the length of time required and the size and type of overcoring needed to effect the transport rate via diffusion through the unsaturated tuff unit. Then a period of one year will be required to complete the experiment.

IV. Interfaces:

A. Inputs:

3.2.2.2.1.1211 Pretest Site **From:** Function 3.2.2.1

B. Outputs:

3.2.2.2.1.12O1	Data	To:	Function 3.2.2.3
3.2.2.2.1.12O2	Samples	To:	Function 3.2.2.3
3.2.2.2.1.12O3	Records	To:	Function 3.2.2.3
3.2.2.2.1.12O4	Characterized Site	To:	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.1.12P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(24) Potential for the movement of radionuclides in a gaseous state through air-filled pore spaces of an unsaturated geologic medium to the accessible environment.

[DOE letter dated 2/27/90]

3.2.2.2.1.12P2 This activity shall determine the effective diffusion coefficients of conservative radionuclides in the CHn.

3.2.2.2.1.12P3 Alcoves shall be provided to perform this activity.

3.2.2.2.1.12P4 Core boreholes shall be drilled dry.

3.2.2.2.1.12P5 A suite of tracers shall be placed in the bottom of the borehole and allowed to diffuse into the formation. One of the tracers shall be bromide.

3.2.2.2.1.12P6 Activity shall be performed in two phases. During Phase 1, overcoring requirements shall be established. During Phase 2, full-scale diffusion tests will be performed.

3.2.2.2.1.12P7 Test locations shall be chosen by the principal investigator.

3.2.2.2.1.12P8 Geologic maps, location maps, photographs and test records shall be prepared.

C. Interface:

3.2.2.2.1.12I1a Water usage during the construction of test alcoves shall be minimized.

3.2.2.2.1.12I1b Overcoring equipment shall be required.

3.2.2.2.1.12O1 Field measurements shall include overcoring requirements, tracer emplacement methodology, and stratigraphy of the subunits.

3.2.2.2.1.12O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.1.12O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.1.12O4 The condition of the site after this activity shall be unchanged, except for the tracers.

Table F3.2.2.2.2 Function Description: Characterize Geochemistry

I. Function ID Number: 3.2.2.2.2

II. Function Title: Characterize Geochemistry

III. Function Definition:

Characterize the geochemistry of both water and rock at the Yucca Mountain site. Measurements and tests should characterize the quantity and spatial distribution of mineral species, the spatial variation of water and mineral chemistry sufficiently to describe the current system and potential changes to that system during the life of the repository, in order to understand the effectiveness of the geochemical barrier.

IV. Interfaces:

A. Inputs:

3.2.2.2.2I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.2O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.2O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.2O3	Records	**To:**	Function 3.2.2.3

3.2.2.2.2O4	Characterized Site	To:	Outside System Boundary
3.2.2.2.2O5	Effluents	To:	Outside System Boundary/ Function 3.2.2.3

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.2.2.1 Function Description: Conduct Petrologic Stratigraphy of the Topopah Spring Member

I. Function ID Number: 3.2.2.2.2.1

II. Function Title: Conduct Petrologic Stratigraphy of the Topopah Spring Member

III. Function Definition:

To conduct petrologic stratigraphy to determine the petrologic variability within the devitrified Topopah Spring Member at Yucca Mountain and to define the stratigraphic distribution of this variability. Studies of the distribution of phenocyst and rock matrix textures in this member have been shown to be useful for defining stratigraphic position. Analysis will be conducted with X-ray diffraction. Chemical analyses will also be used to determine variability on samples collected from the ESF.

This activity requires collecting samples from the Topopah Spring Member. Detailed sampling will depend on the features encountered. Samples will be collected in the drifts in order to assess the lateral variability within a stratigraphic location.

IV. Interfaces:

A. Inputs:

3.2.2.2.2.1I1	Pretest Site	From:	Function 3.2.2.1

B. Outputs:

3.2.2.2.2.1O1	Samples	To:	Outside System Boundary/ Function 3.2.2.3
3.2.2.2.2.1O2	Records	To:	Outside System Boundary/ Function 3.2.2.3
3.2.2.2.2.1O3	Characterized Site	To:	Outside System Boundary/ Function 3.2.2.4

V. **Function Requirements:**

A. **Constraints:** Requirements at this level to be specified

B. **Performance:**

3.2.2.2.2.1P1 Samples (bulk and oriented core) shall be collected in the TSw2 drifts in order to assess the petrologic variability.

3.2.2.2.2.1P2 Sample location map and geologic maps shall be prepared.

C. **Interface:**

3.2.2.2.2.1I1 Requirements at this level to be specified

3.2.2.2.2.1O1 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.2.1O2 Records shall be provided to the appropriate records processing center.

3.2.2.2.2.1O3 The condition of the site after this activity shall be unchanged, except for the sample collection.

Table F3.2.2.2.2.2 Function Description: Conduct Mineral Distributions Between the Host Rock and the Accessible Environment Activity

I. **Function ID Number:** 3.2.2.2.2.2

II. **Function Title:** Conduct Mineral Distributions Between the Host Rock and the Accessible Environment Activity

III. **Function Definition:**

To conduct studies which will provide a three-dimensional description of the distribution and abundances of major minerals for potential flow paths between the repository and accessible environment. Statistical evaluation of the three-dimensional distribution will be part of this activity to estimate natural variability and sample density requirements and to extrapolate between boreholes. Data collected by this activity are quantitative X-ray diffraction (XRD) determinations of mineral abundances, X-ray fluorescence and/or other chemical methods to determine major and trace element abundances in bulk rock, and electron microprobe analyses of mineral composition. Rock samples for this activity

are obtained from the accesses, the main test level (MTL), and the Calico Hills formation.

IV. Interfaces:

A. Inputs:

3.2.2.2.2.2I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.2.2O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.2.2O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.2.2O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.2.2O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.2.2P1 This activity shall result in a three-dimensional description of the distribution and abundances of major minerals for potential flow paths between the repository and accessible environment.

3.2.2.2.2.2P2 Location map and geologic maps shall be prepared.

3.2.2.2.2.2P3 Rock samples shall be obtained from the accesses, the main test level, and the Calico Hills formation.

3.2.2.2.2.2P4 If required, drilling shall be used to obtain samples for laboratory analysis.

C. Interface:

3.2.2.2.2.2I1 Requirements at this level to be specified

3.2.2.2.2.2O1 Laboratory measurements shall include X-ray diffraction and X-ray fluorescence determinations of mineral abundances.

3.2.2.2.2.2O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.2.2O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.2.2O4 The condition of the site after this activity shall be unchanged, except for the sample collection.

Table F3.2.2.2.2.3 Function Description: Determine Fracture Mineralogy

I. Function ID Number: 3.2.2.2.2.3

II. Function Title: Determine Fracture Mineralogy

III. Function Definition:

Determine the minerals present in fracture fillings, and their parageneses throughout the ESF, in order to determine the sorptive nature of the rock and the potential for health hazards from the presence of fibrous zeolites.

In addition to mineralogic sampling by drilling cores and collecting samples from walls and at the working face in the ESF and drifts, samples may be collected on the surface from the muck removed. The samples will be packaged and labeled for shipment to a laboratory for detailed analyses, including age determinations.

This activity requires gathering samples from the entire ESF (includes Calico Hills formation). Detailed sampling of anomalous features will depend on the features encountered. In addition, one to two oriented samples from altered intervals, from lower candidate host rock to upper vitrophyre and two to three oriented samples from lower TSw zeolitized nonwelded tuff and Calico Hills formation tuff will be procured.

IV. Interfaces:

A. Inputs:

3.2.2.2.2.3I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.2.3O1	Samples	**To:**	Function 3.2.2.3
3.2.2.2.2.3O2	Records	**To:**	Function 3.2.2.3
3.2.2.2.2.3O3	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.2.3P1 Bulk and core samples shall be collected from the entire ESF, in order to determine mineralogic variability.

3.2.2.2.2.3P2 Location map and geologic maps shall be prepared.

C. Interface:

3.2.2.2.2.3I1 Water use shall be minimized

3.2.2.2.2.3O1 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.2.3O2 Records shall be provided to the appropriate records processing center.

3.2.2.2.2.3O3 The condition of the site after this activity shall be unchanged, except for the sample collection.

Table F3.2.2.2.2.4 Function Description: Conduct History of Mineralogic and Geochemical Alteration of Yucca Mountain Activity

I. Function ID Number: 3.2.2.2.2.4

II. Function Title: Conduct History of Mineralogic and Geochemical Alteration of Yucca Mountain Activity

III. Function Definition:

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

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

This activity requires collecting samples from both the Topopah Spring Member and Calico Hills formation. Detailed sampling will depend on the features encountered. Samples will be collected of any natural gel found in the ESF.

IV. Interfaces:

A. Inputs:

3.2.2.2.2.4I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.2.4O1	Samples	**To:**	Function 3.2.2.3
3.2.2.2.2.4O2	Records	**To:**	Function 3.2.2.3
3.2.2.2.2.4O3	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.2.4P1 Rock samples shall be collected from the bottom of TSw2 and the CHn.

3.2.2.2.2.4P2 Natural gel samples shall be collected, if found in the ESF.

3.2.2.2.2.4P3 A location map shall be prepared.

C. Interface:

3.2.2.2.2.4I1 Water use shall be minimized

3.2.2.2.2.4O1 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.2.4O2 Records shall be provided to the appropriate records processing center.

3.2.2.2.2.4O3 The condition of the site after this activity shall be unchanged, except for the sample collection.

Table F3.2.2.2.2.5 Function Description: Conduct Biological Sorption and Transport Activity

I. Function ID Number: 3.2.2.2.2.5

II. Function Title: Conduct Biological Sorption and Transport Activity

III. Function Definition:

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

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

This activity requires collecting samples from the Topopah Spring Member. Samples must be collected aseptically to prevent further contamination. Drill and blast may be required to obtain samples.

IV. Interfaces:

A. Inputs:

3.2.2.2.2.5I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.2.5O1	Samples	**To:**	Function 3.2.2.3
3.2.2.2.2.5O2	Records	**To:**	Function 3.2.2.3
3.2.2.2.2.5O3	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.2.5P1 Fluids, cores, and rock samples shall be collected aseptically from TSw2.

3.2.2.2.2.5P2 A location map shall be prepared.

C. Interface:

3.2.2.2.2.5I1a Samples shall be collected aseptically.

3.2.2.2.2.5I1b Drill and blast shall be allowed, if required to obtain samples.

3.2.2.2.2.5O1 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.2.5O2 Records shall be provided to the appropriate records processing center.

3.2.2.2.2.5O3 The condition of the site after this activity shall be unchanged, except for the sample collection.

Table F3.2.2.2.2.6 Function Description: Demonstrate Applicability of Laboratory Data to Repository Transport Calculations Investigation

I. Function ID Number: 3.2.2.2.2.6

II. Function Title: Demonstrate Applicability of Laboratory Data to Repository Transport Calculations Investigation

III. Function Definition:

To demonstrate applicability of laboratory data to repository transport calculations tests will be conducted in alcoves in the Calico Hills formation. Dual breakout rooms will be required for these tests. The main room is below where sampling instruments will be located. The upper room will contain equipment to apply water and tracers to the intervening block. Access will need to be maintained to this room in order to service equipment.

During room excavation, samples will be collected from the alcove area for laboratory characterization of hydrologic and chemical properties. A geologic map of the test block will be prepared.

Tests will involve increasing water content of the test block by either ponding or sprinkling water on top. Both reactive and nonreactive tracers will be used. The slow response of the system will require that tracers be injected during the wetting phase of the experiment rather than bringing the block to a steady-state water content. Water content will be measured in the block, and water flux will be determined by effluent collection. Tracer concentrations and total mass will be measured in the effluent. For reactive tracers that have not broken through, a sampling program will be undertaken once the flux part of the experiment is considered complete.

IV. Interfaces:

A. Inputs:

3.2.2.2.2.6I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.2.6O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.2.6O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.2.6O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.2.6O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.2.6P1 Approximately 8 alcoves of suitable size shall be provided in CHn.

3.2.2.2.2.6P2 Water used in this activity shall contain both reactive and nonreactive tracers.

3.2.2.2.2.6P3 This activity shall be located away from other tests using water or other fluids.

3.2.2.2.2.6P4 During room excavation, samples shall be collected from the alcove area for laboratory characterization of hydrologic and chemical properties.

3.2.2.2.2.6P5 Geologic maps, location maps, test records, photographs, and mining records shall be prepared.

C. Interface:

3.2.2.2.2.6I1 Test alcoves shall be excavated dry.

3.2.2.2.2.6O1 Field measurements shall include tracer concentrations and total mass in the effluent.

3.2.2.2.2.6O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.2.6O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.2.6O4 The condition of the site after this activity shall be unchanged, except for the tracers.

Table F3.2.2.2.3 Function Description: Characterize Structural Features Within the Site Area

I. Function ID Number: 3.2.2.2.3

II. Function Title: Characterize Structural Features Within the Site Area

III. Function Definition:

To characterize structural features within the site area by using geologic mapping and photogrammetry to document lithologic and fracture variability throughout the vertical and horizontal extent of the underground excavations, to investigate structural features, and to provide siting data to confirm (or modify) planned test locations within the underground excavations. It is planned that all of the excavations in the Exploratory Studies Facility (ESF) be mapped. A complete stereo photographic record will be obtained of all the excavations including accesses to the Topopah Spring (TSw) and the Calico Hills formation (CHn). Where stratigraphic contacts occur or where geologic anomalies are encountered, the mapping detail will be comparable in all accesses.

IV. Interfaces:

A. Inputs:

3.2.2.2.3I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.3O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.3O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.3O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.3O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements: Requirements at this level to be specified

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Table F3.2.2.2.3.1 Function Description: Conduct Geologic Mapping of the ESF

I. Function ID Number: 3.2.2.2.3.1

II. Function Title: Conduct Geologic Mapping of the ESF

III. Function Definition:

To conduct geologic mapping and photogrammetry to document lithologic and fracture variability throughout the vertical and horizontal extent of the underground excavations,

to investigate structural features, and to provide siting data to confirm (or modify) planned test locations within the underground excavations. It is planned that all of the excavations in the Exploratory Studies Facility (ESF) be mapped. A complete stereo photographic record will be obtained of all the excavations including accesses to the Topopah Spring (TSw) and the Calico Hills formation (CHn). Where stratigraphic contacts occur or where geologic anomalies are encountered, the mapping detail will be comparable in all accesses.

IV. Interfaces:

A. Inputs:

3.2.2.2.3.1I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.3.1O1	Records	**To:**	Function 3.2.2.3
3.2.2.2.3.1O2	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints:

3.2.2.2.3.1C1 (d) Disqualifying Condition. The site shall be disqualified if site conditions do not allow all portions of the underground facility to be situated at least 200 meters below the directly overlying ground surface.

[10 CFR 960.4-2-5]

B. Performance:

3.2.2.2.3.1P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (b) Favorable conditions.

(5) Conditions that permit the emplacement of waste at a minimum depth of 300 meters from the ground surface. (The ground surface shall be deemed to be the elevation of the lowest point on the surface above the disturbed zone.)

[DOE letter dated 2/27/90]

3.2.2.2.3.1P2 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(11) Structural deformation such as uplift, subsidence, folding, and faulting during the Quaternary Period.

[DOE letter dated 2/27/90]

3.2.2.2.3.1P3 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(15) Evidence of igneous activity since the start of the Quaternary Period.

[DOE letter dated 2/27/90]

3.2.2.2.3.1P4 All excavations in the ESF shall be mapped.

3.2.2.2.3.1P5 Stereo photographs, geologic maps and surveys shall be prepared.

3.2.2.2.3.1P6 Unless safety conditions dictate otherwise, mapping shall be done prior to installation of ground support.

C. Interface:

3.2.2.2.3.1I1a Visual access shall be provided to all ESF surfaces exposed by mining (Collar to CHn).

3.2.2.2.3.1I1b The ability to geologically resurvey stations shall be provided.

3.2.2.2.3.1I1c Rock surfaces shall be cleaned, with a minimum amount of water, to expose fractures, joints, and other geologic features.

3.2.2.2.3.1O1 Records shall be provided to the appropriate records processing center.

3.2.2.2.3.1O2 The condition of the site after this activity shall be unchanged.

Table F3.2.2.2.3.2 Function Description: Conduct Seismic Tomography/Vertical Seismic Profiling

I. Function ID Number: 3.2.2.2.3.2

II. Function Title: Conduct Seismic Tomography/Vertical Seismic Profiling

III. Function Definition:

To conduct seismic tomography and vertical seismic profiling in order to remotely characterize subsurface fracture networks.

This activity requires access to walls of all of the excavated ESF, including the CHn. A vertical environment (shaft) will require the drilling of short boreholes for the emplacement of geophones to obtain information on fracture characteristics using this technique. A horizontal or sub-vertical (ramp) environment will only require access to competent rock. After the instruments have been installed, seismic energy will be introduced.

IV. Interfaces:

A. Inputs:

3.2.2.2.3.2I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.3.2O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.3.2O2	Records	**To:**	Function 3.2.2.3
3.2.2.2.3.2O3	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.3.2P1 Seismic stimuli shall be initiated by using either small explosive charges or vibrations.

3.2.2.2.3.2P2 Geophysical logs, geological maps, geophysical traces, photographs, and test installation history shall be prepared.

C. Interface:

3.2.2.2.3.2I1a Short boreholes shall be provided for the installation of geophones from the Collar to various locations in TSw2 and CHn.

3.2.2.2.3.2I1b No mechanical noise or vibrations from sources external to the activity shall be allowed during the conduct of this activity.

3.2.2.2.3.2O1 Field measurements shall include seismic traces.

3.2.2.2.3.2O2 Records shall be provided to the appropriate records processing center.

3.2.2.2.3.2O3 The condition of the site after this activity shall be unchanged.

Table F3.2.2.2.4 Function Description: Provide Thermal and Mechanical Rock Properties

I. Function ID Number: 3.2.2.2.4

II. Function Title: Provide Thermal and Mechanical Rock Properties

III. Function Definition:

To provide a comprehensive data-base on thermal and mechanical rock properties and ambient stress and temperature conditions at the Yucca Mountain site. This data will be used to develop the three-dimensional thermal, mechanical, and thermomechanical models to assist in assessing performance and design issues.

IV. Interfaces:

A. Inputs:

3.2.2.2.4I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.4O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.4O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.4O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.4O4	Characterized Site	**To:**	Outside System Boundary
3.2.2.2.4O5	Muck	**To:**	Outside System Boundary
3.2.2.2.4O6	Heat	**To:**	Outside System Boundary

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.2.4.1 Function Description: Conduct Studies to Provide the Required Information for Spatial Distribution of Thermal and Mechanical Properties

I. Function ID Number: 3.2.2.2.4.1

II. Function Title: Conduct Studies to Provide the Required Information for Spatial Distribution of Thermal and Mechanical Properties

III. Function Definition:

To conduct studies including laboratory thermal and geoengineering properties tests which will provide bulk, thermal and mechanical properties data for evaluations of

opening stability and related design and performance studies and/or modeling. Data from the laboratory tests will also support analyses of the geomechanical and thermomechanical field tests planned in the ESF. These ESF activities basically consist of collecting, packaging, and labeling of the selected bulk core samples taken from the accesses, drifts, maintest level (MTL), and Calico Hills formation (CHn).

Activity primarily consists of collecting samples from the accesses, main test level, and Calico Hills formation.

IV. Interfaces:

A. Inputs:

3.2.2.2.4.1I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.4.1O1	Samples	**To:**	Function 3.2.2.3
3.2.2.2.4.1O2	Records	**To:**	Function 3.2.2.3
3.2.2.2.4.1O3	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.4.1P1 Core and bulk samples shall be collected from the accesses, drifts, main test level, and CHn.

3.2.2.2.4.1P2 Geologic maps, location maps, and photographs shall be prepared.

C. Interface:

3.2.2.2.4.1I1 Access shall be provided to all accesses, drifts, main test level and CHn.

3.2.2.2.4.1O1 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.4.1O2 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.1O3 The condition of the site after this activity shall be unchanged, except for the sample collection.

Table F3.2.2.2.4.2 Function Description: Conduct Access Convergence Test

I. Function ID Number: 3.2.2.2.4.2

II. Function Title: Conduct Access Convergence Test

III. Function Definition:

Conduct access convergence tests required to monitor rock-mass deformation around the accesses and measure in situ stress (Overcore Stress Test, Function 3.2.2.2.4.16) at the station where convergence is being measured.

Rock-mass deformations around the accesses will be monitored at measurement stations using multiple-point borehole extensometers (MPBXs) placed around the openings. The MPBXs primarily consist of anchors installed at various depth. Deformations will be measured across the openings and as a function of distance and time from the access at multiple locations. In addition to MPBX, deformations shall also be measured with rod extensometers. Extensometer measurements will be made across the opening diameter and at 60° from the MPBX heads.

Each station will also include hydraulic pressure cells in the liner (if installed) to monitor radial stress changes over time as the excavation continues.

The tests will be located at three different locations at stratigraphic horizons of TSw1, TSw2 and in the CHn.

IV. Interfaces:

A. Inputs:

3.2.2.2.4.2I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.4.2O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.4.2O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.4.2O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.4.2O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints:

3.2.2.2.4.2C1 (c) Retrieval of waste. The underground facility shall be designed to permit retrieval of waste in accordance with the performance objectives of Section 60.111.

[10 CFR 60.133]

B. Performance:

3.2.2.2.4.2P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(21) Geomechanical properties that do not permit design of underground opening that will remain stable through permanent closure.

[DOE letter dated 2/27/90]

3.2.2.2.4.2P2 Anchors for rod extensometers shall be installed at TSw1, TSw2, and CHn. At least 3 locations per unit shall be instrumented.

3.2.2.2.4.2P3 Geologic maps, test location maps, photographs, and installation records shall be prepared.

3.2.2.2.4.2P4 Core recovered shall be collected as rock samples for laboratory tests.

C. Interface:

3.2.2.2.4.2I1a Cutouts shall be provided at 3 locations to protect MPBX heads.

3.2.2.2.4.2I1b No construction or drilling activity shall be allowed within 500 ft of this test.

3.2.2.2.4.2I1c Drill holes for multipoint extensometers (MPBX) and borehole pressure cells shall be provided at each test location.

3.2.2.2.4.2I1d Connection to the IDS shall be provided at the test location.

3.2.2.2.4.2O1 Field measurements shall include borehole locations, characteristics; borehole stability, casing; deformation; and in situ stress, magnitude, orientation.

3.2.2.2.4.2O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.4.2O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.2O4 The condition of the site after this activity shall be unchanged, except boreholes with instruments.

I. Function ID Number: 3.2.2.2.4.3

II. Function Title: Conduct Demonstration Breakout Rooms Test

III. Function Definition:

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

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

IV. Interfaces:

A. Inputs:

3.2.2.2.4.3I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.4.3O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.4.3O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.4.3O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.4.3O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.4.3P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(20) Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts.

[DOE letter dated 2/27/90]

3.2.2.2.4.3P2 The DBRs shall only be used for performing functions 3.2.2.2.4.3 and 3.2.2.2.4.5.

3.2.2.2.4.3P3 Cores recovered shall be collected as rock samples for laboratory tests.

3.2.2.2.4.3P4 Geologic maps, test locations maps, photographs, and installation records shall be prepared.

C. Interface:

3.2.2.2.4.3I1a Drifts in TSw1 highly lithophysal zone and TSw2 low lithophysal content zones shall be provided which are consistent with the maximum width of repository openings.

3.2.2.2.4.3I1b Adequate flexibility shall be provided to rotate the orientation of the DBRs depending on the geology.

3.2.2.2.4.3I1c Instruments shall be installed during excavation.

3.2.2.2.4.3I1d No excavation shall be allowed within 50 ft of the DBRs.

3.2.2.2.4.3I1e No parallel drifts shall be allowed within 50 ft of the end of MPBX anchors.

3.2.2.2.4.3I1f Connection to the IDS shall be provided in the DBR.

3.2.2.2.4.3O1 Field measurements shall include deformation rate, excavation methods, efficiency; fracture development, in situ, due to underground facility excavation; and rock-support system loading.

3.2.2.2.4.3O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.4.3O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.3O4 The condition of the site after this activity shall be unchanged, except for the sample collection.

Table F3.2.2.2.4.4 Function Description: Conduct Sequential Drift Mining Test

I. Function ID Number: 3.2.2.2.4.4

II. Function Title: Conduct Sequential Drift Mining Test

III. Function Definition:

To conduct tests to measure deformational response of repository-size openings as the openings are being excavated. This is accomplished by installing instruments from two adjacent drifts into a rockmass and subsequently excavating the instrumented rockmass by a central drift.

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

This test will be performed in the Topopah MTL.

IV. Interfaces:

A. Inputs:

3.2.2.2.4.4I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.4.4O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.4.4O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.4.4O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.4.4O4	Characterized Site	**To:**	Outside System Boundary
3.2.2.2.4.4O5	Muck	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.4.4P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(20) Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts.

(21) Geomechanical properties that do not permit design of underground opening that will remain stable through permanent closure.

[DOE letter dated 2/27/90]

3.2.2.2.4.4P2 Instruments shall be installed in boreholes.

3.2.2.2.4.4P3 Cores recovered shall be collected as rock samples for laboratory tests.

3.2.2.2.4.4P4 Geologic maps, installation history, mining history, and photographs shall be prepared.

C. Interface:

3.2.2.2.4.4I1a No excavation shall be performed to within 50 ft from this activity while the testing is in progress.

3.2.2.2.4.4I1b A repository size drift shall be excavated after instrumenting two parallel drifts.

3.2.2.2.4.4I1c The pillar thickness (between the parallel drifts) shall be equal to twice the repository pillar width plus the repository room width.

3.2.2.2.4.4I1d Instrument holes shall be provided from the two parallel drifts.

3.2.2.2.4.4I1e Connection to the IDS shall be provided in the parallel drifts.

3.2.2.2.4.4O1 Field measurements shall include deformation rate, in situ, due to underground facility excavation; excavation methods, efficiency; and in situ stress, change due to underground facility excavation.

3.2.2.2.4.4O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.4.4O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.4O4 The condition of the site after this activity shall be unchanged, except for the excavated drifts.

Table F3.2.2.2.4.5 Function Description: Conduct Heater Experiment in Unit TSw1

I. Function ID Number: 3.2.2.2.4.5

II. Function Title: Conduct Heater Experiment in Unit TSw1

III. Function Definition:

To conduct heater experiment which measures thermomechanical and thermally induced hydrologic responses in highly lithophysal zone rock to verify scaling relationships needed for repository design and performance calculations.

In the upper demonstration breakout room (UDBR) in TSw1, a heater-emplacement hole will be drilled into the drift wall. Several instrumentation holes parallel to the heater hole will be drilled and then heater and instruments (multiple point borehole extensometers (MPBX) and thermocouples) will be installed. In a borehole near the heater, neutron logs will be run before, during, and after the heating cycle to monitor moisture content changes. After the heater is started the rock response to thermal loading, heat flow, and moisture changes will be monitored.

IV. Interfaces:

A. Inputs:

3.2.2.2.4.5I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.4.5O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.4.5O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.4.5O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.4.5O4	Characterized Site	**To:**	Outside System Boundary
3.2.2.2.4.5O5	Heat	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.4.5P1 Neutron logs shall be run before, during, and after the heating cycle to monitor moisture content changes.

3.2.2.2.4.5P2 Rock response to thermal loading, heat flow, and moisture changes shall be monitored.

3.2.2.2.4.5P3 Cores recovered shall be collected as rock samples for laboratory tests.

3.2.2.2.4.5P4 Photographs, mining records, installation records, and geologic maps shall be prepared.

C. Interface:

3.2.2.2.4.5I1a A suitable alcove shall be provided in TSw1 upper demonstration breakout room.

3.2.2.2.4.5I1b Sufficient flexibility shall be provided to locate the test so that other activities are not adversely affected.

3.2.2.2.4.5I1c This activity shall be initiated after geomechanical testing in the UDBR has been completed.

3.2.2.2.4.5I1d Instrument holes shall be drilled dry.

3.2.2.2.4.5I1e Connections to the IDS shall be provided in the UDBR.

3.2.2.2.4.5O1 Field measurements shall include rock temperature, stress, deformations, moisture content and radon level.

3.2.2.2.4.5O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.4.5O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.5O4 The thermally altered zone shall be limited to approximately 10 ft^3.

Table F3.2.2.2.4.6 Function Description: Conduct Canister-Scale Heater Experiment

I. Function ID Number: 3.2.2.2.4.6

II. Function Title: Conduct Canister-Scale Heater Experiment

III. Function Definition:

To conduct canister-scale heater experiments which will monitor thermomechanical and hydrothermal responses in the repository host rock for design and performance modeling, for assessment of retrievability, and for monitoring radon emanation as a function of heating. During the tests, heat fluxes will be increased so that temperatures near the canister heater exceed design limits. This phase of the test is to aid in determining limits on waste-emplacement borehole stability.

At a location within the MTL in TSw2, a heater hole and parallel small-diameter

instrumentation holes will be drilled. Baseline moisture data in neutron probe holes will be recorded. A heater and instrumentation (thermocouples, MPBXs, borehole deformation gages, and radon monitors) will be installed. Finally, heating steps will be initiated, and thermal, thermomechanical, and hydrothermal phenomena, and radon release rates, will be monitored at increasing heat loads.

IV. Interfaces:

A. Inputs:

3.2.2.2.4.6I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.4.6O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.4.6O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.4.6O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.4.6O4	Characterized Site	**To:**	Outside System Boundary
3.2.2.2.4.6O5	Heat	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.4.6P1 Thermomechanical and hydrothermal responses in the rock shall be monitored.

3.2.2.2.4.6P2 During the test, the heat flux shall be increased so that temperatures near the canister exceed design limits.

3.2.2.2.4.6P3 Geologic maps, photographs, mining records, and installation records shall be prepared.

3.2.2.2.4.6P4 Cores recovered shall be collected as rock samples for laboratory tests.

C. Interface:

3.2.2.2.4.6I1a A heater hole and parallel, small-diameter instrumentation holes shall be provided within the MTL in TSw2.

3.2.2.2.4.6I1b Water usage shall be minimized in the test area.

3.2.2.2.4.6I1c Flexibility shall be provided to locate this activity.

3.2.2.2.4.6I1d Connections to the IDS shall be provided for this activity.

3.2.2.2.4.6O1 Field measurements shall include rock temperatures, radon release rates and heat flux.

3.2.2.2.4.6O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.4.6O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.6O4 The thermally and hydrologically altered zone shall be limited to a radius of approximately 100ft. from the center of the heater.

3.2.2.2.4.6O5 Requirements at this level to be specified

Table F3.2.2.2.4.7 Function Description: Conduct Yucca Mountain Heated Block Test

I. Function ID Number: 3.2.2.2.4.7

II. Function Title: Conduct Yucca Mountain Heated Block Test

III. Function Definition:

To conduct the Yucca Mountain heated block experiment which will (1) measure three-dimensional deformation and temperature changes; (2) measure relationships among fracture permeability, stress, and temperature; (3) monitor moisture movement relative to temperature; and (4) evaluate cross-hole measurement methods in large blocks of welded tuff. Results from 1, 2, and 3 will be used in modeling.

At a selected location in the MTL in TSw2, an alcove will be mined and an area of rock will be defined within the alcove. Baseline fracture permeabilities will be measured, reference survey pins will be established, and crosshole ultrasonic measurements will be made. Next, slots will be cut on each side of the block and flatjacks will be inserted. An array of heaters will be installed in holes on opposite sides of the block. Other instrumentation holes will be drilled and instrumented with thermocouples, multipoint borehole extensometers (MPBXs), and deformation gages. Finally, cyclic tests will be conducted at various mechanical loads (imposed using flatjacks) and thermal loads (imposed using heaters). The rock responses and permeability changes under induced conditions will be monitored.

IV. Interfaces:

A. Inputs:

3.2.2.2.4.7I1 Pretest Site **From:** Function 3.2.2.1

B. Outputs:

3.2.2.2.4.7O1	Data	To:	Function 3.2.2.3
3.2.2.2.4.7O2	Samples	To:	Function 3.2.2.3
3.2.2.2.4.7O3	Records	To:	Function 3.2.2.3
3.2.2.2.4.7O4	Characterized Site	To:	Outside System Boundary
3.2.2.2.4.7O5	Heat	To:	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.4.7P1 Rock responses and permeability changes under induced conditions shall be monitored.

3.2.2.2.4.7P2 Cyclic tests shall be conducted at various mechanical and thermal loads.

3.2.2.2.4.7P3 Installation record, photographs, location map, and water use records shall be prepared.

3.2.2.2.4.7P4 Cores recovered shall be collected as rock samples for laboratory tests.

C. Interface:

3.2.2.2.4.7I1a A suitable size alcove shall be provided in TSw2.

3.2.2.2.4.7I1b Flexibility in location of the test alcove shall be provided to ensure that the block contains joint spacing and orientations that are reasonably representative of the repository horizon.

3.2.2.2.4.7I1c Connection to the IDS shall be provided in the test alcove.

3.2.2.2.4.7I1d An uninterrupted power source shall be provided for the heaters and IDS.

3.2.2.2.4.7O1 Field measurements shall include rock temperature, and heat flux.

3.2.2.2.4.7O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.4.7O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.7O4 The thermally and hydrologically altered zone shall be limited to a radius of approximately 30 ft. from the center of the heater.

3.2.2.2.4.7O5 Requirements at this level to be specified

Table F3.2.2.2.4.8 Function Description: Conduct Thermal Stress Measurements

I. Function ID Number: 3.2.2.2.4.8

II. Function Title: Conduct Thermal Stress Measurements

III. Function Definition:

To conduct tests which will measure thermal stresses in a relatively large volume of jointed rock and relate the stress changes to thermomechanical displacement for numerical modeling. The specific numbers and locations of these experiments have not been determined.

These tests will be performed in the lower demonstration breakout room at the TSw2.

IV. Interfaces:

A. Inputs:

3.2.2.2.4.8I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.4.8O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.4.8O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.4.8O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.4.8O4	Characterized Site	**To:**	Outside System Boundary
3.2.2.2.4.8O5	Heat	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.4.8P1 TSw2 lower demonstration breakout room shall be used for this test.

3.2.2.2.4.8P2 At a location selected by the principal investigator, the roof shall be

instrumented and heaters installed.

3.2.2.2.4.8P3 At each location, slots, one in the roof (back) and one in the rib, shall be provided.

3.2.2.2.4.8P4 In each slot, flatjacks shall be installed.

3.2.2.2.4.8P5 Heaters shall be installed on both sides of the flatjacks in the roof.

3.2.2.2.4.8P6 The instrumented roof shall be heated for 2-3 months.

3.2.2.2.4.8P7 Installation records, photographs, location maps, and geologic maps shall be prepared.

3.2.2.2.4.8P8 Cores recovered shall be collected as rock samples for laboratory tests.

C. Interface:

3.2.2.2.4.8I1a Suitable alcoves in TSw2 lower demonstration breakout room shall be provided for this test.

3.2.2.2.4.8I1b The test shall be initiated after all other tests in the lower demonstration breakout room have been completed.

3.2.2.2.4.8I1c Connections to the IDS shall be provided.

3.2.2.2.4.8O1 Field measurements shall include air temperature, stress deformations and heat loads.

3.2.2.2.4.8O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.4.8O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.8O4 The condition of the site after this activity shall be unchanged, except for thermally and hydrologically induced changes.

3.2.2.2.4.8O5 Requirements at this level to be specified

Table F3.2.2.2.4.9 Function Description: Conduct Heated Room Experiment

I. Function ID Number: 3.2.2.2.4.9

II. Function Title: Conduct Heated Room Experiment

III. Function Definition:

To conduct the heated room experiment which is intended to measure thermomechanical responses in fractured welded tuff at a drift-size scale to acquire data for evaluating both pre- and post-closure design. Measurements will also be used to support the validation phase of both empirical and numerical design methods.

Upon completion of the Sequential Drift Mining Experiment in the TSw2 main test level, the rock around the central drift will be heated to temperatures representative of those expected in the repository.

IV. Interfaces:

A. Inputs:

3.2.2.2.4.9I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.4.9O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.4.9O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.4.9O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.4.9O4	Characterized Site	**To:**	Outside System Boundary
3.2.2.2.4.9O5	Heat	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.4.9P1 Sequential mine test drift will be heated by heaters.

3.2.2.2.4.9P2 The test shall be started as early as possible.

3.2.2.2.4.9P3 Installation records, location map, and photographs shall be prepared.

3.2.2.2.4.9P4 Holes shall be drilled to install heaters.

3.2.2.2.4.9P5 Cores recovered shall be collected as rock samples for laboratory tests.

C. Interface:

3.2.2.2.4.9I1a Existing central drift from sequential drift mining test shall be used for

this test.

3.2.2.2.4.9I1b Standoff shall be provided from other tests.

3.2.2.2.4.9I1c Connection to the IDS shall be provided.

3.2.2.2.4.9O1 Field measurements shall include stress, deformations, power input, air temperature and humidity.

3.2.2.2.4.9O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.4.9O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.9O4 The condition of the site after this activity shall be unchanged, except for heat induced changes.

Table F3.2.2.2.4.10 Function Description: Conduct Plate Loading Tests

I. Function ID Number: 3.2.2.2.4.10

II. Function Title: Conduct Plate Loading Tests

III. Function Definition:

To conduct the plate loading test which loads parallel, diametrically opposed surfaces of rock for the purpose of deformation measurements. Experimental results shall be used to calculate rock mass modulus and interpret the fractured zone adjacent to mine openings.

The plate loading tests will be conducted in alcoves extending from each access, within the main test level, and within the Calico Hills formation. The alcoves shall be approximately 15 ft wide by 6 ft tall. Between twelve and twenty of these tests are anticipated.

IV. Interfaces:

A. Inputs:

3.2.2.2.4.10I1 Pretest Site **From:** Function 3.2.2.1

B. Outputs:

3.2.2.2.4.10O1	Data	To:	Function 3.2.2.3
3.2.2.2.4.10O2	Records	To:	Function 3.2.2.3
3.2.2.2.4.10O3	Characterized Site	To:	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.4.10P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(21) Geomechanical properties that do not permit design of underground opening that will remain stable through permanent closure.

[DOE letter dated 2/27/90]

3.2.2.2.4.10P2 Alcoves shall be provided in TSw2 and CHn for this activity.

3.2.2.2.4.10P3 Installation history, location, photographs, and geologic maps shall be provided.

C. Interface:

3.2.2.2.4.10I1 Existing drifts in TSw2 and CHn shall be used for this activity.

3.2.2.2.4.10O1 Field measurements shall include applied load, plate size, and rock deformations.

3.2.2.2.4.10O2 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.10O3 The condition of the site after this activity shall be unchanged, except for limited damage to the actual test location.

Table F3.2.2.2.4.11 Function Description: Conduct Rock-Mass Strength Experiment

I. Function ID Number: 3.2.2.2.4.11

II. Function Title: Conduct Rock-Mass Strength Experiment

III. Function Definition:

To conduct rock-mass strength experiments which will obtain information on the mechanical response of single joints and multiple jointed volumes of rock. This experiment will be conducted in several areas that are representative of the range of conditions encountered in the main accesses, the main test level of TSw2 and in the Calico Hills formation. The information will evaluate scale effects between laboratory and in situ conditions, provide data to evaluate empirical design criteria, and provide data to evaluate and validate jointed-rock models.

Most of these experiments will be conducted at the MTL in a test alcove. Some of these tests will be performed in alcoves along the main accesses and within the Calico Hills formation. In situ tests for strength and deformability shall be conducted in the Calico Hills formation if the rock mass is fractured or heterogeneous.

IV. Interfaces:

A. Inputs:

3.2.2.2.4.11I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.4.11O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.4.11O2	Records	**To:**	Function 3.2.2.3
3.2.2.2.4.11O3	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.4.11P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(21) Geomechanical properties that do not permit design of underground opening that will remain stable through permanent closure.

[DOE letter dated 2/27/90]

3.2.2.2.4.11P2 Test location shall be chosen by the principal investigator after mapping information is available.

3.2.2.2.4.11P3 Isolate 30-90 ft^3 blocks in rooms for testing in the TSw2 and CHn.

3.2.2.2.4.11P4 Installation history, location map, photographs, and geologic maps shall be prepared.

C. Interface:

3.2.2.2.4.11I1a Flexibility shall be provided for the principal investigator to select the test site in TSw2 and CHn.

3.2.2.2.4.11I1b Blocks with fractures shall be carefully excavated for testing.

3.2.2.2.4.11O1 Field measurements shall include joint orientation, deformation, shear strength (shear load applied).

3.2.2.2.4.11O2 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.11O3 The condition of the site after this activity shall be unchanged, except for the rock surrounding the test site.

Table F3.2.2.2.4.12 Function Description: Conduct Evaluation of Mining Methods Test

I. Function ID Number: 3.2.2.2.4.12

II. Function Title: Conduct Evaluation of Mining Methods Test

III. Function Definition:

To conduct tests which will monitor and evaluate mining methods for shaft and drift openings, with emphasis on rock responses in a variety of lithologic and structural settings that may be encountered in the long exploratory drifts. This activity will be used to gather information for mining of the repository. Mining investigations will include particle velocity measurements, design of blasting rounds, examination of blast-induced damage in boreholes, performance of excavation equipment, and mining records.

This nonintrusive activity will occur at all locations deemed appropriate by the PI. This includes all major accesses and drifts within TSw2 and Calico Hills formation.

IV. Interfaces:

A. Inputs:

3.2.2.2.4.12I1 Pretest Site **From:** Function 3.2.2.1

B. Outputs:

3.2.2.2.4.12O1	Data	To:	Function 3.2.2.3
3.2.2.2.4.12O2	Samples	To:	Function 3.2.2.3
3.2.2.2.4.12O3	Records	To:	Function 3.2.2.3
3.2.2.2.4.12O4	Characterized Site	To:	Outside System Boundary

V. Function Requirements:

A. Constraints:

3.2.2.2.4.12C1 (e) Underground openings.

(1) Openings in the underground facility shall be designed so that operations can be carried out safely and the retrievability option maintained.

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

[10 CFR 60.133]

B. Performance:

3.2.2.2.4.12P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(20) Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts.

[DOE letter dated 2/27/90]

3.2.2.2.4.12P2 Evaluate and document the performance of mining equipment and methods used to excavate the ESF.

3.2.2.2.4.12P3 Geologic maps, photographs, and performance records shall be provided.

3.2.2.2.4.12P4 Samples of dust particles, explosives, rock chips, ventilation air shall be collected and identified by the principal investigator.

Interface:

3.2.2.2.4.12I1a Excavations shall be observed and mining records provided.

3.2.2.2.4.12I1b If blasting is used, blast design related information such as quantity of explosive, type of explosive, initiation of the charge shall be recorded for the principal

investigator.

3.2.2.2.4.12O1 Field measurements shall include particle velocity and blast induced overpressures.

3.2.2.2.4.12O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.4.12O3 Records shall include mining history, equipment type, roof failures, equipment downtime, dust collection methods, mining rate, bit change frequency, vibration controls, explosives used, and stability related observations.

3.2.2.2.4.12O4 The condition of the site after this activity shall be unchanged.

Table F3.2.2.2.4.13 Function Description: Conduct Monitoring of Ground Support Systems Test

I. Function ID Number: 3.2.2.2.4.13

II. Function Title: Conduct Monitoring of Ground Support Systems Test

III. Function Definition:

To conduct tests which will develop recommendations for a ground support requirement for drifts in the repository, based on evaluations of the ground-support techniques used in the underground excavations, and on experimentation with other ground-support configurations in the ESF. This activity will be carried out on the main test level. The selection, installation, and performance of the support systems used will be monitored. Experimentation with ground supports will include pull tests on rock bolts. Observation of unsupported rock, strength measurements on shotcrete cores, and trials of alternate ground-support configurations from those prescribed for the ESF. The effects of heat on ground support will be considered in the heated room experiment.

IV. Interfaces:

A. Inputs:

3.2.2.2.4.13I1 Pretest Site **From:** Function 3.2.2.1

B. Outputs:

3.2.2.2.4.13O1	Data	To:	Function 3.2.2.3
3.2.2.2.4.13O2	Samples	To:	Function 3.2.2.3
3.2.2.2.4.13O3	Records	To:	Function 3.2.2.3
3.2.2.2.4.13O4	Characterized Site	To:	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.4.13P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(20) Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts.

[DOE letter dated 2/27/90]

3.2.2.2.4.13P2 Rock support systems installed in the ESF shall be monitored to document their performance.

3.2.2.2.4.13P3 Rock bolt pull tests shall be performed to ascertain rock anchor capacity.

3.2.2.2.4.13P4 Location, geologic maps, rock support plan, and photographs shall be prepared.

3.2.2.2.4.13P5 Samples of roof bolts, bolt anchors, concrete, etc. shall be collected as identified by the principal investigator.

C. Interface:

3.2.2.2.4.13I1 Existing drifts in TSw2 (including heated room test area) shall be used for this activity.

3.2.2.2.4.13O1 Field measurements shall include rock bolt torque and pull-test data.

3.2.2.2.4.13O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.4.13O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.13O4 The condition of the site after this activity shall be unchanged, except for the locations where the pull tests would have been performed.

Table F3.2.2.2.4.14 Function Description: Conduct Monitoring of Drift Stability Test

I. Function ID Number: 3.2.2.2.4.14

II. Function Title: Conduct Monitoring of Drift Stability Test

III. Function Definition:

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

Test locations will be in the main test level, accesses, and in the Calico Hills formation.

IV. Interfaces:

A. Inputs:

3.2.2.2.4.14I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.4.14O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.4.14O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.4.14O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.4.14O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.4.14P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(20) Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts.

[DOE letter dated 2/27/90]

3.2.2.2.4.14P2 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(21) Geomechanical properties that do not permit design of underground opening that will remain stable through permanent closure.

[DOE letter dated 2/27/90]

3.2.2.2.4.14P3 Boreholes shall be drilled in the accesses, TSw2, and CHn.

3.2.2.2.4.14P4 Photographs, geologic map, installation history, and test locations shall be prepared.

3.2.2.2.4.14P5 Cores recovered shall be collected as rock samples for laboratory tests.

3.2.2.2.4.14P6 Deformation, stress, rockfalls, and stability related maintenance activities shall be recorded.

C. Interface:

3.2.2.2.4.14I1a Connection to the IDS shall be provided at each test location.

3.2.2.2.4.14I1b Flexibility shall be provided to the principal investigator to locate the tests.

3.2.2.2.4.14O1 Field measurements shall include deformation measurements.

3.2.2.2.4.14O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.4.14O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.14O4 Conditions of the site after this activity shall remain unchanged, except the boreholes with instruments.

Table F3.2.2.2.4.15 Function Description: Conduct Air Quality and Ventilation Experiment

I. Function ID Number: 3.2.2.2.4.15

II. Function Title: Conduct Air Quality and Ventilation Experiment

III. Function Definition:

To conduct experiments in order to assess the impact of site characteristics on ventilation requirements to ensure a safe working environment. This activity consists of (1) measurements of radon emanation; (2) surveys of air-flow and pressure, temperature, and humidity; (3) determinations of air resistance factors; and (4) dust characterization. The radon emanation measurements will be made in a dead-end drift that has been sealed with a bulkhead at equilibrium conditions and at various rates of airflow. Radon concentrations might also be measured in a borehole.

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

IV. Interfaces:

A. Inputs:

3.2.2.2.4.15I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.4.15O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.4.15O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.4.15O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.4.15O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.4.15P1 Holes shall be drilled in the drift to Ghost Dance Fault.

3.2.2.2.4.15P2 Bulkheads shall be constructed to block off air flow through the drift to the Ghost Dance Fault.

3.2.2.2.4.15P3 Ventilation records, location maps, installation records, and photographs shall be prepared.

3.2.2.2.4.15P4 Cores recovered shall be collected as rock samples for laboratory tests.

3.2.2.2.4.15P5 Air samples shall be obtained for laboratory analysis.

C. Interface:

3.2.2.2.4.15I1a End section of the Ghost Dance Fault drift shall be sealed using bulkhead.

3.2.2.2.4.15I1b Holes shall be drilled to collect radon gas (if present) samples.

3.2.2.2.4.15O1 Field measurements shall include barometric pressure, temperature, humidity and velocity.

3.2.2.2.4.15O2 Samples of ventilation air and radon gas shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.4.15O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.15O4 The condition of the site after this activity shall be unchanged, except for the bulkheads and drillholes.

Table F3.2.2.2.4.16 Function Description: Conduct Overcore Stress Experiments in the ESF

I. Function ID Number: 3.2.2.2.4.16

II. Function Title: Conduct Overcore Stress Experiments in the ESF

III. Function Definition:

To conduct overcore stress experiments to determine the in situ state of stress above, within, and below the repository horizon, in that portion of the unsaturated zone penetrated by the ESF, to determine the extent of excavation-induced stress changes, and to relate stress parameters to rock-mass heterogeneities.

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

This test will be performed in the ESF accesses, at the Topopah Spring welded tuff and at the Calico Hills formation.

IV. Interfaces:

A. Inputs:

3.2.2.2.4.16I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.4.16O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.4.16O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.4.16O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.4.16O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.4.16P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.122 (c) Potentially adverse conditions. The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(21) Geomechanical properties that do not permit design of underground opening that will remain stable through permanent closure.

[DOE letter dated 2/27/90]

3.2.2.2.4.16P2 Small diameter holes shall be drilled and overcored to obtain in situ stresses in the accesses, TSw2 and CHn.

3.2.2.2.4.16P3 Hydraulic fracturing shall be performed to obtain in situ stress in the accesses, TSw2 and CHn.

3.2.2.2.4.16P4 Geologic map, location documentation, photographs, and installation records shall be prepared.

3.2.2.2.4.16P5 Cores recovered shall be collected as rock samples for laboratory tests.

C. Interface:

3.2.2.2.4.16I1a During the testing period no mining activities shall be allowed near the test area.

3.2.2.2.4.16I1b Traffic shall be suspended during test periods near the test area.

3.2.2.2.4.16I1c Flexibility shall be provided to the principal investigator to locate the test.

3.2.2.2.4.16O1 Field measurements shall include fracture orientation, distribution and apertures and in situ stress.

3.2.2.2.4.16O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.4.16O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.4.16O4 The condition of the site after this activity shall be unchanged, except for the holes drilled.

Table F3.2.2.2.5 Function Description: Demonstrate Technologies for Repository Construction

I. Function ID Number: 3.2.2.2.5

II. Function Title: Demonstrate Technologies for Repository Construction

III. Function Definition:

To demonstrate technologies for repository construction the purpose of which is development and demonstration of special equipment, as necessary.

If these tests are conducted, a designated room on the main test level in TSw2 will be excavated.

IV. Interfaces:

A. Inputs:

3.2.2.2.5I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.5O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.5O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.5O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.5O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements: Requirements at this level to be specified

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Table F3.2.2.2.5.1 Function Description: Conduct Development and Demonstration of Required Equipment Test

I. Function ID Number: 3.2.2.2.5.1

II. Function Title: Conduct Development and Demonstration of Required Equipment Test

III. Function Definition:

This SCPB activity is proposed for the purpose of development and demonstration of special equipment, as necessary.

If these tests are conducted, a designated room on the main test level in TSw2 will be excavated.

IV. Interfaces:

A. Inputs:

3.2.2.2.5.1I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.5.1O1	Records	**To:**	Function 3.2.2.3
3.2.2.2.5.1O2	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.5.1P1 Flexibility shall be provided in the ESF to develop and demonstrate equipment required for the repository.

3.2.2.2.5.1P2 Records of equipment performance, location, geologic maps, and photographs shall be prepared.

C. Interface:

3.2.2.2.5.1I1 As required, alcoves and drifts shall be provided in TSw2.

3.2.2.2.5.1O1 Records shall be provided to the appropriate records processing center.

3.2.2.2.5.1O2 Requirements at this level to be specified

Table F3.2.2.2.6 Function Description: Evaluate Materials and Characteristics of Seals

I. Function ID Number: 3.2.2.2.6

II. Function Title: Evaluate Materials and Characteristics of Seals

III. Function Definition:

To evaluate the characteristics of materials to be used for sealing the geologic repository. The seal tests have not been developed in sufficient detail to evaluate their impact on excavation of the underground facilities. Additional evaluations will be required before defining appropriate field tests for seal components. The most important needs will be the characterization of the repository environment and results of laboratory studies on seal material properties.

While particular experiments are not defined yet, the three general categories of field-test operations are expected to provide some constraints on the test location. For example, if testing is performed to verify emplacement techniques, this operation may involve a significant amount of equipment, as well as construction operations that may require physical separation from other more sensitive tests. Tests will be performed in the accesses of TSw2 and the Calico Hills formations.

IV. Interfaces:

A. Inputs:

3.2.2.2.6I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.6O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.6O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.6O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.6O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.2.6.1 Function Description: Conduct In situ Testing of Seal Components

I. Function ID Number: 3.2.2.2.6.1

II. Function Title: Conduct In situ Testing of Seal Components

III. Function Definition:

To conduct in situ testing of seal components. However, the seal tests have not been developed in sufficient detail to evaluate their impact on excavation of the underground facilities. Additional evaluations will be required before defining appropriate field tests for seal components. The most important needs will be the characterization of the repository environment and results of laboratory studies on seal material properties.

While particular experiments are not defined yet, the three general categories of field-test operations are expected to provide some constraints on the test location. For example, if testing is performed to verify emplacement techniques, this operation may involve a significant amount of equipment, as well as construction operations that may require physical separation from other more sensitive tests. Tests will be performed in the accesses of TSw2 and the Calico Hills formations.

IV. Interfaces:

A. Inputs:

3.2.2.2.6.1I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.6.1O1	Data	To:	Function 3.2.2.3
3.2.2.2.6.1O2	Samples	To:	Function 3.2.2.3
3.2.2.2.6.1O3	Records	To:	Function 3.2.2.3
3.2.2.2.6.1O4	Characterized Site	To:	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.6.1P1 Flexibility shall be provided to locate these tests in accesses to TSw2, and CHn.

3.2.2.2.6.1P2 Connection to the IDS shall be provided at each test location.

3.2.2.2.6.1P3 Geologic maps, location maps, photographs, and seal emplacement records shall be prepared.

3.2.2.2.6.1P4 Cores recovered shall be collected as rock samples for laboratory tests.

C. Interface:

3.2.2.2.6.1I1 Test alcoves and drifts shall be provided at locations specified by the principal investigator.

3.2.2.2.6.1I2 Connection to the IDS shall be provided at each test location.

3.2.2.2.6.1O1 Requirements at this level to be specified.

3.2.2.2.6.1O2 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.6.1O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.6.1O4 The condition of the site after this activity shall be unchanged, except for the seal material in boreholes and backfills.

Table F3.2.2.2.7 Function Description: Characterize Post-Emplacement Near-Field Environment

I. Function ID Number: 3.2.2.2.7

II. Function Title: Characterize Post-Emplacement Near-Field Environment

III. Function Definition:

To characterize post-emplacement near-field environment using a series of heater tests which are planned in TSw1 and TSw2. All are designed to investigate moisture movement and saturation conditions in the host rock during heating and cooling periods of waste storage and to investigate the scale effect of the heater hole on the measured parameters. Some tests will measure the parameters during the thermal cycle using ambient moisture as the initial condition. The other tests will include a simulated percolation event to examine the effect of water percolating or diffusioning through the rock mass.

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

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

Prototype testings with possibly long duration will be conducted before or concurrent to the ESF tests.

IV. Interfaces:

A. Inputs:

3.2.2.2.7I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.7O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.7O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.7O3	Records	**To:**	Function 3.2.2.3

3.2.2.2.7O4	Characterized Site	To:	Outside System Boundary
3.2.2.2.7O5	Heat	To:	Outside System Boundary
3.2.2.2.7O6	Effluents	To:	Outside System Boundary

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.2.7.1 Function Description: Characterize Mechanical Attributes of the Waste Package Environment

I. Function ID Number: 3.2.2.2.7.1

II. Function Title: Characterize Mechanical Attributes of the Waste Package Environment

III. Function Definition:

To characterize the geomechanical response of the rock in the near-field environment to the changing environmental conditions expected to occur over the lifetime of the repository. The test will be conducted in alcoves mined in the non-lithophysal portion of the Topopah Spring Tuff unit away from major faults. Test will require dry drilling boreholes up to approximately 30 inches in diameter. Test requires equipment with capability to lift up to 1.5 tons and office/trailer at the surface. Some tests will study the effect of a heating/cooling cycle on the stability of rock blocks formed by excavation of the emplacement hole. Other tests will assess the potential for spalling or other types of borehole breakout that may occur due to the heating/cooling cycle and associated changes in the rock/fracture properties.

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

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

IV. Interfaces:

A. Inputs:

3.2.2.2.7.1I1	Pretest Site	From:	Function 3.2.2.1

B. Outputs:

3.2.2.2.7.1O1	Data	To:	Function 3.2.2.3
3.2.2.2.7.1O2	Samples	To:	Function 3.2.2.3
3.2.2.2.7.1O3	Records	To:	Function 3.2.2.3
3.2.2.2.7.1O4	Characterized Site	To:	Outside System Boundary
3.2.2.2.7.1O5	Heat	To:	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.7.1P1 Near-field geomechanical response of the non-lithophysal TSw2 shall be determined.

3.2.2.2.7.1P2 Flexibility shall be provided to locate the alcoves and drifts.

3.2.2.2.7.1P3 Heater holes (up to 30-inch diameter) and instrument holes shall be drilled dry.

3.2.2.2.7.1P4 Equipment shall be provided to lift and load up to 1.5 tons.

3.2.2.2.7.1P5 Location map, installation records, photographs, geologic maps, and test performance records shall be prepared.

3.2.2.2.7.1P6 Gas samples shall be collected.

C. Interface:

3.2.2.2.7.1I1a A suitable size alcove shall be excavated in TSw2

3.2.2.2.7.1I1b Uninterrupted power for instruments and regulated power for heaters shall be provided.

3.2.2.2.7.1Ic Geologic logging and neutron logging capabilities shall be provided.

3.2.2.2.7.1Id Connection to IDS shall be provided.

3.2.2.2.7.1O1 Field measurements shall include stress, deformation, air and rock temperature, humidity, geologic changes and rock falls.

3.2.2.2.7.1O2 Cores and bulk samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.7.1O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.7.104 The condition of the site after this activity shall be unchanged, except for heat induced changes.

3.2.2.2.7.105 Requirements at this level to be specified

Table F3.2.2.2.7.2 Function Description: Conduct Repository Horizon Near-Field Hydrologic Properties Test

I. Function ID Number: 3.2.2.2.7.2

II. Function Title: Conduct Repository Horizon Near-Field Hydrologic Properties Test

III. Function Definition:

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

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

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

IV. Interfaces:

A. Inputs:

3.2.2.2.7.2I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.7.2O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.7.2O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.7.2O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.7.2O4	Characterized Site	**To:**	Outside System Boundary
3.2.2.2.7.2O5	Heat	**To:**	Outside System Boundary
3.2.2.2.7.2O6	Effluents	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints:

Requirements at this level to be specified

B. Performance:

3.2.2.2.7.2P1 Near field hydrologic properties shall be determined by conducting prototype tests in the non-lithophysal TSw2.

3.2.2.2.7.2P2 Flexibility shall be provided to locate the alcoves and drifts required for this activity.

3.2.2.2.7.2P3 Heater and instrument holes shall be drilled dry.

3.2.2.2.7.2P4 Equipment shall be provided to lift and load up to 1.5 tons.

3.2.2.2.7.2P5 Water, up to 500 gallons/week, used for infiltration test, shall not contain any tracer or chlorine and shall be from well J-13.

3.2.2.2.7.2P6 Photographs, installation record, geologic map, geologic and geophysical logs and test performance shall be prepared.

3.2.2.2.7.2P7 Cores recovered shall be collected as rock samples for laboratory tests.

3.2.2.2.7.2P8 Gas samples shall be collected.

C. Interface:

3.2.2.2.7.2I1a The test area shall be in TSw2 away from faults and off the main drift.

3.2.2.2.7.2I1b Heater emplacement drift and instrumentation drifts shall be vertically separated by approximately 25 feet.

3.2.2.2.7.2I1c Two inclined drifts shall be provided for instrumentation and observation.

3.2.2.2.7.2I1d The location of the first heater in the test area shall be separated by at least two main drift diameters from other activities in the main drift.

3.2.2.2.7.2I1e Uninterrupted power to instruments and regulated power to heaters shall be provided.

3.2.2.2.7.2I1f Geologic and neutron logging capabilities shall be provided.

3.2.2.2.7.2I1g Connection to the IDS shall be provided.

3.2.2.2.7.2O1 Field measurements shall include temperature, humidity, rock temperature, stress and strain.

3.2.2.2.7.2O2 Cores, bulk samples and gases shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.7.2O3 Records shall be provided to the appropriate records processing center.

3.2.2.2.7.2O4 The condition of the site after this activity shall be unchanged, except for the heat-affected zone.

3.2.2.2.7.2O5 Requirements at this level to be specified

3.2.2.2.7.2O6 Requirements at this level to be specified

Table F3.2.2.2.7.3 Function Description: Conduct Repository Horizon Rock-Water Interaction Activity

I. Function ID Number: 3.2.2.2.7.3

II. Function Title: Conduct Repository Horizon Rock-Water Interaction Activity

III. Function Definition:

To conduct repository horizon rock-water interaction activity which is to obtain large diameter (6 to 8 in.) dry drilled cores or dry mined blocks of sample from the lithophysal zone of Topopah Spring tuff at the contact of Tiva Canyon and Topopah Spring, Topopah Spring Welded unit, Basal Vitrophyre of Topopah Spring, and the top of Vitric Calico Hills formation.

IV. Interfaces:

A. Inputs:

3.2.2.2.7.3I1	Pretest Site	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.2.7.3O1	Samples	**To:**	Function 3.2.2.3
3.2.2.2.7.3O2	Records	**To:**	Function 3.2.2.3
3.2.2.2.7.3O3	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.2.7.3P1 Air drilled core samples 6 to 8 in. diameter or dry mined bulked samples shall be extracted from TSw1 at contact of Tiva Canyon and TSw, TSw2, Basal vitrophyre of TSw and top of the CHn.

3.2.2.2.7.3P2 Location maps, photographs, and geologic maps shall be prepared.

C. Interface:

3.2.2.2.7.3I1 Mining and drilling shall be performed dry.

3.2.2.2.7.3O1 Samples shall be packaged, labeled, and transported offsite for further analysis, or to the Sample Management Facility (SMF) as specified by the Principal Investigator. Documentation of all samples collected shall be submitted to the SMF per approved Technical and/or Project Procedures.

3.2.2.2.7.3O2 Records shall be provided to the appropriate records processing center.

3.2.2.2.7.3O3 The condition of the site after this activity shall be unchanged, except for the removal of samples.

Table F3.2.2.2.8 Function Description: Conduct Other Required ESF Tests

I. Function ID Number: 3.2.2.2.8

II. Function Title: Conduct Other Required ESF Tests

III. Function Definition:

To conduct other ESF tests, as required by DOE and NRC.

The Secretary shall make grants to the State of Nevada and any affected unit of local government for purposes of enabling such State or affected unit of local government - (iii) to engage in any monitoring, testing, or evaluation activities with respect to site characterization programs with regard to such site; (NWPA Sec. 116 (c)(B))

IV. Interfaces:

A. Inputs:

3.2.2.2.8I1	Pretest Site	**From:**	Function 3.2.2.1
3.2.2.2.8I2	Data	**From:**	Function 3.2.2.2.4

B. Outputs:

3.2.2.2.8O1	Data	**To:**	Function 3.2.2.3
3.2.2.2.8O2	Samples	**To:**	Function 3.2.2.3
3.2.2.2.8O3	Records	**To:**	Function 3.2.2.3
3.2.2.2.8O4	Characterized Site	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints:

3.2.2.2.8C1 (B) The Secretary shall make grants to the State of Nevada and any affected unit of local government for purposes of enabling such State or affected unit of local government--

(i) to review activities taken under this subtitle with respect to the Yucca Mountain site for purposes of determining any potential economic, social, public health and safety, and environmental impacts of a repository on such State, or affected unit of local government and its residents;

(ii) to develop a request for impact assistance under paragraph (2);

(iii) to engage in any monitoring, testing, or evaluation activities with respect to site characterization programs with regard to such site;

(iv) to provide information to Nevada residents regarding any activities of such State, the Secretary, or the Commission with respect to such site; and

(v) to request information from, and make comments and recommendations to, the Secretary regarding any activities taken under this subtitle with respect to such site.

[NWPA Sec 116(c)]

3.2.2.2.8C2 (a) DOE shall perform, or permit the Commission to perform, such tests as the Commission deems appropriate or necessary for the administration of the regulations in this part. These may include tests of:

(1) radioactive waste,

(2) the geologic repository including its structures, systems, and components,

(3) radiation detection and monitoring instruments, and

(4) other equipment and devices used in connection with the receipt, handling, or storage of radioactive waste.

[10 CFR 60.74]

B. Performance:	Requirements at this level to be specified
C. Interface:	Requirements at this level to be specified

Table F3.2.2.3 Function Description: Support ESF Operations

I. Function ID Number: 3.2.2.3

II. Function Title: Support ESF Operations

III. Function Definition:

To support, maintain and administer ESF operations.

IV. Interfaces:

A. Inputs:

3.2.2.3I1	Data	**From:**	Function 3.2.2.2
3.2.2.3I2	Samples	**From:**	Function 3.2.2.2
3.2.2.3I3	Effluents	**From:**	Function 3.2.2.1/3.2.2.2

B. Outputs:

3.2.2.3O1	Samples	**To:**	Outside System Boundary
3.2.2.3O2	Operations Records	**To:**	Outside System Boundary
3.2.2.3O3	Utilities/Equipment/ Admin Support/ Personnel/Materials	**To:**	Function 3.2.2.1/3.2.2.2/3.2.2.4 (Resources)
3.2.2.3O4	Data	**To:**	Outside System Boundary/ Function 3.2.2.1 (Control)
3.2.2.3O5	Site Generated Waste	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance: Requirements at this level to be specified

C. Interface:

3.2.2.3O1	Requirements at this level to be specified
3.2.2.3O2	Requirements at this level to be specified
3.2.2.3O3	Uninterrupted power shall be provided
3.2.2.3O4	Requirements at this level to be specified
3.2.2.3O5	Requirements at this level to be specified

Table F3.2.2.3.1 Function Description: Provide Utility Services

I. Function ID Number: 3.2.2.3.1

II. Function Title: Provide Utility Services

III. Function Definition:

To provide utilities, including ventilation, communications, water, power, illumination, and on-site transportation required to support ESF operations. Ongoing maintenance of utilities is not included in this function.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints:

3.2.2.3.1C1 The Secretary of the Army has delegated to the Chief of Engineers the authority to issue or deny section 10 permits. The following additional special policies and procedures shall also be applicable to the evaluation of permit applications under this regulation.

(i) Power transmission lines. (2) The following minimum clearances are required for aerial electric power transmission lines crossing navigable waters of the United States. These clearances are related to the clearances over the navigable channel provided by existing fixed bridges, or the clearances which would be required by the U.S. Coast Guard for new fixed bridges, in the vicinity of the proposed power line crossing. The clearances are based on the low point of the line under conditions which produce the greatest sag, taking into consideration temperature, load, wind, length or span, and type of supports as outlined in the National Electrical Safety Code.

Nominal system voltage, kV	Minimum additional clearance (feet) above clearance required for bridges
115 and below	20
138	22
161	24
230	26
350	30
500	35
700	42
750-765	45

(3) Clearances for communication lines, stream gaging cables, ferry cables, and other aerial crossings are usually required to be a minimum of ten feet above clearances required for bridges. Greater clearances will be required if the public interest so indicates.

(4) Corps of Engineer regulation ER 1110-2-4401 prescribes minimum vertical clearances for power and communication lines over Corps lake projects. In instances where both this regulation and ER 1110-2-4401 apply, the greater minimum clearance is required.

[33 CFR 322 Sec. 322.5]

B. Performance: Requirements at this level to be specified

C. Interface: Requirements at this level to be specified

Table F3.2.2.3.1.1 Function Description: Provide Ventilation (HVAC)

I. Function ID Number: 3.2.2.3.1.1

II. Function Title: Provide Ventilation (HVAC)

III. Function Definition:

To provide ventilation by installing and operating ventilation systems, subsystems and components for both surface and subsurface areas required to support ESF operations. This function includes any necessary conditioning of air, and monitoring of the ventilation systems and the ventilated environments.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints:

3.2.2.3.1.1C1 (g) Underground facility ventilation. The ventilation system shall be designed to -

(1) Control the transport of radioactive particulates and gases within and releases from the underground facility in accordance with the performance objectives of Section 60.111(a),

(2) Assure continued function during normal operations and under accident conditions; and

(3) Separate the ventilation of excavation and waste emplacement areas.

[10 CFR 60.133]

3.2.2.3.1.1C2 Surface and Underground

Sec. 57.8518 Main and booster fans.

(a) All mine main and booster fans installed and used to ventilate the active workings of the mine shall be operated continuously while persons are underground in the active workings. However, this provision is not applicable during scheduled production-cycle shutdowns or planned or scheduled fan maintenance or fan adjustments where air quality is maintained in compliance with the applicable standards of Subpart D of this part and all persons underground in the affected areas are advised in advance of such scheduled or planned fan shutdowns, maintenance, or adjustments.

(b) In the event of main or booster fan failure due to a malfunction, accident, power failure, or other such unplanned or unscheduled event:

(1) The air quality in the affected active workings shall be tested at least within 2-hours of the discovery of the fan failure, and at least every 4-hours thereafter by a competent person for compliance with the requirements of the applicable standards of Subpart D of this part until normal ventilation is restored, or

(2) All persons, except those working on the fan, shall be withdrawn, the ventilation shall be restored to normal and the air quality in the affected active workings shall be tested by a competent person to assure that the air quality meets the requirements of the standards in Subpart D of this part, before any other persons are permitted to enter the affected active workings.

Sec. 57.8519 Underground main fan controls.

All underground main fans shall have controls placed at a suitable protected location remote from the fan and preferably on the surface.

Underground Only

Sec. 57.8520 Ventilation plan.

A plan of the mine ventilation system shall be set out by the operator in written form. Revisions of the system shall be noted and updated at least annually. The ventilation plan or revisions thereto shall be submitted to the District Manager for review and comments upon his written request. The plan shall, where applicable, contain the following:

(a) The mine name.

(b) The current mine map or schematic or series of mine maps or schematics of an appropriate scale, not greater than five hundred feet to the inch, showing:

(1) Direction and quantity of principal air flows;
(2) Locations of seals used to isolate abandoned workings;
(3) Locations of areas withdrawn from the ventilation system;
(4) Locations of all main, booster and auxiliary fans not shown in paragraph (d) of this standard.
(5) Locations of air regulators and stoppings and ventilation doors not shown in paragraph (d) of this standard;
(6) Locations of overcasts, undercasts and other airway crossover devices not shown in paragraph (d) of this standard;
(7) Locations of known oil or gas wells;
(8) Locations of known underground mine openings adjacent to the mine;
(9) Locations of permanent underground shops, diesel fuel storage depots, oil fuel storage depots, hoist rooms, compressors, battery charging stations and explosive storage facilities. Permanent facilities are those intended to exist for one year or more; and
(10) Significant changes in the ventilation system projected for one year.

(c) Mine fan data for all active main and booster fans including manufacturer's name, type, size, fan speed, blade setting, approximate pressure at present operating point, and motor brake horsepower rating.

(d) Diagrams, descriptions or sketches showing how ventilation is accomplished in each typical type of working place including the approximate quantity of air provided, and typical size and type of auxiliary fans used.

(e) The number and type of internal combustion engine units used underground, including make and model of unit, type of engine, make and model of engine, brake horsepower rating of engine, and approval number.

(Approved by the Office of Management and Budget under control number 1219-0016)

Sec. 57.8525 Main fan maintenance.

Main fans shall be maintained according to either the manufacturer's recommendations or a written periodic schedule adopted by the operator which shall be available at the operation on request of the Secretary or his authorized representative.

(Approved by the Office of Management and Budget under control number 1219-0012)

Sec. 57.8527 Oxygen-deficiency testing.

Flame safety lamps or other suitable devices shall be used to test for acute oxygen deficiency.

Sec. 57.8528 Unventilated areas.

Unventilated areas shall be sealed, or barricaded and posted against entry.

Sec. 57.8529 Auxiliary fan systems

When auxiliary fan systems are used, such systems shall minimize recirculation and be maintained to provide ventilation air that effectively sweeps the working places.

Sec. 57.8531 Construction and maintenance of ventilation doors.

Ventilation doors shall be -

(a) Substantially constructed;
(b) Covered with fire-retardant material, if constructed of wood;
(c) Maintained in good condition;
(d) Self-closing, if manually operated; and
(e) Equipped with audible or visual warning devices, if mechanically operated.

Sec. 57.8532 Opening and closing ventilation doors.

When ventilation control doors are opened as a part of the normal mining cycle, they shall be closed as soon as possible to re-establish normal ventilation to working places.

Sec. 57.8534 Shutdown or failure of auxiliary fans.

(a) Auxiliary fans installed and used to ventilate the active workings of the mine shall be operated continuously while persons are underground in the active workings, except for scheduled production-cycle shutdowns or planned or scheduled fan maintenance or fan adjustments where air quality is maintained in compliance with the applicable standards of Subpart D of this part, and all persons underground in the affected areas are advised in advance of such scheduled or planned fan shutdowns, maintenance, or adjustments.

(b) In the event of auxiliary fan failure due to malfunction, accident, power failure, or other such unplanned or unscheduled event:

(1) The air quality in the affected active workings shall be tested at least within 2 hours of the discovery of the fan failure, and at least every 4 hours thereafter by a competent person for compliance with the requirements of the applicable standards of Subpart D of this part until normal ventilation is restored, or

(2) All persons, except those working on the fan, shall be withdrawn, the ventilation shall be restored to normal and the air quality in the affected active workings shall be tested by a competent person to assure that the air quality meets the requirements of the standards in Subpart D of this part, before any other persons are permitted to enter the affected active workings.

Sec. 57.8535 Seals.

Seals shall be provided with a means for checking the quality of air behind the seal and a means to prevent a water head from developing unless the seal is designed to impound water.

[30 CFR 57 Subpart G]

B. Performance: Requirements at this level to be specified

C. Interface: Requirements at this level to be specified

Table F3.2.2.3.1.2 Function Description: Provide Communications

I. Function ID Number: 3.2.2.3.1.2

II. Function Title: Provide Communications

III. Function Definition:

To provide communications by installing and operating communication systems, subsystems, and components required to support ESF operations, including establishing connections as needed with external communication systems. Communications include general and emergency.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.1.3 Function Description: Supply/Control Water

I. Function ID Number: 3.2.2.3.1.3

II. Function Title: Supply/Control Water

III. Function Definition:

To supply and control water in support of ESF operations. These utility services are provided for all operational uses, including drinking water, industrial water, sewage processing, site run-off/drainage, and emergency uses.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints:

3.2.2.3.1.3C1 (b)(1) In the survey of planning of any reservoir by the Corps of Engineers, Bureau of Reclamation, or other Federal agency, consideration shall be given to inclusion of storage for regulation of streamflow, except that any such storage and water releases shall not be provided as a substitute for adequate treatment or other methods of controlling waste at the source.

[33 USC 1251 et seq., Section 1252]

3.2.2.3.1.3C2 Enforcement of drinking water regulations

(c) notice of owner or operator of public water system and frequency of notice; amendment of regulations to provide different types and frequencies of notice; penalties

Each owner or operator of a public water system shall give notice to the persons served by it --

(1) of any failure on the part if the public water system to --

(A) comply with an applicable maximum contaminant level or treatment technique requirement of, or a testing procedure prescribed by, a national primary drinking water regulation, or

(B) perform monitoring required by section 300j-4(a),

[42 USC 300f et seq., Sec. 300g-3]

3.2.2.3.1.3C3 Prohibition On Use of Lead Pipes, Solder, and Flux.

(a) In General --

(1) Prohibition. -- Any pipe, solder, or flux, which is used after the enactment of the Safe Drinking Water Act Amendments of 1986, in the installation or repair of -

(A) any public water system, or

(B) any plumbing in a residential or nonresidential facility providing water for human consumption which is connected to a public water system, shall be lead free (within the meaning of subsection (d)). This paragraph shall not apply to leaded joints necessary for the repair of cast iron pipes.

(d) Definition of lead free. -- For purposes of this section, the term "lead free"

(1) when used with respect to solders and flux refers to solders and flux containing not more than 0.2 percent lead, and

(2) when used with respect to pipes and pipe fittings refers to pipes and pipe fitting containing not more than 8.0 percent lead.

[42 USC 300f et seq., Section 300g-6]

3.2.2.3.1.3C4 Records And Inspections

(a)(1) Every person who is a supplier of water, who is or may be otherwise subject to a primary drinking water regulation prescribed under section 1412 or to an applicable underground injection control program (as defined in section 1422(c)), who is or may be subject to the permit requirement of section 1424 or to an order issued under section 1441, or who is a grantee, shall establish and maintain such records, make such reports, conduct such monitoring, and provide such information as the Administrator may reasonably require by regulation under this title, in determining whether such person has acted or is acting in compliance with this title, in administering any program of financial assistance under this title in evaluating the health risks of unregulated contaminants, or in advising the public

of such risks.

[42 USC 300f et seq., Section 300j-4]

3.2.2.3.1.3C5 Each Federal agency (1) having jurisdiction over any federally owned or maintained public water system or (2) engaged in any activity resulting, or which may result in, underground injection which endangers drinking water (within the meaning of section 300h(d)(2) shall be subject to and comply with, all Federal, State, and local requirements, administrative authorities, and process and sanctions respecting the provision of safe drinking water and respecting any underground injection program in the same manner, and to the same extent, as any nongovernmental entity.

[42 USC 300f et seq., Section 300j-6]

3.2.2.3.1.3C6 (d) Control of water and gas. The design of the underground facility shall provide for control of water or gas intrusion.

[10 CFR 60.133]

B. Performance:

3.2.2.3.1.3P1 Tracers shall be used in all ESF water except as specified by the PI for an individual test.

C. Interface: Requirements at this level to be specified

Table F3.2.2.3.1.4 Function Description: Provide Power

I. Function ID Number: 3.2.2.3.1.4

II. Function Title: Provide Power

III. Function Definition:

To provide power by distributing electrical and other forms of power for use in ESF operations from power sources to the necessary locations. This function may include establishing connections to external power grids and installing onsite power generation and backup systems.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.1.5 Function Description: Provide Illumination

I. Function ID Number: 3.2.2.3.1.5

II. Function Title: Provide Illumination

III. Function Definition:

To provide lighting in support of ESF operations.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.1.6 Function Description: Provide On-Site Transportation

I. Function ID Number: 3.2.2.3.1.6

II. Function Title: Provide On-Site Transportation

III. Function Definition:

To provide the services to transport men and materials within the ESF on the surface, between the surface and underground, and underground.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.2 Function Description: Provide Protective Services

I. Function ID Number: 3.2.2.3.2

II. Function Title: Provide Protective Services

III. Function Definition:

To provide general protective services to ensure the safety and security of men, materials, and operations at the ESF under both normal and off-normal conditions. Off-normal conditions include anticipated events, but not unanticipated events.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.3.2P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.131(b)(4)(ii) The geologic repository operations area shall be designed to include onsite facilities and services that ensure a safe and timely response to emergency conditions and that facilitate the use of available offsite services (such as fire, police, medical and ambulance service) that may aid in recovery from emergencies.
[DOE letter dated 2/27/90]

C. Interface: Requirements at this level to be specified

Table F3.2.2.3.2.1 Function Description: Provide Physical Security

I. Function ID Number: 3.2.2.3.2.1

II. Function Title: Provide Physical Security

III. Function Definition:

To provide adequate physical security for the ESF and ESF operations. Physical security includes protection against the unauthorized entry to the ESF site or underground areas and facilities or other sensitive areas such as archaeological or biota sites.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.3.2.1P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.131(a) Radiological protection. The geologic repository operations area shall be designed to maintain radiation doses, levels, and concentrations of radioactive material in air in restricted areas within the limits specified in Part 20 of this chapter. Design shall include -

(5) Means to control access to high radiation areas or airborne radioactivity areas;

[DOE letter dated 2/27/90]

C. Interface: Requirements at this level to be specified

Table F3.2.2.3.2.2 Function Description: Provide Inspection/Testing Services

I. Function ID Number: 3.2.2.3.2.2

II. Function Title: Provide Inspection/Testing Services

III. Function Definition:

To provide services for performing inspection and testing of ESF services, equipment, and operations.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints:

3.2.2.3.2.2C1 (1) Within 15 days of completion of an inspection (30 days for items dealing with health), a written notice shall be conspicuously posted at or near each place a hazardous working condition exists until the condition has been abated or for 3 working days, whichever is longer. Where it is not practical to post the notice at or near each place, such notice shall be posted in a prominent place where it will be readily observable by all affected employees. The notice shall:

(a) Describe with particularity the nature and extent of the unsafe or unhealthful working condition(s);

(b) Reference any safety or health standard violated;

(c) Establish a reasonable time for abatement of the hazardous condition(s).

(d) Be provided to the appropriate levels of management and the employee representative(s) who participated in the closing conference.

[DOE Order 3790.1A, page I-2]

B. Performance:

3.2.2.3.2.2P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.131(b)(8) Instrumentation and control systems. The design shall include provisions for instrumentation and control systems to monitor and control the behavior of systems important to safety over anticipated ranges for normal operation and for accident conditions.

[DOE letter dated 2/27/90]

C. Interface: Requirements at this level to be specified

Table F3.2.2.3.2.3 Function Description: Provide Emergency Medical Treatment

I. Function ID Number: 3.2.2.3.2.3

II. Function Title: Provide Emergency Medical Treatment

III. Function Definition:

To provide emergency first aid medical response and treatment services at the ESF.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints:

3.2.2.3.2.3C1 l. Medical Emergency Response. Areas with the potential for emergencies shall be identified and a written emergency planning, preparedness, and response program shall be prepared. The medical emergency response capability must include the following:

(1) The ability to treat the initial consequences of potential medical emergencies which might occur on the site and, if necessary, the ability to process injured or sick personnel for transfer to offsite medical emergency facilities; and

(2) The capacity to treat the number of patients and types of illnesses or injuries which are likely to occur on the site.

m. Emergency Tests and Exercises. Medical response capabilities shall be conducted

periodically for the identified potential emergencies. When practicable, tests and exercises shall be conducted under simulated emergency conditions.

[DOE Order 3790.1A, page VIII-5]

B. Performance: Requirements at this level to be specified

C. Interface: Requirements at this level to be specified

Table F3.2.2.3.2.4 Function Description: Provide Fire/Explosion Protection

I. Function ID Number: 3.2.2.3.2.4

II. Function Title: Provide Fire/Explosion Protection

III. Function Definition:

To provide services to respond to fires, explosions, and similar emergencies at the ESF.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints:

3.2.2.3.2.4C1 (3) Protection against fires and explosions.

(iii) 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 important to safety.

[10 CFR 60.131(b)]

B. Performance:	Requirements at this level to be specified
C. Interface:	Requirements at this level to be specified

Table F3.2.2.3.2.5 Function Description: Provide Radiological Protection

I. Function ID Number: 3.2.2.3.2.5

II. Function Title: Provide Radiological Protection

III. Function Definition:

To provide services to respond to radiological emergencies at the ESF.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints:

3.2.2.3.2.5C1 (5) Sampling of work environments shall be conducted where there is reason to suspect that work processes are creating health hazards.

[DOE Order 3790.1A, page I-2]

B. Performance:

3.2.2.3.2.5P1 DOE shall consider the following requirement in ESF design activities:

Sections 60.131 through 60.134 specify minimum criteria for the design of the geologic repository operations area. These design criteria are not intended to be exhaustive, however. Omissions in Sections 60.131 through 60.134 do not relieve DOE from any obligation to provide such safety features in a specific facility needed to achieve the performance objectives .... [10 CFR 60.130]

10 CFR 60.131(a) Radiological protection. The geologic repository operations area shall be designed to maintain radiation doses, levels, and concentrations of radioactive material in air in restricted areas within the limits specified in Part 20 of this chapter. Design shall include -

(1) Means to limit concentrations of radioactive material in air;

(2) Means to limit the time required to perform work in the vicinity of radioactive materials, including, as appropriate, designing equipment for ease of repair and replacement and providing adequate space for ease of operation;

(3) Suitable shielding;

(4) Means to monitor and control the dispersal of radioactive contamination;

(5) Means to control access to high radiation areas or airborne radioactivity areas; and

(6) A radiation alarm system to warn of significant increases in radiation levels, concentrations of radioactive material in air, and of increased radioactivity released in effluents. The alarm system shall be designed with provisions for calibration and for testing its operability.

[DOE letter dated 2/27/90]

C. Interface: Requirements at this level to be specified

Table F3.2.2.3.2.6 Function Description: Provide Non-Radiological Protection

I. Function ID Number: 3.2.2.3.2.6

II. Function Title: Provide Non-Radiological Protection

III. Function Definition:

To provide services to respond to emergencies other than security, radiological, fire and explosion, and medical at the ESF.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints:

3.2.2.3.2.6C1 Rock dust and gas hazards; controls

The dust resulting from drilling in rock shall be controlled by the use of permissible dust collectors, or by water or water with a wetting agent, or by ventilation, or by any other method or device approved by the Secretary *(of Labor)* which is at least as effective in controlling such dust. Respiratory equipment approved by the Secretary (of Labor) and the Secretary of Health and Human Services shall be provided persons exposed for short periods to inhalation hazards from gas, dusts, fumes or mist. When the exposure is for prolonged periods, other measures to protect such persons or to reduce the hazard shall be taken.

[30 USC 801 et seq., Section 844]

3.2.2.3.2.6C2 (5) Sampling of work environments shall be conducted where there is reason to suspect that work processes are creating health hazards.

[DOE Order 3790.1A, page I-2]

3.2.2.3.2.6C3 (1) The Federal Employee Industrial Hygiene Program shall be designed to preserve employee health and well-being. This shall be accomplished by recognition, evaluation, and control of hazardous exposures and stresses found in the occupational environment. These exposures and stresses include, but are not limited to, the following:

(a) Chemical (e.g., liquid, particulate, vapor, gas, and fumes).

(b) Physical (e.g., electromagnetic radiation, noise, vibration, magnetic fields, and extremes of temperature and pressure).

(c) Biological (e.g., infectious diseases).

(d) Ergonomic (e.g., body position in relation to task, repetitive motion, and mental or physical fatigue).

[DOE Order 3790.1A page VII-4]

B. Performance: Requirements at this level to be specified

C. Interface: Requirements at this level to be specified

Table F3.2.2.3.2.7 Function Description: Provide Environmental Protection

I. Function ID Number: 3.2.2.3.2.7

II. Function Title: Provide Environmental Protection

III. Function Definition:

To provide services to mitigate environmental hazards and to respond to environmental hazard emergencies at the ESF.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.3 Function Description: Administer General Support Services

I. Function ID Number: 3.2.2.3.3

II. Function Title: Administer General Support Services

III. Function Definition:

To administer general support services at the ESF.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.3.1 Function Description: Maintain Records

I. Function ID Number: 3.2.2.3.3.1

II. Function Title: Maintain Records

III. Function Definition:

To maintain ESF test records, operating records, and other data; and to provide other records management services.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints:

3.2.2.3.3.1C1 (c) Maintenance, preservation, and availability of records; issuance of regulations; scope of records; periodic inspections by employer; posting of notices by employer; notification of employee of corrective action. (1) Each employer shall make, keep and preserve, and make available to the Secretary (of Labor) or the Secretary of Health and Human Services, such records regarding his activities relating to this chapter as the Secretary, in cooperation with the Secretary of Health and Human Services, may prescribe by regulation as necessary or appropriate for the enforcement of this chapter or for developing information regarding the causes and prevention of occupational accidents and illnesses. In order to carry out the provisions of this paragraph such regulations may include provisions requiring employers to conduct periodic inspections. The Secretary shall also issue regulations requiring that employers, through posting of notices or other appropriate means, keep their employees informed of their protections and obligations under this chapter, including the provisions of applicable standards.

[29 USC 651 et seq., Section 657]

3.2.2.3.3.1C2 (d) Accident investigations; records

All accidents, including unintentional roof falls (except in any abandoned panels or in areas which are inaccessible or unsafe for inspections), shall be investigated by the operator or his agent to determine the cause and the means of preventing a recurrence. Records of such accidents and investigations shall be kept and the information shall be made available to the Secretary *(of Labor)* or his authorized representative and the appropriate State agency. Such records shall be open for inspection by interested persons. Such records shall include man-hours worked and shall be reported at a frequency determined by the Secretary (of Labor), but at least annually.

[30 USC 801 et seq., Section 813]

3.2.2.3.3.1C3 (h) Records and reports; compilation and publication; availability

In addition to such records as are specifically required by this chapter, every operator of a coal or other mine shall establish and maintain such records, make such reports, and provide such information, as the Secretary *(of Labor)* or the Secretary of Health and Human Services may reasonably require from time to time to enable him to perform his functions under this chapter.

[30 USC 801 et seq., Section 813]

3.2.2.3.3.1C4 (c) Certificate

Upon completion of each training program, each operator shall certify, on a form approved by the Secretary *(of Labor)*, that the miner has received the specified training in each subject area of the approved health and safety training plan. A certificate for each miner shall be maintained by the operator, and shall be available for inspection at the mine site, and a copy thereof shall be given to each miner at the completion of such training. When a miner leaves the operator's employ, he shall be entitled to a copy of his health and safety training certificates. False certification by an operator that training was given shall be punishable under section 820(a) and (f) of this title; and each health and safety training certificate shall indicate on its face, in bold letters, printed in a conspicuous manner the fact that such false certification is so punishable.

[30 USC 801 et seq., Section 825]

3.2.2.3.3.1C5 Records and reports; inspections

(a)(1)(A) the Administrator shall require the owner or operator of any point source to (i) establish and maintain such records, (ii) make such reports, (iii) install, use, and maintain such monitoring equipment or methods (including where appropriate, biological monitoring methods), (iv) sample such effluent (in accordance with such methods, at such locations, at such intervals, and in such manner as the Administrator shall prescribe), and (v) provide such other information as he may reasonably require;

[33 USC 1251 et seq., Sec. 1318]

3.2.2.3.3.1C6 Records And Inspections

(a)(1) Every person who is a supplier of water, who is or may be otherwise subject to a primary drinking water regulation prescribed under section 1412 or to an applicable underground injection control program (as defined in section 1422(c)), who is or may be subject to the permit requirement of section 1424 or to an order issued under section 1441, or who is a grantee, shall establish and maintain such records, make such reports, conduct such monitoring, and provide such information as the Administrator may reasonably require by regulation under this title, in determining whether such person has acted or is acting in

compliance with this title, in administering any program of financial assistance under this title, in evaluating the health risks of unregulated contaminants, or in advising the public of such risks.

[42 USC 300f et seq., Section 300j-4]

3.2.2.3.3.1C7 (b) Each record required by this part must be legible throughout the retention period specified by each Commission regulation. The record may be the original or a reproduced copy or a microform provided that the copy or microform is authenticated by authorized personnel and that the microform is capable of producing a clear copy throughout the required retention period. The record may also be stored in electronic media with the capability for producing legible, accurate, and complete records during the required retention period. Records such as letters, drawings, specifications, must include all pertinent information such as stamps, initials, and signatures. The licensee shall maintain adequate safeguards against tampering with and loss of records.

[10 CFR 60.4]

3.2.2.3.3.1C8 3. Records Maintenance. Records shall be maintained in accordance with DOE 1324.2, RECORDS DISPOSITION.

[DOE Order 3790.1A, page VII-8]

B. Performance:

3.2.2.3.3.1P1 Records shall be protected against damage, deterioration, or loss.

[DOE/RW-0214]

3.2.2.3.3.1P2 20.9 DATA RECORDING, STORAGE, AND RETRIEVABILITY.

Original recorded data shall be considered a QA record and shall be handled in accordance with QARD Section 17. Records shall, as appropriate, identify the following elements:

a. Scientific investigation requirements, plans, procedures (including applicable revisions), scientific notebooks, logs, and logbooks.

b. Item or sample investigated.

c. Data of scientific investigation.

d. Identification of the persons performing the scientific investigation and the performer's organizations.

e. Results and acceptability for intended use.

f. Action taken in connection with any deviations noted.

g. Persons evaluating scientific investigation results and evaluators' organization.

h. Identification of equipment used.

[DOE/RW-0214 Appendix A, Sec. 20.9]

C. Interface: Requirements at this level to be specified

Table F3.2.2.3.3.2 Function Description: Provide Engineering Support

I. Function ID Number: 3.2.2.3.3.2

II. Function Title: Provide Engineering Support

III. Function Definition:

To provide engineering support for ESF operation and testing.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.3.3 Function Description: Provide For Human Resources

I. Function ID Number: 3.2.2.3.3.3

II. Function Title: Provide for Human Resources

III. Function Definition:

To provide for human resource services at the ESF.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints:

3.2.2.3.3.3C1 (c) Maintenance, preservation, and availability of records; issuance of regulations; scope of records; periodic inspections by employer; posting of notices by employer; notification of employee of corrective action. (1) Each employer shall make, keep and preserve, and make available to the Secretary (of Labor) or the Secretary of Health and Human Services, such records regarding his activities relating to this chapter as the Secretary, in cooperation with the Secretary of Health and Human Services, may prescribe by regulation as necessary or appropriate for the enforcement of this chapter or for developing information regarding the causes and prevention of occupational accidents and illnesses. In order to carry out the provisions of this paragraph such regulations may include provisions requiring employers to conduct periodic inspections. The Secretary shall also issue regulations requiring that employers, through posting of notices or other appropriate means, keep their employees informed of their protections and obligations under this chapter, including the provisions of applicable standards.

[29 USC 651 et seq., Section 657]

3.2.2.3.3.3C2 (a) Mine office; bulletin board

At each coal or other mine there shall be maintained an office with a conspicuous sign designating it as the office of such mine. There shall be a bulletin board at such office or located at a conspicuous place near an entrance of such mine, in such manner that orders, citations, notices and decisions required by law or regulation to be posted, may be posted thereon, and be easily visible to all persons desiring to read them, and be protected against damage by weather and against unauthorized removal. A copy of any order, citation, notice or decision required by this chapter to be given to an operator shall be delivered to the office of the affected mine, and a copy shall be immediately posted on the bulletin board of such mine by the operator or his agent.

[30 USC 801 et seq., Section 819]

Note: Although the geologic repository is not a mine it shall meet the applicable requirements from 30 USC 801 et seq. listed in this document.

3.2.2.3.3.3C3 Each operator of a coal or other mine shall have a health and safety training program which shall be approved by the Secretary *(of Labor)*.

[30 USC 801 et seq., Section 825]

3.2.2.3.3.3C4 Each training program approved by the Secretary (of Labor) shall provide as a minimum that -

(1) new miners having no underground mining experience shall receive no less than 40 hours or training if they are to work underground. Such training shall include instruction in the statutory rights of miners and their representatives under this chapter, use of the self-rescue device and use of respiratory devices, hazard recognition, escapeways, walk around training, emergency procedures, basic ventilation, basic roof control, electrical hazards, first aid, and the health and safety aspects of the task to which he will be assigned;

(2) new miners having no surface mining experience shall receive no less than 24 hours of training if they are to work on the surface. Such training shall include instruction in the statutory rights of miners and their representatives under this chapter, use of the self-rescue device where appropriate, and use of respiratory devices where appropriate, hazard recognition, emergency procedures, electrical hazards, first aid, walk around training and the health and safety aspects of the task to which he will be assigned;

(3) all miners shall receive no less than eight hours of refresher training no less frequently than once each 12 months, except that miners already employed on the effective date of the Federal Mine Safety and Health Amendments Act of 1977 shall receive this refresher training no more than 90 days after the date of approval of the training plan required by this section;

(4) any miner who is reassigned to a new task in which he has had no previous work experience shall receive training in accordance with a training plan approved by the Secretary (of Labor) under this subsection in the safety and health aspects specific to that task prior to performing that task;

(5) any training required by paragraphs (1), (2) or (4) shall include a period of training as closely related as is practicable to the work in which the miner is to be engaged.

[30 USC 801 et seq., Section 825]

3.2.2.3.3.3C5 (c) Certificate

Upon completion of each training program, each operator shall certify, on a form approved by the Secretary *(of Labor)*, that the miner has received the specified training in each subject area of the approved health and safety training plan. A certificate for each miner shall be maintained by the operator, and shall be available for inspection at the mine site, and a copy thereof shall be given to each miner at the completion of such training. When a miner leaves the operator's employ, he shall be entitled to a copy of his health and safety training certificates. False certification by an operator that training was given shall be punishable under section 820(a) and (f) of this title; and each health and safety training certificate shall indicate on its face, in bold letters, printed in a conspicuous manner the fact that such false certification is so punishable.

[30 USC 801 et seq., Section 825]

3.2.2.3.3.3C6 (1) Within 15 days of completion of an inspection (30 days for items dealing with health), a written notice shall be conspicuously posted at or near each place a

hazardous working condition exists until the condition has been abated or for 3 working days, whichever is longer. Where it is not practical to post the notice at or near each place, such notice shall be posted in a prominent place where it will be readily observable by all affected employees. The notice shall:

(a) Describe with particularity the nature and extent of the unsafe or unhealthful working condition(s);

(b) Reference any safety or health standard violated;

(c) Establish a reasonable time for abatement of the hazardous condition(s).

(d) Be provided to the appropriate levels of management and the employee representative(s) who participated in the closing conference.

[DOE Order 3790.1A, page I-2]

3.2.2.3.3.3C7 (1) Training for Top Management. Top management shall be provided orientation training which will enable them to manage their programs in a safe manner. Such orientation training should include coverage under section 19 of the Occupational Safety and Health Act of 1970, Executive Order 12196, 29 CFR part 1960, and the DOE's Federal Employee Occupational Safety and Health Program.

(2) Training for Supervisors. Supervisors shall be trained through introductory and specialized courses and materials to recognize and eliminate occupational safety and health hazards in their work units. Such training should also include the development of requisite skills in managing the safety and health program within their work unit, including the training and motivation of subordinates toward safe and healthful work practices.

(3) Training for Employees. Occupational safety and health training for employees shall include specialized job safety and health training appropriate to the work performed. Such training shall also include informing employees of their rights and responsibilities under section 19 of the Occupational Safety and Health Act of 1970, Executive Order 12196, 29 CFR part 1960, and the DOE's Federal Employee Occupational Safety and Health Program.

(4) Training for Representatives of Employees. Training for employees who are representatives of employee groups, such as labor organizations which are recognized by the Department, shall include introductory and specialized courses and materials which will enable such groups to function appropriately in the interest of ensuring safe and healthful working conditions and practices in the workplace and, in particular, to enable them to effectively assist in the conduct of workplace safety and health inspections. Nothing in this paragraph shall be construed to alter the provisions of the Federal Service Labor-Management Relations Statute, other provisions of law providing for collective bargaining agreements and procedures, or any agreements entered into pursuant to such provisions.

(5) Training for Safety and Health Professionals. Safety and health personnel shall be trained through courses, laboratory experiences, field study, and other learning experiences to perform the necessary technical monitoring, consulting, testing, inspection, designing, and other tasks which will enable them to determine whether applicable standards are being met

in the workplace. Training should be designed so as to develop skills in hazard recognition, obtaining qualified evaluations, recommending corrective action, and functioning as consultants to management.

(6) Training for Collateral Duty Safety Personnel. Training should be designed so as to develop skills in hazard recognition, obtaining qualified evaluations, recommending corrective action, and functioning as consultants to management.

[DOE Order 3790.1A, page V-1]

3.2.2.3.3.3C8 a. Health Services Personnel. (1) Health services shall be provided under the direction of a licensed physician, and nursing services shall be provided by licensed professional nurses. To the maximum extent feasible, such physicians and nurses shall be qualified in occupational medicine and occupational nursing.

(2) As an alternative, Heads of Field Organizations may elect to contract for medical services. When this option is selected, licensed physicians and nurses shall be qualified in occupational medicine and occupational nursing, if possible, and programs shall comply with the requirements of this chapter.

b. Preplacement Health Evaluation. Prior to employment, where a hazard is associated with job performance, each employee shall have a complete health evaluation, with special emphasis placed upon the health and physical factors that relate to the hazards of the position. The purpose of this examination is to determine an employee's health status prior to any exposures associated with a job. In addition, it is to determine the employee's physical capabilities and any required accommodations necessary for safe and healthy job performance. The health evaluation shall be performed by the health services staff at no cost to the employee.

c. Health Screening Evaluation. Each employee age 45 and over shall be offered a complete health evaluation annually at no cost to the employee.

d. Job Change or Transfer Health Evaluation.

(1) Employees who change or transfer job functions with associated hazards (e.g., electrician to lineman or lineman to crane operator) shall have their health status and physical fitness reviewed with emphasis on the effects of the position vacated and the health and physical factors that relate to the new job tasks and demands. The evaluation shall be at no cost to the employee.

(2) Employees who change or transfer from a job function with associated hazards to a job function with negligible associated hazards or vice versa (e.g., courier to file clerk or draftsman to lineman) shall have their health status and physical fitness reviewed with emphasis on the effects of the position vacated or the health and physical factors that relate to the new job tasks and demands, for whichever involves hazards. The evaluation shall be at no cost to the employee.

e. Retirement or Separation Health Evaluation. The health status of an employee who is retiring or separating from a position where there is an associated hazard shall be

determined by a health evaluation, with emphasis placed upon the health and physical factors of that position. The evaluation shall be at no cost to the employee.

f. Return to Work (Fitness-for-Duty) Evaluation. An employee who occupies a position with an associated hazard, who is absent from work more than 3 consecutive workdays due to either an occupational or a nonoccupational illness or injury, shall submit either a health status report from a personal physician (obtained at the employee's expense) to the employee's supervisor stating that the employee is fit to work, or shall undergo a health evaluation by the health services staff (at no cost to the employee) sufficient to ensure that the employee's return to work will be without undue health hazard or accident risk to the employee or others.

g. Treatment and Medications. The health services staff shall at their discretion administer the following at no cost to the employee:

(1) Vaccines or other medications furnished by the employee and prescribed in writing by the employee's personal physician as reasonably necessary to maintain the employee's health and well-being while at work; and

(2) Treatment prescribed by a physician providing medical care in performance-of-duty injury or illness cases under the Federal Employee's Compensation Act.

h. Screening Examinations. Tests and immunizations for specific diseases shall be provided as necessary by health services personnel.

i. Health Education and Counseling, provided at no cost to employees, shall include:

(1) Lectures on health and health education materials to promote and encourage employees to improve and maintain personal health;

(2) Individual counseling on health matters; and

(3) Utilization of available Employee Assistance Program services.

j. Treatment of Injuries or Illnesses.

(1) Occupational Injury or Illness. Any employee with an occupationally related injury or illness shall be initially examined and treated to allay pain, discomfort, and anxiety without undue delay and at no cost to the employee. The scope and content of the examination and treatment shall be based upon the nature and extent of the injury or illness, and shall be sufficient to determine whether the employee may return to work without undue health hazard or accident risk to the workforce. If necessary, conveyance of the employee to a local hospital emergency room shall be provided.

(2) Nonoccupational Injury or Illness. On-the-job care is given, at no cost to the employee, as necessary to allay pain, discomfort, and anxiety; to allow completion of the workday, and to provide interim care prior to referral of the employee to his or her physician for private medical attention.

[DOE Order 3790.1A, page VIII-3]

3.2.2.3.3.3C9 k. Emergency Training. Employees shall have the opportunity to receive training in the basic elements of first aid and cardiopulmonary resuscitation (CPR) and CPR refresher training, at no cost to the employee.

[DOE Order 3790.1A, page VIII-5]

B. Performance: Requirements at this level to be specified

C. Interface: Requirements at this level to be specified

Table F3.2.2.3.3.4 Function Description: Provide Procurement Services

I. Function ID Number: 3.2.2.3.3.4

II. Function Title: Provide Procurement Services

III. Function Definition:

To provide for the procurement of materials and personnel services for the ESF.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.3.5 Function Description: Administer Public Relations

I. Function ID Number: 3.2.2.3.3.5

II. Function Title: Administer Public Relations

III. Function Definition:

To administrate public relations activities for the ESF.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.3.6 Function Description: Provide Financial Accounting

I. Function ID Number: 3.2.2.3.3.6

II. Function Title: Provide Financial Accounting

III. Function Definition:

To provide financial accounting services for the ESF.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.4 Function Description: Process Site Generated Waste (Non-Rad)

I. Function ID Number: 3.2.2.3.4

II. Function Title: Process Site Generated Waste (Non-Rad)

III. Function Definition:

To collect, store, process and dispose of non-radiological wastes generated at the ESF site.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints:

3.2.2.3.4C1 Disposal or use of sewage sludge

(a) Permit

Notwithstanding any other provision of this chapter or of any other law, in any case where the disposal of sewage sludge resulting from the operation of a treatment works as defined in section 1292 of this title (including the removal of in-place sewage sludge from one location and its deposit at another location) would result in any pollutant from such sewage sludge entering the navigable waters, such disposal is prohibited except in accordance with a permit issued by the Administrator under section 1342 of this title.

[33 USC 1251 et seq., Sec. 1345]

B. Performance: Requirements at this level to be specified

C. Interface: Requirements at this level to be specified

Table F3.2.2.3.4.1 Function Description: Process Hazardous Waste

I. Function ID Number: 3.2.2.3.4.1

II. Function Title: Process Hazardous Waste

III. Function Definition:

To collect, store, process and dispose of hazardous non-radiological wastes generated at the ESF site. Disposal will include off-site shipment.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.4.2 Function Description: Process Non-Hazardous Waste

I. Function ID Number: 3.2.2.3.4.2

II. Function Title: Process Non-Hazardous Waste

III. Function Definition:

To collect, store, process and dispose of non-hazardous non-radiological wastes generated at the ESF site. Disposal can include on-site methods.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.5 Function Description: Maintain Operating Facilities

I. Function ID Number: 3.2.2.3.5

II. Function Title: Maintain Operating Facilities

III. Function Definition:

To maintain the ESF facilities and functions.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.5.1 Function Description: Maintain Surface Operating Facilities

I. Function ID Number: 3.2.2.3.5.1

II. Function Title: Maintain Surface Operating Facilities

III. Function Definition:

To maintain the ESF surface facilities and functions.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.5.2 Function Description: Maintain Subsurface Test Facilities

I. Function ID Number: 3.2.2.3.5.2

II. Function Title: Maintain Subsurface Test Facilities

III. Function Definition:

To maintain the ESF subsurface test facilities and functions.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.5.3 Function Description: Maintain Subsurface Support Facilities

I. Function ID Number: 3.2.2.3.5.3

II. Function Title: Maintain Subsurface Support Facilities

III. Function Definition:

To maintain ESF subsurface support facilities and functions.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.3.6 Function Description: Administer QA

I. Function ID Number: 3.2.2.3.6

II. Function Title: Administer QA

III. Function Definition:

To administer a QA program which is required for all ESF quality affecting work.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.3.6P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.17(a) A general plan for site characterization activities to be conducted at the area to be characterized, which general plan shall include:

(2) A description of such site characterization activities, including the following -

(v) Plans to apply quality assurance to data collection, recording, and retention.

[DOE letter dated 2/27/90]

C. Interface: Requirements at this level to be specified

Table F3.2.2.3.7 Function Description: Manage ESF Test Data

I. Function ID Number: 3.2.2.3.7

II. Function Title: Manage ESF Test Data

III. Function Definition:

To manage the ESF test data. Management includes the collection, handling, storage, and recovery of all data provided from the ESF test program.

IV. Interfaces:

A. Inputs: None identified at this time

B. Outputs: None identified at this time

V. Function Requirements:

A. Constraints: Requirements at this level to be specified

B. Performance:

3.2.2.3.7P1 A common data collection system shall be used to support all ESF tests.

[Decision Documentation #1]

3.2.2.3.7P2 20.4 DATA COLLECTION AND ANALYSIS

a. Equipment to be used to obtain and analyze data shall be evaluated to assure adequacy and proper selection. Data collection and analysis shall be controlled by measures that provide sufficient detail to allow the processes to be repeated by an individual with qualifications comparable to the person originally conducting the task. Where appropriate, verifications shall be performed using recognized methods.

[DOE/RW - 0214 page A-11]

3.2.2.3.7P3 20.4 DATA COLLECTION AND ANALYSIS

b. Data transfer and reduction controls shall be established to assure data transfer is error-free or within a prescribed, permissible error rate to assure that information is not lost in transfer and that the input is completely recoverable from the output. All processes that change either the form of expression or quantity of data, values, or number of data items (data reduction, shall be controlled by prescribed methods that allow verification of the conversion process.

[DOE/RW - 0214 page A-12]

3.2.2.3.7P4 20.9 DATA RECORDING, STORAGE, AND RETRIEVABILITY

Original recorded data shall be considered a QA Record and shall be handled in accordance with QARD Section 17.

[DOE/RW - 0214 page A-13]

C. Interface: Requirements at this level to be specified

Table F3.2.2.4 Function Description: Close ESF

I. Function ID Number: 3.2.2.4

II. Function Title: Close ESF

III. Function Definition:

To close the ESF, if the site is determined to be non-suitable. Closure will occur when the ESF mission is determined to be completed; i.e., the site is determined to be non-suitable. If a non-suitable site is determined, closure will include partial or total decommissioning, site reclamation and restoration to meet environmental regulations. If the site is suitable and a repository is developed, the ESF will be incorporated into the repository system. The ESF will close when the repository closes.

IV. Interfaces:

A. Inputs:

3.2.2.4I1	ESF Facilities	**From:**	Function 3.2.2.1
3.2.2.4I2	Characterized Site	**From:**	Function 3.2.2.2

B. Outputs:

3.2.2.4O1	Decommissioning Records	**To:**	Outside System Boundary
3.2.2.4O2	Salvaged Equipment	**To:**	Outside System Boundary
3.2.2.4O3	Reclaimed Areas	**To:**	Outside System Boundary
3.2.2.4O4	Sealed Access/Boreholes	**To:**	Outside System Boundary

V. Function Requirements:

A. Constraints:

3.2.2.4C1 (A) a general plan for site characterization activities to be conducted at such candidate site, which plan shall include--

> (iii) plans for the decontamination and decommissioning of such candidate site, and for the mitigation of any significant adverse environmental impacts caused by site characterization activities if it is determined unsuitable for application for a construction authorization for a repository;
>
> *[NWPA Sec. 113(b)]*

3.2.2.4C2 If the Secretary at any time determines the Yucca Mountain site to be unsuitable for development as a repository, the Secretary shall - (A) terminate all site characterization activities at such site; (B) notify the Congress, the Governor and legislature of Nevada of such termination and the reasons for such termination; (C) remove any high-level radioactive waste, spent nuclear fuel, or other radioactive materials at or in such site as promptly as practicable; (D) take reasonable and necessary steps to reclaim the site and

to mitigate any significant adverse environmental impacts caused by site characterization activities at such site; (E) suspend all future benefits payments under subtitle F [42 U.S.C. 10173 et seq.] with respect to such site; and (F) report to Congress not later than 6 months after such determination the Secretary's recommendations for further action to assure the safe, permanent disposal of spent nuclear fuel and high-level radioactive waste, including the need for new legislative authority.

[NWPA Sec. 113(c)(3)]

B. Performance:

3.2.2.4P1 DOE shall consider the following requirement in ESF design activities:

10 CFR 60.17(a) A general plan for site characterization activities to be conducted at the area to be characterized, which general plan shall include:

> (3) Plans for the decontamination and decommissioning of such area, and for the mitigation of any significant adverse environmental impacts caused by site characterization activities, if such area is determined unsuitable for application for a construction authorization for a geologic repository operations area;

[DOE letter dated 2/27/90]

C. Interface: Requirements at this level to be specified

Table F3.2.2.4.1 Function Description: Backfill and Seal Subsurface Openings and Accesses

I. Function ID Number: 3.2.2.4.1

II. Function Title: Backfill and Seal Subsurface Openings and Accesses

III. Function Definition:

To backfill with excavated rock and seal subsurface openings and accesses.

IV. Interfaces:

A. Inputs:

3.2.2.4.1I1 Characterized Site **From:** Function 3.2.2.2

3.2.2.4.1I2	Subsurface Facilities/ Accesses	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.4.1O1	Reclaimed Areas	**To:**	Outside System Boundary
3.2.2.4.1O2	Salvaged Equipment	**To:**	Outside System Boundary
3.2.2.4.1O3	Decommissioning Records	**To:**	Outside System Boundary

V. Function Requirements: Requirements at this level to be specified

Table F3.2.2.4.2 Function Description: Decommission Surface Facilities

I. Function ID Number: 3.2.2.4.2

II. Function Title: Decommission Surface Facilities

III. Function Definition:

To decommission salvageable systems, structures and components, perform site recontouring, and environmentally reclaim surface areas.

IV. Interfaces:

A. Inputs:

3.2.2.4.2I1	Surface Facilities	**From:**	Function 3.2.2.1

B. Outputs:

3.2.2.4.2O1	Reclaimed Areas	**To:**	Outside System Boundary
3.2.2.4.2O2	Salvaged Equipment	**To:**	Outside System Boundary
3.2.2.4.2O3	Decommissioning Records	**To:**	Outside System Boundary

V. Function Requirements: Requirements at this level to be specified

Table F3.2.3 Function Description: Conduct Lab Activities

I. Function ID Number: 3.2.3

II. Function Title: Conduct Lab Activities

III. Function Definition:

To conduct ESF laboratory related activities.

IV. Interfaces:

A. Inputs:

3.2.3I1	Samples	**From:**	Function 3.2.1/ 3.2.2

B. Outputs:

3.2.3O1	Data	**To:**	Function 3.2.4

V. Function Requirements: Requirements at this level to be specified

Table F3.2.4 Function Description: Assess Data

I. Function ID Number: 3.2.4

II. Function Title: Assess Data

III. Function Definition:

To assess data provided by the ESF testing, surface-based and other site characterization data which are not included in the environmental investigations, and laboratory activities.

IV. Interfaces:

A. Inputs:

3.2.3I1	Data	**From:**	Function 3.2.1/ 3.2.2/ 3.2.3

B. Outputs:

3.2.3O1	Data Needs/Sample Needs	**To:**	Function 3.2.1 (Control) Function 3.2.2 (Control)

			Function 3.2.3 (Control)
3.2.3O2	Assessment Results	To:	Outside System Boundary
3.2.4O3	Data	To:	Outside System Boundary

V. Function Requirements: Requirements at this level to be specified

3.0 ARCHITECTURE DESCRIPTION

Architecture is defined herein to be that part of the physical system actually built, found, or selected to perform a function subject to its stated requirements. Figure 4 portrays the architectural concepts that comprise an ESF based on how DOE/OCRWM currently plans to satisfy its mission.

Tables A3.2.2 through A3.2.2.7 identify the specific requirements to be satisfied by each architectural concept (at the fourth level), a rationale justifying the need for the architecture, and a description of the concept. A complete description of the ESF and its components is not possible until more detailed design efforts are completed. Nevertheless, the concepts identified in Figure 4 should improve understanding of the overall concept. At the third level (i.e., 3.2.2) the ESF is the conceptual architecture solution for the corresponding function. However, at lower levels the link between the architecture tree and the function tree is through the specific requirement(s) that are satisfied by individual ESF components. Thus, there is not a one-to-one correspondence between architecture numbering and function numbering below the third level.

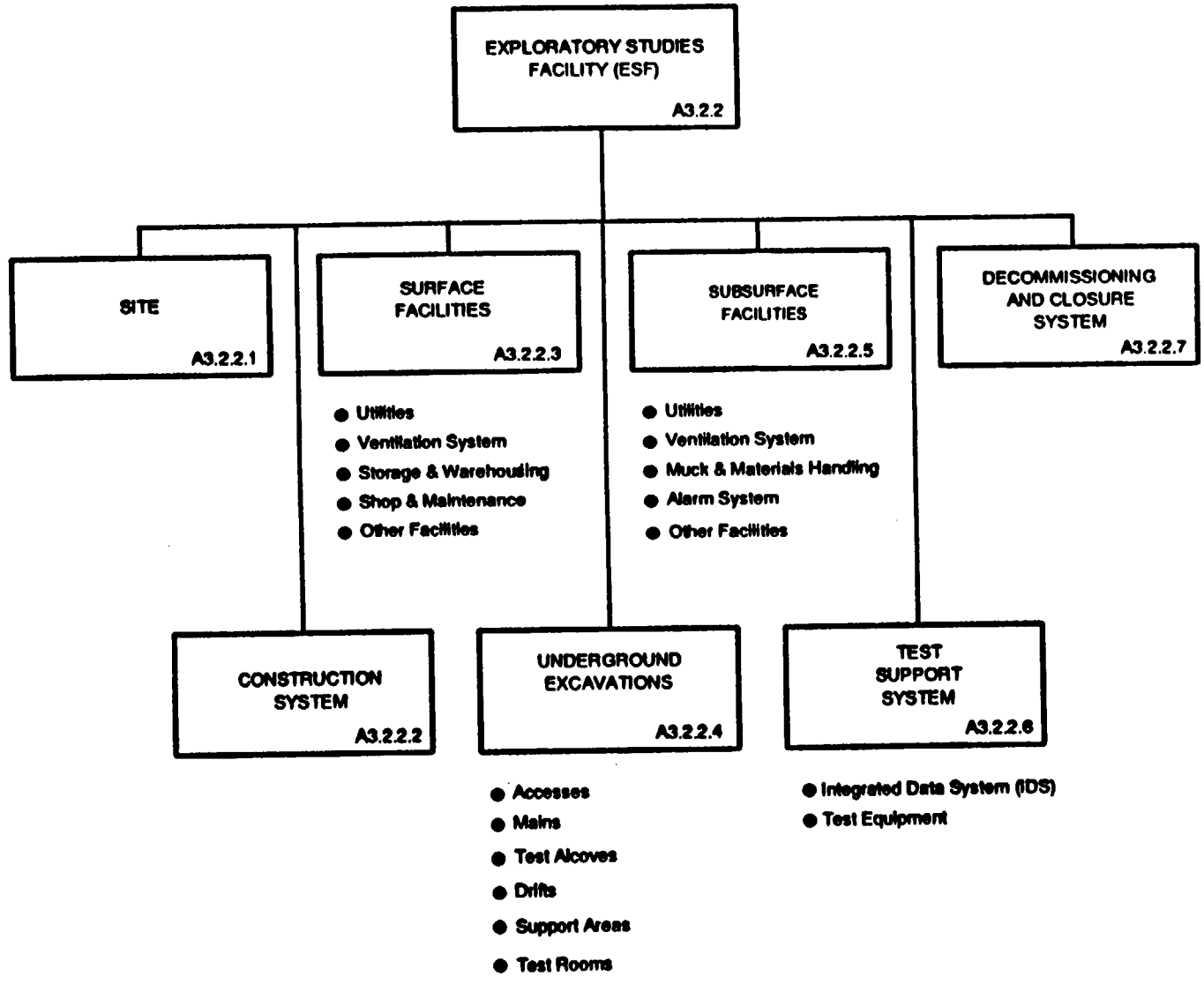

Figure 4. ESF Conceptual Architecture Hierarchy

Table A3.2.2 Exploratory Studies Facility

ARCHITECTURE: Exploratory Studies Facility

REQUIREMENTS SATISFIED:

3.2.2C1-C16, P1-P2, O1; 3.2.2.3.2.2C1; 3.2.2.3.2.3C1; 3.2.2.3.2.5C1; 3.2.2.3.2.6C3; 3.2.2.3.4C1; 3.2.2.3.6P1

RATIONALE:

For determining the suitability of a site for a geologic repository, the NWPA has authorized DOE to conduct scientific investigations including in-situ testing at the site. For conducting such site characterization, an exploratory studies facility is required at the candidate site. [Inferred from NWPA Sec. 113 and 10 CFR 60.2]

DESCRIPTION:

The Exploratory Studies Facility includes borings, excavation of exploratory shafts (or ramps), lateral underground openings, and all other systems, structures, or components required to support and conduct the tests.

Table A3.2.2.1 Site

ARCHITECTURE: Site

REQUIREMENTS SATISFIED:

3.2.2.1.3C9-C11, I1a-c

RATIONALE:

In situ testing at an ESF requires a site.

DESCRIPTION:

The site includes all surface and underground areas dedicated for ESF facilities, including surface roads and utility corridors, surface facility pads, laydown areas, excavated rock storage areas, spoils storage areas, shaft/ramp surface pad areas and sewage/solid waste dumping areas.

Table A3.2.2.2 Construction System

ARCHITECTURE: Construction System

REQUIREMENTS SATISFIED:

3.2.2.1O2a-c, O4a-c; 3.2.2.1.3O6, C10, C11; 3.2.2.2.1.1I1a,b; 3.2.2.2.1.2I1a; 3.2.2.2.1.4I1d; 3.2.2.2.1.5I1a; 3.2.2.2.1.8I1; 3.2.2.2.1.9I1a; 3.2.2.2.1.12I1a; 3.2.2.2.2.3I1; 3.2.2.2.2.4I1; 3.2.2.2.2.5I1b; 3.2.2.2.2.6I1; 3.2.2.2.3.2I1b; 3.2.2.2.4.2I1b; 3.2.2.2.4.3I1c-d; 3.2.2.2.4.4I1a; 3.2.2.2.4.6I1b; 3.2.2.2.4.11I1b; 3.2.2.2.4.12I1b; 3.2.2.2.4.16I1a-b; 3.2.2.2.7.3I1

RATIONALE:

A construction system is required to construct an ESF.

DESCRIPTION:

The construction system includes all necessary equipment and facilities needed for constructing the ESF.

Table A3.2.2.3 Surface Facilities

ARCHITECTURE: Surface Facilities

REQUIREMENTS SATISFIED:

3.2.2.1C1-C2, P1; 3.2.2.2.1.2I1a; 3.2.2.2.1.9I1a; 3.2.2.2.1.11I1b; 3.2.2.2.2.3I1; 3.2.2.2.2.4I1; 3.2.2.2.4.6I1b; 3.2.2.3O3; 3.2.2.3.1C1; 3.2.2.3.1.1C2; 3.2.2.3.1.3C1-C5, P1; 3.2.2.3.2.P1; 3.2.2.3.2.2P1; 3.2.2.3.3.1C1-C8, P1-P2; 3.2.2.3.3.3C1-C9

RATIONALE:

Surface facilities are needed to support construction and operation of the ESF.

DESCRIPTION:

Surface facilities include all necessary surface plant, support facilities, and such supporting subsurface excavation and operation.

Table A3.2.2.3.1 Utilities

ARCHITECTURE: Utilities

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

Utility services, and the capability for these services to operate under normal and abnormal conditions are essential for the operation of the ESF.

DESCRIPTION:

Utilities include water, power distribution, compressed air, transportation, fuel and sanitary facilities.

Table A3.2.2.3.2 Ventilation System

ARCHITECTURE: Ventilation System

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

The surface and subsurface ventilation system is needed to maintain a quality working or testing environment for surface and subsurface facilities.

DESCRIPTION:

The ventilation system includes all equipment and facilities necessary to distribute and control conditioned ventilation air to ESF surface facilities and to the underground. Conditioned air means the air of sufficient quality or "state of comfort" required to meet federal, state or local health and safety requirements or to meet the testing requirements/specifications.

Table A3.2.2.3.3 Storage and Warehousing

ARCHITECTURE: Storage and Warehousing

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

Storage and warehousing facilities are required to maintain the operating functions of the ESF.

DESCRIPTION:

Storage and warehousing includes all equipment and facilities needed to store, protect, and dispense consumable supplies and materials, critical test and operating equipment, parts and tools, fuels and lubricants.

Table A3.2.2.3.4 Shop and Maintenance

ARCHITECTURE: Shop and Maintenance

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

Adequate shop and maintenance facilities are needed to maintain the operation and schedule of the ESF.

DESCRIPTION:

Shop and maintenance includes all surface equipment and facilities needed to maintain and repair ESF facilities and equipment critical to the continuous operation or performance of the ESF and ESF testing.

Table A3.2.2.3.5 Other Facilities

ARCHITECTURE: Other Facilities

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

Additional ancillary facilities and services are also required to maintain the operation and schedule of the ESF.

DESCRIPTION:

The other facilities include administrative, security, emergency, batch plant, and public relations equipment and facilities.

Table A3.2.2.4 Underground Excavations

ARCHITECTURE: Underground Excavations

REQUIREMENTS SATISFIED:

3.2.2.1C1-C2, P1; 3.2.2.1.3C1-C9, I1a, O4a-c; 3.2.2.1.3.1C1; 3.2.2.2P1-P2; 3.2.2.2.1.2I1b; 3.2.2.2.1.3I1a,b; 3.2.2.2.1.4P2, I1a-c; 3.2.2.2.1.6I1a, I1c; 3.2.2.2.1.7P3; 3.2.2.2.1.9P7, I1c; 3.2.2.2.1.11I1b; 3.2.2.2.1.12P3; 3.2.2.2.2.1P1; 3.2.2.2.2.2P3; 3.2.2.2.2.3P1; 3.2.2.2.2.4P1; 3.2.2.2.2.5P1; 3.2.2.2.2.6P1; 3.2.2.2.3.1I1a-b; 3.2.2.2.3.2I1a; 3.2.2.2.4.1P1, I1; 3.2.2.2.4.2I1a, I1c; 3.2.2.2.4.3I1a-b, I1e; 3.2.2.2.4.4I1b-d; 3.2.2.2.4.5I1a-b; 3.2.2.2.4.6I1a, I1c; 3.2.2.2.4.7I1a-b; 3.2.2.2.4.8P1, I1a; 3.2.2.2.4.9I1a-b; 3.2.2.2.4.10P2, I1; 3.2.2.2.4.11P3, I1a; 3.2.2.2.4.13I1; 3.2.2.2.4.14P3, I1b; 3.2.2.2.4.15P1-P2, I1a; 3.2.2.2.4.16P2-P3, I1c; 3.2.2.2.5.1P1, I1; 3.2.2.2.6.1P1, I1; 3.2.2.2.7.1P1-P2, I1a; 3.2.2.2.7.2P1-P2, I1a-d; 3.2.2.2.7.3P1; 3.2.2.3.1.3C6; 3.2.2.3.2P1; 3.2.2.3.2.1P1; 3.2.2.3.2.4C1; 3.2.2.3.25P1

RATIONALE:

Subsurface portions of the ESF need to be excavated for accessing and providing testing space.

DESCRIPTION:

Underground excavations include accesses, test rooms, test alcoves, mains, and support areas of the ESF.

Table A3.2.2.4.1 Accesses

ARCHITECTURE: Accesses

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

The surface and underground portions of the ESF have to be connected to provide access to the in situ testing locations.

DESCRIPTION:

Access openings could be either vertical (shafts) or inclined (ramps/declines/shafts) openings excavated at the ESF site to provide access for personnel and services from the surface to the underground.

Table A3.2.2.4.2 Mains

ARCHITECTURE: Mains

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

Mains are needed to provide access for personnel, ventilation, materials, and services from the bottom of the accesses to the drifts.

DESCRIPTION:

Mains are the primary underground openings (tunnels) at the test level(s). These large-size openings connect between the bottom of access openings and the drifts, and provide access for ventilation and supplies.

Table A3.2.2.4.3 Test Alcoves

ARCHITECTURE: Test Alcoves

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

Test alcoves, or underground test rooms are needed for conducting in situ tests in the ESF, per the NWPA and 10 CFR 60.

DESCRIPTION:

Test alcoves are excavated openings underground of varying sizes and shapes to accommodate in situ testing purposes.

The main test level (MTL) of the ESF is defined as the ESF development within the planned repository horizon, which is currently identified as Topopah Spring Rock Unit 2 (TSw2) within the Topopah Spring Member of the Paintbrush Tuff Formation.

Table A3.2.2.4.4 Drifts

ARCHITECTURE: Drifts

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

Drifts are needed to provide access for personnel, ventilation, materials, and services from the mains to the underground test areas.

DESCRIPTION:

Drifts are the secondary underground openings (tunnels) at the test level(s). These openings connect the mains and the test areas, and provide access for ventilation and supplies.

Table A3.2.2.4.5 Support Areas

ARCHITECTURE: Support Areas

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

Underground support areas are needed to support in situ testing at depth in the ESF.

DESCRIPTION:

Support areas are excavated underground openings which provide the necessary space to place test equipment, underground support, and repair equipment, materials, and utility systems.

Table A3.2.2.4.6 Test Rooms

ARCHITECTURE: Test Rooms

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

Test rooms are needed for conducting in situ tests in the ESF, per the NWPA and 10 CFR 60.

DESCRIPTION:

Test rooms are excavated openings underground of varying sizes and shapes to accommodate in situ testing purposes.

Table A3.2.2.5 Subsurface Facilities

ARCHITECTURE: Subsurface Facilities

REQUIREMENTS SATISFIED:

3.2.2.1C2, P1; 3.2.2.2.1.2I1a; 3.2.2.2.1.5I1a; 3.2.2.2.1.9I1a; 3.2.2.2.1.11I1b; 3.2.2.2.2.3I1; 3.2.2.2.2.4I1; 3.2.2.2.4.6I1b; 3.2.2.2.4.7I1d; 3.2.2.2.7.2I1e; 3.2.2.3.O3; 3.2.2.3.1.1C1-C2; 3.2.2.3.1.3C1-C6, P1; 3.2.2.3.2P1; 3.2.2.3.2.2P1; 3.2.2.3.2.4C1; 3.2.2.3.2.5P1; 3.2.2.3.2.6C1-C2

RATIONALE:

Subsurface facilities are needed to support ESF subsurface construction and operations.

DESCRIPTION:

Subsurface facilities include all underground utilities, underground transport, maintenance facilities, warehousing/supplies, and alarm systems necessary to support ESF subsurface facility construction and operation.

Table A3.2.2.5.1 Utilities

ARCHITECTURE: Utilities

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

Utility services, and the capability for these services to operate under normal and abnormal conditions are essential for the operation of the ESF.

DESCRIPTION:

Utilities includes the underground communications, power, water, and ventilation systems. These systems interface with the surface utilities.

Table A3.2.2.5.2 Ventilation System

ARCHITECTURE: Ventilation System

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

The underground ventilation system is needed to maintain a quality working or testing environment for subsurface facilities.

DESCRIPTION:

The ventilation system includes all equipment and facilities necessary to distribute and control conditioned ventilation air to ESF surface facilities and to the underground. Conditioned air means the air quality or "state of comfort" required to meet federal, state or local health and safety requirements or to meet the testing requirements/specifications.

Table A3.2.2.5.3 Muck and Materials Handling

ARCHITECTURE: Muck and Materials Handling

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

A muck and materials handling system is needed to maintain the underground excavations.

DESCRIPTION:

The muck and materials handling system includes the equipment and facilities required to remove excavated rock from the mining area to the surface, and to transport ground support materials such as rock bolts and mesh to the mining area from the surface.

Table A3.2.2.5.4 Alarm System

ARCHITECTURE: Alarm System

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

An alarm (monitoring and warning) system is needed to maintain a safe and healthful environment underground.

DESCRIPTION:

The alarm system includes all environmental monitoring equipment and facilities to detect, analyze, and warn of potentially unsafe working conditions in the underground areas. The warning system includes both audible and visual systems to alert personnel of unsafe conditions.

Table A3.2.2.5.5 Other Facilities

ARCHITECTURE: Other Facilities

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

Other subsurface support facilities are needed to maintain a continuous and uninterrupted in situ test and work schedule.

DESCRIPTION:

Other facilities includes administrative, maintenance, warehousing/supplies facilities and equipment for ESF subsurface construction and operation.

Table A3.2.2.6 Test Support System

ARCHITECTURE: Test Support System

REQUIREMENTS SATISFIED:

3.2.2.2C1-C4, P1-P3, O1, O3; 3.2.2.2.1.1P1-P4, O2-O4; 3.2.2.2.1.2P1-P6, O2-O4; 3.2.2.2.1.3P1-P5, O1-O3; 3.2.2.2.1.4P1-P3, I1e, O1-O4; 3.2.2.2.1.5P1-P5, I1b-c, O1-O4; 3.2.2.2.1.6P1-P10, I1b, O1-O4; 3.2.2.2.1.7P1-P4, I1, O1-O4; 3.2.2.2.1.8P1-P5, I1, O1-O4; 3.2.2.2.1.9P1-P8, I1b, O1-O3; 3.2.2.2.1.10P1-P7, O1-O3; 3.2.2.2.1.11P1-P9, I1a, O1-O4; 3.2.2.2.1.12P1-P2, P4-P8, O1-O4; 3.2.2.2.2.1P1-P2, O1-O3; 3.2.2.2.2.2P1-P4, O2-O4; 3.2.2.2.2.3P1-P2, O1-O3; 3.2.2.2.2.4P1-P3, O1-O3; 3.2.2.2.2.5P1-P2, I1a, O1-O3; 3.2.2.2.2.6P2-P5, O1-O4; 3.2.2.2.3.1C1, P1-P6, I1c, O1-O2; 3.2.2.2.3.2P1-P2, I1a-b, O1-O3; 3.2.2.2.4.1P1-P2, O1-O3; 3.2.2.2.4.2C1, P1-P4, I1d, O1-O4; 3.2.2.2.4.3P1-P4, I1c, I1f, O1-O4; 3.2.2.2.4.4P1-P4, I1e, O1-O4; 3.2.2.2.4.5P1-P4, I1c-e, O1-O4; 3.2.2.2.4.6P1-P4, I1d, O1-O5; 3.2.2.2.4.7P1-P4, I1c, O1-O4; 3.2.2.2.4.8P1-P8, I1b-c, O1-O4; 3.2.2.2.4.9P1-P5, I1c, O1-O4; 3.2.2.2.4.10P1, P3, O1-O3; 3.2.2.2.4.11P1-P4, O1-O3; 3.2.2.2.4.12C1, P1-P4, I1a, O1-O4; 3.2.2.2.4.13P1-P5, O1-O4; 3.2.2.2.4.14P1-P6, I1a, O1-O4; 3.2.2.2.4.15P1, P3-P5, I1b, O1-O4; 3.2.2.2.4.16P1-P5, O1-O4; 3.2.2.2.5.1P1-P2, O1; 3.2.2.2.6.1P2-P4, I2, O2-O4; 3.2.2.2.7.1P1, P3-P6, I1c-d, O1-O4; 3.2.2.2.7.2P1, P3-P8, I1f-g, O1-O4; 3.2.2.2.7.3P1-P2, I1, O1-O3; 3.2.2.2.8C1-C2; 3.2.2.3.7P1-P4

RATIONALE:

For conducting in situ testing at depth in the ESF, test support systems are needed.

DESCRIPTION:

The test support system includes all testing equipment, data collection and monitoring facilities and maintenance systems needed for performing the numerous in situ tests in the ESF.

Table A3.2.2.6.1 Integrated Data System (IDS)

ARCHITECTURE: Integrated Data System (IDS)

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

In order to facilitate the collection, recording, and handling of data acquired at the ESF, an automated data collection system will be used.

DESCRIPTION:

The IDS includes all data processing equipment needed for collecting and handling data prior to future processing and analyzing.

Table A3.2.2.6.2 Test Equipment

ARCHITECTURE: Test Equipment

REQUIREMENTS SATISFIED:

TBD

RATIONALE:

In order to conduct a comprehensive testing program, test equipment is needed.

DESCRIPTION:

Test equipment includes all necessary test equipment to conduct each of the in situ tests at the ESF.

Table A3.2.2.7 Decommissioning and Closure System

ARCHITECTURE: Decommissioning and Closure System

REQUIREMENTS SATISFIED:

3.2.2.4C1-C2, P1

RATIONALE:

If the site is found to be unsuitable for a repository, the ESF has to be decommissioned unless an alternative use for the ESF is identified. [Inferred from SCP, Sec. 8.7]

DESCRIPTION:

The decommissioning and closure system includes equipment and facilities needed to decommission and close the ESF and to reclaim the site, if the site is determined to be unsuitable for a repository.

4.0 INTERFACES

Interfaces can be either functional interfaces that indicate a flow between functions as in a sequence of activities, or physical interfaces that indicate a necessary fit between architectures. Prior to the preparation of detailed designs, only functional interfaces can be explicitly described.

Figures 5-9 show the functional interfaces at the various levels within the function hierarchy. As depicted in these N-Square charts, functions are located on the diagonal, and functional interfaces are represented as either inputs to a particular function (those items located vertically above or below a function), or outputs from a particular function (those items located horizontally to the right or left of a function). The requirements for each of these interfaces are contained in Tables F3. through F3.2.2.4.2.

A more visual display of the interfaces is illustrated in the functional flow diagrams (Figures 10-14). Functional interfaces enter or exit a box containing a function as either inputs or outputs (see legend on illustration). A compilation of key inputs and outputs of the "Conduct Subsurface-Based Activities" functions are provided in Appendix E. Each interface is automatically tracked through lower level functional flow diagrams, thus assuring both traceability and consistency in logic and material flows. However, to maintain legibility on these diagrams, only key inputs/outputs, addressing the most important concepts at a particular function level, are explicitly shown on each diagram. Therefore, inputs and outputs not shown on lower level diagrams are bracketed (i.e. tunnelled) on the higher level functions and vice versa. Also, only the important controls and resources are shown at each level.

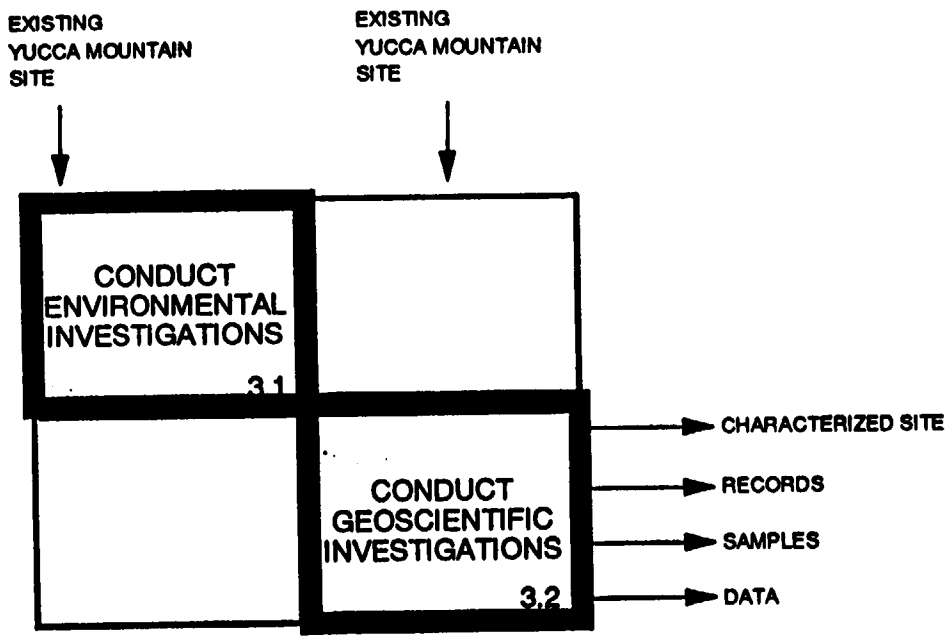

Figure 5. N - Square Chart for 3. Investigate Yucca Mountain Site

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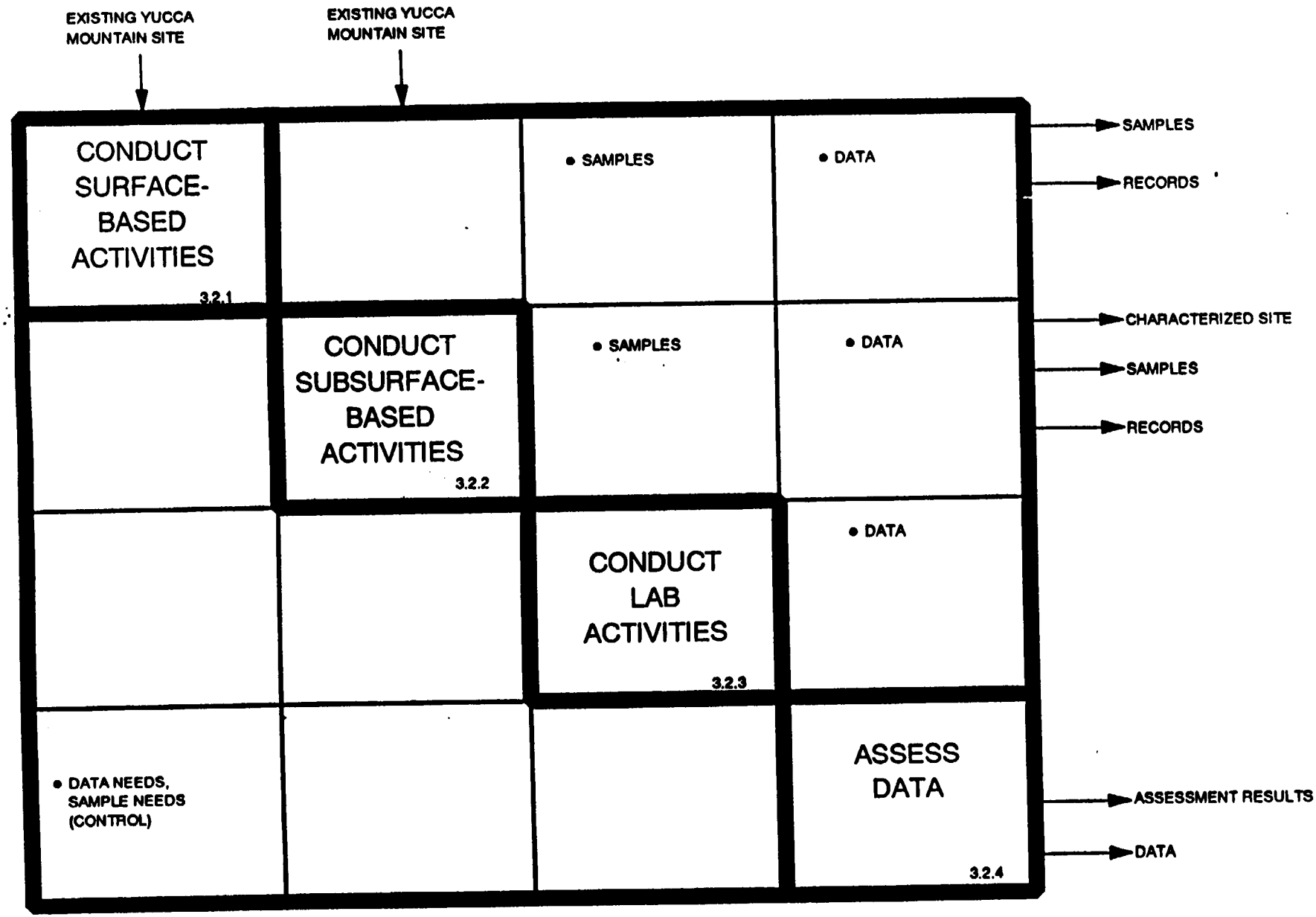

Figure 6. N-Square Chart for 3.2 Conduct Geoscientific Investigations

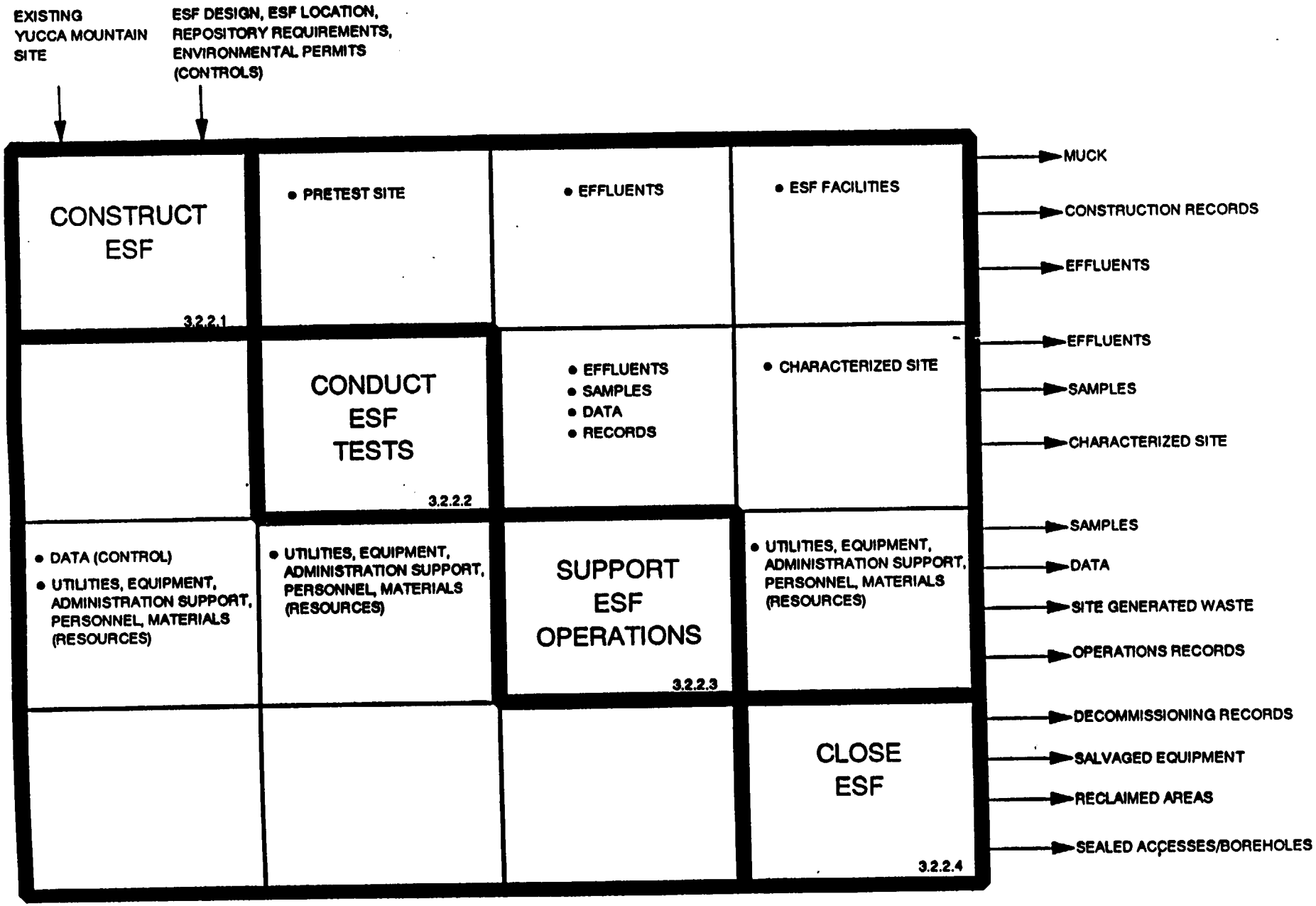

Figure 7. N-Square Chart for 3.2.2 Conduct Subsurface-Based Activities

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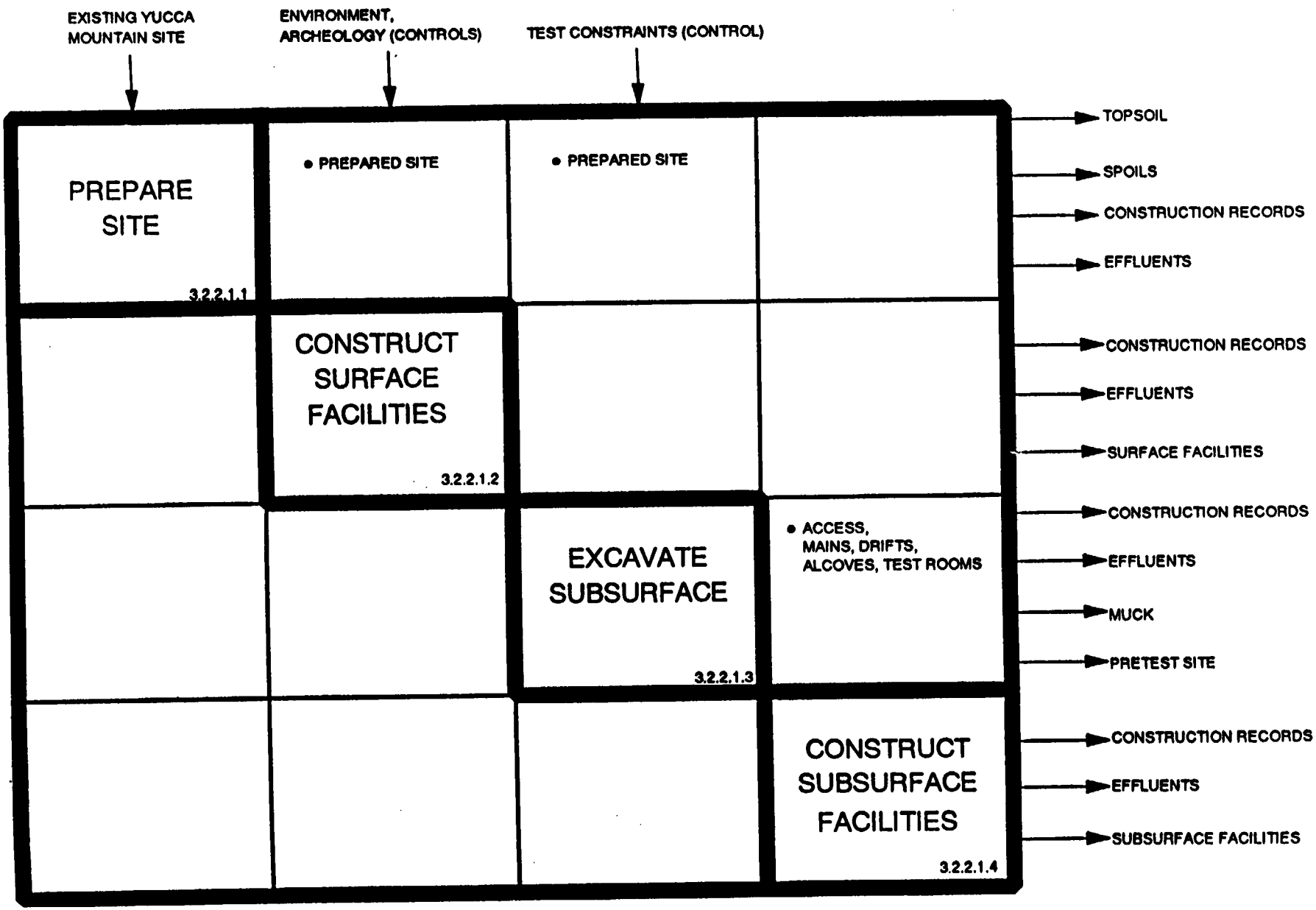

Figure 8. N-Square Chart for 3.2.2.1 Construct ESF

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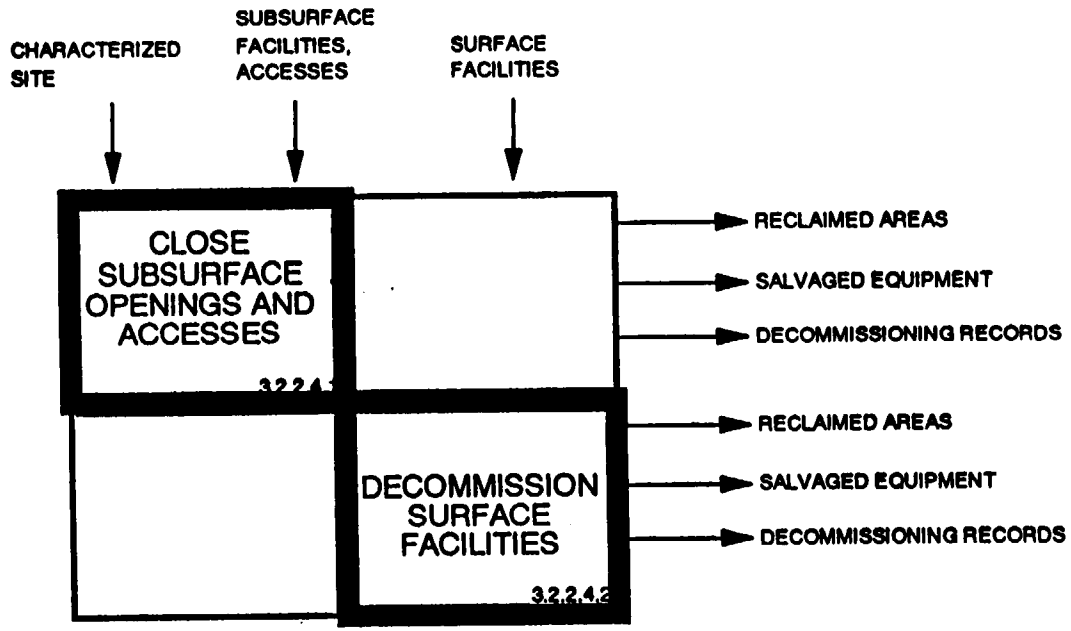

Figure 9. N - Square Chart for 3.2.2.4 Close ESF

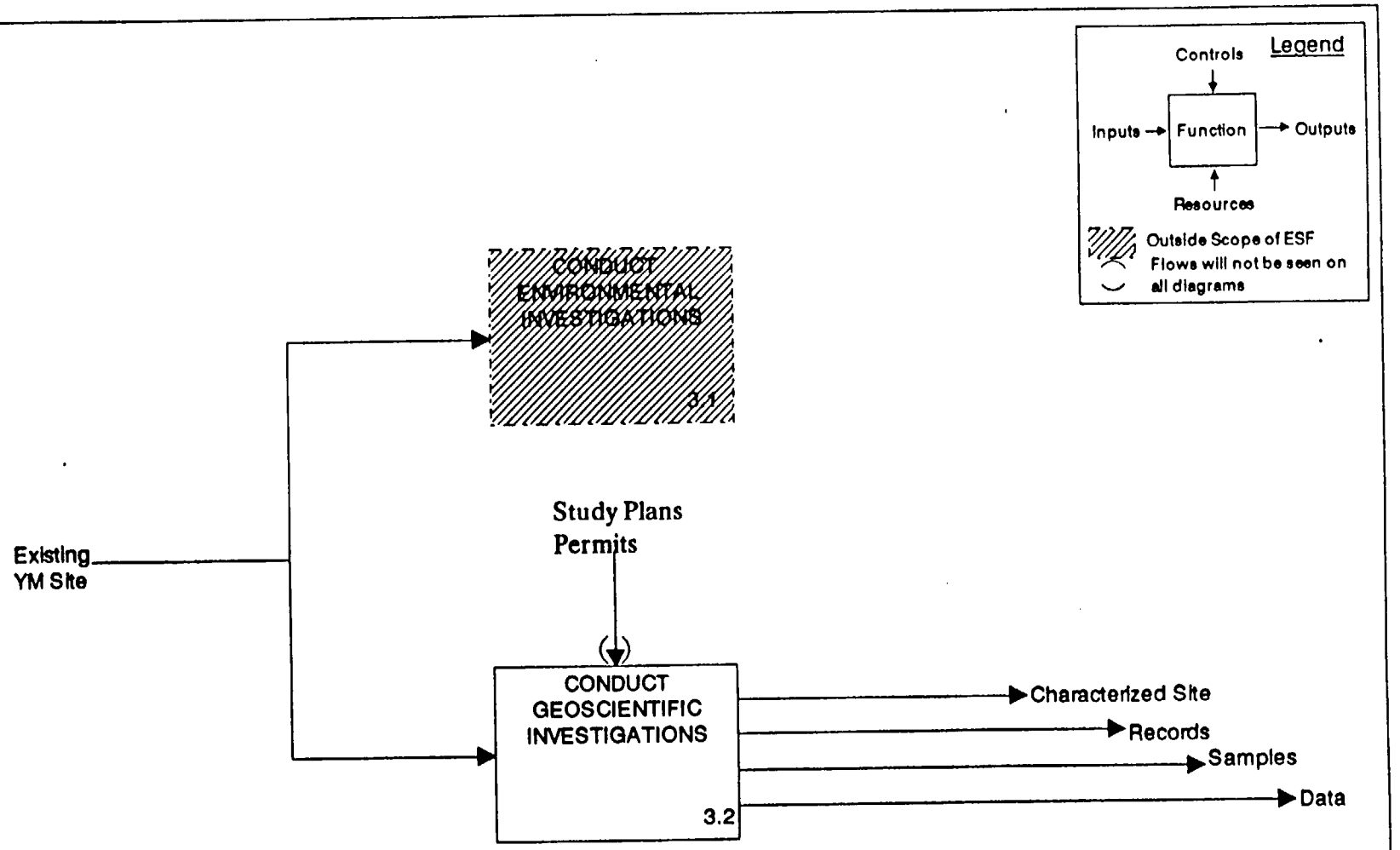

Figure 10 3. INVESTIGATE YUCCA MOUNTAIN SITE

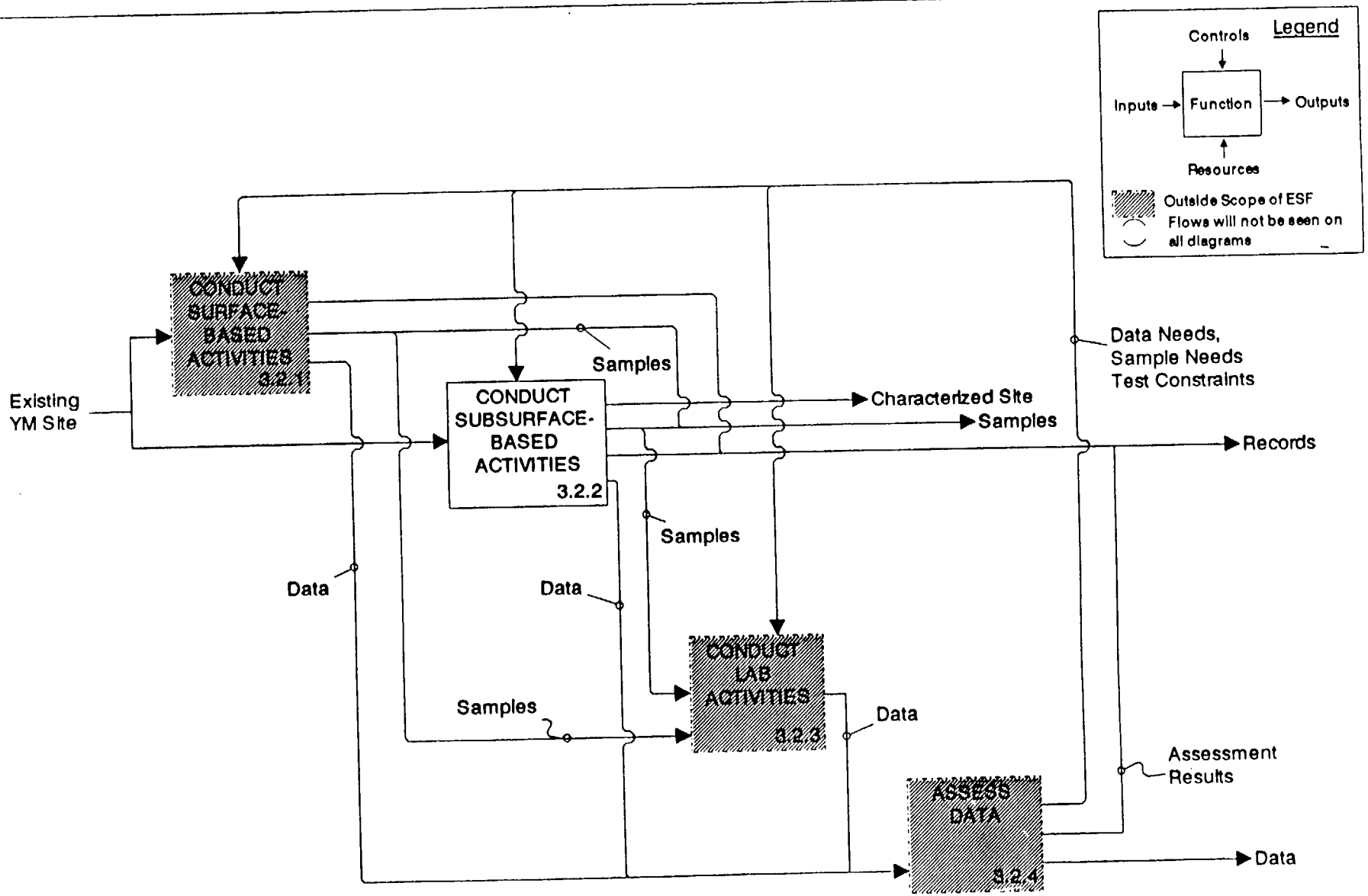

Figure 11 3.2 CONDUCT GEOSCIENTIFIC INVESTIGATIONS

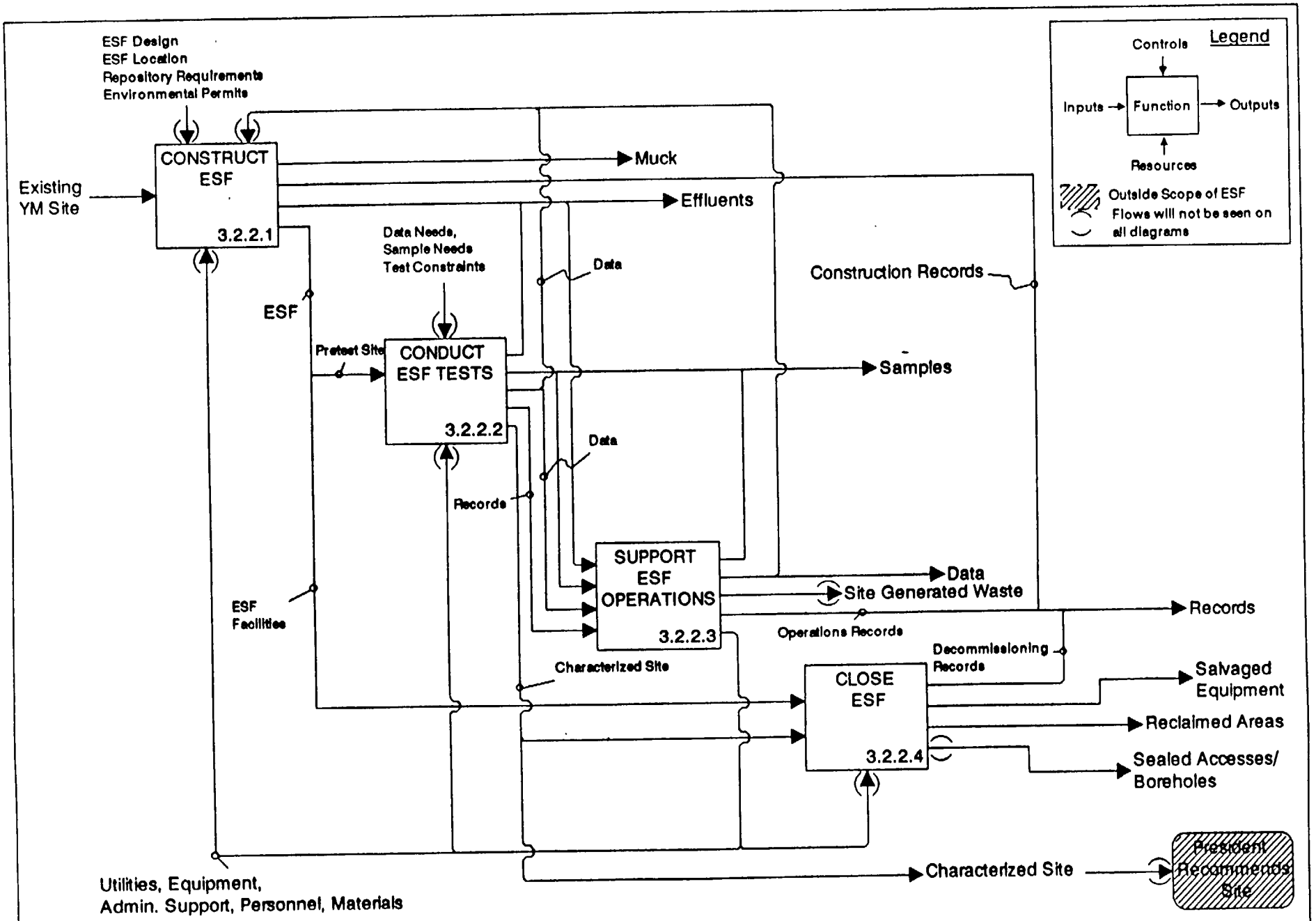

Figure 12 3.2.2 CONDUCT SUBSURFACE-BASED ACTIVITIES

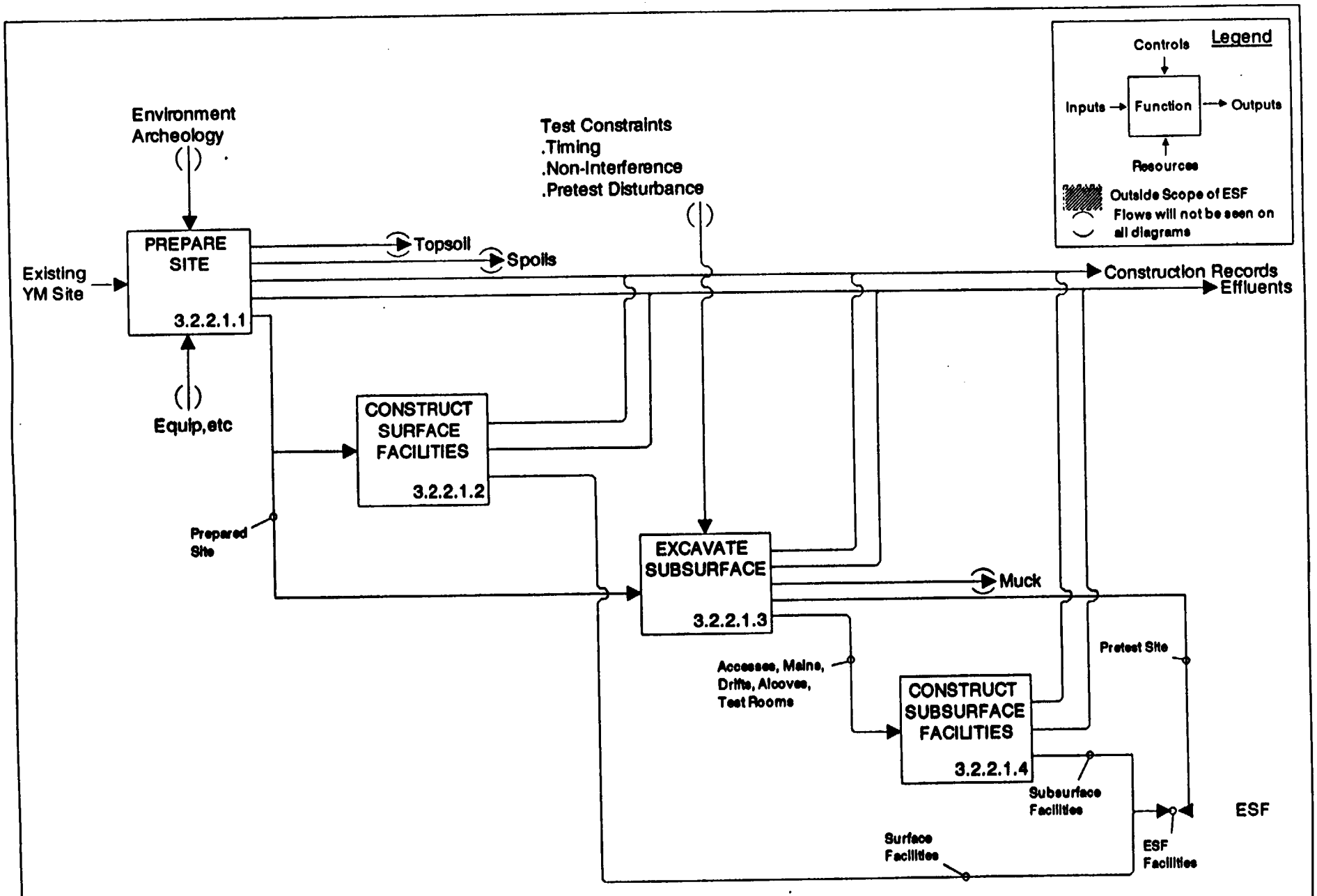

Figure 13 3.2.2.1 CONSTRUCT ESF

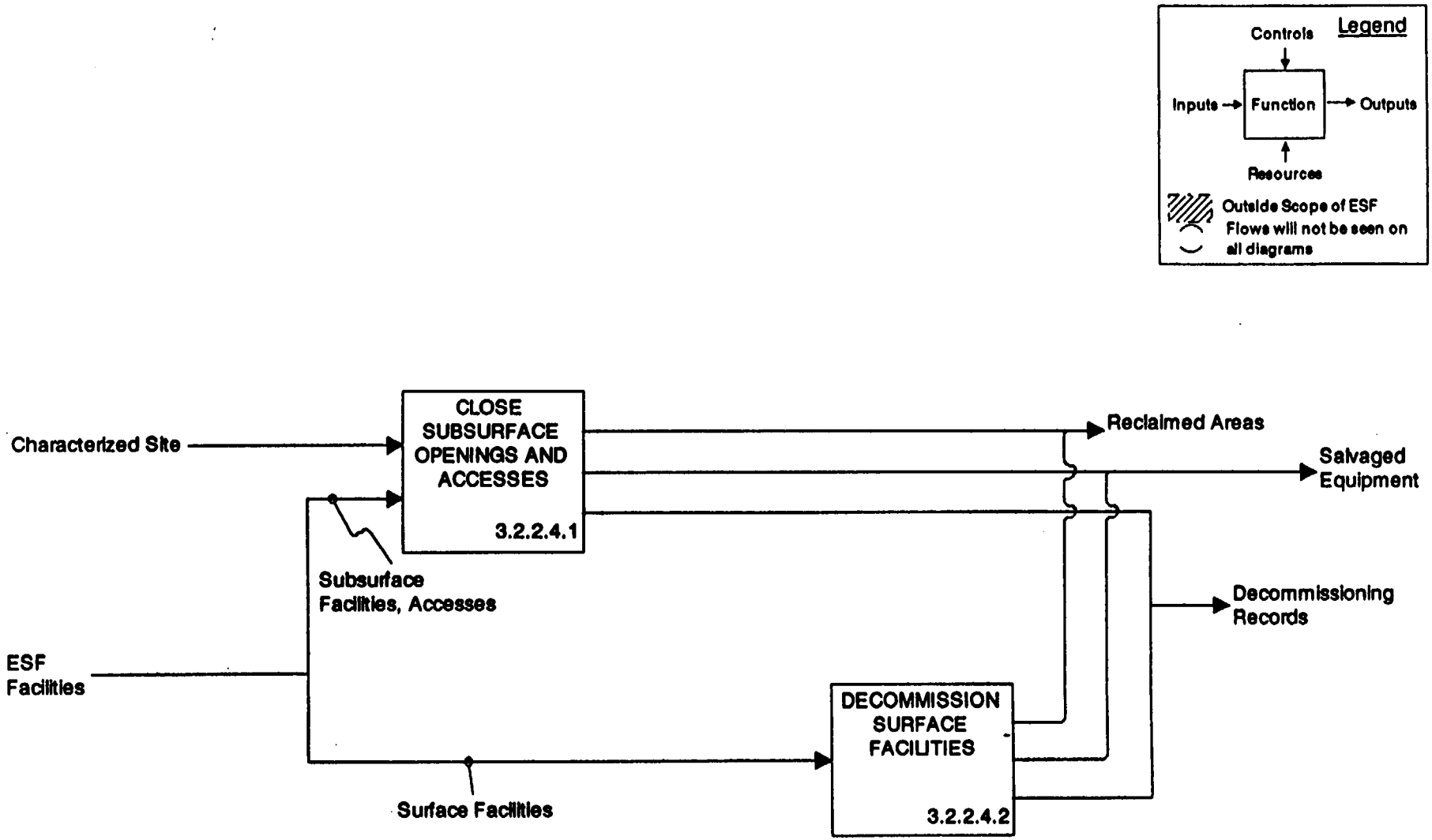

Figure 14 3.2.2.4 CLOSE ESF

1

APPENDICES

APPENDIX A

GLOSSARY

This glossary contains definitions for the various terms used throughout this report and references for those terms that have been previously defined in one or more source documents.

Accessible Environment - (1) The atmosphere, (2) the land surface, (3) surface water, (4) oceans, and (5) the portion of the lithosphere that is outside the controlled area. [10 CFR 60.2]

Active Institutional Control - (1) controlling access to a disposal site by any means other than passive institutional controls; (2) performing maintenance operations or remedial actions at a site; (3) controlling or cleaning up releases from a site; or (4) monitoring parameters related to disposal system performance. [40 CFR 191.12(f)]

Architecture - That part of the physical system actually built, found, or selected to perform a function subject to its stated requirements.

Barrier - Any material or structure that prevents or substantially delays movement of water or radionuclides. [10 CFR 60.2, 10 CFR 960.2]

- Any material or structure that prevents or substantially delays movement of water or radionuclides toward the accessible environment. For example, a barrier may be a geologic structure, a canister, a waste form with physical and chemical characteristics that significantly decrease the mobility of radionuclides, or a material placed over and around waste, provided that the material or structure substantially delays movement of water or radionuclides. [40 CFR 191.12(d)]

Borehole - A hole made with a drill, auger, or other tools for exploring strata in search of minerals, supplying water for blasting, emplacing waste, proving the position of old workings or faults, or releasing accumulations of gas or water. Boreholes include core holes, dry-well-monitoring holes, waste-emplacement boreholes, and test holes for geophysical or ground-water characterization. [SCPB, Vol. 5, page G-9]

Candidate Site - An area, within a geohydrologic setting, that is recommended by the Secretary of Energy under Section 112 of the Act (42 USC 10132) for site characterization, approved by the President under Section 112 of the Act (42 USC 10133) for characterization, or undergoing site characterization under Section 113 (42 USC 10133). [10 CFR 960.2]

Closure or Permanent Closure - The final backfilling of the remaining open operational areas of the underground facility and boreholes after the termination of waste emplacement, culminating in the sealing of shafts. [10 CFR 960.2]

Commencement of Construction - Clearing of land, surface or subsurface excavation, or other substantial action that would adversely affect the environment of a site, but does not include changes desirable for the temporary use of the land for public recreational uses, site characterization activities, other preconstruction monitoring and investigation necessary to establish background information related to the suitability of a site or to the protection of environmental values, or procurement or manufacture of components of the

geologic repository operations area.

Commission - The Nuclear Regulatory Commission or its duly authorized representatives. [10 CFR 60.2]

Constraint - A requirement imposed by the external environment (e.g., NRC).

Containment - The confinement of radioactive waste within a designated boundary. [10 CFR 60.2, 10 CFR 960.2]

Control - See constraint.

Controlled Area[1] - (1) A surface location, to be identified by passive institutional controls, that encompasses no more than 100 square kilometers and extends horizontally no more than five kilometers in any direction from the outer boundary of the original location of the radioactive wastes in a disposal system; and (2) the subsurface underlying such a surface location. [40 CFR 191.12(g)]

Cumulative Releases of Radionuclides - The total number of curies of radionuclides entering the accessible environment in any 10,000-year period, normalized on the basis of radiotoxicity in accordance with 40 CFR Part 191. The peak cumulative release of radionuclides refers to the 10,000-year period during which any such release attains its maximum predicted value. [10 CFR 960.2]

Decommissioning - The permanent removal from service of surface facilities and components necessary for preclosure operations only, after repository closure, in accordance with regulatory requirements and environmental policies. [10 CFR 960.2]

Disposal - The emplacement in a repository of high-level radioactive waste, spent nuclear fuel, or other highly radioactive material with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste. [NWPA Sect. 2(9)]

Disposal Package or Package - The primary container that holds, and is in contact with, solidified high-level radioactive waste, spent nuclear fuel, or other radioactive materials, and any overpacks that are emplaced at a repository. [NWPA Sect. 2(10)]

Disposal System - Any combination of engineered and natural barriers that isolate spent nuclear fuel or radioactive waste after disposal. [40 CFR 191.12(a)]

Disturbed Zone - That portion of the controlled area the physical or chemical properties of which have changed as a result of underground facility construction or as a result of heat generated by the emplaced radioactive wastes such that the resultant change of properties may have a significant effect on the performance of the geologic repository. [10 CFR 60.2]

Drift - An opening that connects mains or submains to the rooms and alcoves for testing or emplacement.

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[1] Controlled area is defined as 5 km from the outer boundary of the underground facility. The DOE does not use the 10 CFR 60.2 and 10 CFR 960.2 definitions.

Engineered Barrier - Manmade components of a disposal system designed to prevent the release of radionuclides into the geologic medium involved. Such term includes the high-level radioactive waste form, high-level radioactive waste canisters, and other materials placed over and around such canisters. [NWPA Sect. 2(11)]

Engineered Barrier System - The waste packages and the underground facility. [10 CFR 60.2]

Facility - Any structure, system, or component, including engineered barriers, created by the DOE to meet repository-performance of functional objectives. [10 CFR 960.2]

Far Field - That portion of the host rock surrounding the underground facility within which the thermal effects of the emplaced waste can be analyzed by considering only the areal power density without consideration of the specific geometric characteristics of the underground facility. [SCPB, Vol. 5, page G-38]

Function - A characteristic action to be accomplished by one of the system elements of equipment (hardware), software, facilities, personnel, procedural data, or any combination thereof. [DSMC]

Functional Analysis - The first step in the Systems Engineering process that defines a baseline of functions and function performance requirements which must be met in order to adequately accomplish the operation, support, test, and production requirements of a system. [DSMC 6.1]

Functional Interface - The interaction between functions, as in the flow of material or information between a sequence of activities.

Geologic Repository - A system which is intended to be used for, or may be used for, the disposal of radioactive wastes in excavated geologic media. A geologic repository includes: (1) the geologic repository operations area, and (2) the portion of the geologic setting that provides isolation of the radioactive waste. [10 CFR 60.2]

- The term "repository" means any system licensed by the Commission that is intended to be used for, or may be used for, the permanent deep geologic disposal of high-level radioactive waste and spent nuclear fuel, whether or not such system is designed to permit the recovery, for a limited period during initial operation, of any materials placed in such system. Such term includes both surface and subsurface areas at which high-level radioactive waste and spent nuclear fuel handling activities are conducted. [NWPA Sect. 2(18)]

Geologic Repository Operations Area - A high-level radioactive waste facility that is part of a geologic repository, including both surface and subsurface areas, where waste handling activities are conducted. [10 CFR 60.2]

Geologic Setting - The geologic, hydrologic, and geochemical systems of the region in which a geologic repository operations area is or may be located. [10 CFR 60.2, 10 CFR 960.2]

High-level Radioactive Waste - (A) the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and (B) other highly radioactive material that the Commission, consistent with existing law, determines by rule requires permanent isolation. [NWPA Sect. 2(12)]

HLW Facility - A facility subject to the licensing and related regulatory authority of the Commission pursuant to Section 202(3) and 202(4) of the Energy Reorganization Act of 1974 (88 Stat. 1244). [10 CFR 60.2]

Host Rock - The geologic medium in which the waste is emplaced. [10 CFR 60.2]

Important to Safety - With reference to structures, systems, and components means those engineered structures, systems, and components essential to the prevention or mitigation of an accident that could result in a radiation dose to the whole body, or any organ, of 0.5 rem or greater at or beyond the nearest boundary of the unrestricted area at any time until the completion of permanent closure. [10 CFR 60.2]

Input - Anything that is acted upon by a function to produce desired outputs. Inputs can be classified as either internal or external. Inputs that originate from outside a particular system are considered to be external. Inputs that are outputs from functions within a particular system are considered to be internal.

Interface Requirements - A requirement which specifies values for the inputs to, or outputs from, the function.

Isolation - Inhibiting the transport of radioactive material so that amounts and concentrations of this material entering the accessible environment will be kept within prescribed limits. [10 CFR 60.2]

Multibarrier System - A system of natural and engineered barriers, operating independently or relatively independently, that acts to contain and isolate the waste. [SCPB, Vol. 5, page G-67]

Natural Barrier - The physical, mechanical, chemical, and hydrologic characteristics of the geologic environment that individually and collectively act to minimize or preclude radionuclide transport. [SCPB, Vol. 5, page G-67]

Natural System - A host rock suitable for repository construction and waste emplacement and the surrounding rock formations. Includes natural barriers that provide containment and isolation by limiting radionuclide transport through the geohydrologic environment to the biosphere and provide conditions that will minimize the potential for human interference in the future. [SCPB, Vol. 5, page G-68]

Natural Transport Media - This includes the assumed groundwater flux and chemistry; air; etc.

Near-field - That portion of the rock surrounding emplaced waste in which analysis of the thermal and thermomechanical effects of the waste must consider the specific geometric characteristics of the underground facility, including borehole size and orientation, standoff distance, drift shape dimensions and spacing, or overall layout of the facility. [SCPB, Vol. 5, page G-68]

Nuclear Waste Management System - (NWMS) - The composite of the sites, and all facilities, systems, equipment, materials, information, activities, and the personnel required to perform those activities necessary to manage waste disposal.

Output - Anything that leaves a function or system.

Passive Institutional Control - (1) Permanent markers placed at a disposal site, (2) public records and archives, (3) government ownership and regulations regarding land or resource use, and (4) other methods of preserving knowledge about the location, design, and contents of a disposal system. [40 CFR 191.12(e)]

Performance Assessment - An analysis that: (1) Identifies the processes and events that might affect the disposal system; (2) examines the effects of these processes and events on the performance of the disposal system; and (3) estimates the cumulative releases of radionuclides, considering the associated uncertainties, caused by all significant processes and events. These estimates shall be incorporated into an overall probability distribution of cumulative release to the extent practicable. [40 CFR 191.12(q)]

Performance Confirmation - The program of tests, experiments, and analyses which is conducted to evaluate the accuracy and adequacy of the information used to determine with reasonable assurance that the performance objectives for the period after permanent closure will be met. [10 CFR 60.2]

Performance Measure - The metric by which one determines how well a requirement has been complied with.

Permanent Closure - The end of active human intervention with respect to the engineered barrier system, including the sealing of shafts. [10 CFR 60.102(d)]

Physical Interface - The boundary at which physical systems interact, as in a necessary fit between architectures.

Physical System - The Nuclear Waste Management System (NWMS) consisting of the composite of the sites, and all facilities, systems, equipment, materials, information, activities, and the personnel required to perform those activities necessary to manage waste disposal.

Postclosure - The period of time after the closure of the geologic repository. [10 CFR 960.2]

Preclosure - The period of time before and during the closure of the geologic repository. [10 CFR 960.2]

Radioactive-Waste Facility - A facility subject to the licensing and related regulatory authority of the NRC pursuant to sections 202(3) and 202(4) of the Energy Reorganization Act of 1974 (88 Stat. 1244). [10 CFR 960.2]

Repository - Any system licensed by the Commission that is intended to be used for, or may be used for, the permanent deep geologic disposal of high-level radioactive waste and spent nuclear fuel, whether or not such system is designed to permit the recovery, for a limited period during initial operation, of any materials placed in such system. Such term includes both surface and subsurface areas at which high-level radioactive waste and spent nuclear fuel handling activities are conducted. [NWPA Sect. 2(18)]

Repository Construction - All excavation and mining activities associated with the construction of shafts, shaft stations, rooms, and necessary openings in the underground facility, preparatory to radioactive-waste emplacement, as well as the construction of necessary surface facilities, but excluding site characterization activities. [10 CFR 960.2]

Requirement - A qualitative or quantitative statement of how well a function must be performed. Requirements may be of three types: Performance Requirements, Constraints, and Interface Requirements.

Requirements Allocation - The further decomposition of system level requirements until a level is reached at which a specific hardware item or software routine can fulfill the needed functional/performance requirements. [DSMC 6.4]

Resource - The people, material, or funds available to support the satisfaction of a function.

Restricted Area - Any area access to which is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials. "Restricted area" shall not include any areas used as residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area. [10 CFR 60.2]

Retrieval - The act of intentionally removing radioactive waste from the underground location at which the waste had been previously emplaced for disposal. [10 CFR 60.2]

Scenario - A sequence of definite types of events and processes that act or occur during the period of performance with prescribed intensities, at prescribed epochs or for prescribed durations, in a prescribed order of occurrence. [Site Characterization Plan]

Scenario Class - The collection of all scenarios involving definite types of events or processes, but with intensities, epochs of occurrence or durations, and orders of occurrence allowed to range freely over the physically possible numerical values. [Site Characterization Plan]

Seal - An engineered component that reduces water flow. [SCPB, Vol. 5, page G-89]

Site - The location of the controlled area. [10 CFR 60.2]

Spent Nuclear Fuel - (SNF) - Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing. [NWPA Sect. 2(23); 10 CFR 961.11, I.18]

System - The geologic setting at the site, the waste package, and the repository, all acting together to contain and isolate the waste. [10 CFR 960.2]

System State - Any complete set of performance parameter values.

System Performance - The complete behavior of a repository system in response to the conditions, processes, and events that may affect it. [10 CFR 960.2]

Systems Engineering - The management function which controls the total system development effort for the purpose of achieving an optimum balance of all system elements. It is a process which transforms an operational need into a description of system parameters and integrates those parameters to optimize the overall system effectiveness. [DSMC 1.3]

- A sequence of activities and decisions that transforms an identified mission need into a description of system performance parameters and a preferred system configuration. [DOE Order 4700.1]

Systems Engineering Process - An iterative process applied throughout the acquisition life cycle. The process itself leads to a well defined, completely documented, and optimally balanced system. It does not produce the actual system itself, but rather, it produces the complete set of documentation, tailored to the needs of a specific program, which fully describes the system to be developed and produced. [DSMC 5.1]

Trade Study - A quantitative or qualitative parametric analysis of alternatives from which comparisons can be made to support the selection of the "better" alternative.

Underground Facility - The underground structure, including openings and backfill materials, but excluding shafts, boreholes, and their seals. [10 CFR 60.2]

Unrestricted Area - Any area, access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, and any area used for residential quarters. [10 CFR 60.2]

Waste Form - The radioactive waste materials and any encapsulating or stabilizing matrix. [10 CFR 60.2, 10 CFR 960.2]

Waste Package - The waste form and any containers, shielding, packing and other absorbent materials immediately surrounding an individual waste container. [10 CFR 60.2]

APPENDIX B

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APPENDIX C

DECISION DOCUMENTATION

1. A common data collection system shall be used to support all ESF tests.

[DOE Memo from J. Blalock to D.L. Vieth, dated May 16, 1986]

APPENDIX D

ACRONYMS

ALARA	As Low as Reasonably Achievable
CCDF	Complementary Cumulative Distribution Function
CFR	Code of Federal Regulations
CHn	Calico Hills Formation
CHLW	Civilian High-Level Radioactive Waste
CRWM	Civilian Radioactive Waste Management
DAS	Data Acquisition System
DBR	Demonstration Breakout Room
DHLW	Defense High-Level Radioactive Waste
DOE	Department of Energy
DOL	Department of Labor
DP	Formerly the Office of Defense Programs, U.S. Department of Energy
DSMC	Defense Systems Management College
EBS	Engineered Barrier System
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESF	Exploratory Studies Facility
FA	Functional Analysis
F-R-A	Functions-Requirements-Architecture
GROA	Geologic Repository Operations Area
HLW	High-Level Radioactive Waste
HVAC	Heating, Ventilation, Air Conditioning
IDS	Integrated Data System
LDBR	Lower Demonstration Breakout Room
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPBH	Multipurpose Boreholes
MPBX	Multiple-Point Borehole Extensometer
MRS	Monitored Retrievable Storage
MSHA	Mine Safety and Health Administration
MSIS	Management System Improvement Strategy
MTHM	Metric Tons of Heavy Metal
MTL	Main Test Level
MTU	Metric Tons of Uranium
NBS	Natural Barrier System

NEPA	National Environmental Policy Act
NQA	Nuclear Quality Assurance
NRC	Nuclear Regulatory Commission
NWMS	Nuclear Waste Management System
NWPA	Nuclear Waste Policy Act
NWPAA	Nuclear Waste Policy Amendments Act
OCRWM	Office of Civilian Radioactive Waste Management
OSB	Outside System Boundary
OSHA	Occupational Safety and Health Administration
PI	Principal Investigator
PM	Performance Measure
QA	Quality Assurance
QARD	Quality Assurance Requirements Document
RC	Records Center
RF	Retardation Factor
RW	Office of Civilian Radioactive Waste Management
SCP	Site Characterization Plan
SCPB	Site Characterization Program Baseline
SMF	Sample Management Facility
SNF	Spent Nuclear Fuel
SDWA	Safe Drinking Water Act
TBD	To Be Determined
TSw1	Lithophysal Topopah Spring Member
TSw2	Non Lithophysal Topopah Spring Member
UDBR	Upper Demonstration Breakout Room
USC	United States Code
UZ	Unsaturated Zone
XRD	X-Ray Diffraction
YM	Yucca Mountain

APPENDIX E

EXPLORATORY STUDIES FACILITY INTERFACES

INTERFACE CONTROL #	FROM	TO	OUTPUT/INPUT TITLE	OUTPUT/INPUT ID #
OSB[1]/3.2.2	Outside System Boundary	Conduct Subsurface-Based Activities	Existing Yucca Mountain Site	3.2.2I1
3.2.2/RC[2]	Conduct Subsurface-Based Activities	Records Center	Records	3.2.2O1
3.2.2/SMF[3]	Conduct Subsurface-Based Activities	Sample Management Facility	Samples	3.2.2O2
3.2.2/OSB	Conduct Subsurface-Based Activities	Outside System Boundary	Characterized Site	3.2.2O4
3.2.2/3.2.3	Conduct Subsurface-Based Activities	Conduct Lab Activities	Samples	3.2.2O2/3.2.3I1
3.2.2/3.2.4	Conduct Subsurface-Based Activities	Assess Data	Data	3.2.2O3/3.2.4I1
3.2.4/3.2.2	Assess Data	Conduct Subsurface-Based Activities	Data Needs/Sample Needs	3.2.4O1/3.2.2 (Control)

[1] OSB - Outside System Boundary

[2] RC - Records Center

[3] SMF - Sample Management Facility

APPENDIX F

INDENTURED LIST OF "CONDUCT SUBSURFACE-BASED ACTIVITIES" FUNCTIONS

3.0 Investigate Yucca Mountain Site for a Repository
- *3.1 Conduct Environmental Investigations*
- *3.2 Conduct Geoscientific Investigations*
  - *3.2.1 Conduct Surface-Based Activities*
  - **3.2.2 Conduct Subsurface-Based Activities**
    - **3.2.2.1 Construct ESF**
      - **3.2.2.1.1 Prepare Site**
        - **3.2.2.1.1.1 Survey Site**
        - **3.2.2.1.1.2 Construct Access Roads**
        - **3.2.2.1.1.3 Perform Site Grading**
        - **3.2.2.1.1.4 Construct Site Pads**
      - **3.2.2.1.2 Construct Surface Facilities**
      - **3.2.2.1.3 Excavate Subsurface**
        - **3.2.2.1.3.1 Excavate Accesses**
        - **3.2.2.1.3.2 Excavate Test Rooms and Test Alcoves**
        - **3.2.2.1.3.3 Excavate Mains**
        - **3.2.2.1.3.4 Excavate Subsurface Support Alcoves**
        - **3.2.2.1.3.5 Excavate Drifts**
      - **3.2.2.1.4 Construct Subsurface Facilities**
    - **3.2.2.2 Conduct ESF Tests**
      - **3.2.2.2.1 Test Unsaturated-Zone Hydrology**
        - **3.2.2.2.1.1 Conduct Chloride and Chlorine-36 Measurements of Percolation at Yucca Mountain**
        - **3.2.2.2.1.2 Conduct Matrix Hydrologic Properties Testing**
        - **3.2.2.2.1.3 Conduct Intact-Fracture Test in the ESF**
        - **3.2.2.2.1.4 Conduct Percolation Tests in the ESF**
        - **3.2.2.2.1.5 Conduct Bulk-Permeability Test in the ESF**
        - **3.2.2.2.1.6 Conduct Radial Borehole Tests in the ESF**
        - **3.2.2.2.1.7 Conduct Excavation Effects Test in the ESF**
        - **3.2.2.2.1.8 Conduct Perched Water Test in the ESF**
        - **3.2.2.2.1.9 Conduct Hydrochemistry Tests in the ESF**
        - **3.2.2.2.1.10 Conduct Multipurpose-Borehole Testing**
        - **3.2.2.2.1.11 Determine Hydrologic Properties of Major Faults Encountered in the Main Test Level of the ESF**
        - **3.2.2.2.1.12 Conduct Diffusion Tests in the ESF**
      - **3.2.2.2.2 Characterize Geochemistry**
        - **3.2.2.2.2.1 Conduct Petrologic Stratigraphy of the Topopah Spring Member**
        - **3.2.2.2.2.2 Conduct Mineral Distributions Between the Host Rock and the Accessible Environment Activity**
        - **3.2.2.2.2.3 Determine Fracture Mineralogy**
        - **3.2.2.2.2.4 Conduct History of Mineralogic and Geochemical Alteration of Yucca Mountain Activity**

3.2.2.2.2.5 Conduct Biological Sorption and Transport Activity
3.2.2.2.2.6 Demonstrate Applicability of Laboratory Data to Repository Transport Calculations Investigation
3.2.2.2.3 Characterize Structural Features Within the Site Area
3.2.2.2.3.1 Conduct Geologic Mapping of the ESF
3.2.2.2.3.2 Conduct Seismic Tomography/Vertical Seismic Profiling
3.2.2.2.4 Provide Thermal and Mechanical Rock Properties
3.2.2.2.4.1 Conduct Studies to Provide the Required Information for Spatial Distribution of Thermal and Mechanical Properties
3.2.2.2.4.2 Conduct Access Convergence Test
3.2.2.2.4.3 Conduct Demonstration Breakout Rooms Test
3.2.2.2.4.4 Conduct Sequential Drift Mining Test
3.2.2.2.4.5 Conduct Heater Experiment in Unit TSw1
3.2.2.2.4.6 Conduct Canister-Scale Heater Experiment
3.2.2.2.4.7 Conduct Yucca Mountain Heated Block Test
3.2.2.2.4.8 Conduct Thermal Stress Measurements
3.2.2.2.4.9 Conduct Heated Room Experiment
3.2.2.2.4.10 Conduct Plate Loading Tests
3.2.2.2.4.11 Conduct Rock Mass Strength Experiment
3.2.2.2.4.12 Conduct Evaluation of Mining Methods Test
3.2.2.2.4.13 Conduct Monitoring of Ground Support Systems Test
3.2.2.2.4.14 Conduct Monitoring of Drift Stability Test
3.2.2.2.4.15 Conduct Air Quality and Ventilation Experiment
3.2.2.2.4.16 Conduct Overcore Stress Experiments in the ESF
3.2.2.2.5 Demonstrate Technologies for Repository Construction
3.2.2.2.5.1 Conduct Development and Demonstration of Required Equipment Test
3.2.2.2.6 Evaluate Materials and Characteristics of Seals
3.2.2.2.6.1 Conduct In situ Testing of Seal Components
3.2.2.2.7 Post-Emplacement Near-Field Environment
3.2.2.2.7.1 Characterize Mechanical Attributes of the Waste Package Environment
3.2.2.2.7.2 Conduct Repository Horizon Near-Field Hydrologic Properties Test
3.2.2.2.7.3 Conduct Repository Horizon Rock-Water Interaction Activity
3.2.2.2.8 Conduct Other Required ESF Tests
3.2.2.3 Support ESF Operations
3.2.2.3.1 Provide Utility Services
3.2.2.3.1.1 Provide Ventilation (HVAC)
3.2.2.3.1.2 Provide Communications
3.2.2.3.1.3 Supply/Control Water
3.2.2.3.1.4 Provide Power
3.2.2.3.1.5 Provide Illumination
3.2.2.3.1.6 Provide On-Site Transportation
3.2.2.3.2 Provide Protective Services
3.2.2.3.2.1 Provide Physical Security
3.2.2.3.2.2 Provide Inspection/Testing Services
3.2.2.3.2.3 Provide Emergency Medical Treatment
3.2.2.3.2.4 Provide Fire/Explosion Protection
3.2.2.3.2.5 Provide Radiological Protection
3.2.2.3.2.6 Provide Non-Radiological Protection

3.2.2.3.2.7 Provide Environmental Protection

3.2.2.3.3 Administer General Support Services

3.2.2.3.3.1 Maintain Records

3.2.2.3.3.2 Provide Engineering Support

3.2.2.3.3.3 Provide for Human Resources

3.2.2.3.3.4 Provide Procurement Services

3.2.2.3.3.5 Administer Public Relations

3.2.2.3.3.6 Provide Financial Accounting

3.2.2.3.4 Process Site Generated Waste (Non-Rad)

3.2.2.3.4.1 Process Hazardous Waste

3.2.2.3.4.2 Process Non-Hazardous Waste

3.2.2.3.5 Maintain Operating Facilities

3.2.2.3.5.1 Maintain Surface Operating Facilities

3.2.2.3.5.2 Maintain Subsurface Test Facilities

3.2.2.3.5.3 Maintain Subsurface Support Facilities

3.2.2.3.6 Administer QA

3.2.2.3.7 Manage ESF Test Data

3.2.2.4 Close ESF

3.2.2.4.1 Backfill and Seal Subsurface Openings and Accesses

3.2.2.4.2 Decommission Surface Facilities

3.2.3 Conduct Lab Activities

3.2.4 Assess Data