GUPTA

SANDIA REPORT

SAND84—2641
Unlimited Release
Printed September 1987

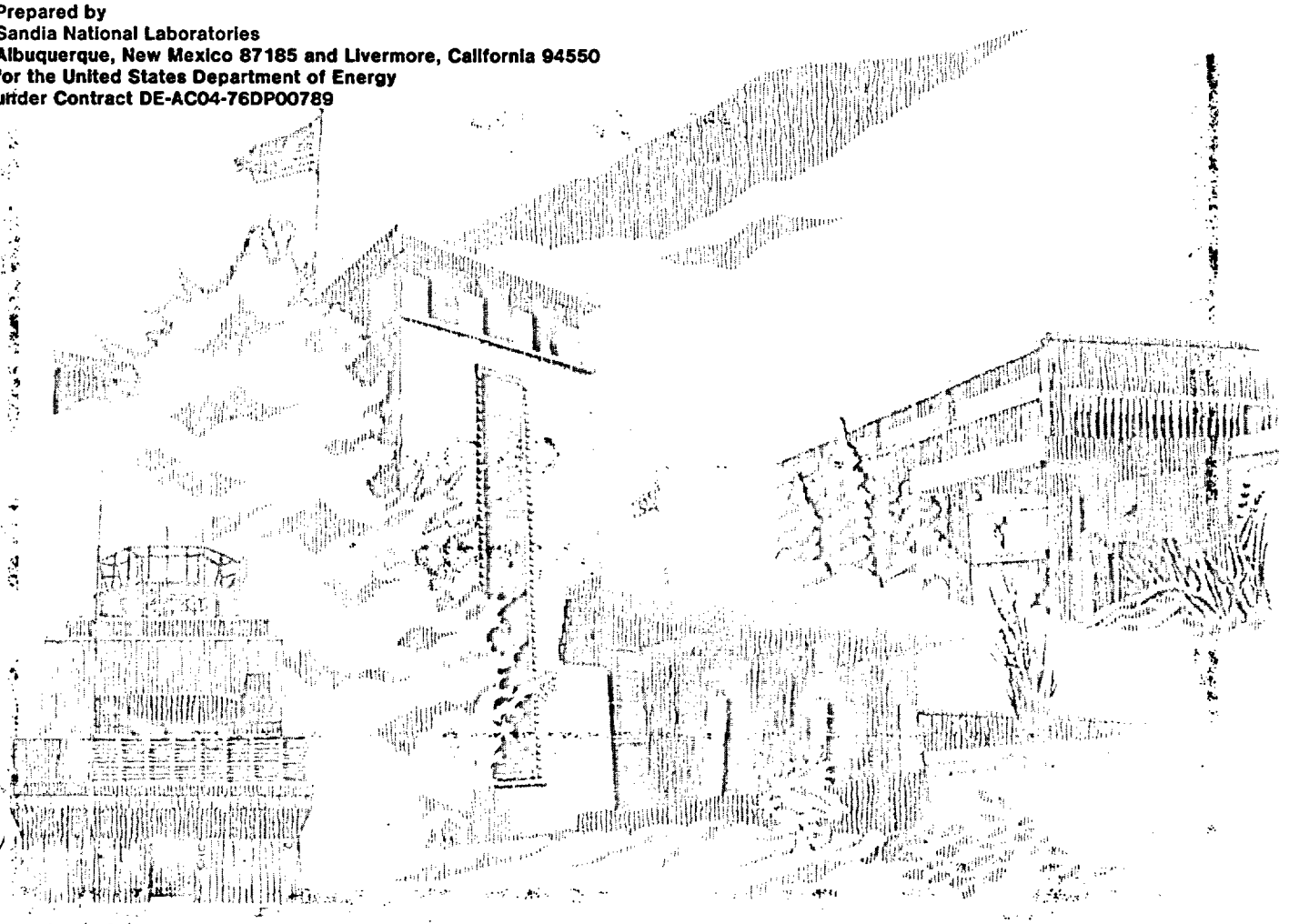
Nevada Nuclear Waste Storage Investigations Project

Site Characterization Plan Conceptual Design Report

Volume 5 Appendices P-R

Compiled by Hugh R. MacDougall, Leo W. Scully, Joe R. Tillerson

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
under Contract DE-AC04-76DP00789



SF2900Q(8-81)

Issued by Sandia National Laboratories, operated for the United States Department of Energy by Sandia Corporation.

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

NTIS price codes
Printed copy: A20
Microfiche copy: A01

SAND84-2641
Unlimited Release
Printed September 1987

SITE CHARACTERIZATION PLAN CONCEPTUAL DESIGN REPORT
Volume 5

Compiled by

H. R. MacDougall, L. W. Scully, and J. R. Tillerson
Nevada Nuclear Waste Storage Investigations Department
Sandia National Laboratories
Albuquerque, New Mexico 87185

Engineering design information provided by

Bechtel National, Inc.
San Francisco, California 94119

and

Parsons Brinckerhoff Quade & Douglas, Inc.
San Francisco, California 94109

ABSTRACT

This document presents a description of a prospective geologic repository for high-level radioactive waste to support the development of the Site Characterization Plan for the Yucca Mountain site. This conceptual design has been developed for the Department of Energy's Nevada Nuclear Waste Storage Investigations Project by Sandia National Laboratories and its supporting contractors.

The site for the prospective repository is located at Yucca Mountain in southwestern Nevada, and the waste emplacement area will be constructed in the underlying volcanic tuffs. The target horizon for waste emplacement is a sloping bed of densely welded tuff more than 650 ft below the surface and typically more than 600 ft above the water table. The conceptual design described in this report is unique among repository designs in that (1) it uses ramps in addition to shafts to gain access to the underground facility, (2) the emplacement horizon is located above the water table, and (3) it is possible that 300- to 400-ft-long horizontal waste emplacement boreholes will be used.

In addition to describing the design and operations, this report summarizes the design bases (site and properties of the waste package), design and performance criteria, and the design analyses performed. The current status of meeting the preclosure performance objectives for licensing and of resolving the repository design and preclosure issues is presented. The repository design presented in this report will be expanded and refined during the advanced conceptual design, the license application design, and the final procurement and construction design phases.

This page intentionally left blank.

TABLE OF CONTENTS

This page intentionally left blank.

APPENDIX P

YUCCA MOUNTAIN MINED GEOLOGIC DISPOSAL SYSTEM REQUIREMENTS

AND

SUBSYSTEM DESIGN REQUIREMENTS TO SUPPORT THE CONCEPTUAL DESIGN STUDIES FOR THE YUCCA MOUNTAIN MINED GEOLOGIC DISPOSAL SYSTEM

The Subsystem Design Requirements (SDR) was written before the establishment of the RIB used in the conceptual design (Appendix Q). The SDR contains an earlier version of the RIB.

CONTENTS

This page intentionally left blank.

APPENDIX P

Design development is an iterative process, starting with the definition of requirements, development of the design criteria, design, evaluation of design against criteria and requirements, and then modification of the design or criteria until the design, criteria and requirements agree. The system requirements for a design are the top-level guidance derived from laws, regulations, and DOE policy and typically change very little during the development of the designs. The draft "Yucca Mountain Mined Geologic Disposal System Requirements" (SAND84-1882), dated January 22, 1986 (SR), is the compiled set of system requirements that has guided the Site Characterization Plan Conceptual Design Report (SCP-CDR) since it has been available. The SR has used the DOE's "Generic Requirements for the Mined Geologic Disposal System" as the source document and has augmented and translated those requirements into a site-specific set of requirements.

The design criteria used to guide the design starting in March 1984 was originally compiled as the draft "Conceptual Design Guidelines" (SAND83-1820). Before publication, the document evolved into a draft "Subsystem Design Requirements to Support the Advanced Conceptual Design Studies for the Yucca Mountain Mined Geologic Disposal System" (SAND85-0260) (SDR). The latter document was extensively reformatted to be compatible with the SR and evolved considerably from the Design Guidelines as the design itself evolved. The draft SDR was issued for use in February 1986 and was immediately placed under change control. The SDR was prepared to guide the advanced conceptual design effort and was issued to support the SCP-CDR effort as well. The February 24, 1986, draft of the SDR and the attached approved Engineering Change Requests provide a historical record of the design criteria under which the SCP-CDR was completed. In accordance with an agreement between the USDOE/OCRWM-OGR and Sandia National Laboratories, the modifier "Advanced" was deleted from the title page of the SDR to clarify that the intent of this document was also for use with the SCP-CDR. The preliminary Reference Information Base (RIB) information that is included as an appendix to the SDR was removed from the document by Design Change Request #8 (also included in this appendix). This change was effected after this preliminary information was superseded by that prepared for and included in SCP-CDR Appendix Q.

This page intentionally left blank.

Distribution
Category UC-70

SAND84-1882
Unlimited Release
Printed _____ 1986

YUCCA MOUNTAIN MINED GEOLOGIC DISPOSAL SYSTEM REQUIREMENTS

Compiled by

James G. Yeager
Jeffrey W. Braithwaite
Terri S. Ortiz
Clinton G. Shirley
Nevada Nuclear Waste Storage Investigations Project Department

Sandia National Laboratories
Albuquerque, New Mexico 87185

Richard C. Kalinski
Los Alamos Technical Associates

ABSTRACT

Radioactive waste from nuclear power reactors, national defense activities, medical research, and other advances in technology has accumulated rapidly over the last three to four decades. This accumulation of radioactive waste has led to potential health risks because there has been no corresponding advancement in technology for safe and environmentally acceptable methods of disposal. The Nuclear Waste Policy Act of 1982 (NWPA; PL97-425) established a schedule for the implementation of one solution for the radioactive-waste disposal problem, disposal in mined geologic disposal systems (MGDSs) deep underground in geologic formations where the natural characteristics of the rock isolate the potential risks from the population and the environment. The U.S. Department of Energy (DOE), U.S. Environmental Protection Agency, and U.S. Nuclear Regulatory Commission regulations that implement the NWPA, as well as other federal, state, and local regulations that affect MGDS construction, operation, closure, and decommissioning, have led to a complex regulatory framework for radioactive waste disposal. This document assembles the legislative, regulatory, and DOE policy requirements that affect the selection of the location

ABSTRACT (Continued)

for, and the subsequent licensing, construction, operation, closure, and decommissioning of, the prospective Yucca Mountain Mined Geologic Disposal System in southern Nevada. This document will be used via systems engineering to help ensure that the prospective MGDS at Yucca Mountain will meet all applicable requirements. The purpose of this document is to identify the requirements that must be met by the Yucca Mountain MGDS. It is not intended to provide specific direction to MGDS developers about how to combine the natural system at Yucca Mountain with facilities, equipment, and procedures in a way that meets all MGDS requirements. This direction will be provided in other NNWSI documentation. This document, and the requirements identified herein, will be a part of the controlled technical baseline that serves as the basis for the management of the technical activities associated with the development of the Yucca Mountain MGDS.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

LIST OF FIGURES

YUCCA MOUNTAIN MINED GEOLOGIC DISPOSAL SYSTEM REQUIREMENTS

Introduction

Disposal of radioactive waste in the prospective Yucca Mountain mined geologic disposal system (MGDS) in southern Nevada will take place within a complex Federal, State, and local regulatory framework. To help guide the development of the prospective system for Yucca Mountain, all requirements dealing with MGDS site selection and licensing have been assembled in this document. These requirements are described in relationship to the MGDS functions to which they apply.

To provide an understanding of the framework in which these requirements will be applied, this introduction will give background information on radioactive waste disposal in the U.S. and will discuss the ways in which the United States Department of Energy (DOE) and the Nevada Nuclear Waste Storage Investigations (NNWSI) Project will use this and other systems engineering documentation to help guide the development of an MGDS that meets all applicable regulatory requirements.

Overview of Radioactive-Waste Management

The DOE has primary Federal responsibility for developing and implementing safe, environmentally acceptable, and cost-effective methods for the long-term disposal of high-level radioactive wastes that are produced by commercial nuclear reactors.

The DOE and its predecessor agencies (the Atomic Energy Commission and the Energy Research and Development Administration) evaluated alternatives for the disposal of radioactive waste and concluded that disposal in mined geologic repositories offers the best likelihood of satisfying the major objectives for long-term disposal:

- o Disposal of radioactive waste in a way that protects the public and the environment from the hazards associated with transportation, processing, and disposal of the waste.
- o Isolation of the emplaced radioactive waste from the environment, where it could cause adverse health effects for future generations.

The decision to dispose of radioactive wastes in MGDSs was documented as a Record of Decision in the May 14, 1981, Federal Register.

Legislative and Regulatory Responsibility. The Nuclear Waste Policy Act of 1982 (NWPA; PL 97-425) established a schedule and funding for the selection of locations for, and construction of, the first two radioactive waste repositories referred to here as MGDSs. The NWPA reaffirmed the responsibility of DOE for developing and implementing methods for disposing of radioactive waste; it further directed the DOE to develop guidelines for selecting MGDS construction sites. The NWPA also directed the U.S. Environmental Protection Agency (EPA) to establish environmental standards for radioactive waste disposal and directed the Nuclear Regulatory Commission (NRC) to develop technical requirements for licensing radioactive waste disposal in mined geologic repositories.

The EPA standards are published in 40 CFR 191,* "Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Waste." The NRC licensing requirements are published in 10 CFR 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories: Licensing Procedures." The DOE guidelines for repository site selection, "Final General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories," are published in 10 CFR 960.

---

*In the body of this document, federal regulations are referred to in a short notation. For example, Title 10 Code of Federal Regulations Part 60 is referred to as 10 CFR 60. Full citations can be found in the References section.

DOE Organization for Radioactive Waste Management. As required by the NWPA, all Federal radioactive-waste-management activities are directed by the Office of Civilian Radioactive Waste Management (OCRWM). The OCRWM serves as the point of contact between the Federal Government and U.S. radioactive waste producers. The Office of Geologic Repositories (OGR) within OCRWM directs the activities for developing mined geologic disposal systems. Four repository development projects are conducting these activities. These projects are conducting detailed investigations, using the guidelines in 10 CFR 960, to evaluate the suitability of four geologic host media--basalt (Basalt Waste Isolation Project), crystalline rock (Office of Crystalline Rock Development), salt (Salt Repository Project Office), and tuff (Nevada Nuclear Waste Storage Investigations, NNWSI).

Figure 1 illustrates the context in which radioactive waste disposal must take place and shows the parts of the radioactive-waste-management system for which the DOE is responsible. Figure 1 also indicates that the prospective Yucca Mountain Mined Geologic Disposal System is one of several MGDS sites under consideration.

Control of Technical Development of Mined Geologic Disposal Systems. Because the development of the first MGDSs is a complicated technical process, the OCRWM has directed that the OGR and the repository development projects develop controlled sets of technical information (Technical Baselines) to serve as the basis for managing the MGDS development and evaluation phase. These requirements are specified in OCRWM and OGR Systems Engineering Management Plans.

The OGR is using systems engineering to develop and maintain a Technical Baseline made up of (1) the top-level legislative, regulatory, and programmatic requirements that guide MGDS development and (2) technical information describing the physical components (natural and engineered) that will be used to meet MGDS requirements. The developing OGR Technical Baseline is published in "Generic Requirements for a Mined Geologic Disposal System" (GR). The OGR will use the GR as a management tool to ensure that MGDS development by the four projects proceeds at a comparable level of detail and addresses a common set of requirements.

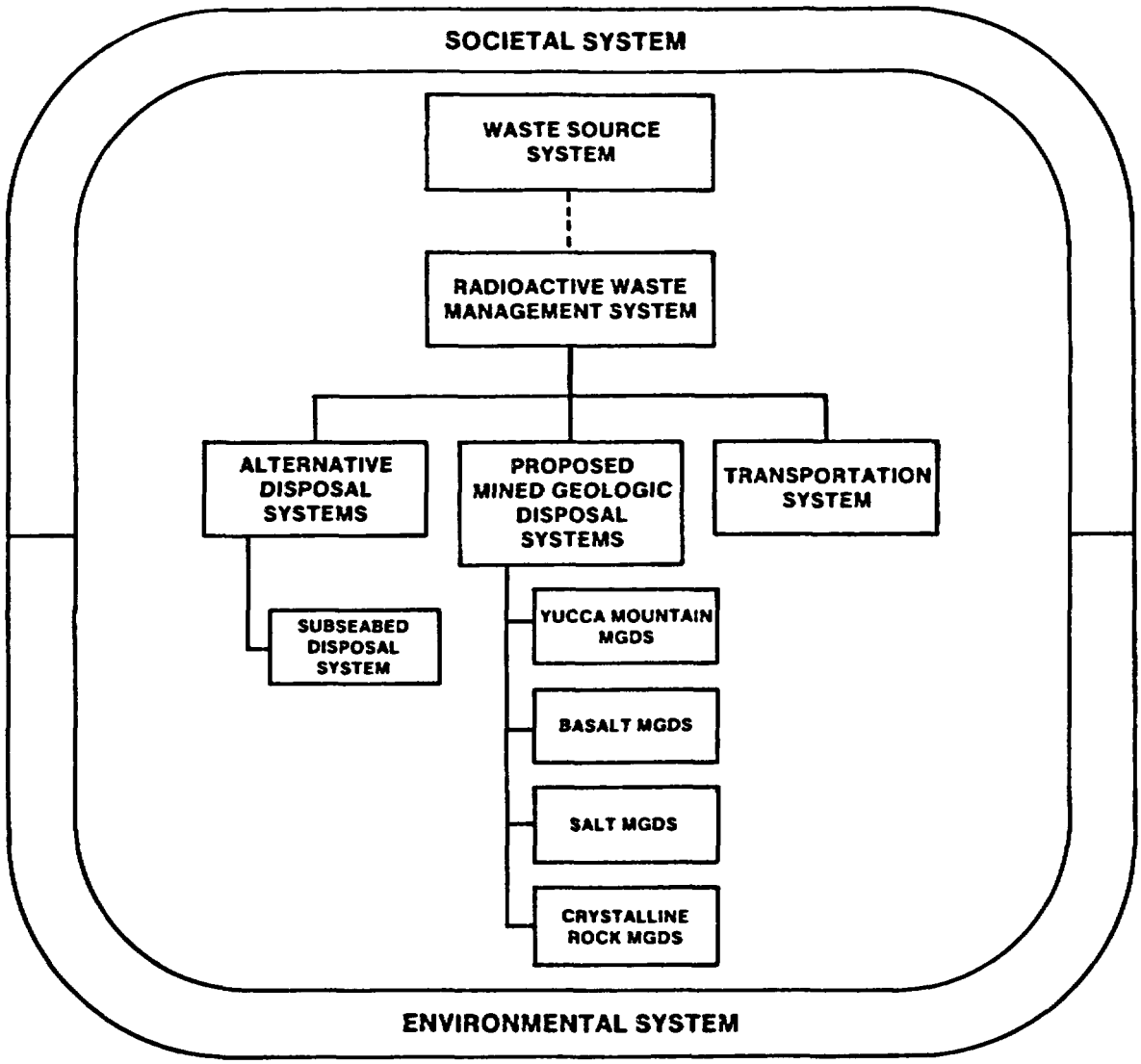


Figure 1. Context for radioactive waste disposal and parts of the U.S. Department of Energy radioactive waste management system

The OGR has in turn directed the NNWSI project and the other repository-development projects to use systems engineering to develop and maintain similar Technical Baselines that describe the social, regulatory, geologic, and physical environments specific to the sites being evaluated.

NNWSI Technical Baseline. As directed by the OGR, the NNWSI Project is using systems-engineering procedures to develop and maintain an NNWSI Technical Baseline. The NNWSI Technical Baseline will be used (via procedures to be described in the NNWSI Systems Engineering Management Plan) as one of the bases for managing the technical activities involved in developing an MGDS at Yucca Mountain in southern Nevada.

As illustrated in Figure 2, the NNWSI Technical Baseline is derived from and is an expansion of the GR, which represents a synthesis of source requirements relating to MGDS development. The NNWSI Technical Baseline consists of a Technical Requirements Baseline containing the detailed legislative, regulatory, and programmatic requirements to be met by an MGDS at Yucca Mountain and a Technical Information Baseline containing a physical description of the MGDS to be developed for radioactive-waste disposal at Yucca Mountain.

NNWSI Technical Requirements Baseline. The NNWSI Technical Requirements Baseline describes what an MGDS at Yucca Mountain has to do. It is made up of two documents. This document, the Yucca Mountain Mined Geologic Disposal System Requirements (SR), contains a detailed identification of site-selection, licensing, and programmatic requirements to be met by an MGDS at Yucca Mountain. The second document is the NNWSI Subsystem Design Requirements (SDR), which identifies federal, state, and local requirements that must be met in addition to those identified here and lists the industry codes and standards to be used. It also provides detailed guidance to architect engineers (AEs) for the design of facilities, equipment, and procedures that will work together to meet the requirements identified in the SR and the SDR.

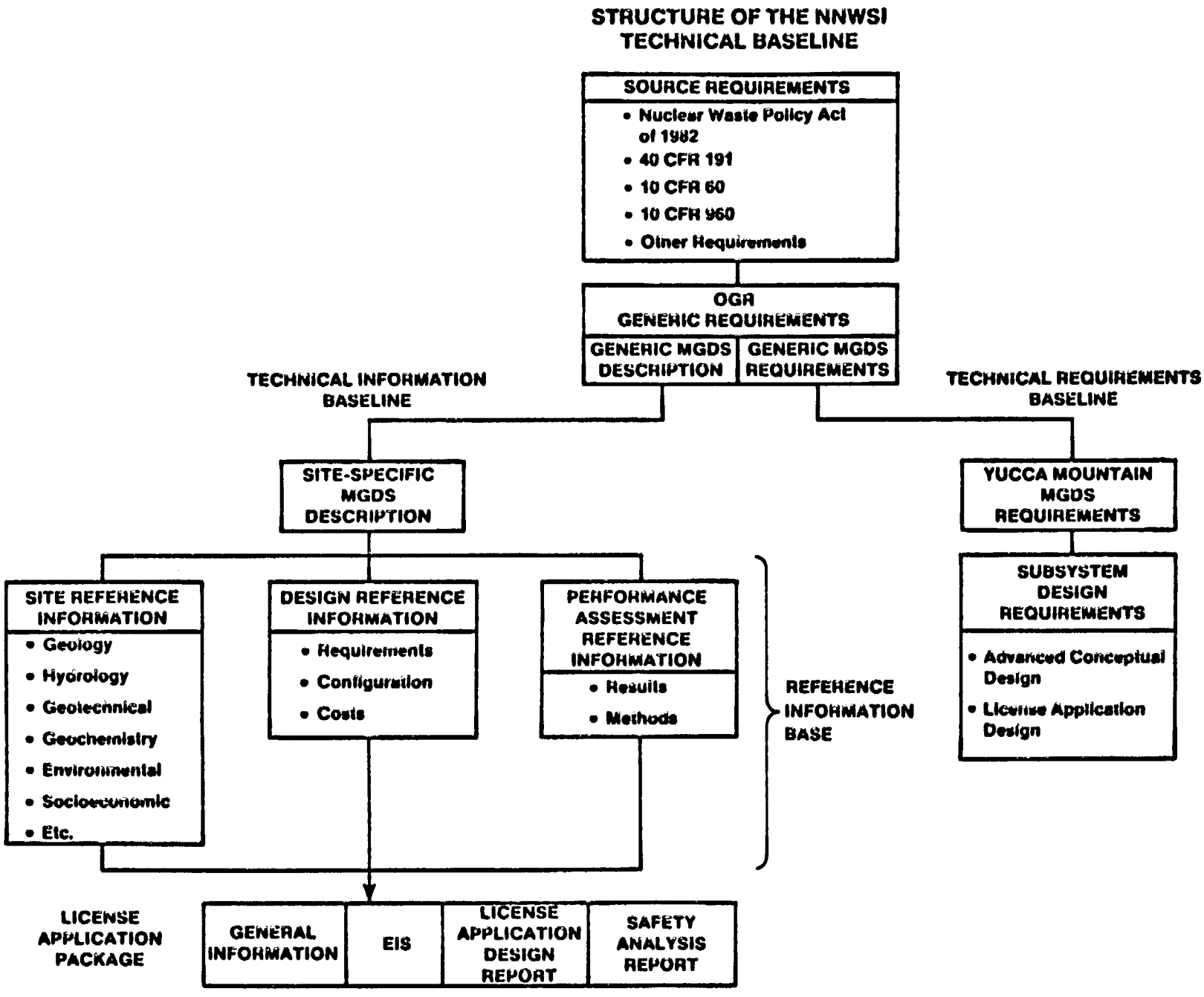


Figure 2. Structure of the NNWSI Technical Baseline

NNWSI Technical Information Baseline. The Technical Information Baseline is made up of two parts. The first part is a Site-Specific MGDS Description (SD) that will contain a detailed top-level summary of the natural and engineered parts of the Yucca Mountain MGDS as well as a description of how the natural and engineered parts of the system will work together to accomplish radioactive-waste disposal.

The second part is the Reference Information Baseline (RIB) that provides the detailed data describing the MGDS at Yucca Mountain. The RIB will contain the site, design, and performance-assessment information that will be generated during the development of the MGDS at Yucca Mountain. The RIB will contain the controlled information that will be used to demonstrate that the MGDS at Yucca Mountain meets the requirements identified in the SR and SDR. Ultimately, if Yucca Mountain is selected as the site for construction of the first or subsequent MGDS, the RIB will serve as a primary source of information for the license application package submitted by the DOE to the NRC.

Organization of Requirements for the Yucca Mountain Mined Geologic Disposal System

To systematically organize the radioactive-waste-disposal system requirements for a Yucca Mountain MGDS, three independent steps were performed. The first step was the identification of the site selection, licensing, and programmatic requirements that must be met. The second step involved the identification of the functions and components associated with waste disposal at Yucca Mountain. Finally the individual site-selection, licensing and programmatic requirements identified from legislation, regulations, and DOE policy and guidance were linked to the MGDS function or components that will be responsible for meeting the requirement. These three steps, termed requirements identification, function analysis, and function or requirements allocation by the discipline of systems engineering, are the same as those used by OGR to develop the GR.

The organization of requirements in a way that links each requirement with the MGDS functions and components responsible for meeting that requirement, provides a framework to help ensure that each requirement is appropriately considered in site characterization and design. This framework will be used by NNSWI systems engineering and in the performance allocation process to accomplish this goal. The use of the SR as the basis for performance allocation and systems engineering is briefly discussed in a later section titled "Use of the Yucca Mountain Mined Geologic Disposal System Requirements."

Identification of Requirements for the Yucca Mountain Mined Geologic Disposal System. The requirements placed on the prospective Yucca Mountain MGDS originate from a number of legislative, regulatory, and programmatic sources. The development of a radioactive waste disposal system at Yucca Mountain will take place over a number of years. This development will include periods of site characterization, site selection, repository design, repository construction and operation, repository closure and decommissioning. Therefore, the identification of requirements will be an ongoing process, and the SR will grow and change over time.

The first steps in the development of the Yucca Mountain MGDS are concerned with evaluating the suitability of the Yucca Mountain site against the requirements in 40 CFR 191, 10 CFR 60, and 10 CFR 960. The first publication of the SR gives a detailed allocation of the requirements that govern the selection of a site and the licensing of a radioactive-waste-disposal system as well as additional requirements found in the GR. The detailed requirements in the first SR are found in the following sources:

1. Nuclear Waste Policy Act of 1982 (PL 97-425)
2. 40 CFR 191 - EPA environmental standards
3. 10 CFR 60 - NRC licensing requirements
4. 10 CFR 20 - Radiation-protection requirements included by reference in 10 CFR 60
5. 10 CFR 19 - Radiation survey and worker-notification requirements included by reference in 10 CFR 20
6. 10 CFR 960 - Guidelines and requirements for selection of sites for radioactive-waste-disposal systems

7. 30 CFR Chapter I, Subchapters D, E, and N - Mine safety and health requirements included by reference in 10 CFR 60 for structures, systems, and components important to safety
8. DOE Order 5632 Series - Safeguards and security requirements for special nuclear material in DOE facilities
9. DOE Order 5500.3 - Emergency planning and emergency response requirements included by reference in 10 CFR 960
10. Generic Requirements for a Mined Geologic Disposal System - Generic requirements and OCRWM and OGR guidance

Other requirements (not related to the licensing process) affecting construction, operation, and decommissioning of a radioactive-waste-disposal system will originate from Federal, State, and local regulatory processes. The intent of the SR is to identify the requirements that affect the functions of a radioactive-waste-disposal system at Yucca Mountain rather than to provide guidance about how repository designers should combine facilities, equipment, personnel, and procedures to meet the system requirements. If required, this guidance will be provided in another part of the NNWSI Technical Baseline--the SDR.

Subsequent revisions to the SR will be made to add new requirements that are applicable to the Yucca Mountain MGDS, to delete or modify existing requirements, or to add additional detail that may be required as MGDS development proceeds.

<u>Identification of Functions and Components Involved in Radioactive-Waste Disposal</u>. The process of MGDS function and component identification produced a hierarchical tree that has at its apex the primary function of a waste-disposal system: to dispose of radioactive-waste in a way that will protect public health and the environment for this and future generations.

The next level of the tree was defined by answering the question "What functions or components must be provided by the Yucca Mountain MGDS for it to accomplish its objective?" The two-part answer, processing and emplacement of the radioactive waste and long-term isolation of the emplaced waste from the accessible environment, defined the two second-level functions, 1.0 PRECLOSURE

WASTE DISPOSAL and 2.0 POSTCLOSURE WASTE DISPOSAL. Successive levels were identified by answering, for each function and component, the same question: "What functions or components must be provided for this function to accomplish its objectives?" The process was repeated for each branch of the tree until all of the important functions, subfunctions, and components of the Yucca Mountain MGDS had been identified.

The function and component hierarchy developed for the Yucca Mountain MGDS is shown in Figure 3. It should be noted that the hierarchy is made up of both functions and components (physical objects). This was done to preserve some of the traditional terms used in radioactive-waste disposal, to be consistent with the GR function hierarchy and to provide a framework for NNWSI performance allocation.

Because the notion of a mixed function-component hierarchy is often difficult to visualize, Figures 4 and 5 are included to show conceptual drawings of the physical parts of the Yucca Mountain MGDS that will be designed to meet the requirements identified in the SR.

Figure 4 shows the surface facilities of the repository that will receive radioactive waste from the Waste Source System (reactors or other facilities where radioactive waste is temporarily stored) shown in Figure 1 by way of the Transportation System also shown in Figure 1. The waste will be processed in repository surface facilities, and an emplacement container (waste-emplacement package) will be prepared. The waste-emplacement package will be transported to the underground facilities of the repository, where it will be placed in a borehole drilled into the rock. After permanent closure the waste-emplacement package, underground repository facilities, and the natural barriers contributed by the geologic setting will combine to limit release of radioactivity to the accessible environment, where it would pose a health hazard to the public.

Figure 5 is a pictorial representation showing the parts of the Yucca Mountain MGDS that will combine to isolate radioactive waste after permanent closure. Any radioactive waste escaping from emplaced waste packages would be isolated by the natural and engineered components of the engineered barrier

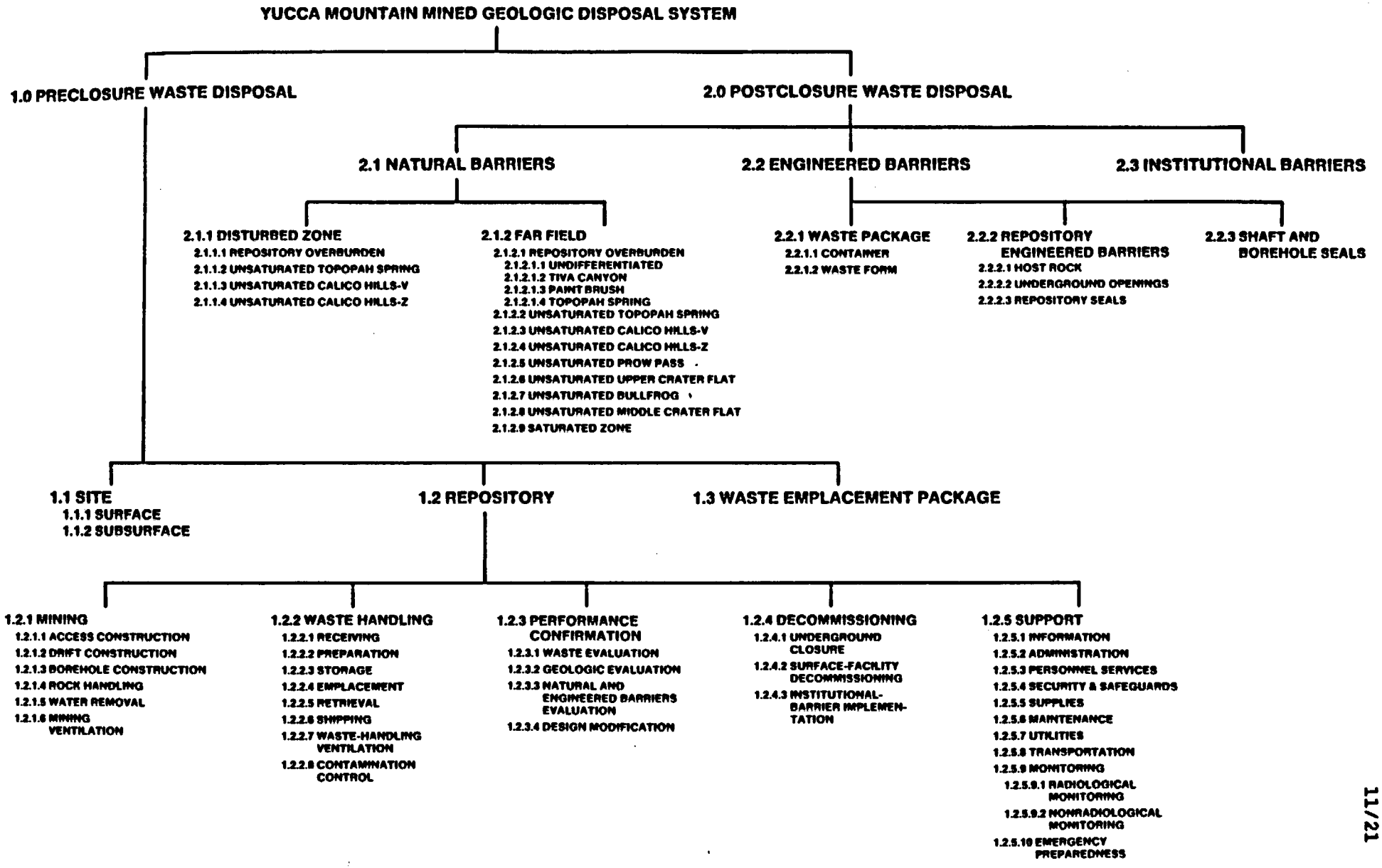


Figure 3. Hierarchy of functions and components that make up the Yucca Mountain Mined Geologic Disposal System

11/21

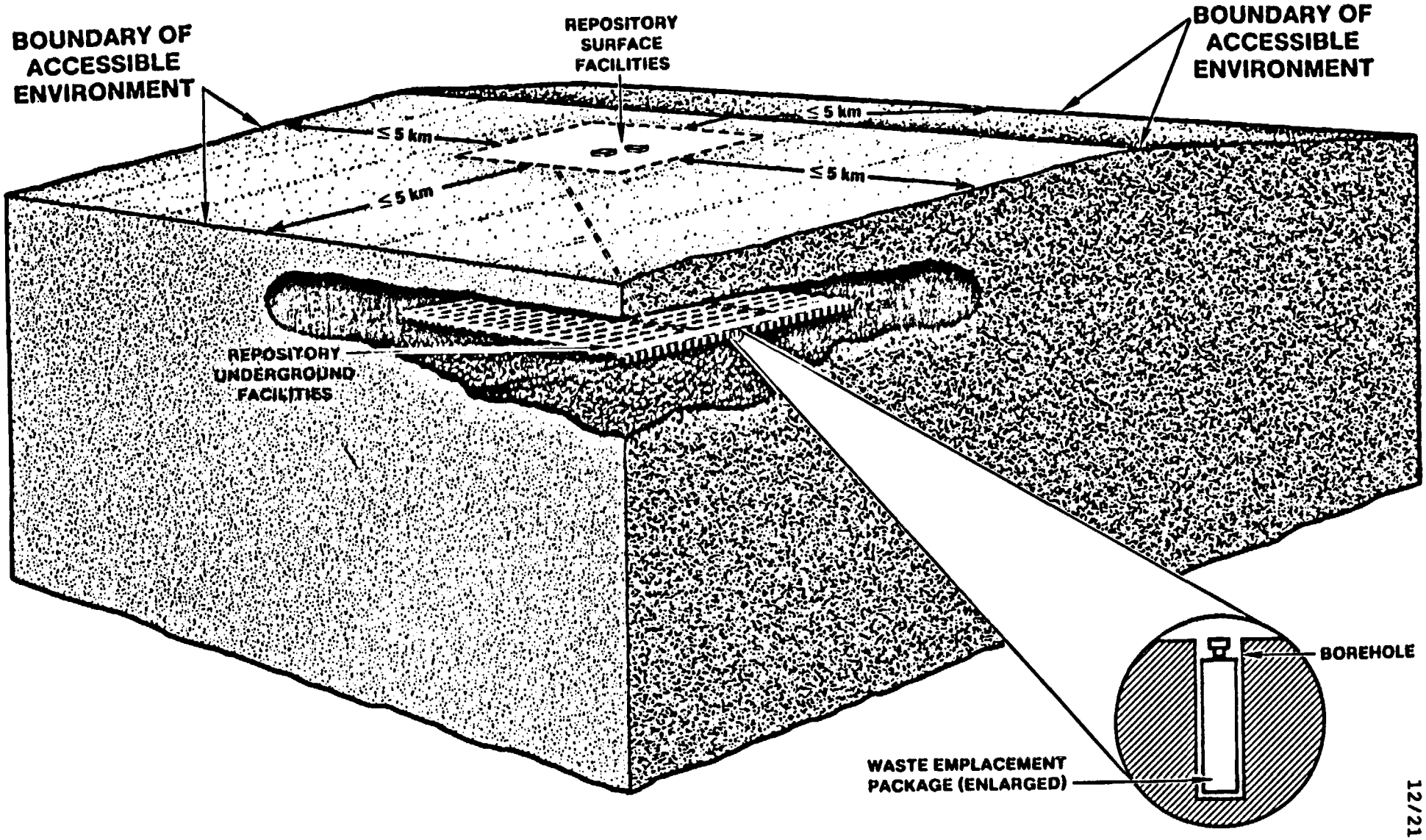


Figure 4. Parts of the Yucca Mountain Mined Geologic Disposal System

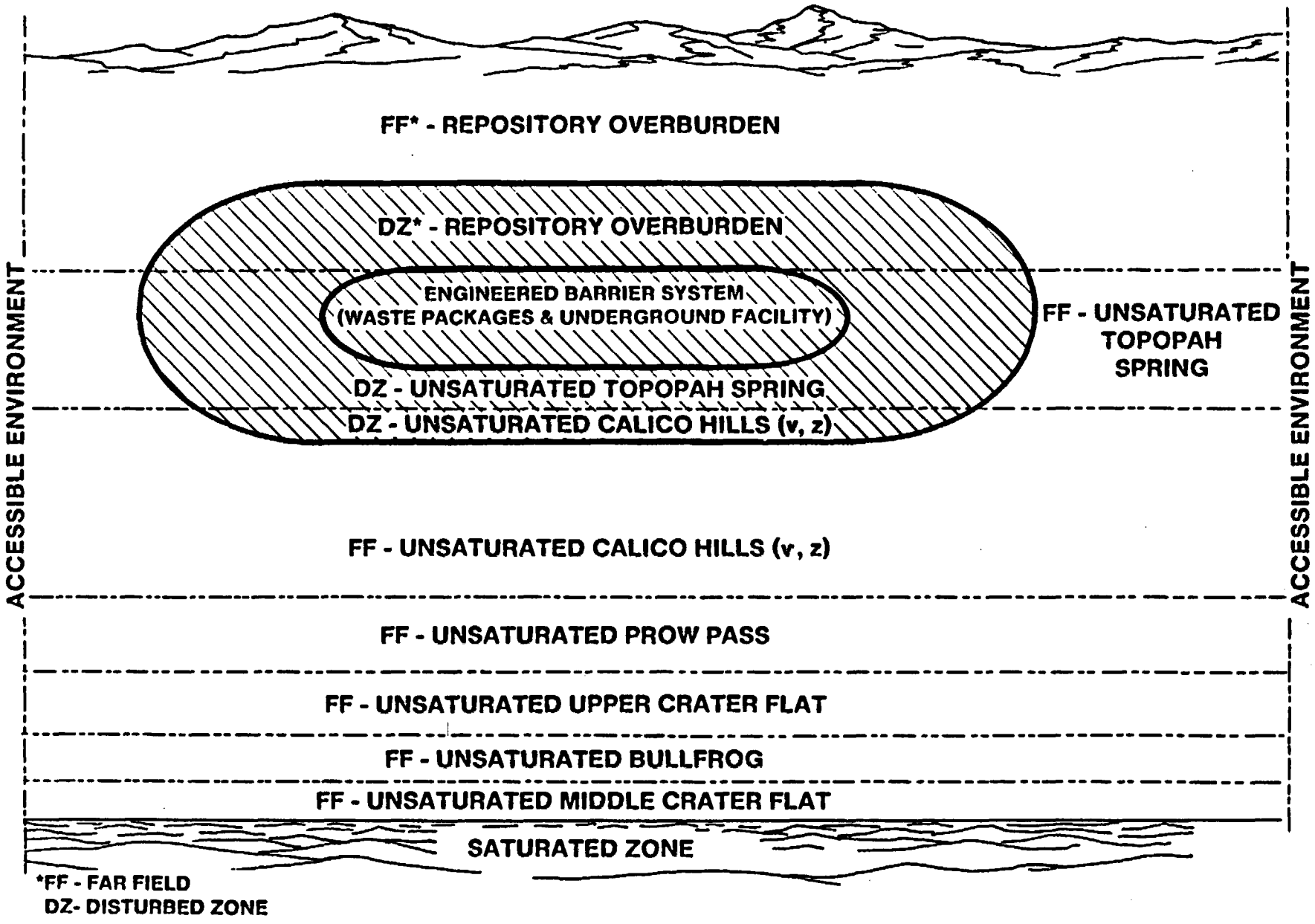


Figure 5. Parts of the Yucca Mountian MGDS that will isolate radioactive waste after permanent closure

system. Movement of radioactive waste to the accessible environment would be further delayed by the natural barriers in the disturbed zone (cross-hatched area outside the engineered barrier system), far field and saturated. Definition of these natural and engineered barriers and a detailed identification of their functions and requirements can be found in Sections 2.1 - 2.2 of this document.

Allocation of Requirements to MGDS Functions and Components--To complete the requirements-organization process, requirements were linked (allocated) to the MGDS functions and components responsible for meeting them. This process is termed function allocation or requirements allocation in systems engineering literature. To do this, each of the hierarchy functions and components is described in a standard format that includes the headings shown below and answers to the questions shown following the headings:

DEFINITION: What is the function or component under consideration? In general, what are the physical parts that will accomplish the function and what boundaries are associated with these parts?

FUNCTIONAL REQUIREMENTS: What is this function or component supposed to do if it is to contribute to the operation of the entire Yucca Mountain MGDS?

PERFORMANCE CRITERIA: As defined in legislative, regulatory, or programmatic requirements, how well must this function or component perform? If known, what are the indicators to be used to evaluate performance? A Performance Criterion is stated for each Functional Requirement.

CONSTRAINTS: What requirements and limitations are placed on this function or component as a result of interaction with other functions and components, the regulatory process, the design process, and the physical and chemical environment in which the function or component must perform?

INTERACTIONS: What are the other functions or components inside and outside of the Yucca Mountain MGDS that interact with this function or component as it meets specific requirements?

Requirements on Yucca Mountain MGDS functions and components are classified either as Performance Criteria or Constraints. The distinction between the two is somewhat arbitrary and not always clear. Performance Criteria are quantitative or qualitative requirements that state how well a function or component (identified in a Functional Requirement) must do its job. Constraints are additional requirements that must be met at the same time the function or component is complying with its Performance Criteria. The same level of importance is attached to both Performance Criteria and Constraints. Both must be met by the MGDS.

When Performance Criteria and Constraints are quantitatively stated in legislation, regulations, and other sources of requirements, they are stated quantitatively in the individual function and component descriptions. When Performance Criteria and Constraints must be established by analyses or studies, a qualitative statement of the basis for showing compliance will be used in the function and component descriptions. These qualitative statements show that an analysis is needed to determine the required level of performance or the effect of any Constraints that are placed on the required level of performance.

The requirements allocation process results in the identification of requirements (Performance Criteria and Constraints) at the highest level in the hierarchy to which they apply. For example, a Constraint identified in the description for 1.0 PRECLOSURE WASTE DISPOSAL would apply to all, or almost all, of the subfunctions comprised by 1.0 PRECLOSURE WASTE DISPOSAL. The Constraint is then reidentified by reference in the descriptions of each of the subfunctions of 1.0 PRECLOSURE WASTE DISPOSAL which must contribute to meeting the requirement. This process will help ensure that each requirement is addressed adequately by the various activities involved in MGDS development.

Use of the Yucca Mountain Mined Geologic Disposal System Requirements

The SR and the SDR make up the NNWSI Technical Requirements Baseline. These two documents identify all requirements to be met by the proposed Yucca Mountain MGDS.

Use of the SR in NNWSI Systems Engineering. As part of the technical management process, NNWSI will use the tools provided by systems engineering to help ensure that the requirements identified in the SR form an integral part of the site-characterization process. The systems engineering process will also help to ensure that requirements are reflected in the design of the facilities, equipment, and procedures that will work together with the natural system to provide reasonable assurance that the individual and collective requirements on the Yucca Mountain MGDS are met. This traceability from requirements through design is required by the NRC as part of the repository licensing process specified in 10 CFR 60.21(c)(2).

The requirements allocation tool just discussed leads to an organization scheme in which each MGDS requirement is allocated to the highest level in the hierarchy where compliance must be demonstrated. The requirement is then re-allocated to every subfunction or component in the hierarchy that must contribute to meeting the requirement. In this way high-level system requirements are broken into manageable pieces that can be addressed by the appropriate MGDS development activity. Thus compliance with each allocated requirement at the subfunction and component level will ensure that the system-level requirement is met.

Use of the SR in Performance Allocation. The NNWSI will use another systems engineering tool, performance allocation, to help ensure that the information (data, design, and analysis) provided by the various MGDS development activities, such as site characterization and design, will be sufficient to demonstrate compliance with each MGDS requirement as allocated in the SR. In the performance allocation process quantitive performance goals will be established for each function, subfunction, or component that will contribute to meeting a given requirement. The quantitive performance goals

will then be used as the basis for definition of the site characterization, design, or other MGDS-development activities that will provide the information needed to demonstrate compliance with each requirement.

A phased application of this performance allocation process will be started when planning is underway for site characterization and associated design activities. In this period, performance allocation will emphasize those SR requirements that require information about the site for a demonstration of compliance. This phase of performance allocation will provide guidance for the definition of site characterization testing and for design activities that take place during the site characterization period. Primary emphasis will be placed on the performance objectives identified in 10 CFR 60 and the site-selection requirements in 10 CFR 960.

Subsequent extension of the performance allocation process will eventually include all of the requirements identified and allocated in the SR.

Rigorous, ongoing application of these systems-engineering tools during all phases of MGDS development will lead to the design of an MGDS at Yucca Mountain that will effectively combine natural and engineered barriers to dispose of radioactive waste and will meet the NRC pre- and postclosure licensing requirements with the reasonable assurance required in the licensing process.

Relationship of the SR and NNWSI Issues Hierarchy. A similar process for identifying information needs based on EPA and NRC requirements was used previously by the NNWSI Project to develop the NNWSI Issues Hierarchy found in Appendix C. The Issues Hierarchy is currently used as the basis for managing the technical activities that support the development of the NNWSI Technical Information Baseline. The process led to the definition of Key Issues and Issues concerning the ability of a waste-disposal system at Yucca Mountain to dispose of radioactive waste and effectively isolate the waste from the accessible environment under both current and future conditions. Key Issues and Issues were used to identify the information needed to resolve those Key Issues and Issues.

The NNWSI Issues Hierarchy will continue to be used as the basis for NNWSI Project technical management. If required, project deficiencies uncovered during the ongoing SR-based performance allocation process described above will be translated into modified NNWSI technical activities through controlled changes to the NNWSI Issues Hierarchy. These change control procedures will be detailed in the NNWSI Systems Engineering Management Plan.

Because the detailed organization of the SR and more simplified organization of the NNWSI Issues Hierarchy are based on the same MGDS requirements, each requirement identified in the SR is reflected in the Key Issues, Issues, and Information Needs in the Issues Hierarchy. Appendix D shows the correlation between requirements in the SR and the Key Issues, Issues, and Information Needs in the NNWSI Issues Hierarchy.

Control of the Yucca Mountain Mined Geologic Disposal System Requirements

The NNWSI Technical Requirements Baseline published in this SR will be placed under change control as specified in the NNWSI Systems Engineering Management Plan. SR revisions will be published as requirements are added or deleted, as requirements change, or as information needed to satisfy system requirements is refined by site characterization, design, and performance assessment. Major revisions will be published to reflect the status of the NNWSI Project at the completion of the major design steps in the MGDS development and evaluation phase. If Yucca Mountain is selected as the location for construction of the first or subsequent MGDS, the SR will be updated as required to support final design, construction, and operation. Each revision of the SR is to be approved as specified in the NNWSI Systems Engineering Management Plan.

Description of System Requirements

The remainder of the SR contains descriptions (i.e., Definition, Functional Requirements, Performance Criteria, Constraints, and Interactions) for each of the functions and components that make up the hierarchy illustrated in Figure 3. The format for these descriptions and an explanation of shorthand notation is provided in Figure 6. To facilitate updating, no page numbers are assigned to the individual descriptions. A function identification number and pagination information are printed in the upper right-hand corner of each page. For example, a notation 1.2.5-1/4 indicates page 1 of 4 pages in the description of the 1.2.5 SUPPORT function. Function names are printed in capital letters throughout this document. Interactions listed at the end of each function description identify the other MGDS functions that participate in meeting a Performance Criterion or Constraint.

A References and Bibliography section follows the descriptions of the individual functions that are performed by the Yucca Mountain MGDS. Appendix A contains a glossary of terms used in the SR. An attempt has been made to be consistent with usage in regulatory or guidance documents. Where usage differs, the definition that applies in the SR will be given. Appendix B contains a matrix that demonstrates the correlation between each of the requirements identified in the GR and those identified in the SR. Appendix C contains the NNWSI Issues Hierarchy, and Appendix D provides the correlation between the requirements in the SR and the Key Issues, Issues, and Information Needs that make up the NNWSI Issues Hierarchy.

A final note on the use of the SR is in order. Because many requirements are placed on the various subsystems that make up the Yucca Mountain MGDS and because, where possible, requirements are allocated to each appropriate function, subfunction, and component the SR is a long document. The SR does not have to be read in its entirety by an individual interested in the requirements placed on a single function or component or its subfunctions or subcomponents. Rather, the SR should be used as a reference source by looking

1.2.1 MINING ⟹ Function Name

⟹ Function Number

Subfunctions are:

What subfunctions make up this function?

DEFINITION:

What physical parts perform this function?

FUNCTIONAL REQUIREMENTS:

1. What does this function do?
2.

PERFORMANCE CRITERIA:

1. How well must the function be done?
2.

CONSTRAINTS:

A. What factors affect how this function works?
B.

INTERACTIONS: ⟹ What other functions are involved?

Function Interacted with		1.2.1 Requirement
1.2.2.5 RETRIEVAL	⇓	PC#1; C#J

MINING Performance Criterion 1 and Constraint J
Interact with RETRIEVAL

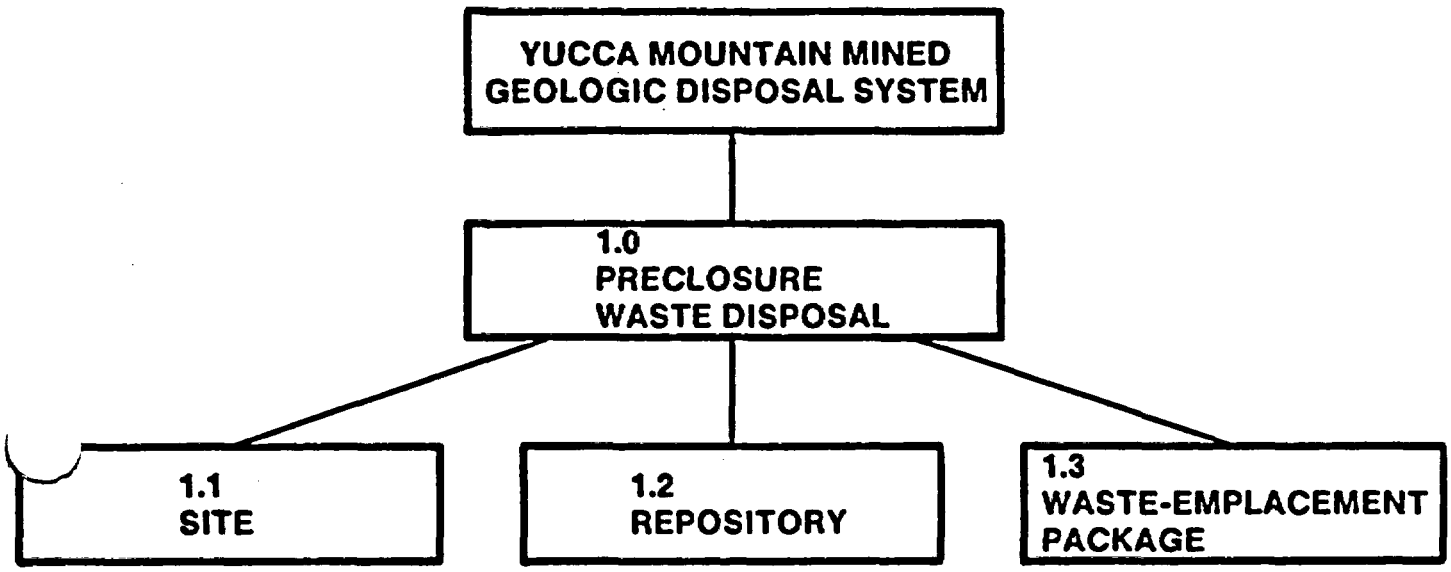
Figure 6. Example format for description of Yucca Mountain Mined Geologic Disposal System functions and components

up the description of the requirements associated with a function or component of interest. It is helpful to read the descriptions above and below the one being considered to gain a complete perspective.

In many cases requirements have been combined or paraphrased from their original source. The reader should consult the original source(s) for any needed clarification.

This page intentionally left blank.

The section that follows identifies the mined geologic disposal system requirements that have been allocated to 1.0 PRECLOSURE WASTE DISPOSAL portion of the YUCCA MOUNTAIN MINED GEOLOGIC DISPOSAL SYSTEM. As indicated below, 1.0 PRECLOSURE WASTE DISPOSAL comprises the 1.1 SITE, 1.2 REPOSITORY, and 1.3 WASTE-EMPLACEMENT PACKAGE functions. Requirements allocated to these functions will be identified in subsequent sections.



This page intentionally left blank.

YUCCA MOUNTAIN MINED GEOLOGIC DISPOSAL SYSTEM

Subfunctions are:

1.0 PRECLOSURE WASTE DISPOSAL
2.0 POSTCLOSURE WASTE DISPOSAL

DEFINITION:

The functions and components required for the NRC-licensed disposal of radioactive waste at Yucca Mountain in southern Nevada.

FUNCTIONAL REQUIREMENTS:

1. To receive and emplace radioactive waste.

2. To isolate the emplaced radioactive waste from the accessible environment.

PERFORMANCE CRITERIA:

1. The Yucca Mountian MGDS shall be capable of disposing of 70,000 MTHM (metric tons of heavy metal) equivalent of radioactive waste in its operating lifetime [GR MGDS PC#1].

2. Disposal shall comply with the containment individual protection, and groundwater protection requirements specified in 40 CFR 191.13, .15, and .16 [40 CFR 191].

CONSTRAINTS:

A. 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 do not exceed the limits specified in YMMGD PC#2 [10 CFR 60.112].

B. Waste disposal operations shall be conducted on land for which DOE shall obtain, in accordance with the requirements of 10 CFR 60.121, ownership, surface and subsurface rights, and control of access that are required in order that potential surface and subsurface activities at the site will not be likely to lead to radionuclide releases greater than those allowable in 40 CFR 191 [10 CFR 960.4-2-8-2(a)].

C. A quality assurance program based on the applicable criteria of Appendix B of 10 CFR Part 50 as supplemented by the requirements of 10 CFR 60.151 shall be implemented for systems, structures, and components important to safety and to design and characterization of barriers important to waste isolation [10 CFR 60.152]. Activities include:

Site characterization
Facility and equipment construction
Facility operation
Performance confirmation
Permanent closure
Decontamination and dismantling of surface facilities.

INTERACTIONS:

	Function Interacted With	YMMGD Requirement
	SOCIETAL	C#C
	TRANSPORTATION	PC#1
1.0	PRECLOSURE WASTE DISPOSAL	C#A
2.0	POSTCLOSURE WASTE DISPOSAL	C#A

NOTE: The organization of the SR organizes MGDS requirements into two major groups, those that apply to radioactive waste disposal operations occurring before permanent closure and those that relate to postclosure performance of the MGDS. A consequence of this organization is that the integral relationships between all 1.0 PRECLOSURE WASTE DISPOSAL and 2.0 POSTCLOSURE WASTE DISPOSAL requirements is not sufficiently clear. Not only do 40 CFR 191 and 10 CFR 60 require that the geologic repository safely conduct preclosure operations of radioactive waste receipt and emplacement, but they also require that this same geologic repository (consisting of engineered and natural parts) operate after permanent closure to isolate the emplaced radioactive waste from the public and the environment. This major interdependence between pre- and postclosure radioactive waste disposal is expressed in Constraint A above. This requirement is also allocated to appropriate 1.0 PRE-CLOSURE WASTE DISPOSAL functions and components.

To ensure that the interdependence expressed in Constraint A is adequately addressed in NNWSI repository design activities, the requirement is repeated in Section 4.1 of the SDR. This section contains SR requirements that are to be met by all design activities directed by the SDR.

This page intentionally left blank.

1.0 PRECLOSURE WASTE DISPOSAL

Subfunctions are:

1.1 SITE
1.2 REPOSITORY
1.3 WASTE EMPLACEMENT PACKAGE

DEFINITION:

The Yucca Mountain MGDS function that provides construction, operation, closure, and decommissioning.

FUNCTIONAL REQUIREMENTS:

1. To dispose of radioactive waste.

2. To permit the retrieval of any emplaced waste.

PERFORMANCE CRITERIA:

1. Construct, operate, close, and decommission waste facilities such that at least 70,000 MTHM equivalent of radioactive waste is disposed of [YMMGD PC#1]. Stage-one facilities capable of disposal of 400 MTHM per year for five years shall be available to receive radioactive waste by January 31, 1998. Stage-two facilities shall be available to accommodate the waste types and receipt schedules identified in the NNWSI, RIB, and in Appendix B.1 of the GR.

2. Design and operation shall not preclude retrieval of any or all of the emplaced radioactive waste within a period of 34 years, starting at any time for up to 50 years after emplacement or for a period to be specified by NRC at the completion of the Performance Confirmation Program [NWPA 122, 10 CFR 60.111(b), GR 1.0 PC#2].

CONSTRAINTS:

A. Any radiological exposures of the general public and any releases of radioactive materials to restricted and unrestricted areas during preclosure waste disposal operations shall meet the applicable safety requirements set forth in 10 CFR 20; 10 CFR 60.131(a); 40 CFR 191, Subpart A [10 CFR 960.5-1(a)(1)]. Specific requirements include:

1. The combined annual dose equivalent to any member of the public in the general environment resulting from: (a) nuclear fuel cycle operations covered by 40 CFR 190, (b) planned discharges of radioactive material to the general environment from development, operation, and closure of the repository, and (c) direct radiation from development, operation, and closure of the repository; shall not exceed 25 millirems to the whole body, 75 millirems to the thyroid, or 25 millirems to any other critical organ [10 CFR 60.111(a); 40 CFR 191.03(a)].

2. Radiation exposures to workers from all PRECLOSURE WASTE DISPOSAL functions, shall be as low as reasonably achievable both on an individual and on a total work force basis, taking into account technical, social, and economic considerations [10 CFR 20.1(c)].

3. Radiation exposures to individuals in restricted areas received in any period of one calendar quarter shall not exceed the following limits [10 CFR 60.131(a) and 20.101(a)]:

   a. Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads..... 1 1/4 rem
   b. Hands and forearms; feet and ankles..... 18 3/4 rem
   c. Skin of whole body..... 7 1/2 rem

Procedures and requirements for permitting greater exposures than these limits are described in 10 CFR 20.101(b).

4. Radiation exposures to individuals in unrestricted areas within the site boundary shall not exceed the following limits [10 CFR 60.131(a) and 20.105]:

   a. Whole body dose in any period of one calendar year..... 0.5 rem
   b. For continuous presence in the area, dose in any one hour..... 2.0 mrem
   c. For continuous presence in the area, dose in any consecutive seven days..... 0.1 rem

5. Individuals in restricted areas shall not be permitted to inhale and/or absorb through the skin a quantity of radioactive material in any period of one calendar quarter greater than the quantity which would result from inhalation for 40 hours per week for 13 weeks at uniform concentrations of radioactive material in air specified in Appendix B, Table I, Column 1 of 10 CFR 20 [10 CFR 60.131(a) and 20.103(a)(1) and (2)].

6. Process or other engineering controls shall be used, to the extent practicable, to limit concentrations of radioactive materials in air in restricted areas to levels below those which delimit an airborne radioactivity area which is defined as any room, enclosure, or operating area in which the airborne radioactive material concentrations, averaged over the number of hours in any week during which individuals are in the area, exceed 25 percent of the amounts specified in Appendix B, Table I, Column 1 of 10 CFR 20 [10 CFR 60.131(a); 10 CFR 20.103(b)(1); 10 CFR 20.203(d)(1)(ii)].

7. When it is impracticable to comply with Subpart 6 above, other precautionary measures, such as increased surveillance, limitation of working times, or provision of respiratory protective equipment shall be used to limit intake of radioactive material by any individual during any period of seven consecutive days as much as is reasonably achievable below that intake which would result from inhalation of

such material for 40 hours at the uniform concentrations specified in 10 CFR 20, Appendix B, Table I, Column 1; whenever this 40 hour control measure is exceeded actions to assure against recurrence shall be taken and records suitable for summary review and evaluation by the NRC shall be maintained; respiratory protective equipment used to control airborne radioactivity exposures shall comply with the requirements of 10 CFR 20.103(c) [10 CFR 20.103(b)(2) and (c)].

8. Radioactive material released to unrestricted areas within the site boundary shall be released at annual average concentrations that do not exceed the limits specified in 10 CFR 20, Appendix B, Table II; NRC approval to exceed these limits may be obtained in accordance with 10 CFR 20.106(b) [10 CFR 60.131(a) and 20.106].

9. Radiation exposures to persons under 18 years of age shall be limited to 10% of the limits stated in Subpart 3 above; exposure of persons under 18 years of age to airborne radioactivity shall be limited to concentrations averaged over a period not greater than one week that do not exceed the limits specified in 10 CFR 20, Appendix B, Table II; the provisions of Subpart 7 above also apply to exposures to persons under 18 years of age, except where reference is made in Subpart 6 to 10 CFR 20, Appendix B, Table I, Column 1, the reference here shall be deemed to be made to 10 CFR 20, Appendix B, Table II, Column 1 [10 CFR 60.131(a) and 20.104].

10. Preclosure waste disposal operations shall be located such that, during repository operation and closure, (1) the expected average radiation dose to members of the public, within any highly populated area, will not be likely to exceed a small fraction of the limits allowable under the requirements specified in Constraint A above, and (2) the expected radiation dose to any member of the public in an unrestricted area will not be likely to exceed the limits allowable under the other requirements specified in Constraint A above [10 CFR 960.5-2-1(a)].

B. Construction, operation, closure, and decommissioning 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(a)(3)].

C. During 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(a)(2)].

D. No surface facility shall be located in a highly populated area [10 CFR 960.5-2-1(d)(1), NWPA 112(a)(1-2), 10 CFR 60.122(b)(6)].

E. No surface facility shall be located adjacent to an area 1 mile by 1 mile having a population of not less than 1,000 individuals as enumerated by the most recent U.S. census [10 CFR 960.5-2-1(d)(2), NWPA 112(a)(1-2), 10 CFR 60.122(b)(6)].

F. An emergency preparedness program shall be developed which meets the requirements specified in DOE Order 5500.3 (Reactor and Non-Reactor Facility Emergency Planning, Preparedness, and Response Program for Department of Energy Operations) and related guides or, when issued by the NRC, in 10 CFR 60, Subpart I, "Emergency Planning Criteria" [10 CFR 960.5-2-1(d)(3)].

G. During preclosure construction, operation, closure, and decommissioning, the quality of the environment in the affected area in southern Nevada shall be adequately protected and projected environmental impacts in the affected area will be mitigated to an acceptable degree, taking into account programmatic, technical, social, economic, and environmental factors [10 CFR 960.5-2-5(a) and (d)(1)].

H. No part of the restricted area or repository support facilities shall be located within the boundaries of a component of the National Park System, the National Wildlife Refuge System, the National Wilderness Preservation System, or the National Wild and Scenic Rivers System [10 CFR 960.5-2-5(d)(2)].

I. The presence of the restricted area or the repository support facilities shall not conflict irreconcilably with the previously designated resource-preservation use of a component of the National Park System, the National Wildlife Refuge System, the National Wilderness Preservation System, the National Wild and Scenic Rivers System, or National Forest Lands, or any comparably significant State-protected resource that was dedicated to resource preservation at the time of the enactment of the NWPA [10 CFR 960.5-2-5(d)(3)].

J. Preclosure operations shall be carried out such that present and projected effects from nearby industrial, transportation, and military installations and operations, including atomic energy defense activities, (1) will not significantly affect repository, 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 set forth in 10 CFR 20, 10 CFR 60, and 40 CFR 191 Subpart A [10 CFR 960.5-2-4(a)].

K. Atomic energy defense activities in proximity to preclosure operations shall not conflict irreconcilably with repository construction, operation, closure, or decommissioning [10 CFR 960.5-2-4(d)].

L. Preclosure facilities shall be located such that (1) the access routes constructed from existing local highways and railroads to the site (i) will not conflict irreconcilably with the previously designated use of any resource listed in Constraints G and H above; (ii) can be designed and constructed using reasonably available technology; (iii) will not require transportation system components to meet performance standards more stringent than those specified in the applicable DOT and NRC regulations, nor require the development of new packaging containment technology; (iv) will allow transportation operations to be conducted without causing an unacceptable risk to the public or unacceptable environmental impacts, taking into account programmatic, technical, social, economic, and environmental factors; and (2) Constraint C above can be met [10 CFR 960.5-2-7(a)].

M. Except as modified by the NWPA, preclosure activities shall meet all requirements of the National Environmental Policy Act (NEPA) as implemented for DOE projects in DOE Order 5440.1B, "Implementation of the National Environmental Policy Act" [NWPA 114(f)].

N. Preclosure operations shall meet the requirement of Executive Order 12088, Federal Compliance with Pollution Control Standards, as implemented in DOE Order 5480.1A (Environmental Protection, Safety and Health Protection Programs for DOE Operations) and DOE Order 5480.4 (Environmental Protection, Safety, and Health Protection Standards) [GR 1.0 C#M].

O. Permanent closure and decommissioning shall meet the requirements of 1.2.4 DECOMMISSIONING and shall be performed in accordance with Appendix C of Generic Requirements Document [GR 1.0 C#N].

P. Preclosure facilities and operations 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, the State of Nevada, and local government jurisdictions, and affected Indian tribes; and (2) the requirements specified in Constraint D above can be met [10 CFR 960.5-2-6(a)].

Q. Construction, operation, and closure shall not 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 in a way that cannot be compensated for or mitigated by reasonable measures [10 CFR 960.5-2-6(d)].

R. Preclosure activities at facilities shall be planned and operated in a way that promotes the participation of the relevant institutional entities in Nevada and the public [NWPA 111(a)(6), 116, 117, 118; NWTS 33(1); 10 CFR 960.3-3].

S. Preclosure facilities shall be built and operated in a way that makes efficient use of natural and economic resources [GR 1.0 C#U].

T. PRECLOSURE WASTE DISPOSAL shall be conducted such that the natural and engineered portions will function after permanent closure to assure that releases of radioactive material to the accessible environment conform to the requirements in YMMGD PC#2 and C#A.

U. System performance shall be monitored to confirm that the system is operating and is likely to operate as predicted in performance assessments [10 CFR 60.140].

V. PRECLOSURE WASTE DISPOSAL shall meet the quality assurance requirements of YMMGD C#B.

W. Preclosure facilities shall be designed to ensure that a nuclear criticality accident is not possible under normal or accident conditions unless two unlikely, independent and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. The effective multiplication factor (K_{eff}) must be sufficiently below unity to show at least a 5% margin after allowance for the associated uncertainties. Further, the construction, operation, and closure shall be done in a way that greatly reduces the potential for a nuclear criticality accident after permanent closure [10 CFR 60.131.(b)(7)].

X. Prior to the availability of a second mined geologic disposal system, no more than 70,000 MTHM of radioactive waste shall be disposed of; should a monitored retrievable storage facility (MRS) be located within 50 miles of the repository, this requirement applies to the combined capacity of the MRS and the repository [NWPA 114(d)].

Y. All systems, structures, and components important to safety shall continue to perform their safety functions under [10 CFR 60.131(b)]:

1. Anticipated natural phenomena and environmental conditions [10 CFR 60.131(b)(1)].

2. Dynamic effects of equipment failure and other similar events [10 CFR 60.131(b)(2)].

3. Credible fires and explosions in the geologic repository operations area [10 CFR 60.131(b)(3)].

   a. Noncombustible and heat resistant materials shall be used to the extent possible in the geologic repository operations area [10 CFR 60.131(b)(3)(ii)].

   b. Explosion and fire detection alarm systems and appropriate suppression systems sufficient to reduce adverse effects of explosion and fires on structure, systems, and components important to safety shall be used [10 CFR 60.131(b)(3)(iii)].

   c. Systems, structures, and components important to safety shall withstand adverse effects of the failure of operation of fire suppression systems [10 CFR 60.131(b)(3)(iv)].

4. Emergency situations to maintain control of radioactive waste and effluents; permit prompt termination of operations; and permit evacuation of personnel [10 CFR 60.131(b)(4)].

Z. PRECLOSURE WASTE DISPOSAL structures, systems, and components important to safety shall permit periodic inspection, testing, and maintenance sufficient to ensure continued functioning and readiness [10 CFR 60.131(b)(6)].

AA. The behavior of all PRECLOSURE WASTE DISPOSAL systems, structures, and components important to safety shall be monitored and controlled over the anticipated ranges for normal operation and for accident conditions [10 CFR 60.131(b)(8)].

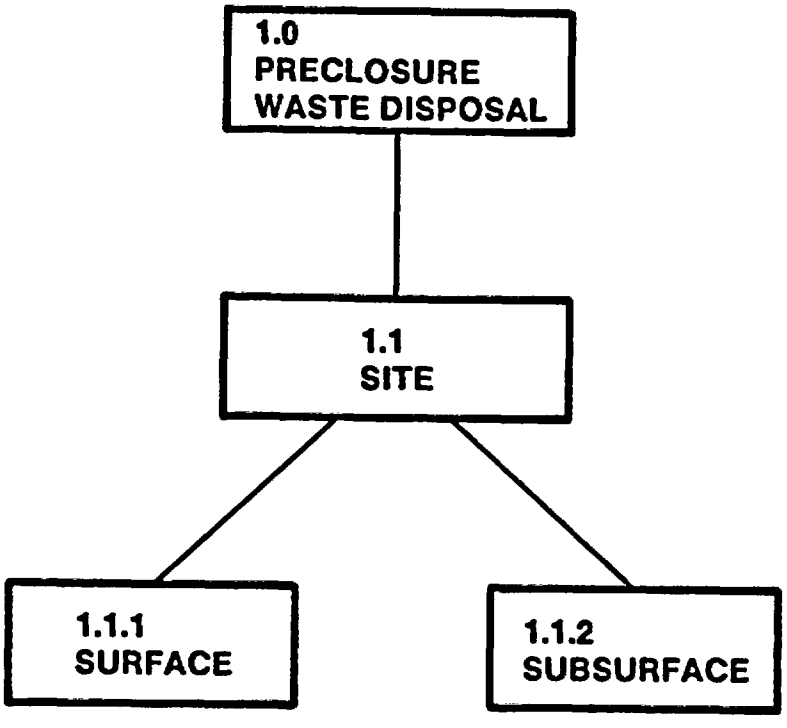
BB. PRECLOSURE WASTE DISPOSAL functions shall follow those design requirements of 30 CFR, Chapter I, Subchapters D, E, and N that are necessary to protect workers such that systems, structures, and components important to safety can perform their intended functions [10 CFR 60.131(b)(9)].

CC. The repository shall be located on land for which the DOE can obtain, in accordance with the requirements of 10 CFR 60.121, ownership, surface and subsurface rights, and control of access that are required to ensure that repository operations will not be likely to lead to radionuclide releases to an unrestricted area greater than those specified in YMMGD C#A.

INTERACTIONS:

	Function Interacted With	1.0 Requirement
	SOCIETAL	C#A,C,D,E,H,I,J,K,L,N,P,Q,R,CC
	ENVIRONMENTAL	C#C,G,H,I,Q
	TRANSPORTATION	PC#1;C#L
2.0	POSTCLOSURE WASTE DISPOSAL	C#T

The sections that follow identify the mined geologic disposal system requirements that have been allocated to the 1.1 SITE and its constituent subfunctions, 1.1.1 SURFACE and 1.1.2 SUBSURFACE.



This page intentionally left blank.

1.1 SITE

Subfunctions are:

1.1.1 SURFACE
1.1.2 SUBSURFACE

DEFINITION:

The portion of the lithosphere which contains the waste disposal facility and which is inside the controlled area and extends to the accessible environment.

FUNCTIONAL REQUIREMENTS:

1. To provide a suitable location for the construction, operation, closure, decommissioning, and supporting activities of a Mined Geologic Disposal System.

PERFORMANCE CRITERIA:

1a. The primary determination of the suitability of a site shall be based on 10 CFR 960, Subparts C and D.

b. The site shall also meet the requirements of 10 CFR 60.122.

CONSTRAINTS:

A. The site shall be located in a geologic setting in which any projected effects of expected tectonic phenomena or igneous activity on repository construction, operation, or closure will be such that the

requirements specified in 10 CFR 960.5-1(a)(3) concerning ease and cost of siting, construction, operation, and closure can be met [10 CFR 960.5-2-11(a)].

B. The site shall be located such that based on the expected nature and rates of fault movement or other ground motion, it is not 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(d)].

C. The site shall be selected such that after permanent closure, it will combine with the engineered parts of the repository to ensure that releases of radioactive materials to the accessible environment meet the requirements in 1.1 C#T.

INTERACTIONS:

Function Interacted With		1.1 Requirement
1.2	REPOSITORY	C#A,B,C
2.0	POSTCLOSURE WASTE DISPOSAL	C#C
2.1	NATURAL BARRIERS	C#C
2.2	ENGINEERED BARRIERS	C#C

1.1.1 SURFACE

DEFINITION:

The portion of the site that includes the hydrologic and meteorlogic conditions, the topographic features, and the surficial deposits which include those materials encountered to foundation depth.

FUNCTIONAL REQUIREMENTS:

1. To provide surface conditions compatible with the construction, operation, closure, and decommissioning of an MGDS and its supporting activities.

PERFORMANCE CRITERIA:

1. Conditions shall conform to applicable local, State, and Federal codes and standards referring to natural hazard and foundation stability such as those requirements specified in DOE Order 6430 [GR 1.1.1 PC#1].

CONSTRAINTS:

A. The site shall be located such that expected meteorological conditions during 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 10 CFR 960.5-1(a)(1) concerning preclosure radiological safety [10 CFR 960.5-2-3(a)].

B. 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 10 CFR 960.5-1(a)(3) concerning ease and cost of siting, construction, operation, and closure can be met during repository siting, construction, operation, and closure [10 CFR 960.5-2-8(a)].

C. The surface shall be selected such that after permanent closure the requirements in 1.1 C#C will be met.

INTERACTIONS:

	Function Interacted With	1.1.1 Requirement
1.1.2	SUBSURFACE	C#C
1.2	REPOSITORY	C#B
2.1	NATURAL BARRIERS	C#C
2.2	ENGINEERED BARRIERS	C#C

1.1.2 SUBSURFACE

DEFINITION:

The portion of the geologic media that contains the shafts, boreholes, and underground facility.

FUNCTIONAL REQUIREMENTS:

1. To provide a geologic environment compatible with the construction, operation, closure, and decommissioning of a Mined Geologic Disposal System.

PERFORMANCE CRITERIA:

1. The thickness, lateral extent, characteristics, and composition of the geologic medium which includes the host rock and the other parts of the lithosphere inside the controlled area and extending to the accessible environment must be suitable for accommodation of the repository [GR 1.1.2 PC#1].

CONSTRAINTS:

A. The site shall be located so that the rock characteristics are not such that the activities associated with repository construction, operation, or closure are predicted to cause significant risk to the health and safety of personnel, taking into account mitigating measures that use reasonably available technology [10 CFR 960.5-2-9(d)].

B. The site shall be located such that (1) the thickness and lateral extent and the characteristics and composition of the host rock will be suitable for accomodation of the underground facility; (2) the repository construction, operation, and closure will not cause undue hazard to personnel; and (3) the requirements specified in 10 CFR 960.5-1(a)(3) concerning ease and cost of siting, construction, operation, and closure can be met [10 CFR 960.5-2-9(a)].

C. The geologic repository shall be located so that pre-waste-emplacement groundwater travel times along the fastest path of radionuclide travel from the disturbed zone to the accessible environment shall be at least 1000 years or such other travel time as may be approved or specified by the NRC [10 CFR 60.113(a)(2)].

D. The site shall be located such that the geohydrologic setting of the site will (1) be compatible with the activities required for repository construction, operation, and closure; (2) not compromise the intended functions of the shaft liners and seals; and (3) permit the requirements specified in 10 CFR 960.5-1(a)(3) concerning ease and cost of siting, construction, operation, and closure to be met [10 CFR 960.5-2-10(a)].

E. The site shall be located such that, based on expected groundwater conditions, it will be unlikely 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(d)].

F. Subsurface conditions must not preclude the repository from being designed to preserve the option of retrieval of waste during waste emplacement and through the performance confirmation period [1.0 PC#2].

G. SUBSURFACE shall function together with 1.2 REPOSITORY and 1.3 WASTE EMPLACEMENT PACKAGE to meet the radiation protection requirements of 1.0 C#A.

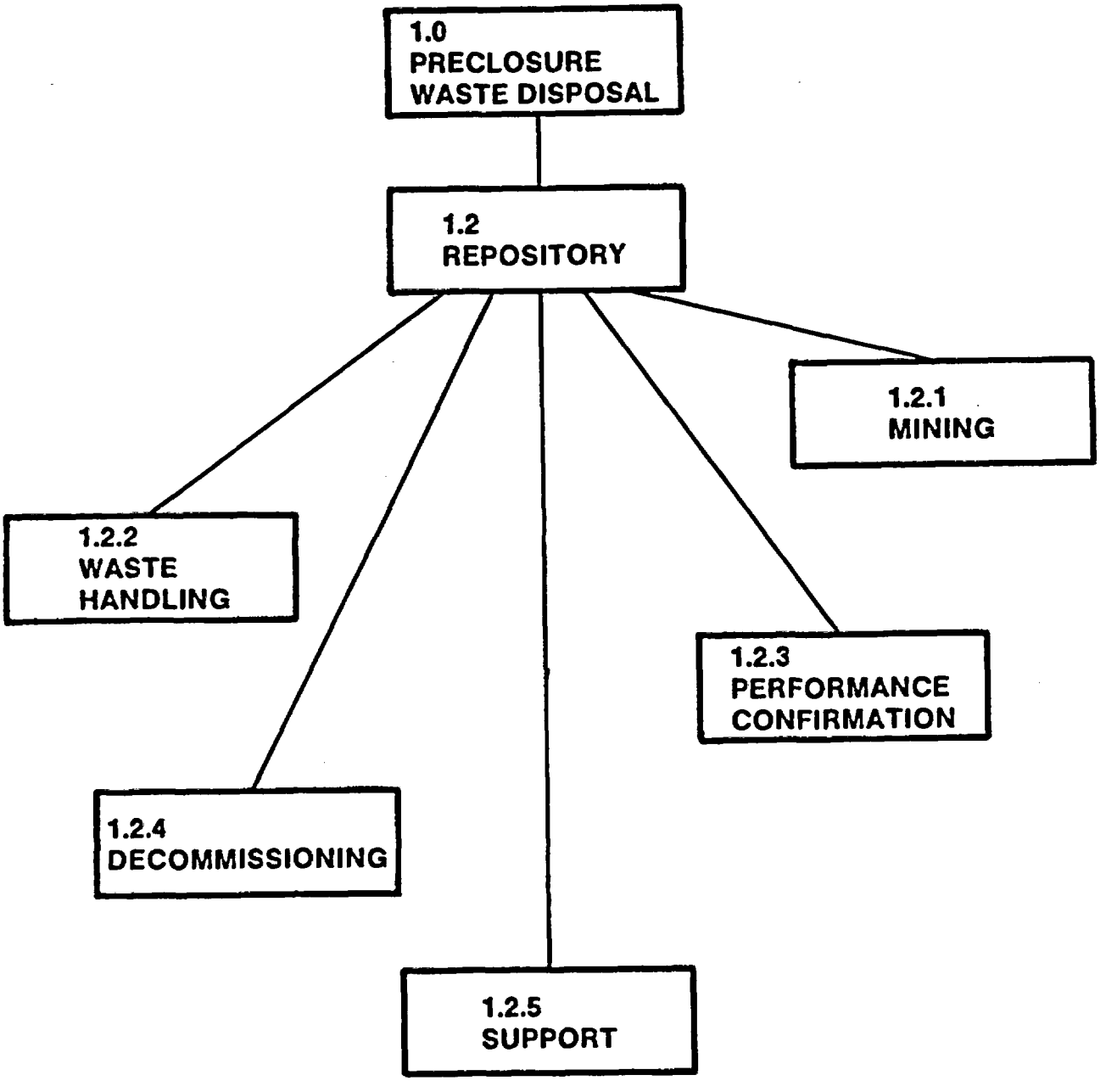
H. The SUBSURFACE shall be selected such that after permanent closure the requirements in 1.1 C#C will be met.

INTERACTIONS:

	Function Interacted With	1.1.2 Requirement
1.1.1	SURFACE	C#C
1.2	REPOSITORY	PC#1;C#A,B,D,F,G
1.3	WASTE-EMPLACEMENT PACKAGE	C#G
2.0	POSTCLOSURE WASTE DISPOSAL	C#C
2.1	NATURAL BARRIERS	C#C
2.2	ENGINEERED BARRIERS	C#C

This page intentionally left blank.

The section that follows identifies the mined geologic disposal system requirements that have been allocated to the 1.2 REPOSITORY function. As indicated below, 1.2 REPOSITORY comprises 1.2.1 MINING, 1.2.2 WASTE HANDLING, 1.2.3 PERFORMANCE CONFIRMATION, 1.2.4 DECOMMISSIONING, and 1.2.5 SUPPORT functions. Requirements allocated to these repository subfunctions are identified in subsequent sections.



This page intentionally left blank.

1.2 REPOSITORY

Subfunctions are:

1.2.1 MINING
1.2.2 WASTE HANDLING
1.2.3 PERFORMANCE CONFIRMATION
1.2.4 DECOMMISSIONING
1.2.5 SUPPORT

DEFINITION:

The function that provides all preclosure waste disposal activities for development, operation, closure, and decommissioning the radioactive waste disposal facility.

FUNCTIONAL REQUIREMENTS:

1. To develop surface and the subsurface facilities necessary for radioactive waste disposal.

2. To conduct radioactive waste handling operations necessary for disposal and retrieval if required.

3. To identify non-reference conditions, test the performance of the disposal system, and accordingly modify the reference design.

4. To close and decommission the preclosure waste disposal facilities.

5. To provide support facilities and services for the development, operation, and closure of the repository.

PERFORMANCE CRITERIA:

1. Surface and subsurface facilities for radioactive waste disposal shall dispose of up to 70,000 MTHM of the radioactive waste described in the NNWSI RIB and in Appendix B of the GR [NWPA 114(d)] and shall be constructed and tested to the extent that they are ready to accept radioactive waste at the initial receipt rate no later than January 31, 1998, [NWPA 302(a)(5)]. Subsequent construction shall proceed at a rate that will accommodate full-scale waste receipt.

2. WASTE HANDLING shall be sufficient to accommodate a spent power reactor fuel receipt rate of 400 MTU/yr for five years and a maximum waste receipt rate equivalent to 3000 MTU/yr of the radioactive waste described in the NNWSI RIB and in Appendix B of the GR during the remainder of the operating period. Retrieval, if necessary, shall meet the requirements in 10 CFR 60.111(b).

3. Prior to final closure, it shall be confirmed that the disposal system has been constructed and operated and is performing within the limits and expectations assumed in the licensing review or that necessary changes identified by data gathering and testing activities have been properly implemented [10 CFR 60.137 and Subpart F].

4. The decommissioning capability shall be sufficient to close the subsurface facility and to decontaminate and/or dismantle the surface facility in accordance with the provisions of an NRC approved License Amendment for Permanent Closure [10 CFR 60.51].

5. The support facilities and services shall be sufficient to enable all 1.2 REPOSITORY functions to be performed in accordance with Performance Criteria 1-4; and shall also be sufficient to ensure that essential safety functions can be performed under both normal and accident conditions at the repository [10 CFR 60.131].

CONSTRAINTS:

A. All REPOSITORY operations shall comply with all applicable Federal, State, and local nonradiological environmental protection regulations as required in DOE Order 5440.1B [GR 1.2 C#A]. The combined discharges of all 1.2 REPOSITORY functions whose operations involve planned discharges of hazardous substances to the environment shall not exceed the limits in applicable regulations. Compliance shall include, but not be limited to, the requirements identified below:

1. All stationary sources (point sources) of air emissions shall comply with the provisions of the Clean Air Act, as amended (42 U.S.C. 7401), which could include Prevention of Significant Deterioration (PSD) permitting, or offset Policy Review, or both. Federal regulations pertaining to compliance with the Clean Air Act include: 40 CFR 50 (National Primary and Secondary Ambient Air Quality Standards) and 40 CFR 60 (Standards of Performance for New Stationary Sources). Since this program could be administered by an authorized State agency in place of the EPA, there could also be additional, or more stringent, State or local standards.

2. All fugitive air emissions (non-point sources) shall be controlled in accordance with the provisions of the Clean Air Act, as amended (42 USC 7401), as well as all applicable State and local air quality regulations.

3. All point source discharges of treated wastewaters into surface water systems shall comply with the provisions of the Clean Water Act, as amended (33 U.S.C. 1251), as implemented through the National Pollutant Discharge Elimination System (NPDES) permit process (Section 402 of the Clean Water Act). Since the NPDES program could be administered by an authorized State agency in place of the EPA, there could also be additional, or more stringent, State or local standards.

4. Any placement of fill or dredged material into navigable waters shall be performed in accordance with the requirements of Section 404 of the Clean Water Act, which requires permitting of such action (known as the "404 permit"). Federal regulations regarding this permit are contained in 33 CFR 323. Since the 404 permit program could be administered by an authorized State agency in place of the Army Corps of Engineers, there could be additional, or more stringent, State regulations regarding such activities (33 USC 1251).

5. Runoff and erosion at the repository system shall be controlled in accordance with applicable State and local regulations.

6. Any repository activity which may impact a drinking water source must meet the National Interim Primary Drinking Water Regulations (40 CFR 141) and the National Secondary Drinking Water Regulations (40 CFR 143).

7. The management and disposal of solid and any hazardous wastes (excluding any radioactive wastes) shall be conducted in accordance with the requirements of the Resource Conservation and Recovery Act (RCRA), as amended (42 U.S.C. 3251, et seq), which could include RCRA permitting for the hazardous wastes. Since the RCRA program could be administered by an authorized State agency, there could be additional or more stringent State or local standards.

8. The handling, use, and disposal of any toxic substances shall comply with the requirements of the Toxic Substances Control Act (TSCA), as amended (15 U.S.C. 2601). Federal regulations implementing TSCA are coded in Title 40, Chapter I, Subchapter R.

9. The use of pesticides shall comply with the requirements of the Federal Insecticide, Fungicide, and Rodenticide Act (P.L. 92 - 140 and P.L. 95 - 396) and its implementing regulations which include 40 CFR 162 (Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act). Any applicable State and local regulations on pesticides shall also be followed.

10. Noise levels shall be controlled in accordance with the requirements of the Noise Control Act of 1972 (P.L. 92 - 574, as amended), and shall adhere to applicable Federal, State, and local regulations.

11. Any activity involving underground injections (i.e., of non-radioactive material) must comply with the provision of the Safe Drinking Water Act, as amended (42 USC 300f), which could require an Underground Injection Control (UIC) permit. Because the UIC program could be administered by an authorized State agency, there could be additional, or more stringent, State or local standards.

12. Any activity occurring within the coastal zone must comply with the provisions of the Coastal Zone Management Act of 1972 (16 USC 1451, et seq.) and any applicable associated State implementing regulations. Disposal of materials (non-radioactive) into offshore waters would also need to be performed in compliance with appropriate regulations such as the EPA Ocean Dumping Regulations and Criteria (40 CFR 220 to 225 and 227 to 229).

B. REPOSITORY operations shall meet the disposal limitation requirements in 1.0 C#X.

C. All REPOSITORY functions shall comply with the applicable radiation protection requirements in 1.0 C#A.

D. Precautionary procedures for radiation protection, including surveys, personnel monitoring, posting of areas, handling packages of radioactive waste, personnel training, and control of licensed materials in unrestricted areas, shall comply with the requirements of 10 CFR 20.201 through 20.207.

E. Radioactive waste generated on-site shall be disposed in accordance with the requirements of 10 CFR 20.301 through 20.311 and applicable requirements in 60.132(d).

F. Radiation protection records, reports, and notifications shall be made in accordance with the requirements of 10 CFR 20.401 through 20.409.

G. Records shall be maintained and reports shall be made as required by the conditions of the repository license or by NRC rules, regulations, and orders and shall include a complete history of the radioactive waste from the shipper through disposal, underground facility construction records, reports of deficiencies found in the characteristics of the site or in the licensed design or construction of the repository, and records and reports of tests, experiments, and changes made to the geologic repository operations area on the basis of such tests [10 CFR 60.44, 60.71, 60.72, and 60.73].

H. Provisions shall be made for tests deemed appropriate by the NRC and for NRC inspection of the repository [10 CFR 60.74 and 60.75].

I. REPOSITORY operations shall be carried out so that the option of waste retrieval shall be preserved throughout the period during which wastes are being emplaced, and thereafter, until the completion of a performance confirmation program and NRC review of the information obtained from that program; the total time period during which the retrieval option shall be preserved is 50 years after waste emplacement operations are initiated, unless a different time period is approved or specified by the NRC [1.0 PC#2].

J. REPOSITORY facilities shall be constructed, operated, and decommissioned with all safety provisions necessary to achieve the performance objectives specified in 10 CFR 60.111, 60.112, and 60.113 in a manner that is consistent with the results of site characterization activities [10 CFR 60.130].

K. All systems, structures, and components associated with REPOSITORY functions that are important to safety shall meet the applicable requirements of 1.0 C#Y.

L. An emergency capability shall be provided that is sufficient, in terms of on-site facilities and services and utilization of off-site services, to ensure a safe and timely response to emergency conditions [10 CFR 60.131(b)(4)].

M. REPOSITORY functions shall include development of an emergency preparedness program which meets the requirements specified in DOE Order 5500.3 (Reactor and Nonreactor Facility Emergency Planning, Preparedness, and Response Program for Department of Energy Operations) and related guides, or, when issued by NRC, in 10 CFR 60, Subpart I [10 CFR 960.5-2-1(d)(3)].

N. Utilities important to safety shall provide redundant systems, emergency sources, and other features necessary to assure that necessary safety functions can be performed under both normal and accident conditions [10 CFR 60.131(b)(5)].

O. Physical structures, systems, and components important to safety shall permit periodic inspection, testing, and maintenance sufficient to ensure continued functioning and readiness [1.0 C#Z].

P. The behavior of all REPOSITORY systems important to safety shall be monitored and controlled over the anticipated ranges for normal operation and for accident conditions [1.0 C#AA].

Q. REPOSITORY operations involving radioactive waste shall be performed in a manner that precludes the possibility of a nuclear criticality accident as required by 1.0 C#W.

R. All REPOSITORY design and operations shall follow the applicable Mine Safety and Health requirements in 1.0 C#BB. Specific requirements include those identified below:

1. new prototype mobile diesel-powered equipment [30 CFR 32]
2. safety and health standards - metal and nonmetal underground mines [30 CFR 57]

S. The geologic repository operations area shall include [10 CFR 60.131(a)]:

- means to limit concentrations of radioactive material in air
- means to limit the time required to work near radioactive materials

- o suitable shielding
- o ways to monitor and control dispersal of radioactive contamination
- o ways to control access to high radiation or airborne radioactivity areas
- o an alarm system to warn of significant increases in radiation levels, concentration of radioactive material in air, and increased radioactivity in effluents.

T. REPOSITORY functions shall interact in an efficient and cost-effective manner with external TRANSPORTATION as identified in the NNWSI RIB and Appendix B.2 of the GR.

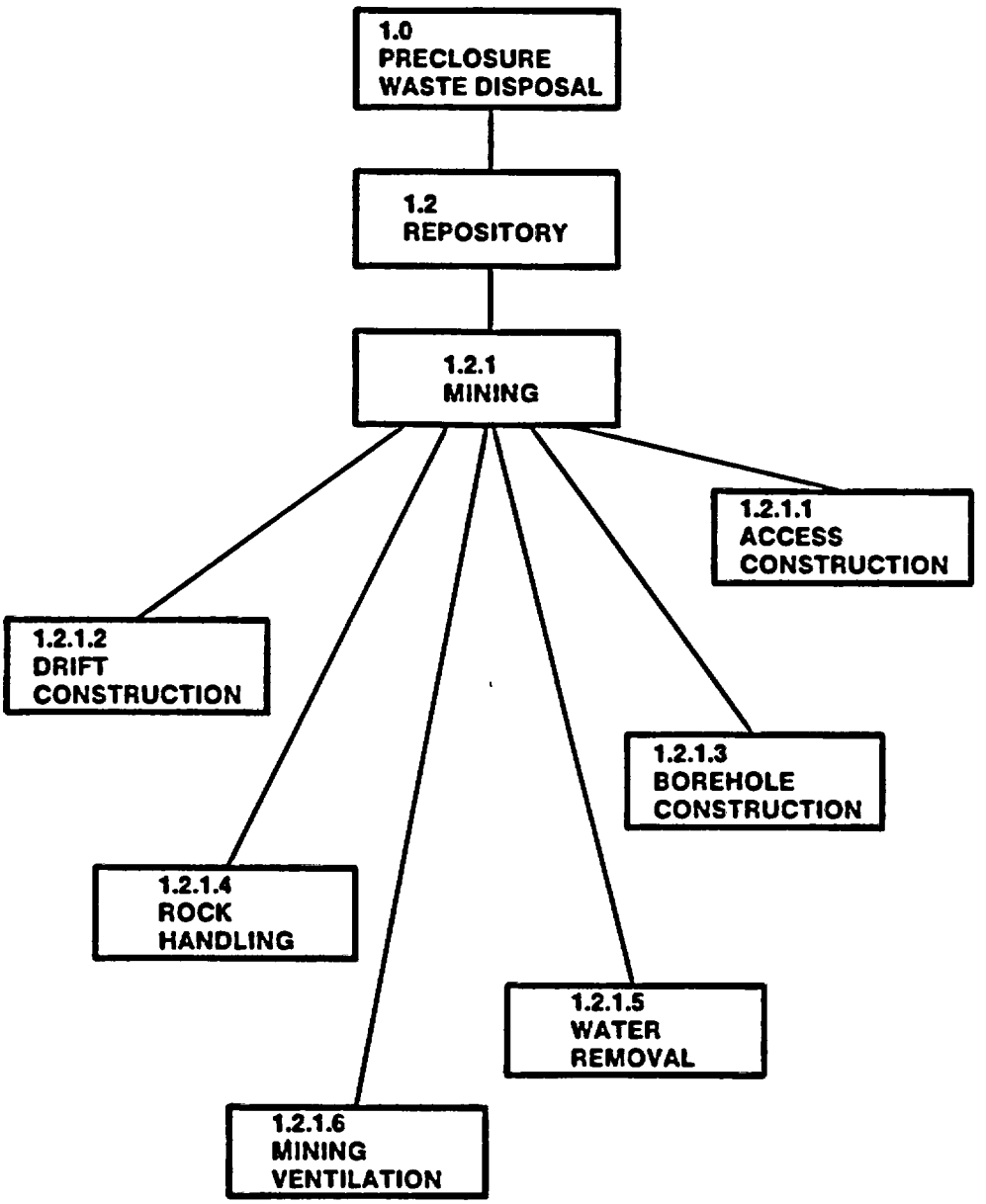
U. Surface facilities shall be compatible with decontamination or dismantlement as required in other parts of Chapter 10 Code of Federal Regulations [10 CFR 60.132(e)].

V. REPOSITORY surface and underground facilities shall be designed and constructed such that after permanent closure, the engineered and natural portions of the repository will work together to ensure that the requirements in 1.0 C#A are met.

INTERACTIONS:

	Function Interacted With	1.2 Requirement
	WASTE SOURCE	PC#1
	TRANSPORTATION	C#T
	SOCIETAL	C#A,H,I,L,M
	ENVIRONMENTAL	C#A
1.0	SITE	C#V
1.1.2	SUBSURFACE	C#C
1.3	WASTE EMPLACEMENT PACKAGE	C#C,V
2.0	POSTCLOSURE WASTE DISPOSAL	C#V
2.1	NATURAL BARRIERS	C#V
2.2	ENGINEERED BARRIERS	C#V

The sections that follow identify the mined geologic disposal system requirements that have been allocated to 1.2.1 MINING and its constituent subfunctions as shown below.



This page intentionally left blank.

1.2.1 MINING

Subfunctions are:

1.2.1.1 ACCESS CONSTRUCTION
1.2.1.2 DRIFT CONSTRUCTION
1.2.1.3 BOREHOLE CONSTRUCTION
1.2.1.4 ROCK HANDLING
1.2.1.5 WATER REMOVAL
1.2.1.6 MINING VENTILATION

DEFINITION:

The function that provides construction and maintenance of subsurface openings as necessary for radioactive waste disposal and supporting activities.

FUNCTIONAL REQUIREMENTS:

1. To construct, operate, and maintain all surface mining facilities and all accesses that are between the surface and the underground facility.

2. To construct and maintain all openings in the underground facility, including boreholes for radioactive waste disposal.

3. To handle, prepare, and emplace (for reuse) or dispose of rock excavated from the subsurface openings.

4. To remove water that is released into the subsurface openings.

5. To maintain an acceptable subsurface working environment for mining, drilling, or other subsurface development operations.

PERFORMANCE CRITERIA:

1. Accesses between the surface and the underground facilities and the associated surface facilities shall be available for waste disposal operations by January 31, 1998; subsequent construction, operation, and maintenance of accesses shall be sufficient to accommodate the underground development, waste disposal, and decommissioning schedules [1.2 PC#1].

2. Entries, drifts, rooms, boreholes, and other openings in the underground facility shall be available by January 31, 1998; subsequent development and maintenance of boreholes the underground facility shall be sufficient to accommodate waste disposal and decommissioning schedules [1.2 PC#1].

3. The rock handling capability shall be sufficient to accommodate the subsurface development and decommissioning activities [1.2 PC#1].

4. Water removal during subsurface development, operation, and decommissioning shall be sufficient for anticipated and actual water release rates into the subsurface openings [1.2 PC#1, 10 CFR 60.133(d)].

5. Ventilation capacity and quality shall be sufficient for control, suppression, or removal of harmful airborne agents and for control of air temperature and humidity during subsurface development operations [1.2 PC#1, 10 CFR 60.133(g), 30 CFR 57.5].

CONSTRAINTS:

A. Discharges of nonradioactive, hazardous materials to the environment by MINING shall be managed such that, in combination with all discharges from 1.2 REPOSITORY functions, applicable Federal, State, and local requirements are met [1.2 C#A].

B. MINING functions, in combination with all other 1.2 REPOSITORY functions, shall satisfy the radiation protection requirements of Constraint 1.2.C#C.

C. The subsurface openings shall be constructed and maintained with sufficient stability that the option of waste retrieval is preserved for 50 years after waste emplacement operations are initiated or for a different time period approved or specified by the NRC; subsurface openings constructed prior to the issuance of the Construction Authorization, e.g., for the Exploratory Shaft facilities and possibly the Test and Evaluation Facility, shall, if used throughout the lifetime of the repository, be maintainable and stable for the same period [1.2 C#I 10 CFR 60.133(c), GR Appendix B.1].

D. All systems, structures, and components associated with MINING that are important to safety shall continue to perform their safety functions as required by 1.2 C#K [10 CFR 60.131(b)]:

E. MINING functions shall follow those design requirements of 30 CFR, Part 57 that are necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions (1.2C#R). Specific requirements include but are not limited to those identified below:

1. Storage Buildings for Flammables or Combustibles [57.4531(a)].
2. Escape Exits [57.4530].
3. Fire Resistant Air Intake Structures [57.4533].
4. Detonators and Explosives [57.6000-.6250].
5. Equipment and Machinery [57.14006-.14008, .14011, .14027 and .14036].
6. Personnel Protection [57.15002-.15007].
7. Materials, Storage and Handling [57.16007, .16014, .16016].
8. Safety Programs [57.18002, .18020, and .18025].
9. Intoxicating Beverages and Narcotics [57.20001].
10. Housekeeping [57.20003].
11. Posted Warnings [57.20011].

F. The orientation, geometry, layout, and depth of the underground facility shall contribute to the containment and isolation of radionuclides [10 CFR 60.133(a)(1)].

G. The subsurface facilities shall be designed, constructed, and operated such that credible disruptive events, such as fires, flooding, and explosions will not spread through the facility [10 CFR 60.133(a)(2)].

H. The underground facility shall be designed, constructed, and operated with sufficient flexibility to accommodate specific site conditions identified through in situ monitoring, testing, or excavation [10 CFR 60.133(b)].

I. The subsurface facilities shall provide for control of water or gas intrusion [10 CFR 60.133(d)].

J. Subsurface openings shall be designed, constructed, and maintained so that operations can be conducted safely, efficiently, the retrievability option maintained and the potential for deleterious rock movement or fracturing of overlying or surrounding rock is reduced [10 CFR 60.133(e)].

K. Underground excavation methods (including boreholes) shall be selected so that they will limit the potential for creating a preferential pathway for groundwater or radioactive waste migration to the accessible environment [10 CFR 60.133(f)].

L. Ventilation of mining construction areas shall control the transport of radioactive particulates and gases within and releases from the underground facilities within the requirements of 1.2.1 C#B, shall assure continued functioning under normal and accident conditions, and shall be separated from the waste emplacement areas [10 CFR 60.133(g)].

M. The subsurface facilities shall be developed so that the public and environmental protection performance objectives (10 CFR 60.111-113) will be met taking into account the predicted thermal and thermomechanical response of the host rock, surrounding strata, and groundwater system [10 CFR 60.133(i)].

N. The underground facility shall be developed in a manner that will help ensure that seals installed at closure do not become pathways for radionuclide or groundwater movement that would compromise the ability of the repository to satisfy the postclosure performance objectives of 10 CFR 60.112 and 113 [10 CFR 60.134].

O. Underground facilities shall be designed to facilitate underground closure at decommissioning [10 CFR 60.132(e)].

P. Underground facility design and construction shall allow measurement of water inflow into subsurface areas [10 CFR 60.141(c)].

Q. Areas for performance confirmation testing shall be provided in the underground facility [10 CFR 60.137].

R. MINING shall interact with 1.2.3.2 GEOLOGIC EVALUATION and 1.2.5.1 INFORMATION to assure that sufficient and appropriate data are obtained and recorded to characterize the actual geologic conditions encountered during in situ monitoring, testing, or excavation [1.2 PC#3].

S. The MINING systems, structures, and components which are important to safety shall meet the monitoring, inspection, testing, and maintenance requirements in 1.2 C#O&P.

T. MINING operations shall be compatible with 1.2.5.10 EMERGENCY PREPAREDNESS [1.2 C#L&M].

U. A change house shall be established of sufficient size to provide all underground personnel with a place to bathe and dry clothes. Location and construction shall comply with 30 CFR 57-4-43 and State and local regulations [GR 1.2.1 PC#3a].

V. Capacity of surface rock and materials handling equipment and facilities shall be compatible with mining, rock hoisting, and mine back-filling rates, and the design of the facilities shall meet applicable requirements of DOE Order 5480.1a and 6430.1 [GR 1.2.1 PC#3b].

W. Surface explosives and cap storage magazines, if required, shall be provided that meet all requirements of 30 CFR 57.6, 29 CFR 1910.109, applicable State and local regulations and DOE Orders 5480.1a and 6430.1 [GR 1.2.1 PC#3c].

X. Mine type hoists shall have rated capacities consistent with repository requirements and safety features consistent with 30 CFR 57.19-1 through 18 [GR 1.2.1 PC#3d].

Y. Head frames with sheaves shall be sized for repository requirements and contain the safety considerations found in 30 CFR 57.19-35 through 41 [GR 1.2.1 PC#3e].

Z. A suitable system for treating and disposing of expected underground water inflow and nonroutine water intrusion inflows shall be provided for all water pumped to the surface [GR 1.2.1 PC#3f].

AA. All main ventilation fans located on the surface shall be sized to provide the ventilation air movement required for that particular shaft. The fan system will contain safety features in accordance with 30 CFR 57.5-18B through 18F, and if the repository is classified as gassy, the system will comply with 30 CFR 57.21-20 through 23 [GR 1.2.1 PC#3g].

BB. Utility systems such as electric power, air, water, etc., shall be provided to underground construction and operations areas. These when installed shall not restrict foot, vehicular, or shaft conveyance traffic, obstruct ventilation or cause safety concerns [GR 1.2.1 C#C].

CC. Sequence and planning of underground development shall ensure that the development can proceed concurrently with and does not interfere with waste handling and emplacement activities [GR 1.2.1 C#B].

DD. Subsurface excavation techniques shall ensure minimum overbreak of rock and minimum disturbance to the integrity of adjoining rock mass and efforts shall be made to maintain as smooth a wall surface as practicable during excavation in order to assist ventilation by minimizing losses due to frictional resistance [GR 1.2.1.1 PC#2b].

EE. Rock support and other repository structural anchoring materials must be compatible with those of the waste package and not interfere with containment or degrade radionuclide migration control [GR 1.2.1.1 PC#4C].

FF. Use of blasting agents and explosives shall, upon commencement of waste disposal, be controlled so that waste emplacement operations are not affected [GR 1.2.1.1 C#A].

GG. Mechanical excavation methods should be used if feasible and practical [GR 1.2.1.1 C#B].

HH. Underground development should be accomplished in a modular fashion that allows waste emplacement operations to be conducted at an adequate distance from the excavation process [GR 1.2.1.1 C#C].

II. Facilities and equipment shall be available to deal effectively with subsurface ground control including emergencies such as rock falls, rock bursts, and squeezing and swelling rock [GR 1.2.1.1 C#E].

JJ. Design of excavated areas and their support must take into consideration pillar and room geometries which limit the extent of fracturing due to excessive stress concentrations [GR 1.2.1.1 C#G].

INTERACTIONS:

	Function Interacted With	1.2.1 Requirement
1.2.2	WASTE HANDLING	C#E-.3,.4,.5
1.2.2.4	EMPLACEMENT	PC#1,2
1.2.2.5	RETRIEVAL	PC#1; C#C,J
1.2.3	PERFORMANCE CONFIRMATION	PC#1; C#H,I,M,Q,R
1.2.4	DECOMMISSIONING	PC# 1,3; C#N,O
1.2.5	SUPPORT	C#B,D,E-.6,.7,.8,.9,.10,G,P,R,S,T
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#A
2.1	NATURAL BARRIERS	C#F,K
2.2	ENGINEERED BARRIERS	C#K

This page intentionally left blank.

1.2.1.1 ACCESS CONSTRUCTION

DEFINITION:

The function that provides for the construction, operation, and maintenance of all accesses between the associated surface facilities and the underground facility.

FUNCTIONAL REQUIREMENTS:

1. To construct and maintain accesses and their associated surface facilities.

2. To provide and operate all access conveyances and associated facilities for transfer of personnel, vehicles, equipment, and materials, except for radioactive waste and excavated rock.

PERFORMANCE CRITERIA:

1. Surface facilities and access(es) construction shall meet the requirements of 1.2.1 PC#1. The accesses shall be located in conformance with the reference design or as specified by 1.2.3.4 DESIGN MODIFICATION.

2. Conveyances in accesses and any associated facilities and equipment shall be sufficient to accomplish the transfer of personnel, vehicles, equipment, and material to support 1.2 REPOSITORY construction and operation [1.2.1 PC#1].

CONSTRAINTS:

A. Discharges of nonradioactive, hazardous materials to the environment by ACCESS CONSTRUCTION shall be managed such that, in combination with all of 1.2.1 MINING functions, the requirements in 1.2.1 C#A are met.

B. Access construction shall, in combination with other 1.2.1 MINING functions, meet the radiation protection requirements in 1.2.1 C#B.

C. ACCESS CONSTRUCTION systems, structures, and components important to safety shall continue to perform their safety functions as required by 1.2.1 C#D.

D. ACCESS CONSTRUCTION shall meet the flexibility requirement of 1.2.1 C#H.

E. Each access will provide emergency ingress and egress features to satisfy 1.2.1 C#E.2.

F. Access shall be constructed in a way that they contribute to meeting the requirement identified in 1.2.1 C#N.

G. Each access will provide features to accommodate water removal from the underground facility during the preclosure period [1.2.1 C#I].

H. Conveyances in vertical shafts, where used to transport radioactive waste, shall be provided with hoists that are designed to preclude cage free-fall, that are equipped with a reliable cage location system, that are equipped with reliable interlocks on loading and unloading systems that will fail safely upon malfunction, and that have two independent indicators to indicate when waste packages are in place and ready for transfer [10 CFR 60.131(b)(10)].

I. All ACCESS CONSTRUCTION shall follow those design requirements of 30 CFR 57 necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended function [1.2.1 C#E]. Specific requirements include but are not limited to:

1. Escapeways [57.11050-.11059]
2. Hoisting Explosives [57.6075 & .0676]
3. Hoisting Equipment Inspections [57.19120]

J. The accesses shall be constructed and operated such that they contribute to the ability to prevent credible disruptive events, such as fires, flooding, and explosions, from spreading through the subsurface facilities [1.2.1 C#G].

K. Access excavation methods shall be used that will limit the potential for creating a preferential pathway for groundwater or radioactive waste migration [1.2.1 C#K].

L. ACCESS CONSTRUCTION will be done to assure that 10 CFR 60.111-113 performance objectives will be met, taking into account predicted thermal and thermomechanical response of the host rock, surrounding strata, and groundwater system [1.2.1 C#M].

M. ACCESS CONSTRUCTION systems, structures, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements of 1.2.1 C#S.

N. Accesses shall meet the stability requirements of 1.2.1 C#C.

O. Accesses shall be oriented to contribute to the containment and isolation of radionuclides [1.2.1 C#F].

INTERACTIONS:

	Function Interacted With	1.2.1.1 Requirement
1.1.1	SURFACE	PC#1
1.1.2	SUBSURFACE	PC#1
1.2.1.5	WATER REMOVAL	PC#1;C#G
1.2.1.6	MINING VENTILATION	PC#1
1.2.3.2	GEOLOGIC EVALUATION	PC#1&3; C#D,K
1.2.3.3	NATURAL AND ENGINEERED BARRIERS EVALUATION	C#K,L,O

	Function Interacted With	1.2.1.1 Requirement
1.2.3.4	DESIGN MODIFICATION	PC#1; C#D,K,O
1.2.5.6	MAINTENANCE	C#I.3,P,M
1.2.5.9	MONITORING	C#C,M
1.2.5.9.1	RADIOLOGICAL MONITORING	C#B
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#A,J
1.2.5.10	EMERGENCY PREPAREDNESS	C#C,J
2.1	NATURAL BARRIERS	C#K,L,O
2.2	ENGINEERED BARRIERS	C#L
2.2.3	SHAFT AND BOREHOLE SEALS	C#F,K

1.2.1.2 DRIFT CONSTRUCTION

DEFINITION:

The function that provides for the construction and maintenance of all entries, drifts, rooms, and other openings necessary for the underground facility, except accesses and boreholes for radioactive waste disposal.

FUNCTIONAL REQUIREMENTS:

1. To construct and maintain all openings in the underground facility, except accesses and waste-emplacement boreholes.

PERFORMANCE CRITERIA:

1. Drifts and other openings in the underground facility (except accesses and waste-emplacment boreholes) shall meet the requirements of 1.2.1 PC#2. The underground openings shall be located in conformance with the reference design or as specified by 1.2.3.4 DESIGN MODIFICATION, and shall meet the stability requirements of 1.2.1 C#C and J.

CONSTRAINTS:

A. Nonradioactive, hazardous materials discharged to the environment by the DRIFT CONSTRUCTION shall be managed such that, in combination with all of the 1.2.1 MINING functions, the requirements in 1.2.1 C#A are met.

B. DRIFT CONSTRUCTION shall, in combination with other 1.2.1 MINING functions, meet the radiation protection requirements in 1.2.1 C#B.

C. DRIFT CONSTRUCTION systems, structures, and components important to safety shall continue to perform their safety functions as required by 1.2.1 C#D.

D. Each opening in the underground facility shall provide emergency ingress and egress features to satisfy 1.2.1 C#E.2.

E. Each opening in the underground facility shall be constructed in a way that it assists in meeting the requirement identified in 1.2.1 C#N.

F. Each opening in the underground facility will provide features to accommodate water removal from the underground facility during the preclosure period, as required by 1.2.1 C#N.

G. The openings in the underground facility shall be located and oriented in the layout prescribed by the reference design, as modified by the 1.2.3.4 DESIGN MODIFICATION, to satisfy the thermal and other criteria associated with 1.2.2.4 EMPLACEMENT [1.2.1 C#M].

H. Openings in the underground facility shall be constructed to accommodate local geologic conditions that are encountered [1.2.1 C#H].

I. DRIFT CONSTRUCTION shall follow those design requirements of 30 CFR, Part 57 that are necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2.1 C#E]. Specific requirements include, but are not limited to, those identified below:

1. Self Rescue Devices [57.15030-31]
2. Electric Lamps [57.17010]
3. Ground Support [57.3020]
4. Strength of Pillars or Supports [57.3029]
5. Rock Bolt Test Procedures [57.3053]
6. Rock Bolt Torque Requirements [57.3054]
7. Point-Anchor Rock Bolt Installation [57.3055]
8. Rock Bolt Hole Diameter, Washers, and Bolting Sequence [57.3056-58]

9. Gasoline Storage and Use [57.4460-61].
10. Use of Liquified Petroleum [57.4053].
11. Use of Fires, Torches, and Candles [57.4161].
12. Storage of Flammable and Combustible Liquids [57.4460, .4462].
13. Labeling of Explosive Magazines [57.6029].
14. Construction and Location of Magazines [57.6030].
15. Vehicles Loaded with Explosives [57.6077].
16. Warning Before Blasting [57.6175].
17. Escapeways and Refuges Construction, Location, Communications, Utilities [57.11050-.11059].
18. Shelter Holes [57.9110-11].

J. The underground facility shall be constructed and operated such that credible disruptive events, such as fires, flooding, and explosions, shall be prevented from spreading through the subsurface facilities [1.2.1 C#G].

K. Methods used to excavate the underground facility shall be selected in order to limit the potential for creating a preferential pathway for groundwater or radioactive waste migration [1.2.1 C#K].

L. Areas and other provisions shall be included in the underground facility for performance confirmation testing [1.2.1 C#Q].

M. DRIFT CONSTRUCTION systems, structures, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements identified in 1.2.1 C#S.

N. Drift orientation, geometry, layout, and depth shall contribute to the containment and isolation of radionuclides [1.2.1 C#F].

INTERACTIONS:

	Function Interacted With	1.2.1.2 Requirement
	SOCIETAL	C#A
1.1.2	SUBSURFACE	C#H,I.3,J.4
1.2.3	PERFORMANCE CONFIRMATION	C#G,L
1.2.3.1	WASTE EVALUATION SYSTEM	C#G
1.2.3.2	GEOLOGIC EVALUATION	C#G,H,I.3,I.4,K,N
1.2.3.3	NATURAL AND ENGINEERED BARRIERS EVALUATION	C#G,H,K,N
1.2.3.4	DESIGN MODIFICATION	PC#1; C#G,H,I.4,K,N
1.2.4.1	UNDERGROUND CLOSURE	C#E
1.2.5.2	ADMINISTRATION	C#I.9,I.10,I.11,I.12,I.13,I.14
1.2.5.5	SUPPLIES	C#I.1,I.2,I.9,I.10,I.11,I.12, I.15
1.2.5.6	MAINTENANCE	C#M
1.2.5.8	TRANSPORTATION	C#I.15
1.2.5.9	MONITORING	C#C
1.2.5.9.1	RADIOLOGICAL MONITORING	C#B,C,M
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#C,J,M
1.2.5.10	EMERGENCY PREPAREDNESS	C#C,I.1,I.2,I.17,I.18,J
2.1	NATURAL BARRIERS	C#K,N
2.2.3	SHAFT AND BOREHOLE SEALS	C#K

1.2.1.3 BOREHOLE CONSTRUCTION

DEFINITION:

The function that provides for the construction and maintenance of all boreholes for radioactive waste-emplacement in the underground facility.

FUNCTIONAL REQUIREMENTS:

1. To construct and maintain waste-emplacement boreholes within the underground facility.

PERFORMANCE CRITERIA:

1. Boreholes for radioactive waste disposal shall be constructed at a rate sufficient to support 1.2.2.4 WASTE EMPLACEMENT and within the tolerances specified by the reference design or by 1.2.3.4 DESIGN MODIFICATION, and shall meet the stability requirements of 1.2.1 C#C and J.

CONSTRAINTS:

A. Nonradioactive, hazardous materials discharged to the environment by the BOREHOLE CONSTRUCTION shall be managed such that, in combination with all of 1.2.1 MINING functions, the requirements in 1.2.1 C#A are met.

B. BOREHOLE CONSTRUCTION shall, in conjunction with other 1.2.1 MINING functions, meet the radiation protection requirements in 1.2.1 C#B.

C. BOREHOLE CONSTRUCTION systems, structures, and components important to safety shall continue to perform their safety functions as required by 1.2.1 C#D.

D. Borehole geometry, layout, depth, and orientation shall contribute to the containment and isolation of radionuclides [1.2.1 C#F].

E. Boreholes for radioactive waste disposal shall be constructed and oriented as prescribed by the reference design, layout, or as modified by the 1.2.3.4 DESIGN MODIFICATION, to satisfy the thermal and other criteria associated with the waste package emplacement [1.2.1 C#M].

F. Boreholes for radioactive waste disposal shall be constructed to accommodate local geologic conditions that are encountered [1.2.1 C#H].

G. Borehole construction operations shall be designed and developed so as to prevent disruptive events, such as fires, flooding, and explosions, from spreading through the subsurface facilities [1.2.1 C#G].

H. Methods used to drill boreholes shall limit the potential for creating a preferential pathway for groundwater or radioactive waste migration [1.2.1 C#K].

I. If required for 1.2.3 PERFORMANCE CONFIRMATION, boreholes, representative of those used for radioactive waste disposal, shall be provided for performance confirmation testing [1.2.1 C#Q].

J. BOREHOLE CONSTRUCTION shall provide features to facilitate sealing and permanent closure [1.2.1 C#N].

K. BOREHOLE CONSTRUCTION shall provide control of water or gas intrusion [1.2.1 C#I].

L. BOREHOLE CONSTRUCTION shall follow those additional design requirements of 30 CFR, Part 57 that are necessary to protect workers in such a way that systems structures and components important to safety can perform their intended functions [1.2.1 C#E].

INTERACTIONS:

	Function Interacted With	1.2.1.3 Requirement
1.2.2.4	EMPLACEMENT	PC#1; C#E
1.2.3	PERFORMANCE CONFIRMATION	C#I
1.2.3.2	GEOLOGIC EVALUATION	C#F,H
1.2.3.3	NATURAL AND ENGINEERED BARRIERS EVALUATION	C#D,E,F
1.2.3.4	DESIGN MODIFICATION	PC#1, C#D,E,F,H
1.2.4.1	UNDERGROUND CLOSURE	C#J
1.2.5.9	MONITORING	C#C
1.2.5.9.1	RADIOLOGICAL MONITORING	C#B
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#A,G,K
1.2.5.10	EMERGENCY PREPAREDNESS	C#C,G
2.1	NATURAL BARRIERS	C#D,H
2.2.3	SHAFT AND BOREHOLE SEALS	C#H

This page intentionally left blank.

1.2.1.4 ROCK HANDLING

DEFINITION:

The function that provides for the breaking, loading, transferring, storing (for reuse), and disposal or backfilling of rock excavated from the subsurface openings.

FUNCTIONAL REQUIREMENTS:

1. To process excavated rock, as necessary for handling.

2. To transfer the broken rock with conveyance equipment for removal.

3. To store excavated rock during the interim between construction and decommissioning of the repository.

4. To reuse or dispose of excavated rock, as required.

PERFORMANCE CRITERIA:

1.-4. ROCK HANDLING shall be sufficient to support 1.2 REPOSITORY construction, operation, closure, and decommissioning [1.2 PC#1].

CONSTRAINTS:

A. Nonradioactive, hazardous materials discharged to the environment by ROCK HANDLING shall be managed such that, in combination with all of the 1.2.1 MINING functions, the requirements in 1.2.1 C#A are met.

B. ROCK HANDLING shall, in combination with other 1.2.1 MINING functions, meet the radiation protection requirements in 1.2.1 C#B.

C. ROCK HANDLING systems, structures, and components important to safety shall continue to perform their safety functions as required by 1.2.1 C#D.

D. ROCK HANDLING systems, structures, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements specified in 1.2.1 C#S.

E. ROCK HANDLING shall follow those design requirements of 30 CFR 32.9 & 57 necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2.1 C#E]. Specific requirements include, but are not limited to, those identified below:

1. Loading, Handling, and Dumping [57.9001-3, 5, 6, 7, 10-12, 17, 23-24, 26-27, 31, 36-37, 39, 45, 49, 53, 67-71, 74].
2. Safety Guards [57.14001-6].
3. Mobile Diesel-Powered Equipment [32.9].

INTERACTIONS:

	Function Interacted With	1.2.1.4 Requirement
	SOCIETAL	C#A
1.2.4.1	UNDERGROUND CLOSURE	PC#1-4
1.2.5.2	ADMINISTRATION	C#E.1
1.2.5.6	MAINTENANCE	C#D,E.1
1.2.5.8	TRANSPORTATION	C#E.1
1.2.5.9	MONITORING	C#C,D
1.2.5.9.1	RADIOLOGICAL MONITORING	C#B
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#A
1.2.5.10	EMERGENCY PREPAREDNESS	C#C

1.2.1.5 WATER REMOVAL

DEFINITION:

The function that provides for removal of water released into subsurface openings during construction, operation, and final closure of the underground facility.

FUNCTIONAL REQUIREMENTS:

1. To remove, by collection, diversion, drainage, pumping, or other means, water that is released into the subsurface openings.

2. To treat water, as necessary, prior to removal from the underground openings.

PERFORMANCE CRITERIA:

1. Water removal capacity shall be sufficient to accommodate the predicted and actual rate of flow into subsurface facilities and flexible enough to accommodate flux rates encountered during repository development [GR 1.2.1.3 PC#1c].

2. Treatment of water prior to removal from the subsurface openings shall be adequate to support the requirements of 1.2 REPOSITORY construction, operation, and closure [1.2.1 PC#1].

CONSTRAINTS:

A. Nonradioactive, hazardous materials discharged to the environment by the WATER REMOVAL shall be managed such that, in combination with all of the 1.2.1 MINING functions, the requirements in 1.2.1 C#A are met.

B. WATER REMOVAL shall, in combination with other 1.2.1 MINING functions, meet the radiation protection requirements in 1.2.1 C#B.

C. Any WATER REMOVAL systems, structures, and components important to safety shall continue to perform their safety functions as required by 1.2.1 C#D.

D. WATER REMOVAL shall be designed, constructed, and operated such that credible disruptive events, such as fires, flooding, and explosions, will not spread through the subsurface facilities [1.2.1 C#G].

E. WATER REMOVAL methods shall limit the potential for creating a preferential pathway for groundwater or radioactive waste migration to the accessible environment [1.2.1 C#K].

F. WATER REMOVAL systems, structures, and components important to safety shall meet monitoring, inspection, testing, and maintenance requirements specified in 1.2.1 C#S.

G. Underground openings and drainage systems shall be designed in such a way to minimize standing water areas on the floors of openings through which ventilation air will be flowing to control humidity in air and to preserve the quality of ventilation air being supplied [GR 1.2.1.3 PC#3].

H. Applicable requirements of 30 CFR 57 and State and local regulations shall be satisfied [GR 1.2.3.1 C#A].

I. Consideration should be given during the design phase regarding potential access and control problems that may arise in accessing and dewatering a flooded, waste-loaded repository during the life of the repository [GR 1.2.1.3 C#B].

J. Facilities for plugging or grouting water inflow areas shall be available if water is known to exist in the vicinity of subsurface workings [1.2.1.3 C#C].

INTERACTIONS:

	Function Interacted With	1.2.1.5 Requirement
	ENVIRONMENTAL	PC#2
1.1.2	SUBSURFACE	PC#1,2
1.2.3.2	GEOLOGIC EVALUATION	PC#1,2; C#E
1.2.3.3	NATURAL AND ENGINEERED BARRIERS EVALUATION	C#E
1.2.3.4	DESIGN MODIFICATION	C#E
1.2.5.6	MAINTENANCE	C#F
1.2.5.9	MONITORING	PC#2; C#C,F
1.2.5.9.1	RADIOLOGICAL MONITORING	C#B
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#A,D
1.2.5.10	EMERGENCY PREPAREDNESS	C#C,D
2.1	NATURAL BARRIERS	C#E
2.2	ENGINEERED BARRIERS	PC#2
2.2.3	SHAFT AND BOREHOLE SEALS	C#E

This page intentionally left blank.

1.2.1.6 MINING VENTILATION

DEFINITION:

The function that provides and maintains ventilation to subsurface areas in which mining, drilling, or other subsurface development operations are occurring.

FUNCTIONAL REQUIREMENTS:

1. To maintain an acceptable working environment by controlling airborne contaminants, temperature, humidity, and oxygen content of the air within the subsurface development areas.

PERFORMANCE CRITERIA:

1. Ventilation and cooling shall satisfy applicable Federal, State, and local limits on air contamination, temperature, humidity, oxygen content, and other conditions on a schedule adequate to support 1.2.1 MINING construction activities [1.2.1 PC#1].

CONSTRAINTS:

A. Nonradioactive, hazardous materials discharged to the environment by the MINING VENTILATION shall be managed such that, in combination with all of the 1.2.1 MINING functions, the requirements of 1.2.1 C#A are met.

B. MINING VENTILATION shall, in combination with all other 1.2.1 MINING functions, meet the radiation protection requirements in 1.2.1 C#B.

C. MINING VENTILATION systems, structures, and components important to safety shall continue to perform their safety functions as required by 1.2.1 C#D.

D. MINING VENTILATION shall follow those design requirements of 30 CFR 57 necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2.1 C#E]. Specific requirements include, but are not limited to, the following:

1. Surface Fan Installations and Mine Operations [57.4131]
2. Fan Installations [57.4504]
3. Mine Opening Vicinity [57.4533]
4. Mine Entrances [57.4560]
5. Ventilation Control Measures [57.4760-61]
6. Air Quality [57.5001-50]
7. Ventilation [57.8518-35]

E. MINING VENTILATION shall be constructed and operated such that credible disruptive events, such as fires, flooding, and explosions, will not spread through the subsurface facilities [1.2.1 C#G].

F. MINING VENTILATION shall have sufficient flexibility to accommodate geologic conditions encountered during in situ monitoring, testing, or development of subsurface facilities that may affect air contaminant levels or other conditions [1.2.1 C#H].

G. MINING VENTILATION systems, structures, and components important to safety shall meet the monitoring, inspection, testing ,and maintenance requirements in 1.2.1 C#S.

H. MINING VENTILATION shall be separated from 1.2.2.7 WASTE HANDLING VENTILATION [10 CFR 60.133(g)(3)].

I. Leakage and recirculation in the ventilation system shall be minimized [GR 1.2.1.4 PC#5].

J. The ventilation shall be designed, but not equipped unless necessary, to meet the repository environmental needs during the period of waste retrieval, if retrieval becomes a necessity [GR 1.2.1.4 C#A].

K. In order to reduce shock losses, the following measures shall be taken [GR 1.2.1.4 C#B]:

1. Ventilation airways shall avoid, as far as possible, abrupt changes in airflow direction and shall be maintained and kept clear of obstructions such as construction materials, rock falls, etc.

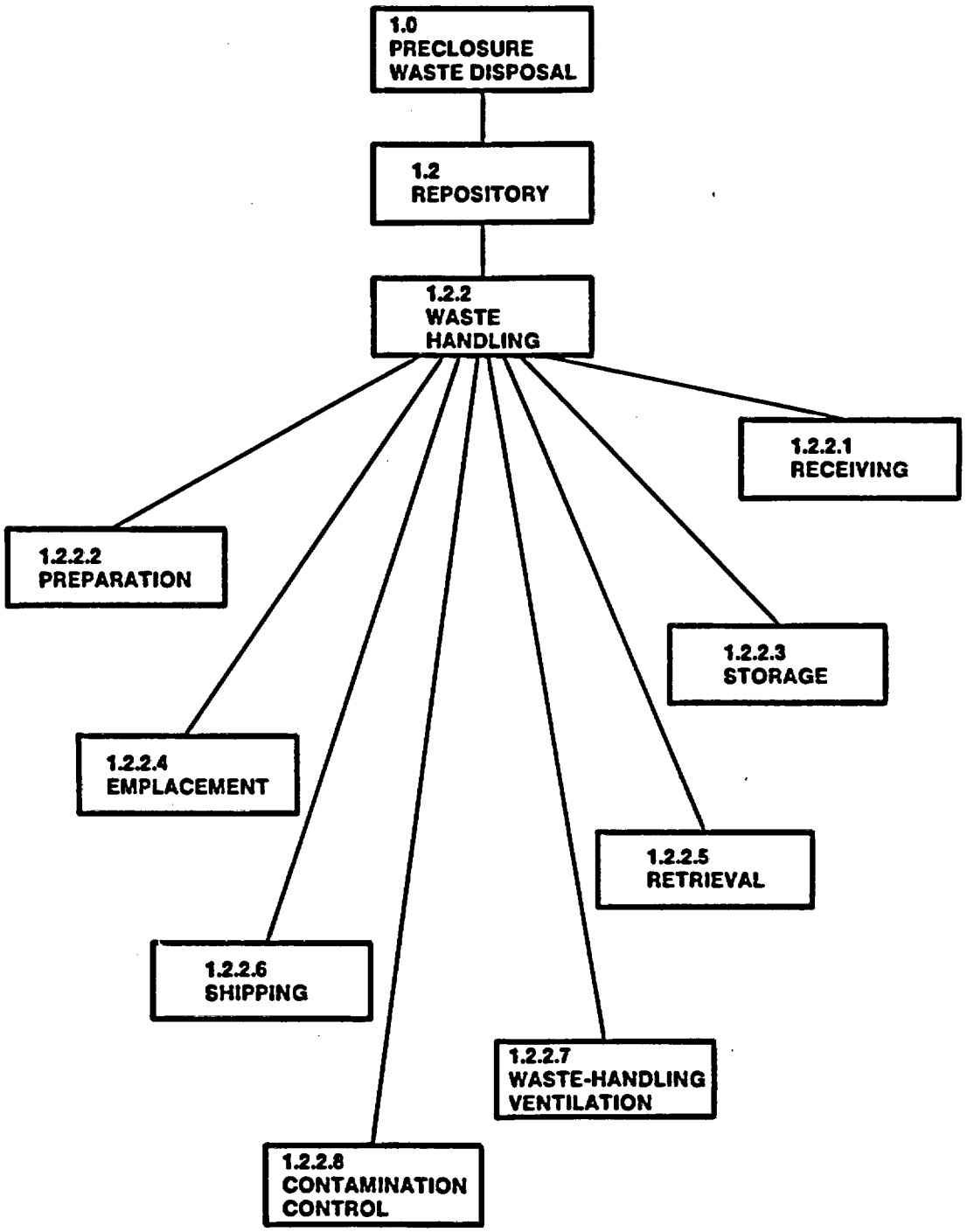
2. Air locks shall be designed and constructed so they do not overly restrict or obstruct air flow. The use of doors for ventilation controls shall be minimized to the extent possible in the dual ventilation system required for the repository.

INTERACTIONS:

	Function Interacted With	1.2.1.6 Requirement
	SOCIETAL	PC#1
1.2.2.7	WASTE HANDLING VENTILATION	C#H
1.2.3.2	GEOLOGIC EVALUATION	C#G
1.2.3.4	DESIGN MODIFICATION	PC#1
1.2.5.6	MAINTENANCE	C#E,G
1.2.5.9	MONITORING	PC#1; C#C,G
1.2.5.9.1	RADIOLOGICAL MONITORING	C#B
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#A,E,G
1.2.5.10	EMERGENCY PREPAREDNESS	C#C,E

This page intentionally left blank.

The sections that follow identify the mined geologic disposal system requirements that have been allocated to 1.2.2 WASTE HANDLING and its constituent subfunctions as shown below.



This page intentionally left blank.

1.2.2 WASTE HANDLING

Subfunctions are:

1.2.2.1 RECEIVING
1.2.2.2 PREPARATION
1.2.2.3 STORAGE
1.2.2.4 EMPLACEMENT
1.2.2.5 RETRIEVAL
1.2.2.6 SHIPPING
1.2.2.7 WASTE-HANDLING VENTILATION
1.2.2.8 CONTAMINATION CONTROL

DEFINITION:

The function that provides the facilities and equipment for the receipt, preparation, disposal, and, as necessary, retrieval of radioactive waste.

FUNCTIONAL REQUIREMENTS:

1. To receive and temporarily store radioactive waste and transportation equipment from shipments that are delivered to the surface facilities and to prepare and return the transportation packagings and vehicles to the shipper.

2. To inspect, catalog, and prepare radioactive waste for final disposal in the underground facility.

3. To transfer radioactive waste emplacement packages from the surface waste-handling facility to emplacement locations in the underground facility.

4. To retrieve radioactive waste packages from the underground facility as required for demonstration, performance confirmation, safety, or other reasons.

5. To accept retrieved radioactive waste from the underground facility and to prepare and transfer it to its intended destination, including shipment off-site as necessary.

6. To provide controlled ventilation to all areas, on the surface or underground, where radioactive waste is handled or present.

7. To manage radioactive contamination of areas and equipment and the radioactive waste that is generated on-site.

PERFORMANCE CRITERIA:

1a. Receipt and storage for radioactive waste and transportation equipment shall be sufficient for 69,350 MTU of spent power reactor fuel and 650 MTU of other high-level waste described in the NNWSI RIB and the GR Appendix B.1 during the operational period [1.2 PC# 1]. Facilities shall also be capable of disposing of an amount of Defense High-Level Waste (DHLW) up to an equivalent of 10,000 MTU of reactor fuel without interfering with other disposal schedules.

1b. Acceptance and unloading capacity shall be sufficient for shipments delivering radioactive waste at a rate of 400 MTU of spent power reactor fuel per year during the phase-one operating period (beginning in January 31, 1998) and at a rate equivalent to 3000 MTU per year of spent power reactor fuel and other high-level waste during the phase-two operating period; reference receiving schedules and durations for the two phases of the operating period are given in the NNWSI RIB and Appendix B of the GR [1.2 PC# 2].

2a. Inspection, cataloging, and preparation shall be done according to the license specifications as modified, with NRC approval, by 1.2.3 PERFORMANCE CONFIRMATION at a rate compatible with the receiving schedule in the NNWSI RIB and Appendix B of the GR [1.2 PC#2].

2b. Waste preparation and packaging shall be done in a way that meets the requirements of 1.3 WASTE EMPLACEMENT PACKAGE and 2.2.1 WASTE PACKAGE.

3. The total capacity for transferring waste emplacement packages from surface to underground waste-handling facilities and emplacement in underground boreholes shall be sufficient to accommodate phase-one operations and subsequent transitions to phase-two operations [1.2 PC#1].

4a. A capacity for retrieving emplaced radioactive waste packages shall be provided for demonstration, performance confirmation, or other inspection purposes [1.2 PC#3 and C#I].

4b. If necessary radioactive waste shall be retrieved in about the same amount of time that was devoted to construction of the surface and subsurface facilities and to emplacement of the waste [1.2 C#I, 10 CFR 60.111(b)(3)].

5a. Surface waste-handling facilities shall receive waste from PC#4a above and prepare it for transferring it to its intended destination on or off-site [1.2 PC#3, C#I].

5b. The capacity for processing retrieved waste shall be compatible with the retrieval rate in 1.2.2 PC#4b [1.2 C#I, 10 CFR 60.111(b)(3)].

6. Sufficient ventilation capacity to maintain safety and other conditions for all areas where radioactive waste is handled shall be available for the phase-one and phase-two waste-handling facilities and operations [1.2 PC#1 and GR Appendix B.1].

7. Management of radioactive contamination shall be sufficient for the radioactive contamination and radioactive waste that results from 1.2.2 WASTE HANDLING operations [1.2 C#E].

CONSTRAINTS:

A. Nonradioactive, hazardous material discharges to the environment as a result of WASTE HANDLING shall be limited such that combined discharges by all other 1.2 REPOSITORY operations will not exceed the limits on the total system stated in 1.2 C#A.

B. WASTE HANDLING shall, in combination with other 1.2 REPOSITORY functions, meet requirements for off-site release of radioactive materials and the applicable radiation protection requirements in 1.2 C#C.

C. Radioactive waste generated on-site shall be disposed as specified by 1.2 C#E.

D. All systems, structures, and components associated with WASTE HANDLING functions that are important to safety shall continue to perform their safety functions as required by 1.2 C#K.

E. Structures, systems, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements in 1.2 C#O and P.

F. WASTE HANDLING operations, including loading, assembly, and handling of waste disposal packages, shall meet the nuclear criticality requirements in 1.2 C#Q.

G. WASTE HANDLING design and operation shall follow those design requirements of 30 CFR Part 57 that are necessary to protect workers in such a way that systems components and structures important to safety can perform their intended functions [1.2 C#R].

H. WASTE HANDLING shall meet the waste acceptance criteria specified in the operating license. The current assessment of the characteristics of the waste that will be accepted are in the NNWSI RIB and Appendix B of the GR [10 CFR 60.43(b)(1-4)].

I. WASTE HANDLING shall interact with external TRANSPORTATION that delivers the radioactive waste in an efficient and cost-effective manner [1.2 C#T].

J. Wastes shall be disposed of promptly once the disposal system is available and the wastes have been suitably conditioned for disposal [40 CFR 191.14(a)].

K. WASTE HANDLING shall ensure that waste-handling equipment and facilities are configured and used in a way that facilitates decontamination, dismantlement, or other decommissioning operation [1.2 C#U].

L. Facilities for receipt and retrieval of waste shall be designed to allow safe handling and storage of wastes either before emplacement or after retrieval [10 CFR 60.132(a)].

M. WASTE HANDLING operations shall be carried out such that the option for waste retrieval is not precluded [1.2 C#I].

INTERACTIONS:

	Function Interacted With	1.2.2 Requirement
	WASTE SOURCE	PC#1a,1b; C#H
	TRANSPORTATION	PC#1a,1b; C#C,I
1.2.1	MINING	C#G
1.2.3	PERFORMANCE CONFIRMATION	PC#4a,4b,5a
1.2.3.1	WASTE EVALUATION	C#F,H
1.2.4	DECOMMISSIONING	C#J,K
1.2.5.1	INFORMATION	PC#2a
1.2.5.6	MAINTENANCE	C#E
1.2.5.9	MONITORING	PC#6; C#D,E,F
1.2.5.9.1	RADIOLOGICAL MONITORING	C#B

	Function Interacted With	1.2.2 Requirement
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#A
1.2.5.10	EMERGENCY PREPAREDNESS	C#D
1.3	WASTE-EMPLACEMENT PACKAGE	PC#2b
2.2.1	WASTE PACKAGE	PC#2b,; C#C

1.2.2.1 RECEIVING

DEFINITION:

The function that provides facilities and equipment for the receipt and unloading of radioactive waste delivered by external TRANSPORTATION and the preparation of transportation packagings and other equipment for return to external TRANSPORTATION.

FUNCTIONAL REQUIREMENTS:

1. To receive radioactive waste from external TRANSPORTATION, transfer loaded and unloaded packages and equipment among REPOSITORY surface facilities associated with waste handling and unload radioactive waste for further processing.

2. To prepare TRANSPORTATION components for return.

PERFORMANCE CRITERIA:

1. Receipt and unloading of radioactive waste shall be sufficient to handle rail and truck shipments during phase-one and phase-two operations according to waste types and receiving schedules in the NNWSI RIB and Appendix B of the GR. Received waste shall satisfy the waste acceptance criteria specified in the operating license [1.2.2 PC#1; GR Appendix B.1 and B.2].

2. Transportation vehicles and packaging shall be returned to external TRANSPORTATION under normal and adverse conditions (e.g., repairs are required) on a turnaround schedule to be determined [GR 1.2.2.1 PC#4].

CONSTRAINTS:

A. The RECEIVING shall be capable of receiving and transferring rail and truck shipments of DHLW during the phase-two operating period, without interfering with spent fuel and other receiving rates. DHLW shipment capacities and other characteristics are in the NNWSI RIB and Appendix B of the GR [1.2.2 PC#1a].

B. Nonradioactive, hazardous material discharges to the environment as a result of RECEIVING shall be limited such that, combined with discharges by other 1.2.2 WASTE HANDLING functions, the limits in 1.2.2 C#A are not exceeded.

C. RECEIVING shall, in combination with other 1.2.2 WASTE HANDLING functions, meet the radiation protection requirements in 1.2.2 C#B.

D. All systems, structures, and components associated with RECEIVING that are important to safety shall continue to perform their safety functions as required by 1.2.2 C#D.

E. RECEIVING structures, systems, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements in 1.2.2 C#E.

F. RECEIVING operations shall be conducted in a manner that meets the nuclear criticality requirements in 1.2.2 C#F.

G. RECEIVING shall interact with external TRANSPORTATION that delivers the radioactive waste in an efficient and cost-effective manner. Pertinent specifications of TRANSPORTATION are in the NNWSI RIB and Appendix B of the GR [1.2.2 C#I].

H. RECEIVING shall ensure that waste-shipment handling and unloading equipment and facilities are configured and used in a way that facilitates decontamination, dismantlement, or other decommissioning operation [1.2.2 C#K].

I. Radioactive waste generated during RECEIVING operations shall be managed as required by 1.2.2 C#C.

INTERACTIONS:

	Function Interacted With	1.2.2.1 Requirement
	WASTE SOURCE	C#A
	TRANSPORTATION	PC#1,2; C#A,G,I
1.2.2.2	PREPARATION	C#I
1.2.2.8	CONTAMINATION CONTROL	C#I
1.2.3.1	WASTE EVALUATION	C#F
1.2.4.2	SURFACE FACILITY DECOMMISSIONING	C#H
1.2.5.9	MONITORING	C#D,E,F
1.2.5.9.1	RADIOLOGICAL MONITORING	C#C
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#B
1.2.5.10	EMERGENCY PREPAREDNESS	C#D

This page intentionally left blank.

1.2.2.2 PREPARATION

DEFINITION:

The function that provides the facilities and equipment and prepares and/or packages radioactive waste for final disposal in the underground facility.

FUNCTIONAL REQUIREMENTS:

1. To receive radioactive waste from 1.2.2.1 RECEIVING or 1.2.2.3 STORAGE, prepare waste for disposal, including assembling, loading, and sealing disposal packages and installing emplacement components and performance confirmation instrumentation, as necessary, and return to 1.2.2.3 STORAGE, if required.

2. To prepare representative samples of the radioactive waste for waste performance evaluation experiments and for waste characteristics assessments.

PERFORMANCE CRITERIA:

1a. Preparation of the phase-one and phase-two radioactive wastes listed in Appendix B shall be done in accordance with the license specifications. PREPARATION shall occur at a rate compatible with 1.2.2.3 STORAGE requirements and receiving schedules in the NNWSI RIB and Appendix B of the GR [1.2 PC#2].

1b. Radioactive waste preparation shall be done such that the requirements of 1.3 WASTE EMPLACEMENT PACKAGE, PC#1,2, C#A,B,C,D,E,F; 2.2.1 WASTE PACKAGE PC#1,2; and 2.2.1.1 CONTAINER C#A are met.

2. A portion of the waste shall be prepared for assessment of characteristics important to post-disposal performance and for performance confirmation as directed by 1.2.3.1 WASTE EVALUATION.

CONSTRAINTS:

A. PREPARATION shall also be capable of preparing DHLW for testing and disposal, during the phase-two operating period, without interfering with spent fuel and other high-level waste receiving rates and schedules [1.2.2 PC#1]. Preparation of DHLW shall be done according to the license specifications.

B. PREPARATION facilities shall be designed to control the release of radioactive materials in effluents during normal operations so as to meet the performance objectives of 10 CFR 60.111(a) [10 CFR 60.132(c)(1)].

C. All combustible radioactive wastes shall be reduced to a noncombustible form unless it can be demonstrated that a fire involving the waste packages containing combustibles will not compromise the integrity of other waste packages; adversely affect any structures, systems, or components important to safety; or compromise the ability of the underground facility to contribute to waste isolation [10 CFR 60.135(c)(3)].

D. Nonradioactive, hazardous material discharges to the environment as a result of PREPARATION shall be limited such that, combined with discharges by all 1.2.2 WASTE HANDLING functions, the limits in 1.2.2 C#A are not exceeded.

E. PREPARATION shall, in combination with other 1.2.2 WASTE HANDLING functions, meet the radiation protection requirements in 1.2.2 C#B.

F. Radioactive waste generated during preparation of waste disposal packages or testing samples shall be managed as required by 1.2.2 C#C.

G. All systems, structures, and components associated with PREPARATION functions that are important to safety shall continue to perform their safety functions as required by 1.2.2 C#D.

H. PREPARATION structures, systems, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements in 1.2.2 C#E.

I. PREPARATION operations shall be conducted in a manner that meets the nuclear criticality requirements in 1.2.2 C#F.

J. PREPARATION shall ensure that waste preparation equipment and facilities are configured and used in a manner that facilitates decontamination, dismantlement, or other decommissioning [1.2.2 C#K].

K. During PREPARATION, waste-emplacement package identification number(s) shall be correlated with the emplacement location and entered into the repository records documentation system [GR 1.2.2.4 C#D].

INTERACTIONS:

	Function Interacted With	1.2.2.2 Requirement
	TRANSPORTATION	C#F
	WASTE SOURCE	C#A
1.2.2.1	RECEIVING	PC#1a; C#A
1.2.2.3	STORAGE	PC#1a; C#A
1.2.2.4	EMPLACEMENT	C#A,F
1.2.2.8	CONTAMINATION CONTROL	C#F
1.2.4.2	SURFACE FACILITY DECOMMISSIONING	C#J
1.2.5.1	INFORMATION	C#K
1.2.5.6	MAINTENANCE	C#H
1.2.5.9	MONITORING	C#G,H,I
1.2.5.9.1	RADIOLOGICAL MONITORING	C#B,E
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#D
1.2.5.10	EMERGENCY PREPAREDNESS	C#G
1.3	WASTE EMPLACEMENT PACKAGE	PC#1b
2.2.1	WASTE PACKAGE	PC#1b

This page intentionally left blank.

1.2.2.3 STORAGE

DEFINITION:

The function that provides facilities, equipment, and operations for temporary storage of radioactive waste before or after preparation and facilities for temporary storage of loaded and empty transportation vehicles and packagings.

FUNCTIONAL REQUIREMENTS:

1. To provide for transfer and surge, on-line, or other storage for radioactive waste before and after preparation.

2. To provide required storage for loaded and empty radioactive-waste transportation vehicles and packagings.

PERFORMANCE CRITERIA:

1a. Temporary storage capacity for three month's waste receipts shall be provided during phase-one and phase-two repository operations for waste received from off-site or prepared onsite to minimize interruptions in repository operations or interruptions in external TRANSPORTATION operations [GR 1.2.2.3 PC#1a].

1b. The ability to withdraw and place in storage waste packages in transit through 1.2.2 WASTE HANDLING operations shall be provided [GR 1.2.2.3 PC#1b].

1c. Adequate on-line storage capacity shall be available to sustain minor disruptions in operations [GR 1.2.2.3 PC#2].

2. Temporary storage for loaded and empty radioactive waste transportation vehicles and packagings shall be adequate for phase-one and phase-two operations [1.2.2 PC#1a,b].

CONSTRAINTS:

A. STORAGE shall be capable of storing and transferring DHLW as described in the NNWSI RIB and Appendix B of the GR and DHLW transportation equipment during the phase-two operating period, without interfering with the spent fuel and other storage and transfer requirements [1.2.2 PC#1a].

B. Nonradioactive, hazardous material discharges to the environment as a result of PREPARATION shall be limited such that, combined with discharges by all other 1.2.2 WASTE HANDLING functions, the limits in 1.2.2 C#A are not exceeded.

C. STORAGE shall, in conjunction with other 1.2.2 WASTE HANDLING functions, meet the radiation protection requirements in 1.2.2 C#B.

D. Radioactive waste generated on site during transfer and storage of radioactive waste and its transportation equipment shall be managed as required by 1.2.2 C#C.

E. All systems, structures, and components associated with STORAGE functions that are important to safety shall continue to perform their safety functions to meet the requirements identified in 1.2.2 C#D.

F. Structures, systems, and components associated with STORAGE that are important to safety shall meet the monitoring, inspection, testing, and maintenance requirements in 1.2.2 C#E.

G. STORAGE operations, involving transferring and storing radioactive waste in the various forms, shall meet the nuclear criticality requirements in 1.2.2 C#F.

H. STORAGE shall interact with the external TRANSPORTATION in an efficient and cost-effective manner. Pertinent specifications of TRANSPORTATION are in the NNWSI RIB and Appendix B of the GR [1.2.2 C#I].

I. STORAGE shall ensure that the transfer and storage equipment and facilities are configured and used in a way that facilitates decontamination, dismantlement, or other decommissioning operation [1.2.2 C#K].

INTERACTIONS:

	Function Interacted With	1.2.2.3 Requirement
	WASTE SOURCE	C#A
	TRANSPORTATION	PC#2; C#D,H
1.2.2.1	RECEIVING	C#A
1.2.2.2	PREPARATION	PC#1b,; C#A,D
1.2.2.4	EMPLACEMENT	C#A,D
1.2.2.8	CONTAMINATION CONTROL	C#D
1.2.3.1	WASTE EVALUATION	C#G
1.2.4.2	SURFACE-FACILITY DECOMMISSIONING	C#I
1.2.5.6	MAINTENANCE	C#F
1.2.5.9	MONITORING	C#E,F,G
1.2.5.9.1	RADIOLOGICAL MONITORING	C#C,E,F
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#B
1.2.5.10	EMERGENCY PREPAREDNESS	C#E

This page intentionally left blank.

1.2.2.4 EMPLACEMENT

DEFINITION:

The function that provides facilities, equipment, and operations for transferring waste emplacement packages from surface waste-handling facilities and emplacing them into underground disposal locations.

FUNCTIONAL REQUIREMENTS:

1. To transfer waste emplacement packages from surface waste-handling facilities to designated underground disposal locations.

2. To emplace waste-emplacement packages in designated positions in the emplacement boreholes.

3. To make necessary borehole preparations prior to waste emplacement (e.g., install shield doors and other equipment) and, when filled to designated capacity, install borehole plugs and perform other operations to complete disposal.

4. To isolate storage location zones when emplacement is completed.

PERFORMANCE CRITERIA:

1.-2a. Underground transfer and emplacement of radioactive waste shall be sufficient to transfer 400 MTU equivalent per year during phase-one operations and a graduated capability for 3000 MTU equivalent per year during phase-two operations. Reserve capacity shall be provided to maintain these rates with allowances for scheduled and non-scheduled interruptions [1.2.2 PC#3, GR 1.2.2.4 PC#2a].

2b. Waste emplacement packages shall be positioned in emplacement boreholes as specified in the reference design and in the conditions of the operating license as modified (with NRC approval) by 1.2.3 DESIGN MODIFICATION.

3.- 4. Pre- and post-closure borehole preparation and isolation of completed storage zones shall be accomplished in accordance with license specifications and on a schedule compatible with other 1.2.2 WASTE-HANDLING operations [1.2.2 PC#3].

CONSTRAINTS:

A. As required by 10 CFR 60.131(b)(10), any EMPLACEMENT hoists important to safety shall meet the requirements identified in 1.2.1.1 C#H.

B. Handling, transporting, and emplacement equipment for radioactive waste shall be designed to provide adequate safety to operating personnel under normal and accident conditions [GR 1.2.2.4 C#B].

C. Underground waste transport and emplacement shall be scheduled and conducted such that other development activities underground do not unnecessarily interfere with waste handling [GR 1.2.2.4 C#C].

D. Adequate measures (such as packing or sorbent material) shall be provided, if necessary, to prevent radionuclide migration from the emplacement area [GR 1.2.2.4 C#F(i)].

E. Adequate shielding, if necessary, shall be provided to cover the placement area to protect personnel from radiation exposure [GR 1.2.2.4 C#F(ii)].

F. Waste emplacement equipment and operations shall prevent damage to waste emplacement packages [GR 1.2.2.4 PC#4b].

G. The sequence of waste emplacement underground shall, to the extent possible, minimize traffic of personnel and equipment through areas in which waste is already emplaced [GR 1.2.2.4 PC#4c].

H. EMPLACEMENT design and operation shall follow the design requirements of 30 CFR Part 57 that are necessary to protect workers in such a way that systems, components, and structures important to safety can perform their intended functions [1.2.2 C#G].

I. EMPLACEMENT operations shall meet the applicable state/local mine-safety regulations [GR 1.2.2.4 PC#2b].

J. EMPLACEMENT shall be capable of emplacing DHLW for disposal during the phase-two operating period without interfering with spent fuel and WVHLW receiving rates and schedules [1.2.2 PC#3].

K. Nonradioactive, hazardous material discharges to the environment as a result of EMPLACEMENT shall be limited such that, combined with all other WASTE-HANDLING functions, the limits in 1.2.2 C#A are not exceeded.

L. EMPLACEMENT operations shall, in combination with all other 1.2.2 WASTE-HANDLING functions, meet the radiation protection requirements in 1.2.2 C#B.

M. Radioactive waste generated on site during EMPLACEMENT operations shall be managed as required by 1.2.2 C#C.

N. EMPLACEMENT operations shall assist, as required by 1.2.3.3 NATURAL AND ENGINEERED BARRIERS EVALUATION, in performance confirmation tests [1.2.3 C#L].

O. All systems, structures, and components associated with EMPLACEMENT functions that are important to safety shall continue to perform their safety functions to meet the requirements identified in 1.2.2 C#D.

P. Structures, systems, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements in 1.2.2 C#E.

Q. EMPLACEMENT shall be conducted in a manner that meets the nuclear criticality requirements in 1.2.2 C#F.

R. Ready-for-emplacement waste disposal packages shall be handled and emplaced in a manner that assures their ability to survive normal handling and disposal operations, retrieval and transfer operations, and abnormal conditions in accordance with the requirements prescribed in 1.2.2.2 PC#1b.

S. EMPLACEMENT operations shall be compatible with the requirements for preserving the option for waste-retrieval in the period before permanent closure [1.2.2 C#M].

T. EMPLACEMENT shall ensure that waste emplacement equipment and facilities are configured and used in a manner that facilitates decontamination, dismantlement, or other decommissioning [1.2.2 C#K].

U. Waste-emplacement equipment shall be capable of accurate, repeated operation under the conditions expected underground [GR 1.2.2.4 PC#4a].

INTERACTIONS:

	Function Interacted With	1.2.2.4 Requirement
	TRANSPORTATION	PC#1,2a
	WASTE SOURCE	PC#1,2a
	SOCIETAL	C#I
1.2.1	MINING	C#C,H,S
1.2.2.2	PREPARATION	C#D
1.2.2.5	RETRIEVAL	C#S
1.2.2.8	CONTAMINATION CONTROL	C#M
1.2.3	PERFORMANCE CONFIRMATION	C#C
1.2.3.1	WASTE EVALUATION	C#Q
1.2.3.3	NATURAL AND ENGINEERED BARRIERS EVALUATION	C#N
1.2.3.4	DESIGN MODIFICATION	PC#1,2a,2b
1.2.4	DECOMMISSIONING	C#T
1.2.5.9	MONITORING	C#B,O,P,F
1.2.5.9.1	RADIOLOGICAL MONITORING	C#B,E,L
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#K
1.2.5.10	EMERGENCY PREPAREDNESS	C#O

1.2.2.5 RETRIEVAL

DEFINITION:

Upon establishing the requirement for retrieval, the function that provides facilities, equipment, and operations for retrieval of emplaced waste packages from designated disposal positions underground and transfers them to surface waste-handling facilities, as required for performance confirmation, safety, or other reasons.

FUNCTIONAL REQUIREMENTS:

1. To retrieve designated emplaced waste packages from underground and tranfer them to surface waste-handling facilities for shipment off-site or other disposition.

2. To retrieve designated waste emplacement packages from underground locations as required for 1.2.3 PERFORMANCE CONFIRMATION, demonstration, or other testing.

PERFORMANCE CRITERIA:

1. If retrieval is necessary, the capability to retrieve emplaced waste packages and transfer them to the surface facilities shall be sufficient to retrieve the waste in about the same time as that devoted to construction of the geologic repository operations area and emplacement of the waste [10 CFR 60.111(b)(3)].

2. The capability to retrieve designated waste emplacement packages for performance confirmation demonstration or other testing shall be sufficient to meet the requirements of 1.2.3 PERFORMANCE CONFIRMATION.

CONSTRAINTS:

A. RETRIEVAL shall also be capable of retrieving any DHLW that has been disposed [1.2.2 PC#4].

B. Nonradioactive, hazardous material discharges to the environment as a result of RETRIEVAL shall be limited such that, combined with all other 1.2.2 WASTE-HANDLING functions, the limits in 1.2.2 C#A are not exceeded.

C. RETRIEVAL shall, in combination with all other 1.2.2 WASTE-HANDLING functions, meet the radiation protection requirements in 1.2.2 C#B.

D. If retrieval becomes necessary, it shall be sequenced as far as possible to remove waste in a safe, efficient, and acceptable manner [GR 1.2.2.4 C#E].

E. Radioactive waste generated on site during RETRIEVAL operations shall be managed as required by 1.2.2 C#C.

F. All systems, structures, and components associated with RETRIEVAL functions that are important to safety shall continue to perform their safety functions to meet the requirements identified in 1.2.2 C#D.

G. RETRIEVAL structures, systems, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements in 1.2.2 C#E.

H. RETRIEVAL functions shall follow those design requirements of 30 CFR, Part 57 necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2.2 C#G].

I. RETRIEVAL operations shall be conducted in a manner that meets the nuclear criticality requirements in 1.2.2 C#F.

J. Waste disposal packages shall be retrieved and handled in a way that preserves their ability to survive retrieval and transfer operations and is consistent with their disposition for health and safety reasons or for the recovery of economically valuable contents [NWPA Section 122].

K. RETRIEVAL shall ensure that waste-retrieval equipment and facilities are configured and used in a manner that facilitates decontamination, dismantlement, or other decommissioning [1.2.2 C#K].

L. Waste disposal packages shall be retrieved and handled in a manner that assures their ability to survive retrieval and transfer operations, and abnormal conditions in accordance with the requirements prescribed in 1.2.2.2 PC#1b.

INTERACTIONS:

	Function Interacted With	1.2.2.5 Requirement
1.2.1	MINING	C#G
1.2.2.6	SHIPPING	C#J,L
1.2.2.8	CONTAMINATION CONTROL	C#E
1.2.3.1	WASTE EVALUATION	C#I
1.2.3.3	NATURAL AND ENGINEERED BARRIERS EVALUATION	PC#2
1.2.4	DECOMMISSIONING	C#K
1.2.5.6	MAINTENANCE	C#G
1.2.5.9	MONITORING	C#D,F,G,I
1.2.5.9.1	RADIOLOGICAL MONITORING	C#B
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#A
1.2.5.10	EMERGENCY PREPAREDNESS	C#D,F
1.3	WASTE-EMPLACEMENT PACKAGE	C#J,L

This page intentionally left blank.

1.2.2.6 SHIPPING

DEFINITION:

The function that provides facilities, equipment, and operations to accept retrieved waste packages and transfer them to their intended on- or off-site destinations.

FUNCTIONAL REQUIREMENTS:

1. To accept, prepare, and transfer retrieved radioactive waste as required for demonstration, performance confirmation, or other required evaluations.

2. To accept, prepare, transfer on site, and/or ship off site any radioactive waste that is retrieved for safety-related reasons.

PERFORMANCE CRITERIA:

1. Acceptance, preparation and transfer of retrieved radioactive waste shall be sufficient to handle the waste types and schedules prescribed by 1.2.3 PERFORMANCE CONFIRMATION or other required evaluations [1.2.2 PC#5a].

2. Acceptance, preparation and transfer or shipment of radioactive waste retrieved for public health and safety purposes shall be sufficient to accommodate the retrieved waste types (including DHLW) and schedules developed by 1.2.3.4 DESIGN MODIFICATION [1.2.2 PC#5b]. Specific performance criteria will be prescribed by 1.2.3.4 DESIGN MODIFICATION based on an evaluation of the conditions under which retrieval has become necessary.

CONSTRAINTS:

A. Nonradioactive, hazardous material discharges to the environment as a result of SHIPPING shall be limited such that, in conjunction with other 1.2.2 WASTE-HANDLING functions, the limits in 1.2.2 C#B are not exceeded.

B. SHIPPING shall, in combination with all other 1.2.2 WASTE-HANDLING functions, meet the applicable radiation protection requirements in 1.2.2 C#B.

C. Radioactive waste generated on site during SHIPPING operations shall be managed as required by 1.2.2 C#C.

D. All systems, structures, and components associated with SHIPPING functions that are important to safety shall continue to perform their safety functions to meet the requirements identified in 1.2.2 C#D.

E. SHIPPING structures, systems, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements in 1.2.2 C#E.

F. SHIPPING functions shall follow those design requirements of 30 CFR, Part 57 necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2.2 C#G].

G. SHIPPING operations shall be conducted in a manner that meets the nuclear criticality requirements in 1.2.2 C#F.

H. SHIPPING shall ensure that retrieved-waste processing equipment and facilities are configured and used in a manner that facilitates decontamination, dismantlement, or other decommissioning [1.2.2 C#K].

I. SHIPPING shall be compatible with external TRANSPORTATION for off-site shipment of retrieved radioactive waste.

INTERACTIONS:

	Function Interacted With	1.2.2.6 Requirement
	TRANSPORTATION	C#I
1.2.1	MINING	C#F
1.2.2.2	PREPARATION	PC#1,2
1.2.2.3	STORAGE	PC#1,2
1.2.2.5	RETRIEVAL	PC#1,2
1.2.2.8	CONTAMINATION CONTROL	C#C,H
1.2.3	PERFORMANCE CONFIRMATION	PC#1
1.2.3.4	DESIGN MODIFICATION	PC#2
1.2.4	DECOMMISSIONING	C#H
1.2.5.6	MAINTENANCE	C#E
1.2.5.9	MONITORING	C#D,E,G
1.2.5.9.1	RADIOLOGICAL MONITORING	C#B
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#A
1.2.5.10	EMERGENCY PREPAREDNESS	C#D

This page intentionally left blank.

1.2.2.7 WASTE-HANDLING VENTILATION

DEFINITION:

The function that provides the facilities, equipment, and operations for controlled ventilation to all areas, on the surface or underground, where radioactive waste is handled or present.

FUNCTIONAL REQUIREMENTS:

1. To control the quality and quantity of supply ventilation and the quality of exhaust ventilation in surface waste-handling facilities where the potential for airborne radioactivity exists and where:

   a. Airborne radioactivity meets the requirements in 1.0 C#A6
   b. Airborne radioactivity exceeds the limits identified in 1.0 C#A5-6.

2. To control the quality and quantity of supply ventilation and the quality of exhaust ventilation in subsurface facilities where radioactive wastes are handled during 1.2.2.4 EMPLACEMENT and the 1.2.2.5 RETRIEVAL operations and in areas where radioactive wastes have been emplaced and where operations other than inspection, testing, and maintenance have been completed.

PERFORMANCE CRITERIA:

1.-2. The quality and quantity of supply ventilation for surface and subsurface waste handling areas shall provide a safe and comfortable working environment for personnel, and shall meet the requirements of

10 CFR 20, Appendix B, Table I; 29 CFR 1926.800(c); 30 CFR 31.9(a); 30 CFR 32.9(a); 30 CFR 36.45(b); 30 CFR 37.5; DOE Orders 5480.1A, Chapters I, XI, and XII; 6430.1, Chapters I, V, XI, and XXI, 7(e); and applicable state and local regulations [GR 1.2.2.5 PC#1].

The quality of exhaust ventilation shall be controlled such that, in conjunction with discharges from all other 1.2 REPOSITORY functions, the limits established in 10 CFR 20, Appendix B, Table II; 40 CFR 191.03 and the Clean Air Act (42 U.S.C 7401) shall be met [10 CFR 60.132(b); GR 1.2.2.5 PC#2; 1.0 C#A].

CONSTRAINTS:

A. Hot cells and other radioactive waste-handling areas shall be served by separate ventilation systems [GR 1.2.2.5 C#A].

B. The leakage airflow shall be from uncontaminated areas to areas with potential for contamination [GR 1.2.2.5 C#B].

C. Nonradioactive, hazardous material discharges to the environment by WASTE-HANDLING VENTILATION shall be limited such that in conjunction with other 1.2.2 WASTE-HANDLING functions, the limits in 1.2.2 C#A are not exceeded.

D. WASTE-HANDLING VENTILATION shall, in combination with all other 1.2.2 WASTE-HANDLING functions, meet the radiation protection requirements identified in 1.2.2 C#B.

E. Radioactive waste generated on site during WASTE-HANDLING VENTILATION equipment operation, maintenance, and repair shall be managed as required by 1.2.2 C#C.

F. All systems, structures, and components associated with WASTE-HANDLING VENTILATION functions that are important to safety shall continue to perform their safety functions to meet the requirements identified in 1.2.2 C#D.

G. WASTE-HANDLING VENTILATION structures, systems, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements in 1.2.2 C#E.

H. WASTE-HANDLING VENTILATION functions shall follow those design requirements of 30 CFR, Part 57 necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions. Relevant requirements include but are not limited to those in 1.2.1.6 MINING VENTILATION [1.2.2 C#G].

I. WASTE-HANDLING VENTILATION shall ensure that ventilation equipment and facilities are configured and used in a manner that facilitates decontamination, dismantlement, or other decommissioning operation [1.2.2 C#K].

J. Subsurface WASTE-HANDLING VENTILATION shall be separate from 1.2.1.6 MINING VENTILATION and designed to assure continued function during normal and accident conditions [10 CFR 60.133(g)(2)(3)]. Waste handling areas shall always be maintained at lower pressure compared to areas served by 1.2.1.6 MINING VENTILATION such that potentially contaminated air from waste handling areas does not flow into non-waste handling areas [GR 1.2.2.5.3 C#D].

K. The subsurface WASTE-HANDLING VENTILATION shall provide adequate environmental conditions to support waste handling with minimum interruptions [GR 1.2.2.5.3 PC#1A].

L. Separate exhaust routes shall be provided for radioactively contaminated air from subsurface facilities, and contaminated exhaust air shall be routed through a treatment facility for controlling radioactive discharges within the limits specified in 10 CFR 20 and 40 CFR 191.03.

M. WASTE-HANDLING VENTILATION shall be designed, but not equipped unless necessary, to meet environmental needs during 1.2.2.5 RETRIEVAL operations [GR 1.2.2.5.3 C#B].

N. Ventilation airways shall be maintained and kept clear of obstructions such as construction materials, rock piles, large standing equipment, and doors and airlocks in main airways, and avoid abrupt changes in air flow direction in order to reduce shock losses [GR 1.2.2.5.3 C#C].

INTERACTIONS:

	Function Interacted With	1.2.2.7 Requirement
	SOCIETAL	PC#1,2
1.2.1	MINING	C#N
1.2.1.6	MINING VENTILATION	C#A,B,H,J,L
1.2.2.5	RETRIEVAL	C#M
1.2.2.8	CONTAMINATION CONTROL	C#E,I
1.2.4	DECOMMISSIONING	C#I
1.2.5.6	MAINTENANCE	C#G
1.2.5.7	UTILITIES	C#A,B,J,L
1.2.5.9	MONITORING	PC#1,2; C#F,G
1.2.5.9.1	RADIOLOGICAL MONITORING	C#D
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#C
1.2.5.10	EMERGENCY PREPAREDNESS	C#F

1.2.2.8 CONTAMINATION CONTROL

DEFINITION:

The function that provides facilities, equipment, and operations to control radioactive contamination of areas and equipment where radioactive waste is handled or present, and to manage the radioactive waste that is generated as a result of 1.2.2 WASTE-HANDLING operations.

FUNCTIONAL REQUIREMENTS:

1. To perform decontamination of personnel, facilities, and equipment during radioactive waste-handling operations.

2. To process and package any radioactive wastes generated during waste-handling operations for disposal on site or transfer and shipment off site.

PERFORMANCE CRITERIA:

1. Decontamination capability shall be sufficient for phase-one and subsequent phase-two operations. Decontamination capabilities shall be adequate for all radioactive waste types described in the NNWSI RIB and Appendix B of the GR and to support the contribution of all 1.2.2 WASTE-HANDLING functions to meeting the occupational and public health radiation exposure requirements for 1.2 REPOSITORY operations as identified in 1.0 C#A.

2. The capability to process and transfer or ship all solid, liquid, and gaseous radioactive waste generated on site shall be sufficient for all waste generated during phase-one and phase-two operations. The waste shall be processed for on-site disposal according to the waste-acceptance criteria developed for waste-handling operations or into a form suitable for transfer and disposal at an alternative disposal site [10 CFR 60.132(d); GR 1.2.2.2 PC#2].

CONSTRAINTS:

A. Nonradioactive, hazardous material discharges to the environment as a result of CONTAMINATION CONTROL shall be limited such that, in conjunction with other 1.2.2 WASTE-HANDLING functions, the limits in 1.2.2 C#A are not exceeded.

B. CONTAMINATION CONTROL operations off-site release of radioactive materials and direct radiation exposures to the public and workers shall, in conjunction with other 1.2.2 WASTE-HANDLING functions, meet the applicable requirements identified in 1.2.2 C#B.

C. All systems, structures, and components associated with CONTAMINATION CONTROL functions that are important to safety shall continue to perform their safety functions to meet the requirements identified in 1.2.2 C#D.

D. CONTAMINATION CONTROL structures, systems, and components important to safety meet the monitoring, inspection, testing, and maintenance requirements in 1.2.2 C#E.

E. CONTAMINATION CONTROL functions shall follow those design requirements of 30 CFR, Part 57 that are necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2.2 C#G].

F. CONTAMINATION CONTROL shall ensure that radioactive waste management and decontamination equipment and facilities are configured and used in a manner that facilitates decontamination, dismantlement, or other decommissioning operation [1.2.2 C#K].

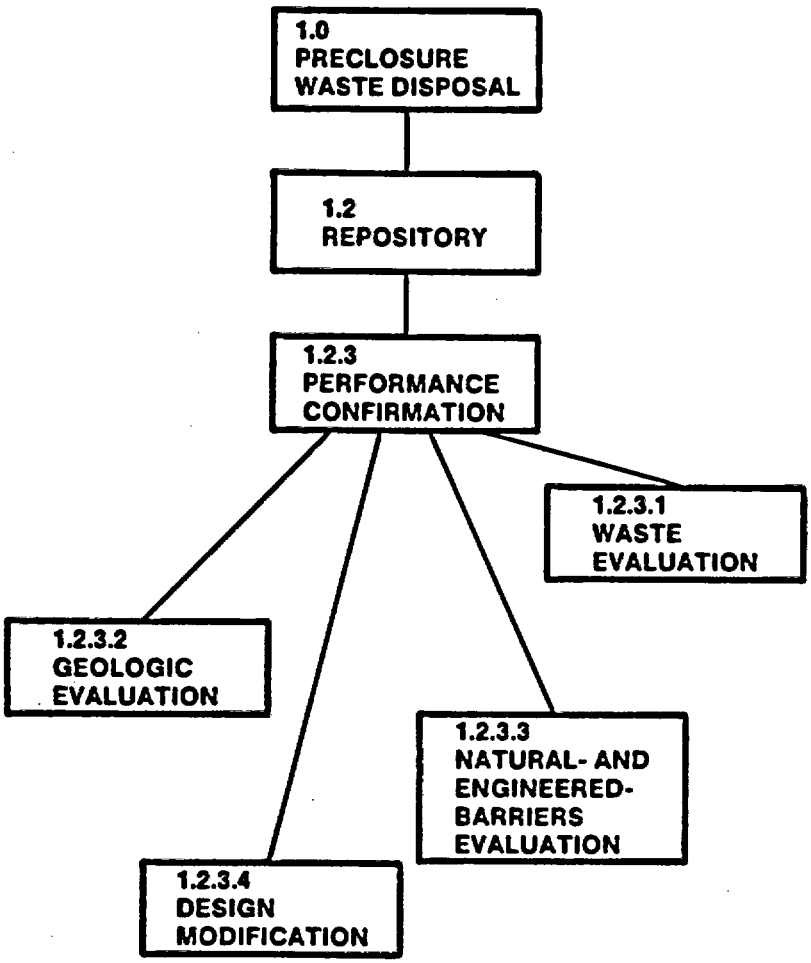
G. CONTAMINATION CONTROL shall interact with the external TRANSPORTATION SYSTEM for any off-site shipment of radioactive waste in an efficient and cost-effective manner to ensure that relevant TRANSPORTATION requirements are met [1.2.2 C#I].

INTERACTIONS:

	Function Interacted With	1.2.2.8 Requirement
	TRANSPORTATION	PC#2; C#G
1.2.1	MINING	PC#1; C#E
1.2.2	WASTE HANDLING	PC#1
1.2.3	PERFORMANCE CONFIRMATION	PC#1
1.2.3.1	WASTE EVALUATION	PC#1
1.2.4	DECOMMISSIONING	PC#1; C#F
1.2.5	SUPPORT	PC#1
1.2.5.6	MAINTENANCE	C#D
1.2.5.9	MONITORING	C#C,D
1.2.5.9.1	RADIOLOGICAL MONITORING	C#B
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#A
1.2.5.10	EMERGENCY PREPAREDNESS	C#C

This page intentionally left blank.

The sections that follow identify the mined geologic disposal system requirements that have been allocated to 1.2.3 PERFORMANCE CONFIRMATION and its constituent subfunctions as shown below.



This page intentionally left blank.

1.2.3 PERFORMANCE CONFIRMATION

Subfunctions are:

1.2.3.1 WASTE EVALUATION
1.2.3.2 GEOLOGIC EVALUATION
1.2.3.3 NATURAL- AND ENGINEERED-BARRIERS EVALUATION
1.2.3.4 DESIGN MODIFICATION

DEFINITION:

The function that provides observations, field and laboratory experiments, associated instrumentation, and analyses that are used to evaluate geologic conditions and waste characteristics, to test the performance of the natural and engineered barriers, and to accordingly specify appropriate modifications to the reference design during repository construction and operation.

FUNCTIONAL REQUIREMENTS:

1. To evaluate the properties and condition of waste received at the repository.

2. To evaluate geotechnical characteristics, conditions, and behavior encountered during in situ testing and construction and any changes that may result from construction and operation of the geologic repository.

3. To monitor, test, and evaluate the performance of natural and engineered systems required for repository operation or as barriers after permanent closure.

4. To provide an established plan for feedback and analysis of performance confirmation data and for implementation of appropriate action that results from the analyses.

PERFORMANCE CRITERIA:

1. Evaluation of the received radioactive waste shall include those properties and conditions specified in the YMMGD Waste Acceptance Criteria as reflected in the license specifications and shall be done with sufficient accurracy and precision to support ongoing assessments of waste disposal system performance [10 CFR 60.43(b), .74, 140(a)].

2. Evaluation of geotechnical conditions shall be sufficient to provide baseline information and analysis of parameters and natural processes of the geologic setting that may be changed by site characterization, construction, and operation. Accuracy and precision of the evaluations shall be adequate to support the determination that geologic conditions are within the limits assumed in the licensing review and to support the ongoing assessment of the postclosure performance of natural and engineered barriers [10 CFR 60.140(a)(1-2)].

3. Evaluation of natural and engineered barriers before and during waste disposal shall provide data with sufficient accuracy and precision required to support ongoing evaluations that natural and engineered systems required for repository operation or as barriers after permanent closure are functioning as intended and anticipated [10 CFR 60.140(a)(2)].

4. Analysis of performance confirmation data shall be adequate to determine whether actual subsurface conditions encountered and changes in those conditions are within the limits assumed in the licensing review, and that natural and engineered systems are operating as required for repository operations and as intended and anticipated in predictions of postclosure performance. Feedback from these analyses shall be adequate to maintain the flexibility of design required by 10 CFR 60.133(b) [10 CFR 60.140].

CONSTRAINTS:

A. PERFORMANCE CONFIRMATION shall, in combination with other 1.2 REPOSITORY functions, meet the radiation protection requirements identified in 1.2 C#C.

B. Where possible the radioactive wastes generated during PERFORMANCE CONFIRMATION will be disposed in accordance with the requirements identified in 1.2 C#E.

C. PERFORMANCE CONFIRMATION functions shall follow those design requirements of 30 CFR, Part 57 that are necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2 C#R].

D. All systems, structures, and components associated with PERFORMANCE CONFIRMATION functions that are important to safety shall continue to perform their safety functions to meet the requirements identified in 1.2 C#K.

E. PERFORMANCE CONFIRMATION structures, systems, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements identified in 1.2 C#O and P.

F. PERFORMANCE CONFIRMATION shall be conducted in a manner that meets the nuclear criticality requirements in 1.2 C#Q.

G. Tests or experiments by PERFORMANCE CONFIRMATION may not be conducted without prior NRC approval if they involve a change in the specifications of the license or an unreviewed safety question [10 CFR 60.44(a)(2)].

H. For tests and experiments judged not to be regulated by Constraint G above, records shall be maintained including a written evaluation showing that the tests or experiments do not involve unreviewed safety questions. These tests and evaluations shall be reported at least annually to NRC [10 CFR 60.44(b)].

I. PERFORMANCE CONFIRMATION tests and analyses shall be sufficient to serve as the basis for license amendments required by 10 CFR 60.46 including the license amendment for permanent closure required by 10 CFR 60.51.

J. PERFORMANCE CONFIRMATION shall continue the activities started during site characterization until permanent closure [10 CFR 60.140(b)].

K. PERFORMANCE CONFIRMATION shall not adversely affect the preclosure and postclosure functions of the waste disposal system [10 CFR 60.140(d)(i)].

L. PERFORMANCE CONFIRMATION shall include underground test areas for the design testing required by 10 CFR 60.142.

M. PERFORMANCE CONFIRMATION shall include a program at the geologic repository operations area to monitor the condition of waste packages [10 CFR 60.143].

N. All PERFORMANCE CONFIRMATION activities involved in the evaluation of systems, structures, and components important to safety or to design and characterization of barriers important to waste isolation shall meet the quality assurance requirements in 1.0 C#V.

O. PERFORMANCE CONFIRMATION testing shall include such tests (to be performed by DOE or NRC) as NRC deems appropriate or necessary for the administration of the regulations in 10 CFR 60 [10 CFR 60.74].

P. PERFORMANCE CONFIRMATION shall perform in situ monitoring, laboratory and field testing, and in situ experiments as appropriate [10 CFR 60.140(c)].

Q. Discharges of nonradioactive, hazardous materials to the environment by PERFORMANCE CONFIRMATION activities shall be limited such that, in combination with discharges from all 1.2 REPOSITORY functions, applicable federal, state, and local limits are not exceeded [1.2 C#A].

R. Temperature limits must be imposed to ensure that thermomechanical and thermochemical interactions will not endanger the structural stability of the repository, cause significant impacts on the hydrologic properties, or lead to premature degradation of the waste packages [GR 1.2.3.3 C#A].

INTERACTIONS:

	Function Interacted With	1.2.3 Requirement
	WASTE SOURCE	PC#1
	SOCIETAL	C#G,P
1.0	PRECLOSURE WASTE DISPOSAL	C#K
1.2.1	MINING	PC#2,4; C#C,L
1.2.2	WASTE HANDLING	PC#4
1.2.2.1	RECEIVING	PC#1
1.2.2.2	PREPARATION	C#M
1.2.2.8	CONTAMINATION CONTROL	C#B
1.2.5	SUPPORT	C#D
1.2.5.1	INFORMATION	C#G,H
1.2.5.2	ADMINISTRATION	C#I,N
1.2.5.6	MAINTENANCE	C#E
1.2.5.9	MONITORING	C#E,F
1.2.5.9.1	RADIOLOGICAL MONITORING	C#A
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#Q
1.2.5.10	EMERGENCY PREPAREDNESS	C#D
1.3	WASTE EMPLACEMENT PACKAGE	C#M
2.0	POSTCLOSURE WASTE DISPOSAL	C#K

This page intentionally left blank.

1.2.3.1 WASTE EVALUATION

DEFINITION:

The function that evaluates the properties and condition of waste received at the repository.

FUNCTIONAL REQUIREMENTS:

1. To measure or calculate thermal, radioactive, and other key properties of waste received or scheduled to be received at the repository.

2. To examine the physical condition of waste forms, containers, or other waste package components that will be emplaced in the repository.

PERFORMANCE CRITERIA:

1. Measurement or calculation of properties of the received radioactive waste shall include those properties specified in the YMMGD Waste Acceptance Criteria as reflected in the license specifications or any other properties necessary to establish compliance with license specifications. Properties and their associated accuracy and precision shall be adequate to support the confidence requirements of 1.2.2.3 NATURAL- AND ENGINEERED-BARRIERS EVALUATION and 1.2.4.4 DESIGN MODIFICATION [10 CFR 60.43(b); .74; 140(a)].

2. The examination of the physical conditions of waste forms, containers, and other waste emplacement package components to be emplaced in the repository shall include those properties and associated levels of confidence needed by 1.2.4.4 DESIGN MODIFICATION to make decisions about 1.2.2 WASTE HANDLING operations [10 CFR 60.43(b)].

CONSTRAINTS:

A. The evaluation the properties of waste received or to be received at the repository shall be done on a schedule that is consistent with the waste receiving schedule and the temporary storage capacity. This information shall be supplied to 1.2.3.4 DESIGN MODIFICATION with sufficient lead time to modify the reference design as necessary and to prepare the disposal locations underground [1.2.3 C#K].

B. WASTE EVALUATION shall, in combination with other 1.2.3 PERFORMANCE CONFIRMATION functions, meet the radiation protection requirements in 1.2.3 C#A.

C. Where possible the radioactive wastes generated during WASTE EVALUATION will be disposed in accordance with the requirements in 1.2.3 C#B.

D. WASTE EVALUATION functions shall follow those design requirements of 30 CFR, Part 57 that are necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2.3 C#C].

E. All systems, structures, and components associated with WASTE EVALUATION functions that are important to safety shall continue to perform their safety functions as required by 1.2.3 C#D.

F. WASTE EVALUATION structures, systems, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements in 1.2.3 C#E.

G. WASTE EVALUATION shall be conducted in a manner that meets the nuclear criticality requirements in 1.2.3 C#F.

H. Waste canisters shall be inspected as necessary upon receipt to determine surface dose rates, heat output, gasses, and surface contamination, examine canister integrity, and verify contents with accompanying documentation and perform any other required examinations and evaluations [GR 1.2.2.1 PC#5].

INTERACTIONS:

	Function Interacted With	1.2.3.1 Requirement
	WASTE-SOURCE SYSTEM	PC#1,2
1.2.1	MINING	C#D
1.2.2	WASTE HANDLING	PC#2
1.2.2.1	RECEIVING	PC#2; C#A,H
1.2.2.2	PREPARATION	PC#2
1.2.2.3	STORAGE	C#A
1.2.2.8	CONTAMINATION CONTROL	C#C
1.2.3.3	NATURAL- AND ENGINEERED-BARRIERS EVALUATION	PC#1
1.2.3.4	DESIGN MODIFICATION	PC#1,2; C#A
1.2.5.6	MAINTENANCE	C#F
1.2.5.9	MONITORING	C#E,F,G
1.2.5.9.1	RADIOLOGICAL MONITORING	C#B,H
1.2.5.10	EMERGENCY PREPAREDNESS	C#E

This page intentionally left blank.

1.2.3.2 GEOLOGIC EVALUATION

DEFINITION:

The function that provides field and laboratory experiments, testing, monitoring, and observations used to evaluate geologic, hydrologic, and other conditions and behavior that are encountered during in situ testing and construction and that result from construction and operation of the geologic repository.

FUNCTIONAL REQUIREMENTS:

1. To provide geotechnical data during construction and operations for use in evaluating system performance.

PERFORMANCE CRITERIA:

1. The continuing program of geotechnical evaluation shall be sufficient to provide appropriate data with sufficient accuracy and precision for:

   a. Baseline information and analysis of parameters and natural processes of the geologic setting that may be changed by site characterization, construction, and operation [10 CFR 60.140(d)(2)].

   b. Monitoring changes from the baseline geotechnical conditions that result from construction and operation [10 CFR 60.140(d)(3)].

   c. Indicating whether actual subsurface conditions encountered are within the limits assumed in the licensing review [10 CFR 60.140(a)(1); .141(a)(d)].

d. Support of ongoing evaluation of the performance of natural and engineered barriers during repository operation and after permanent closure [10 CFR 60.140(a)(1-2)].

e. Support of the requirements of 1.2.3.4 DESIGN MODIFICATION needed to maintain the flexibility of design required by 10 CFR 60.133(b).

f. Any tests deemed appropriate by NRC [10 CFR 60.74].

CONSTRAINTS:

A. Geotechnical evaluations shall be performed continuously during construction and operation of the repository and shall not be discontinued until permanent closure [10 CFR 60.141(a)(e)].

B. GEOLOGIC EVALUATION shall, in combination with other 1.2.3 PERFORMANCE CONFIRMATION functions, meet the radiation protection requirements identified in 1.2.3 C#A.

C. Any discharges of nonradioactive, hazardous materials to the environment during GEOLOGIC EVALUATION shall be limited such that, in combination with all discharges by all 1.2.3 PERFORMANCE CONFIRMATION functions, they are within applicable federal, state, and local limits [1.2.3 C#Q].

D. GEOLOGIC EVALUATION activities shall follow those design requirements of 30 CFR, Part 57 that are necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2.3 C#C].

E. All systems, structures, and components assoiated with GEOLOGIC EVALUATION functions that are important to safety shall continue to perform their safety functions as required by 1.2.3 C#D.

F. GEOLOGICAL EVALUATION structures, systems, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements 1.2.3 C#E.

G. 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 (where applicable) including those along fractures and joints, and the thermal and thermomechanical response of the rock mass as a result of repository development and operations [10 CFR 60.141(c)].

H. GEOLOGIC EVALUATION tests or experiments not described in license specifications may be conducted without prior NRC approval provided the test or experiment does not involve a change in license conditions or an unreviewed safety question. Records of these tests or experiments shall be maintained and reported at least annually to NRC. These records shall include a written safety evaluation showing that the test or experiment does not involve an unreviewed safety question [10 CFR 60.44(a-b)].

I. GEOLOGIC EVALUATION shall include appropriate in situ, monitoring, laboratory and field testing, and in situ experiments [10 CFR 60.140(c)].

J. GEOLOGIC EVALUATION shall be conducted so that they will not adversely affect the ability of the natural and engineering portions to meet the performance objectives in 10 CFR 60 [10 CFR 60.140(d)].

INTERACTIONS:

	Function Interacted With	1.2.3.2 Requirement
	SOCIETAL	PC#1f; C#H
1.0	PRECLOSURE WASTE DISPOSAL	C#J
1.2.1	MINING	C#D
1.2.3.3	NATURAL- AND ENGINEERED-BARRIERS EVALUATION	PC#1d
1.2.3.4	DESIGN MODIFICATION	PC#1e
1.2.5.1	INFORMATION	C#H

	Function Interacted With	1.2.3.2 Requirement
1.2.5.2	ADMINISTRATION	C#A
1.2.5.6	MAINTENANCE	C#F
1.2.5.9	MONITORING	C#E,F
1.2.5.9.1	RADIOLOGICAL MONITORING	C#B
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#C
1.2.5.10	EMERGENCY PREPAREDNESS	C#E
2.0	POSTCLOSURE WASTE DISPOSAL	C#J

1.2.3.3 NATURAL AND ENGINEERED BARRIERS EVALUATION

DEFINITION:

The function that provides monitoring, testing, and evaluation of the natural and engineered systems and components required as barriers after permanent closure.

FUNCTIONAL REQUIREMENTS:

1. To provide data which indicate whether natural and engineered systems and components which are designed or assumed to operate as barriers to radionuclide release after permanent closure are functioning as intended and anticipated and to provide data for use by 1.2.3.4 DESIGN MODIFICATION.

PERFORMANCE CRITERIA:

1. The in situ monitoring, laboratory, and field testing, and in situ experiments shall be sufficient to provide the appropriate data with sufficient accuracy and precision for:

   a. Evaluation of the performance natural and engineered systems designed or assumed to operate as barriers after permanent closure (10 CFR 60.140(a)(2)].

   b. 1.2.3.4 DESIGN MODIFICATION comparison with design bases and assumptions used in licensing [10 CFR 60.141(d)].

   c. Evaluation of the thermomechanical response of the underground facility [10 CFR 60.141(e)].

   d. Evaluation of borehole and shaft seals and backfill (if used) [10 CFR 60.142(a)].

e. Evaluation of thermal interaction effects of waste packages, backfill (if used) rock, and groundwater [10 CFR 60.142(a)].

f. Test the effectiveness of backfill placement and emplacement procedures (if required) against design requirements before permanent backfill placement is begun [10 CFR 60.142(c)].

g. Monitoring the condition of waste packages [10 CFR 60.143].

h. Establish baseline conditions of parameters associated with the performance of engineered and natural systems and components [10 CFR 60.140(d)(2)].

i. Monitor and analyze changes from baseline condition that could indicate changes in the performance of engineered and natural systems and components [10 CFR 60.140(d)(3)].

j. Any tests deemed appropriate by NRC [10 CFR 60.74].

CONSTRAINTS:

A. Natural and engineered barrier performance evaluation shall be initiated as early as practicable, shall be conducted during the early or developmental stages of underground construction, and shall continue until permanent closure [10 CFR 60.142(a)(b)].

B. A backfill test section shall be constructed to test the effectiveness of placement and compaction procedures [10 CFR 60.142(c)].

C. A seal test section shall be constructed and the effectiveness of the seals and their installation procedures shall be tested before full-scale sealing operations are begun [10 CFR 60.142(d)].

D. The waste packages chosen for the monitoring program shall be representative of those to be emplaced in the underground facility [10 CFR 60.143(a)].

E. 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 [10 CFR 60.143(b)].

F. The waste package monitoring program shall include laboratory experiments which focus on the internal conditions of the waste packages in an environment which, to the extent practicable, duplicates the disposal environment [10 CFR 60.143(c)].

G. 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 [10 CFR 60.143(c)].

H. The waste package monitoring program shall continue as long as practical up to the time of permanent closure [10 CFR 60.143(d)].

I. Evaluations of natural and engineered systems and components shall be conducted such that they do not adversely affect performance of the mined geologic disposal system after permanent closure [10 CFR 60.140(d)(1)].

J. Evaluations of natural and engineered sytems and components shall be done on a schedule that provides timely information to 1.2.3.4 DESIGN MODIFICATION to maintain the design flexibility required by 10 CFR 60.133(b) and to allow appropriate changes to be made by 1.2.1 MINING and 1.2.2 WASTE HANDLING [10 CFR 60.140(d)(4)].

K. Evaluations not described in license specifications may be conducted without prior NRC approval provided the evaluation does not involve a change in license conditions or an unreviewed safety question. Records of

these tests shall be maintained and reported at least annually to NRC. The records shall include written safety evaluations showing that the evaluation does not involve an unreviewed safety question [10 CFR 60.44 (a-b)].

L. NATURAL AND ENGINEERED BARRIERS EVALUATIONS shall, in combination with all other 1.2.3 PERFORMANCE CONFIRMATION functions, meet the radiation protection requirements in 1.2.3 C#A.

M. Where possible any radioactive wastes generated during NATURAL AND ENGINEERED BARRIERS EVALUATION will be disposed in accordance with the requirements identified in 1.2.3 C#B.

N. Discharges of nonradioactive, hazardous materials to the environment during NATURAL AND ENGINEERED BARRIERS EVALUATION shall be limited such that in combination with all discharges by all 1.2.3 PERFORMANCE CONFIRMATION functions, they are within applicable federal, state and local limits [1.2.3 C#Q].

O. NATURAL AND ENGINEERED BARRIERS EVALUATION shall follow those design requirements of 30 CFR, Part 57 that are necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2.3 C#C].

P. All systems, structures, and components associated with NATURAL AND ENGINEERED BARRIERS EVALUATION functions that are important to safety shall continue to perform their safety functions as required by 1.2.3 C#D.

Q. NATURAL AND ENGINEERED BARRIERS EVALUATION structures, systems, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements in 1.2.3 C#E.

R. NATURAL AND ENGINEERED BARRIERS EVALUATION shall be conducted in a manner that meets the nuclear criticality requirements in 1.2.3 C#F.

INTERACTIONS:

	Function Interacted With	1.2.3.3 Requirement
1.2.1	MINING	PC#1d; C#B,C,J,O
1.2.2	WASTE HANDLING	C#J
1.2.2.1	RECEIVING	C#D
1.2.2.2	PREPARATION	C#D,S
1.2.2.8	CONTAMINATION CONTROL	C#M
1.2.3.1	WASTE EVALUATION	C#A
1.2.3.2	GEOLOGIC EVALUATION	PC#1b,1d,1f,1i
1.2.3.4	DESIGN MODIFICATION	C#A,J
1.2.4.1	UNDERGROUND CLOSURE	PC#1c,1f,1g; C#C
1.2.5.1	INFORMATION	C#K
1.2.5.2	ADMINISTRATION	C#A,H,K
1.2.5.6	MAINTENANCE	C#Q
1.2.5.9	MONITORING	C#P,Q,R
1.2.5.9.1	RADIOLOGICAL MONITORING	C#L
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#N
1.2.5.10	EMERGENCY PREPAREDNESS	C#P
1.3	WASTE EMPLACEMENT PACKAGE	PC#1a,1h
2.1	NATURAL BARRIERS	C#I
2.2	ENGINEERED BARRIERS	C#I

This page intentionally left blank.

1.2.3.4 DESIGN MODIFICATION

DEFINITION:

The function that provides ongoing engineering and scientific analysis of data gathered by 1.2.3 PERFORMANCE CONFIRMATION and appropriate feedback (e.g., change in operations or design) to other 1.2 REPOSITORY functions based on the results of the analyses.

FUNCTIONAL REQUIREMENTS:

1. To analyze information received from 1.2.3.1 WASTE EVALUATION, 1.2.3.2 GEOLOGIC EVALUATION, and 1.2.3.3 NATURAL- AND ENGINEERED-BARRIERS EVALUATION and compare this information to the design bases and assumptions and system performance predictions used in the licensing reviews.

2. To specify adjustments to underground facility design or construction methods 1.3 WASTE EMPLACEMENT PACKAGE design, or operating procedures that are necessary to accommodate specific geologic condition and behavior, properties or conditions of radioactive waste received at the repository, or results obtained during the evaluation of natural and engineered systems or components necessary for repository operation or for engineered barriers after permanent closure.

3. To provide procedures for reporting to the NRC any changes to the underground facility design, construction methods, and waste package design.

PERFORMANCE CRITERIA:

1. Analysis of information shall be sufficient to determine whether natural and engineered systems and components required for repository operation or as barriers after permanent closure are functioning as intended or

anticipated and whether significant differences exist between performance confirmation results and the design basis and assumptions used in the licensing review [10 CFR 60.140(a)(2); .141(d)].

2. Adjustments to the construction and operating procedures assumed in the licensing review shall result in the same degree of assurance that the system will perform acceptably as that accepted in licensing and shall preserve the flexibility of design required by 10 CFR 60.133(b).

3. Reporting procedures shall provide notification to NRC of significant differences between PERFORMANCE CONFIRMATION results and design basis and assumptions or predictions of performance used in the licensing review. Procedures shall provide prior NRC review and approval of any application adjustments to construction and operating procedures that involve deviations from the conditions of the license or an unreviewed safety question [10 CFR 60.44, .141(d)].

CONSTRAINTS:

A. In addition to the analyses of test data and the specification of changes in design or operating procedures, DESIGN MODIFICATION shall perform or allow NRC to perform any other analyses or specification of changes deemed appropriate by the NRC [1.2.3 C#O].

B. The analysis of data and information supplied by 1.2.3 PERFORMANCE CONFIRMATION and specification of design changes shall be made on a schedule that is consistent with the waste disposal schedule and that provides sufficient lead-time to implement the changes [1.2.3 C#K].

C. Changes to design or operating procedures shall not be made without prior NRC approval if they involve a change in the specifications of the license or an unreviewed safety question [1.2.3 C#G].

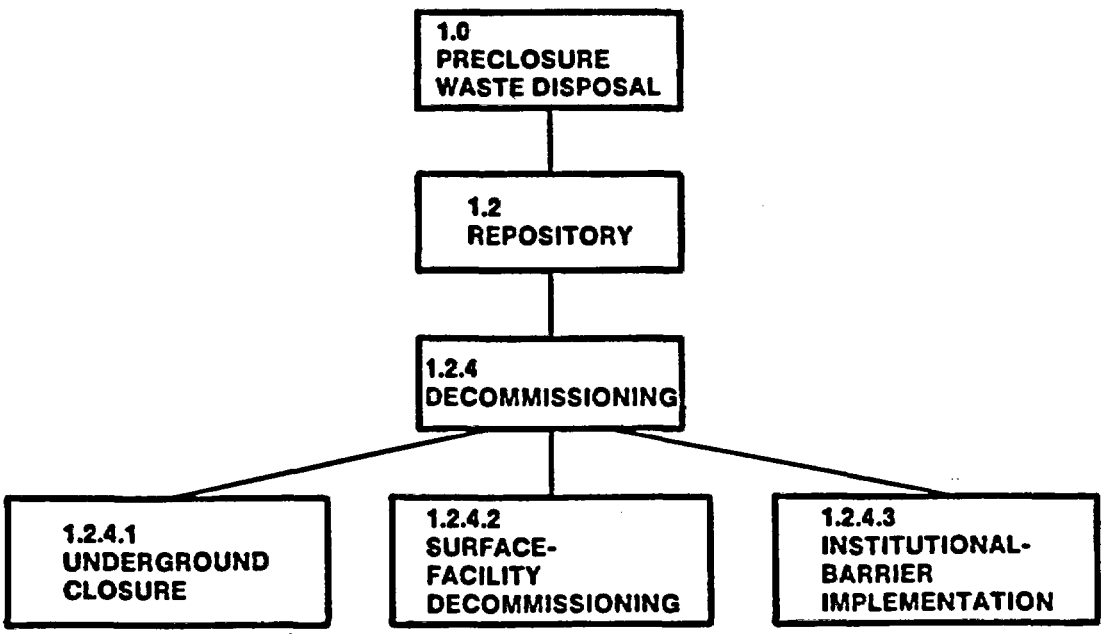
D. For changes exempted by "C" above, records shall be maintained, including a written evaluation showing that the change does not involve an unreviewed safety question. These changes shall be reported at least annually to NRC [1.2.3 C#H].

INTERACTIONS:

	Function Interacted With	1.2.3.4 Requirement
	SOCIETAL	PC#2,3; C#A,C
1.2.1	MINING	PC#2; C#B
1.2.2	WASTE HANDLING	PC#2; C#B
1.2.3.1	WASTE EVALUATION	PC#1
1.2.3.2	GEOLOGIC EVALUATION	PC#1
1.2.3.3	NATURAL- AND ENGINEERED-BARRIERS EVALUATION	PC#1
1.2.4	DECOMMISSIONING	PC#2; C#B
1.2.5	SUPPORT	PC#2; C#B
1.2.5.1	INFORMATION	PC#3; C#D
1.2.5.2	ADMINISTRATION	PC#3; C#B,C
1.3	WASTE-EMPLACEMENT PACKAGE	PC#2; C#B
2.1	NATURAL BARRIERS	PC#1,2
2.2	ENGINEERED BARRIERS	PC#1,2
2.3	INSTITUTIONAL BARRIERS	PC#1,2

This page intentionally left blank.

The sections that follow identify the mined geologic disposal system requirements that have been allocated to 1.2.4 DECOMMISSIONING and its constituent subfunctions as shown below.



This page intentionally left blank.

1.2.4 DECOMMISSIONING

Subfunctions are:

1.2.4.1 UNDERGROUND CLOSURE
1.2.4.2 SURFACE FACILITY DECOMMISSIONING
1.2.4.3 INSTITUTIONAL BARRIER IMPLEMENTATION

DEFINITION:

DECOMMISSIONING provides the facilities, equipment, and operations needed to terminate preclosure waste-disposal operations at the successful completion of the Performance Confirmation Program.

FUNCTIONAL REQUIREMENTS:

1. To permanently close and seal the underground and access facilities.

2. To decontaminate, dismantle, dispose, and perform other activities necesary to remove surface facilities from operation.

3. To implement the procedures and construct the facilities that will be associated with 2.3 INSTITUTIONAL BARRIERS.

PERFORMANCE CRITERIA:

1. Permanent closure of the access and underground portions of the REPOSITORY shall be completed in accordance with the plan presented in the Safety Analysis Report [required by 10 CFR 60.21(c)(15)(iv)], as amended in license amendment for permanent closure required by 10 CFR 60.51.

2. Decommissioning of the surface facilities of the REPOSITORY shall be completed in accordance with the plan presented in the Safety Analysis Report [required by 10 CFR 60.21(c)(15)(iv)], as amended in the license amendment for permanent closure, and shall be done in a manner that is consistent with the proposed subsequent use of the facilities and surface parts of the repository operations area [10 CFR 60.51].

3. Facilities and procedures associated with 2.3 INSTITUTIONAL BARRIERS will be completed in accordance with the plan presented in the Safety Analysis Report [required by 10 CFR 60.21(c)(15)(iv)] as modified by the license amendment for permanent closure requirements [10 CFR 60.51].

CONSTRAINTS:

A. Runoff and erosion during decommissioning shall be controlled in accordance with applicable state and local regulations [GR Appendix C].

B. All decommissioning-related air emissions shall comply with the requirements of the repository state's air quality protection program. Applicable air quality standards and emission control procedures would exist at the state or local level [GR Appendix C].

C. Any activity performed within navigable waterways shall conform to the requirements of Section 404 of the Clean Water Act (33 USC 125, as amended) and shall be permitted under such Act [GR Appendix C].

D. All waste-waters shall be treated and disposed of in accordance with the requirements of Section 402 of the Clean Water Act, and any applicable state and local requirements [GR Appendix C].

E. The ultimate disposal of sludge from the wastewater treatment facilities shall be performed in accordance with the requirements of Section 405 of the Clean Water Act, and any applicable state and local regulations [GR Appendix C].

F. The ultimate disposal of solid wastes shall comply with the Guidelines for Thermal Processing of Solid Wastes (40 CFR 240) and the Guidelines for the Land Disposal of Solid Wastes (40 CFR 241), along with any applicable state or local regulations regarding the transport or disposal of such materials [GR Appendix C].

G. The ultimate disposal of hazardous wastes (not the high-level radioactive wastes) shall be performed in accordance with the requirements of the Resource Conservation and Recovery Act (15 USC 3251, as amended) and any additional state or local requirements [GR Appendix C].

H. Transportation of radioactively contaminated materials to an approved disposal site shall conform with the requirements of 10 CFR 71 (NRC) and 49 CFR 173-178 (DOT) and the waste acceptance requirements of the receiving facility.

I. DECOMMISSIONING shall, in combination with all other 1.2 REPOSITORY functions, meet the radiation protection requirements of 1.2 C#C.

J. Where possible the radioactive wastes generated during decommissioning shall be disposed in accordance with the requirements in 1.2 C#E.

K. Discharges of nonradioactive, hazardous materials to the environment during DECOMMISSIONING shall be limited such that, in combination with all discharges by all 1.2 REPOSITORY functions, they are within applicable federal, state, and local limits [1.2 C#A].

L. Decommissioning functions shall follow those design requirements of 30 CFR, Part 57 that are necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2 C#R].

M. Decommissioning functions shall establish the transition to 2.0 POSTCLOSURE WASTE DISPOSAL in a way that meets the conditions of the license amendment for permanent closure, and the requirements for

termination of the license, and such that there is reasonable assurance that the performance objectives of 10 CFR 60.112 and 113 will be met [10 CFR 60.51, 60.52, and 60.101].

N. All systems, structures, and components associated with DECOMMISSIONING functions that are important to safety shall meet the applicable requirements of 1.2 C#K.

O. DECOMMISSIONING structures, systems, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements in 1.2 C#O and D.

P. DECOMMISSIONING shall be conducted in a manner that meets the nuclear criticality requirements of 1.2 C#Q.

INTERACTIONS:

	Function Interacted With	1.2.4 Requirement
	SOCIETAL	C#A,B,C,D,E,F,G
	TRANSPORTATION	C#H
1.2.1	MINING	C#L
1.2.2.8	CONTAMINATION CONTROL	C#J
1.2.3	PERFORMANCE CONFIRMATION	PC#1
1.2.5.6	MAINTENANCE	C#O
1.2.5.9	MONITORING	C#N,O,P
1.2.5.9.1	RADIOLOGICAL MONITORING	C#I
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#K
1.2.5.10	EMERGENCY PREPAREDNESS	C#N
2.0	POSTCLOSURE WASTE DISPOSAL	PC#1,2,3; C#M

1.2.4.1 UNDERGROUND CLOSURE

DEFINITION:

The function that provides facilities, equipment, and operations for the permanent closure of the underground and access facilities associated with PRECLOSURE WASTE DISPOSAL.

FUNCTIONAL REQUIREMENTS:

1. To remove any equipment and hardware used in the construction and operation of preclosure facilities that will not be part of or that will interfere with 2.0 POSTCLOSURE WASTE DISPOSAL.

2. To install subsurface monitoring equipment required by 2.3 INSTITUTIONAL BARRIERS to monitor waste disposal system performance after permanent closure and decommissioning.

3. To design and emplace engineered components in underground facility that will provide 2.2 ENGINEERED BARRIERS and emplace seals in access ramps, shafts, and exploratory boreholes.

PERFORMANCE CRITERIA:

1. Components of the underground facility shall be removed according to the specifications in the license amendment for permanent closure required by 10 CFR 60.51.

2. Monitoring equipment to be placed in underground facilities for postclosure monitoring shall be emplaced according to the specifications in the license amendment for permanent closure required in 10 CFR 60.51.

3a. Engineered components placed in the underground facility for 2.2 ENGINEERED BARRIERS shall be designed and installed to meet the requirements in 2.2.2 PC#1.

b. Seals to be emplaced in shafts, ramps, and exploratory boreholes, shall be designed and installed so that following permanent closure they do not become pathways that compromise the ability of 2.0 POSTCLOSURE WASTE DISPOSAL to meet the requirements stated in 2.0 PC#1 [10 CFR 60.112, .134(a-b)].

CONSTRAINTS:

A. Any emplaced seals shall not preclude the retrieval of the emplaced waste in the period before permanent closure [1.2 C#I].

B. Underground closure operations shall comply with the design requirements of 30 CFR Part 57 that are necessary to protect workers in a way that systems, structures and components important to safety can perform their intended functions [1.2.4 C#L].

C. Nonradioactive, hazardous materials discharged to the environment as a result of UNDERGROUND CLOSURE shall be limited such that in conjunction with other 1.2.4 DECOMMISSIONING functions, the limits in 1.2.4 C#K are not exceeded.

D. UNDERGROUND CLOSURE shall, in combination with all other 1.2.4 DECOMMISSIONING functions, meet the radiation protection requirements of 1.2.4 C#I.

E. Radioactive wastes generated during UNDERGROUND CLOSURE shall be processed into a form suitable for disposal either at the geologic repository operations area or at an alternative site in accordance with the requirements in 10 CFR 60 or 10 CFR 20.301-.311 and .106 [1.2.4 C#J].

F. UNDERGROUND CLOSURE shall be accomplished such that it does not compromise the ability of POSTCLOSURE WASTE DISPOSAL to meet the performance objectives stated in 10 CFR 60.112 and .113 [1.2.4 C#M].

G. All systems, structures, and components associated with UNDERGROUND CLOSURE functions that are important to safety shall meet the applicable requirements of 1.2.4 C#N.

H. UNDERGROUND CLOSURE structures, systems, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements in 1.2.4 C#O.

I. UNDERGROUND CLOSURE shall be conducted in a manner that meets the nuclear criticality requirement of 1.2.4 C#P.

J. Materials and placement methods for shaft and borehole seals shall be selected to reduce to the extent practicable the potential for creating preferential pathway for groundwater to contact the waste packages or to reduce radionuclide migration through existing pathway [10 CFR 60.134(b)].

INTERACTIONS:

	Function Interacted With	1.2.4.1 Requirement
1.2.1	MINING	C#B
1.2.2.5	RETRIEVAL	C#A
1.2.2.8	CONTAMINATION CONTROL	C#E
1.2.4.1	INSTITUTIONAL BARRIER IMPLEMENTATION	C#C,F,G,H,I,J,L
1.2.4.2	SURFACE FACILITY DECOMMISSIONING	C#C,F,G,H,I,J,L
1.2.5	SUPPORT	C#P
1.2.5.6	MAINTENANCE	C#H
1.2.5.9	MONITORING	C#G,H,I
1.2.5.9.1	RADIOLOGICAL MONITORING	C#D
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#C
1.2.5.10	EMERGENCY PREPAREDNESS	C#G

INTERACTIONS:

	Function Interacted With	1.2.4.1 Requirement
2.0	POSTCLOSURE WASTE DISPOSAL	C#F
2.2	ENGINEERED BARRIER ISOLATION	PC#3a
2.2.2	UNDERGROUND FACILITY BARRIERS	PC#3a
2.2.3	SHAFT AND BOREHOLE SEALS	PC#3b
2.3	INSTITUTIONAL BARRIERS	PC#2

1.2.4.2 SURFACE FACILITY DECOMMISSIONING

DEFINITION:

The function that provides the decontamination, dismantlement, and decommissioning of the surface facilities associated with preclosure 1.2 REPOSITORY functions.

FUNCTIONAL REQUIRMENTS:

1. To remove radioactive contamination from the surface facilities and dispose of the resulting radioactive waste.

2. To modify, dismantle, demolish, or relocate surface facilities; dispose of the resulting nonradioactive hazards and nonhazardous waste; and construct any surface facilities required for 2.0 POSTCLOSURE WASTE DISPOSAL activities.

3. To perform habitat restoration of the areas adversely impacted by construction, operation, closure, and decommissioning of preclosure facilities.

PERFORMANCE CRITERIA:

1a. Depending on plans for their future intended use, surface facilities shall be decontaminated to the same extent that would be required under other parts of Title 10 Code of Federal Regulations Chapter I for facilities where equivalent licensed activities are conducted [10 CFR 60.132 (e)]. Facilities shall be decontaminated to the levels specified in NRC Regulatory Guide 1.86.

b. Radioactive waste resulting from surface facility decontamination shall be disposed of in accordance with the requirements in 1.2.4 C#J.

2a. Surface facility modification, dismantling or demolition shall be accomplished in accordance with the plan required by 10 CFR 60.21(c)(15)(IV) as modified by the license amendment for permanent closure [10 CFR 60.51].

b. The disposal of waste water and sludge from treatment facilities shall be done in accordance with the requirements of Sections 402 and 405 of the Clean Water Act and applicable state and local regulations [1.2.4 C#D&E].

c. The ultimate disposal of solid wastes shall comply with the Guidelines for Thermal Processing of Solid Wastes (40 CFR 240) and the Guidelines for the Land Disposal of Solid Wastes (40 CFR 241) as well as any applicable state and local regulations [1.2.4 C#F].

d. The ultimate disposal of hazardous nonradioactive waste shall be performed in accordance with the requirements of the Resource Conservation and Recovery Act (15 USC 3251, as amended) and any additional state or local requirements [1.2.4 C#G].

3. Restoration of the habitat in areas adversely impacted by construction, operation, and decommissioning will be conducted in accordance with the plan required by 10 CFR 60.21 as amended by the license application for permanent closure [10 CFR 60.51(B)].

CONSTRAINTS:

A. SURFACE FACILITY DECOMMISSIONING shall, in combination with all other 1.2.4 DECOMMISSIONING functions, meet the radiation protection requirement of 1.2.4 C#I.

B. SURFACE FACILITY DECOMMISSIONING shall be accomplished such that it does not compromise the ability of POSTCLOSURE WASTE DISPOSAL to meet the performance objectives stated in 10 CFR 60.112 and .113 [1.2.4 C#M].

C. All systems, structures, and components associated with SURFACE FACILITY DECOMMISSIONING functions that are important to safety shall meet the applicable requirements of 1.2.4 C#N.

D. SURFACE FACILITY DECOMMISSIONING structures, systems, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements in 1.2.4 C#O.

E. SURFACE FACILITY DECOMMISSIONING shall be conducted in a manner that meets the nuclear criticality requirements of 1.2.4 C#P.

INTERACTIONS:

	Function Interacted With	1.2.4.2 Requirement
	TRANSPORTATION	PC#1b
	ENVIRONMENTAL	PC#3
	SOCIETAL	PC#2b,2c,2d
1.2.2.8	CONTAMINATION CONTROL	PC#1b
1.2.5.6	MAINTENANCE	C#D
1.2.5.9	MONITORING	PC#2d; C#C,D,E
1.2.5.9.1	RADIOLOGICAL MONITORING	C#A
1.2.5.10	EMERGENCY PREPAREDNESS	C#C
2.0	POSTCLOSURE WASTE DISPOSAL	PC#1a; C#B

This page intentionally left blank.

1.2.4.3 INSTITUTIONAL BARRIER IMPLEMENTATION

DEFINITION:

The function that provides final planning and implementation of the postclosure procedures and facilities that will monitor postclosure performance of the Yucca Mountain Mined Geologic Disposal System and will prevent or reduce the chances of human activities that are incompatible with radionuclide containment and isolation.

FUNCTIONAL REQUIREMENTS:

1. To assemble records of location, amount, and characteristics of the emplaced waste and place them in the prescribed locations.

2. To plan final monitoring and enforcement procedures for use by 2.3 INSTITUTIONAL BARRIERS and accomplish transfer of control to 2.3 INSTITUTIONAL BARRIERS.

3. To build and emplace any physical barriers or markers required to prevent or reduce the likelihood of human activities that are incompatible with radionuclide containment and isolation.

4. To design and install monitoring facilities and equipment required for 2.3 INSTITUTIONAL BARRIERS.

PERFORMANCE CRITERIA:

1-4. All activities of INSTITUTIONAL BARRIER IMPLEMENTATION shall be accomplished according to the requirements and schedule in the license amendment for permanent closure required by 10 CFR 60.51. All activities shall meet the requirements presented in Performance Criteria 1-3 and Constraints A-F associated with 2.3 INSTITUTIONAL BARRIERS.

CONSTRAINTS:

A. INSTITUTIONAL BARRIER IMPLEMENTATION shall be acomplished such that it does not compromise the ability of POSTCLOSURE WASTE DISPOSAL to meet the performance objectives in 10 CFR 60.112.1B [1.2.4 C#M].

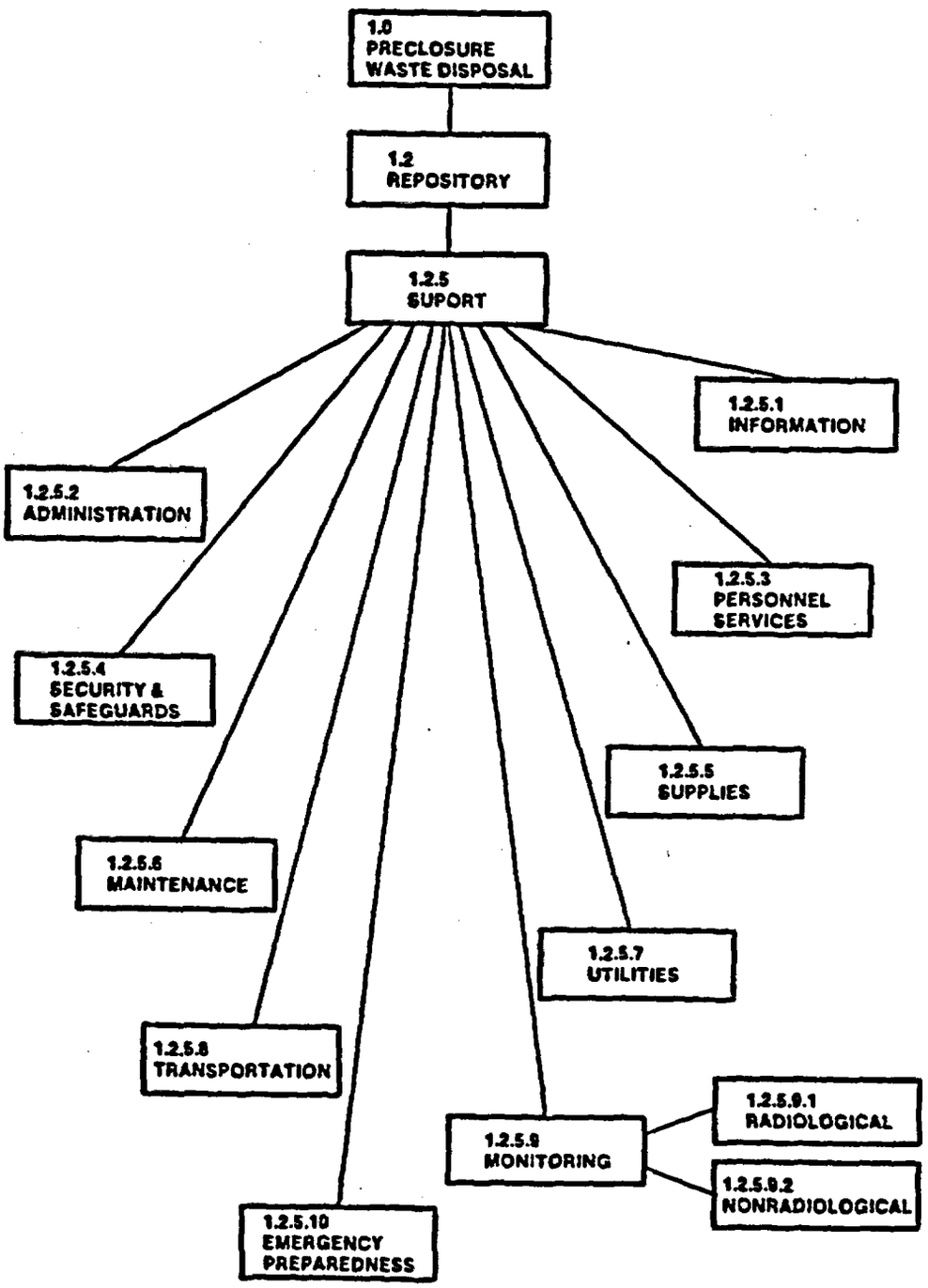
B. INSTITUTIONAL BARRIER IMPLEMENTATION shall, in combination with all other DECOMMISSIONING functions, meet the radiation protection requirements of 1.2.4 C#I.

C. Easily recognizable and legible signs or symbols, which identify the boundaries of the Yucca Mountain MGDS and the dangers of the wastes, will be designed, fabricated, and emplaced to last as long as is technically feasible [GR 2.3 PC#1b].

INTERACTIONS:

	Function Interacted With	1.2.4.3 Requirement
	SOCIETAL	PC#1,2,3,4
1.2.5.1	INFORMATION	PC#1
2.1	NATURAL BARRIERS	C#A
2.3	INSTITUTIONAL BARRIERS	PC#1,2,3,4; C#A,B

The sections that follow identify the mined geologic disposal system requirements that have been allocated to 1.2.5 SUPPORT and its constituent subfunctions as shown below.



This page intentionally left blank.

1.2.5 SUPPORT

Subfunctions are:

1.2.5.1 INFORMATION
1.2.5.2 ADMINISTRATION
1.2.5.3 PERSONNEL SERVICES
1.2.5.4 SECURITY AND SAFEGUARDS
1.2.5.5 SUPPLY
1.2.5.6 MAINTENANCE
1.2.5.7 UTILITIES
1.2.5.8 SURFACE TRANSPORTATION
1.2.5.9 MONITORING
1.2.5.10 EMERGENCY PREPAREDNESS

DEFINITION:

The system that provides auxiliary facilities, and general services during the construction, operation, closure, and decommissioning of the repository.

FUNCTIONAL REQUIREMENTS:

1. To provide data and records management to support preclosure operations.

2. To provide organization, monitoring, and technical support for all 1.2 REPOSITORY activities.

3. To provide health, safety, and training services and facilities for personnel engaged in activities at the site.

4. To protect against acts of sabotage and theft by controlling access to the area where operations are conducted.

5. To provide purchasing and warehousing support for preclosure operations.

6. To provide support for upkeep and repair of facilities and equipment associated with operations.

7. To provide ventilation energy sources, communication, sanitary and other services to support operations.

8. To provide movement of personnel and material in support of preclosure operations.

9. To provide detection and control of release of radioactive and nonradioactive hazardous materials and collect associated data to ensure the safety and health of the public and workers associated with preclosure operations.

10. To provide response to radiologic and nonradiologic emergencies to protect the health and safety of the public and personnel associated with preclosure operations.

PERFORMANCE CRITERIA:

General performance criteria below are expanded in descriptions of the individual functions that constitute 1.2.5 SUPPORT.

1. Primary and backup information on all aspects of REPOSITORY SYSTEM construction, operation, and closure and decommissioning will be maintained in accordance with the quality assurance requirements specified in 10 CFR 60 Subpart G.

2. The management of activities of the REPOSITORY SYSTEM will provide administrative controls over organization and management, procedures, record keeping, reviews, audits, and reporting necessary to assure that activities at the facility are conducted in a safe manner and in conformity with license specifications [10 CFR 60.43(b)(6)].

3. Personnel procedures will ensure that selection training, physical condition, and general health of personnel certified for operations that are important to safety are such that operational errors that could endanger public health and safety are not likely [10 CFR 60.162].

4. The facilities, equipment, and procedures that implement SECURITY AND SAFEGUARDS will ensure that preclosure activities will not be inimical to the common defense and security, and will be certified by DOE to be the same as those provided at comparable DOE facilities [10 CFR 60.41(c), 60.21(b)(3)].

5. Materials and supplies shall be ordered, distributed, and stored in a way that supports the requirements of construction, operation, closure, and decommissioning [GR 1.2.4.6 PC#1].

6. Personnel, equipment, and material shall be sufficient to support inspection testing, upkeep and repair of repository equipment and facilities. Maintenance of structures, systems, and components important to safety will be adequate to ensure their continued function and readiness [10 CFR 60.131(b)(6)].

7. Primary and backup energy sources and communications equipment and other utilities that are important to safety shall be adequate to perform essential safety functions under both normal and accident conditions. Other utilities will be sufficient to enable normal repository operations at all times prior to decommissioning [10 CFR 60.131(b)(5)].

8. Surface transportation will be adequate to support movement of personnel, material, and equipment both during normal and emergency operations [GR 1.2.4.9].

9. Monitoring capability shall include the ability to detect fire and explosions that may have an effect on structures, systems, and components important to safety [10 CFR 60.131(b)(3)(iii)], and radionuclides in any REPOSITORY SYSTEM effluents [10 CFR 60.111(a)]. Monitoring capability shall also include the detection of nonradiological toxic materials that would pose a hazard to workers and the general public. Monitoring systems shall include alarm systems for notification of on-site and off-site personnel [10 CFR 60.131(b)(4)(ii)]. MONITORING shall also provide the capability to monitor the performance of engineered systems required for repository operation as required by 1.2.3.3 NATURAL AND ENGINEERED BARRIERS EVALUATION [10 CFR 60.140].

10. The emergency response capability shall include on-site facilities and services that will ensure a safe and timely response to emergency conditions and the ability to use available off-site services that may aid in recovery from emergencies [10 CFR 60.131(b)(4)(ii)]. Emergency response capabilities will meet the requirements specified in DOE Order 5500.3 ("Reactor and Nonreactor Facility Emergency Planning, Preparedness, and Response Program for Department of Energy Operations") and related guides or, when issued by the NRC, in 10 CFR 60, Subpart I, "Emergency Planning Criteria" [10 CFR 960.5-2-1(d)(3)].

CONSTRAINTS:

A. All systems, structures, and components associated with SUPPORT functions that are important to safety shall continue to perform their safety functions to meet the requirements in 1.2 C#K.

B. SUPPORT shall, in combination with other 1.2 REPOSITORY functions, meet the radiation protection requirements identified in 1.2 C#C.

C. Where possible the radioactive wastes generated during SUPPORT shall be disposed in accordance with the requirements identified in 1.2 C#E.

D. SUPPORT functions shall follow those design requirements of 30 CFR Part 57 that are necessary to protect workers in such a way that systems, structures, and components important to safety shall continue to perform their functions [1.2 C#R].

E. SUPPORT systems, structures, and components important to safety shall meet the monitoring, inspection, testing, and maintenance requirements identified in 1.2 C#O and P.

F. SUPPORT functions shall be conducted in a manner that meets the nuclear criticality requirements in 1.2 C#Q.

G. Discharges of nonradioactive hazardous materials to the environment by SUPPORT functions shall be limited such that, in combination with discharges from all 1.2 REPOSITORY functions, applicable federal, state, and local limits are not exceeded [1.2 C#A].

INTERACTIONS:

	Function Interacted With	1.2.5 Requirement
1.2.1	MINING	PC#1-10
1.2.2	WASTE HANDLING	PC#1-10
1.2.3	PERFORMANCE CONFIRMATION	PC#1-10
1.2.4	DECOMMISSIONING	PC#1-10

1.2.5.1 INFORMATION

DEFINITION:

The function that stores, preserves, recovers, and disseminates information on construction, operation, closure, and decommissioning, including information on the radioactive waste received and stored in the Yucca Mountain mined geologic disposal system.

FUNCTIONAL REQUIREMENTS:

1. To establish, maintain, and retrieve records related to construction, operation, closure, and decommissioning.

2. To make required reports of construction, operation, closure, and decommissioning.

PERFORMANCE CRITERIA:

1a. The records of repository construction, operation, closure, and decommissioning shall conform with the conditions of the license for construction authorization and the license to receive and possess source, special nuclear or by-product material, or by rules, regulations, and orders of NRC [10 CFR 60.71(a)]. Records shall be maintained until a license amendment permitting destruction or other disposal is obtained [GR 1.2.4.1 PC#1a].

1b. Records of the receipt, handling, and disposition of radioactive waste at the repository area shall be maintained and shall contain sufficient information to provide a complete history of the movement of each waste package from the shipper through all phases of storage and disposal [10 CFR 60.71(b)].

1c. The following records shall be maintained for radioactive materials [GR 1.2.2.4 C#D; GR 1.2.4.1 PC#1b]:

(a) Receipt, inventory (including source), disposal location in the repository acquisition, and transfer of all nuclear materials received at the repository.

(b) Results of periodic physical inventories of nuclear materials as required by the license.

(c) Records in duplicate of nuclear materials either in storage or disposed of. The duplicate set shall be kept at a separate location sufficiently remote from the original records so that a single event would not destroy both sets of records.

(d) WASTE EMPLACEMENT PACKAGE identification numbers shall be correlated to emplacement location and entered into the repository documentation system.

1d. Records of construction of the repository shall include the following [10 CFR 60.72(b)].

a. Surveys of the underground facility excavations, shafts, and boreholes referenced to readily identifiable surface features or monuments.

b. A description of the materials encountered.

c. Geologic maps and geologic cross sections.

d. Locations and amount of seepage.

e. Details of equipment, methods, progress, and sequence of work.

f. Construction problems.

g. Anomalous conditions encountered.

h. Instrument locations, readings, and analysis.

i. Location and description of structural support systems.

j. Location and description of dewatering systems.

k. Details, methods of emplacement, and location of seals and backfill used.

1e. Nuclear material accountability shall be provided at the repository for the reverification of identity and quantity of contained nuclear material within each waste container received at the repository in the following cases [GR 1.2.4.1 PC#3]:

a. A canister which is not tamper-safe.

b. A canister on which the tamper-safing is found to have been compromised.

c. A canister that has been damaged prior to receipt at the repository in such a manner as to expose its contents (it is assumed that canisters will not be damaged while in shipping casks).

d. Any other situations which may develop during the repository operations.

1f. Records of the following shall be maintained [GR 1.2.4.1 PC#4].

a. Names, addresses, and badge numbers of all individuals authorized to have access to vital equipment or special nuclear material, and the vital areas and material access areas to which authorization is granted.

b. Visitors, vendors, and other individuals not employed by the operator.

c. Names, badge numbers, time of entry, reason for entry, and time of exit of all individuals granted access to a normally unoccupied vital area.

d. All routine security tours and inspections, and all tests, inspections, and maintenance performed on physical barriers, intrusion alarms, communications equipment, and other security-related equipment.

e. Each alarm, false alarm, alarm check, and tamper indication that identifies the type of alarm, location, alarm circuit, date, and time. Details of response by facility guards and watchmen to each alarm, intrusion, or other security incident shall be recorded.

f. Procedures for controlling access to protected areas and for controlling access to keys and locks used to protect special nuclear materials.

1g. a. Records showing the radiation exposures of all individuals for whom personnel monitoring is required under 10 CFR 20.202 shall be maintained in accordance with 10 CFR 20.401(a).

b. Records of individual exposure to radiation and to radioactive material, and records of bioassays, including results of whole body counting examinations made pursuant to 10 CFR 20.108, shall be preserved until the Commission authorizes disposition.

c. Records of the results of surveys and monitoring which must be maintained shall be preserved for 2 years after completion of the survey except that the following records shall be maintained until the Commission authorizes their disposition: (1) Records of the results of surveys to determine compliance with 10 CFR 20.103(a); (2) in the the absence of personnel monitoring data, records of the results of surveys to determine external radiation doses; and (3) records of the results of surveys used to evaluate the release of radioactive effluents to the environment.

d. Records which must be maintained may be the original or a reproduced copy of microform if such reproduced copy or microform is duly authenticated by authorized personnel and the microform is capable of producing a clear and legible copy after storage for the period specified by Commission regulations [10 CFR 20.401(c)(4)].

e. Record-keeping forms shall comply with the requirements of 10 CFR 20.101.

1h. Records of changes in geologic repository operations area and of changes in procedures as described in the license application shall be maintained. Records of test and experiments not described in the license application shall also be maintained. These records shall include a written safety evaluation which provides the basis for the determination that the changes, test, or experiment does not involve an unreviewed safety question [10 CFR 60.44(a)].

1i. Records necessary to demonstrate compliance with environmental protection "requirements" such as those related to permitting, and records pertaining to personnel training and certifications, medical and employment history of personnel, etc., shall be maintained. Any other necessary records relevant to the safety of personnel and operations shall also be maintained [10 CFR 60.160,161; GR 1.2.4.1 PC#7].

1j. The records keeping system shall be organized in such a way that recovery of specific information needed from stored data is available to concerned users within a minimum amount of time [GR 1.2.4.1 PC#8].

1k. Records shall include a description of the administrative controls and provisions relating to the organization and management, procedures to assure that activities at the facility are conducted in a safe manner and in conformity with other license specifications [10 CFR 60.43(b)(6)].

1l. Records shall include a description of changes in the geologic repository operations area, changes in procedures, and tests or experiments that constitute a change in license specifications or an unresolved safety issue [10 CFR 60.44(b)].

1m. Information will be maintained as listed below to satisfy the requirements of 30 CFR 57:

1. Records of semiannual mine evacuation drills [57.4361(c)].

2. Records of training for mine escape and evacuation [57.4363(d)].

3. Records of inspections of boiler and pressure vessels in accordance with requirements of the National Board Inspection Code [57.13015(b)].

4. Records of safety inspections of the underground work areas each shift [57.18002(b)].

5. Records of required yearly training in mine rescue [57.18028(d)].

6. A checkin-checkout system record of persons in the mine shall be maintained in a surface location chosen to minimize the danger of destruction by fire or other hazard [57.11058].

7. Medical certification of hoist operators' fitness maintained in the surface facilities [57.19057)].

8. Complete records of inspections, tests, and maintenance of shafts and hoisting equipment [57.19121].

9. Records of defects affecting safety in self-propelled equipment to be used underground [57.9001].

10. Records of quarterly or weekly monitoring for airborne radon daughter concentrations [57.5037(c)].

11. Records of the calculation of individual exposure to radon daughters [30 CFR 57.5040].

12. Any reports related to the following tests and inspections:

    a. Auxiliary fan inspection [57.21031].

    b. Weekly airflow measurement [57.21035].

    c. Changes in ventilation [57.21038].

    d. Actions in response to the presence of methane [57.21039-.21042, .21045].

    e. Shift examinations [57.18002].

    f. Conditions of explosives use [57.21095].

    g. Main fan operation and inspection [57.21021].

    h. Main fan failure [57.21024].

    i. Failure of mine ventilation [57.21025].

    j. Personnel hoisting examinations [57.19023].

    k. Record keeping for inspections [57.19121].

l. Examination and tests of personnel hoists at beginning of shift [57.19129].

m. Examination of personnel hoist conveyance shaft [57.19130].

n. Examination of personnel hoisting safety catches [57.1932].

o. Hazardous conditions [57.21066].

2a. Reports will be made according to the schedule and requirements stipulated in the conditions of the license for construction authorization and license to receive and possess source, special nuclear or by-product material [10 CFR 60 Subpart D].

2b. Reports on REPOSITORY SYSTEM construction, operation, and decommissioning will include reports to NRC relating to deficiencies that may, if uncorrected, be a substantial safety hazard; represent a significant deviation from design bases and design criteria presented in the license application; or represent a significant deviation from conditions stated in the terms of the license [10 CFR 60.73].

2c. The following reports will be prepared to satisfy the requirements of 30 CFR 57:

a. On or before February 15 of each calendar year, or within 45 days of the shutdown of repository operations, the operator of the repository shall submit to the Mine Safety and Health Administration a copy of "Record of Individual Exposure to Radon Daughters" (Form 4000-9) or equivalent for all personnel for whom calculation and recording of exposure was required during the previous calendar year [30 CFR 57.5040(b)(2)].

2d. The following reports will be made to satisfy the requirements of 10 CFR 20:

a. Reports of theft or loss of licensed material [10 CFR 20.402].

b. Notification of incidents regarding radioactive material [10 CFR 20.403].

c. Reports of overexposures and excessive levels and concentrations of radioactive materials [10 CFR 20.405].

d. Personnel monitoring reports [10 CFR 20.407].

e. Reports on individuals who have terminated or completed work assignment [10 CFR 20.408].

f. Reports to individuals [10 CFR 20.409].

CONSTRAINTS:

A. Applicable requirements of following DOE Orders shall be satisfied: 5500.1, Chapters I and II, 1324.2, 1700.1, 1800.1, 5630.2, 7, 9, and 10 [GR 1.2.4.1 C#A].

B. All systems, structures, and components associated with INFORMATION functions that are important to safety shall continue to perform their safety functions as required by 1.2.5 C#A.

C. INFORMATION structures, systems, and components important to safety shall permit periodic inspection, testing, and maintenance sufficent to ensure continued functioning and readiness [10 CFR 60.131(b)(6)].

D. The behavior of INFORMATION structures, systems, and components important to safety shall be monitored and controlled over the anticipated ranges for normal operation and for accident conditions [10 CFR 60.131(b)(8)].

E. Information shall, in combination with other 1.2.5 SUPPORT functions, meet the radiation protection requirements in 1.2.5 C#B.

INTERACTIONS:

	Function Interacted With	1.2.5.1 Requirement
1.2.1	MINING	PC#1d,1m8,1m9,1m12
1.2.2	WASTE HANDLING	PC#1b,1c,1e,1m9,1m12,12d
1.2.3	PERFORMANCE CONFIRMATION	
1.2.3.1	WASTE EVALUATION	PC#1c,1e
1.2.3.2	GEOLOGICAL EVALUATION	PC#1d
1.2.3.4	DESIGN MODIFICATION	PC#2b
1.2.5.2	ADMINISTRATION	PC#1f,1h,1k,1l,1m6,2d
1.2.5.3	PERSONNEL SERVICES	PC#1i,1m7
1.2.5.4	SECURITY AND SAFEGUARDS	PC#1f,2d
1.2.5.6	MAINTENANCE	PC#1m8,1m12; C#C
1.2.5.9.1	RADIOLOGICAL MONITORING	PC#1g,1m11,2d; C#E
1.2.5.9.2	NONRADIOLOGICAL MONITORING	PC#1m7; C#D
1.2.5.10	EMERGENCY PREPAREDNESS	PC#1m1,1m2,1m5

1.2.5.2 ADMINISTRATION

DEFINITION:

The function that provides organization, management, and control activities for 1.2 REPOSITORY operations.

FUNCTIONAL REQUIREMENTS:

1. To provide administrative facilities and support for 1.2 REPOSITORY construction, operation, and decommissioning.

PERFORMANCE CRITERIA:

1. a. ADMINISTRATION activities shall satisfy the license specifications for administrative controls [10 CFR 60.43(b)(6)].

   b. ADMINISTRATION activities shall comply with applicable portions of the following DOE Orders [GR 1.2.4.3 PC#1d].

   1323.1, 1324.2, 1325.1A, 1330.1A, 1340.1A, Chapter 1, 1350.1, 1540.1, 1600 series, 1700.1, 1800.1, 2100.4, 2200.1, 2250.1A, 3220.1, 3220.2, 3230.2A, 3304.1, 3710.1, 3750.1, 3771.1, 4200.3, 4200.4, 4220.3A, 4320.1A, 4330.4, 5031.1, 5100.1, 5420.1, 5440.1B, 5480.1A, 5481.1A, 5482.1A, 5483.1A, 5484.1, 5484.2, 5500.2, 5500.3, 5500.4, 5700.2B, 5700.4, 5700.5, 5700.6A, 5700.7A, 5900.1, 5900.2, 6410.1, and 6430.1, Chapter XVI.3.

c. ADMINISTRATION shall ensure that applicable requirements of NWPA, 40 CFR 191, 10 CFR 60, 10 CFR 960, 10 CFR 20, 30 CFR, Chapter I, Subchapters D, E, and N, are complied with during the repository construction and operation in order to provide worker protection and public safety [GR 1.2.4.3 C#A]).

d. ADMINISTRATION shall implement a Quality Assurance program based on the criteria of Appendix B of 10 CFR 50.

e. Necessary procedures and maintenance of personnel records, reports, and reviews shall be followed and performed in a timely manner [GR 1.2.4.3 PC#1b].

CONSTRAINTS:

A. A Quality Assurance Program based on the criteria of Appendix B of 10 CFR 50 shall be implemented for all systems, structures, and components important to safety, and for design and characterization of barriers important to waste isolation and related activities [YMMGD C#B].

B. Procedures shall be implemented to ensure that intoxicating beverages and narcotics are not be permitted in or around the underground facilities and that persons under the influence of alcohol or narcotics shall not be permitted on the job [30 CFR 57.2001].

C. ADMINISTRATION shall prepare any required amendments to the license to receive and possess source, special nuclear, or by-product material according to the conditions specified in 10 CFR 60.45-46.

D. ADMINISTRATION shall, upon request by the Director, Office of Inspection and Enforcement for NRC, provide rent-free office space of approximately 250 square feet for exclusive use of NRC inspection personnel [10 CFR 60.75(c)].

E. ADMINISTRATION shall, in combination with other 1.2.5 SUPPORT functions, meet the radiation protection requirements identified in 1.2.5 C#B.

F. All systems, structures, and components associated with ADMINISTRATION functions that are important to safety shall continue to perform their safety functions as required by 1.2.5 C#A.

G. ADMINISTRATION structures, systems, and components important to safety shall meet the monitoring, control, inspection, testing, and maintenance requirements identified in 1.2.5 C#E.

H. ADMINISTRATION activities shall interact with other 1.2.5.9 MONITORING functions to ensure that prescribed radiation surveys and other safety procedures are carried out and that prescribed records are maintained [1.2 C#D, E, F].

I. ADMINISTRATION shall ensure that the reporting requirements of 10 CFR 20.8 are met.

J. ADMINISTRATION shall ensure that the Environmental Report required by 10 CFR 60.51(a) is modified before decommissioning.

K. Traffic rules including speed signals and warning signs shall be standardized and posted [30 CFR 57.9071].

INTERACTIONS:

	Function Interacted With	1.2.5.2 Requirement
	SOCIETAL	C#C,D,I
1.1	MINING	PC#1
1.2	WASTE HANDLING	PC#1
1.3	PERFORMANCE CONFIRMATION	PC#1; C#A
1.4	DECOMMISSIONING	PC#1; C#J

	Function Interacted With	1.2.5.2 Requirement
1.2.5.1	INFORMATION	C#H
1.2.5.3	PERSONNEL SERVICES	C#C
1.2.5.4	SECURITY AND SAFEGUARDS	C#B
1.2.5.6	MAINTENANCE	C#G
1.2.5.9	MONITORING	C#F,G,H
1.2.5.9.1	RADIOLOGICAL MONITORING	C#E
1.2.5.10	EMERGENCY PREPAREDNESS	C#F

1.2.5.3 PERSONNEL SERVICES

DEFINITION:

The function that provides personnel support for construction, operation, closure, and decommissioning.

FUNCTIONAL REQUIREMENTS:

1. To provide the training and facilities necessary to support all 1.2 REPOSITORY activities.

PERFORMANCE CRITERIA:

1. a. Training shall be provided to all repository personnel in basic radiation health physics and procedures to minimize radiation doses [GR, 1.2.4.4 PC#1a].

   b. Adequate and ongoing safety and safety awareness programs shall be incorporated to educate repository personnel for meeting the safety requirements [GR, 1.2.4.4 PC#1b].

   c. Training and safety requirements prescribed under 29 CFR 1926.21 shall be satisfied [GR, 1.2.4.4 PC#1c].

CONSTRAINTS:

A. To minimize radiation doses to repository personnel and visiting public, PERSONNEL SERVICES shall work with other 1.2 REPOSITORY functions to provide [10 CFR 60.131(a)]:

   1. 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.

   2. Means to control access to high radiation areas or airborne radioactivity areas.

B. Operation of systems and components that have been identified as important to safety in the Safety Analysis Report and in the license shall be performed only by trained and certified personnel or by personnel under the direct visual supervision of an individual with training and certification in such operation. Supervisory personnel who direct operations that are important to safety must also be certified in such operations [10 CFR 60.160].

C. The physical condition and the general health of personnel certified for operations that are important to safety shall not be such as might cause operational errors that could endanger the public health and safety. Any condition which might cause impaired judgment or motor coordination must be considered in the selection of personnel for activities that are important to safety. These conditions need not categorically disqualify a person, so long as appropriate provisions are made to accommodate such conditions [10 CFR 60.162].

D. Applicable requirements of the following DOE Orders pertaining to safety, selection, and training of personnel for the repository shall be satisfied [GR 1.2.4.4 C#D]:

- o 1600 series
- o 3220.1
- o 3220.2
- o 3400.1
- o 3410 series
- o 3790.1
- o 5483.1A

E. On an annual or more frequent basis as required by the regulations cited below, qualified instructors shall give training in the following areas to meet the requirements of 30 CFR 57:

- o New Employee Indoctrination [57.18006].
- o Mine Emergency Training [57.18028(a)].
- o First Aid Training [57.18010].
- o Self-rescue Training [57.18028(b)].
- o Respirator Training [57.5005].
- o Current Escape and Evacuation Plans [57.4363].

F. Signs warning against smoking and open flames shall be posted so they can be readily seen in areas or places where fire or explosion hazards exist [30 CFR 57.401].

G. PERSONNEL SERVICES shall work with other 1.2 REPOSITORY functions to ensure that the personnel noise exposure requirements in 30 CFR 57.5050 are met.

H. PERSONNEL SERVICES shall work with 1.2 MINING to ensure that persons who use or handle explosives or detonators are experienced and understand the hazards involved; trainees shall do such work only under the supervision of and in the immediate presence of experienced persons [30 CFR 57.6090].

I. Medical examinations by a qualified licensed physician will be given to all hoist operators [30 CFR 57.19057].

J. When respiratory protective equipment is used, a program shall be developed for selection, maintenance, training supervision, cleaning, and use of respirators. The program shall meet the minimum requirements of 30 CFR 57.5005.

K. PERSONNEL SERVICES shall work with other 1.2 REPOSITORY functions to ensure that persons shall not be permitted to receive an exposure to radon daughters in excess of 4 WLM (Working-Level Months) in any calendar year. Except as provided in 30 CFR 57.5005 persons shall not be exposed to air containing concentrations of radon daughters exceeding 1.0 WL (Working Level) in active repository workings [30 CFR 57.5038-39].

L. Caution signs, labels, signals, and controls in radiation areas and high radiation areas shall meet the requirements of 10 CFR 20.203.

M. Notices to workers shall be posted to meet the requirements of 10 CFR 19.11.

N. Employment discrimination by a licensee or a contractor or subcontractor of a licensee against an employee for engaging in protected activities under 10 CFR 19, or 10 CFR 30, 40, 50, 60, 72, or 150 is prohibited [10 CFR 19.20].

O. All individuals working in or frequenting any portion of a restricted area shall be kept informed of the storage, transfer, or use of radioactive materials or of radiation in such portions of the restricted area; shall be instructed in the health protection problems associated with exposure to such radioactive materials or radiation, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed; shall be instructed in, and instructed to observe, to the extent within the worker's control, the applicable provisions of NRC regulations and licenses for the protection of personnel from exposures to radiation or radioactive materials occurring in such areas; shall be

instructed of their responsibility to report promptly to the licensee any condition which may lead to or cause a violation of NRC regulations and licenses or unnecessary exposure to radiation or to radioactive material; shall be instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation or radioactive material; and shall be advised as to the radiation exposure reports which workers may request pursuant to 10 CFR 19.13. The extent of these instructions shall be commensurate with potential radiological health protection problems in the restricted area [10 CFR 19.12].

P. PERSONNEL SERVICES shall, in combination with other 1.2.5 SUPPORT functions, meet the radiation protection requirements identified in 1.2.5 C#B.

Q. All systems, structures, and components associated with PERSONNEL SERVICES functions that are important to safety shall continue to perform their safety functions to meet the requirements of 1.2.5 C#A.

R. PERSONNEL SERVICES structures, systems, and components important to safety shall meet the monitoring, control, inspection, testing, and maintenance requirements identified in 1.2.5 C#E.

S. Radiological Emergency Response training shall be provided for management, specialized emergency-duty personnel and other nonrepository personnel having emergency responsibilities [DOE 5500.8 Attachment 1, page 10].

T. Every person underground shall carry positive means of identification [30 CFR 57.19057].

INTERACTIONS:

	Function Interacted With	1.2.5.3 Requirement
1.2.1	MINING	C#A,B,C,G,H,I,J,K
1.2.2	WASTE HANDLING	C#A,B,C,G,J,K,L,O
1.2.3	PERFORMANCE CONFIRMATION	C#A,B,C,G
1.2.4	DECOMMISSIONING	C#A,B,C,G,J,L
1.2.5.6	MAINTENANCE	C#R
1.2.5.9	MONITORING	C#Q,R
1.2.5.9.1	RADIOLOGICAL MONITORING	C#P
1.2.5.10	EMERGENCY PREPAREDNESS	C#Q

1.2.5.4 SECURITY AND SAFEGUARDS

DEFINITION:

The function that provides physical protection of repository facilities and the radioactive waste contained in the various waste forms from acts of sabotage, terrorism, hostility, and theft.

FUNCTIONAL REQUIREMENTS:

1. To protect repository personnel, repository facilities, and radioactive waste material from acts of sabotage, terrorism, and theft.

2. To perform security inspections on incoming TRANSPORTATION components.

PERFORMANCE CRITERIA:

1. a. Safeguards for the geologic repository operations area shall meet DOE requirements for comparable DOE surface facilities and be so certified to NRC [10 CFR 60.21(b)(3-4),.41(c)].

   b. Based on the quantity category of special nuclear material to be disposed, the level of protection applied to the nuclear material shall meet the general and specific requirements of DOE Order 5632.2.

   c. SECURITY AND SAFEGUARDS shall protect the repository facility and the radioactive waste material stored in it from acts of sabotage, terriorism, and theft by enforcing controlled access to the repository site, and by providing physical protection. The applicable requirements of 10 CFR 73 shall be satisfied [GR 1.2.4.5 PC#1].

2. A thorough inspection of arriving transport vehicles for the presence of explosives or other hazardous materials shall be performed at a place within the repository area sufficiently removed from repository surface facilities that would minimize the effects of explosions resulting from the inspections [GR 1.2.2.1 PC#3].

CONSTRAINTS:

A. As a minimum, applicable requirements of the following DOE Orders shall be satisfied: 5300.1A; 5631.1, 2, and 3; 5632.1, 2, and 3; 5633.1; 5635.1; 5650.2; 6430.1, Chapter I.3.C and Chapter XIV [GR 1.2.4.5 C#A].

B. The quantity and classification of nuclear material to be disposed and associated security and safeguards must be documented in a facility safeguards and security plan that meets the requirements of DOE Order 5632.2 Paragraph 4d and 7. The plan shall be submitted to NRC as part of the licensing process [10 CFR 60.21(b)(3-4), 60.41(c)].

C. Theft or diversion of the radioactive waste should not be considered in the development of the physical security plan [10 CFR 60.21(b)(4)].

D. The 1.2 REPOSITORY shall not receive, use, process, or store special nuclear material until facility approval, based upon a review of the safeguards and security plan and an on-site survey by the responsible DOE Operations Office, has been granted [DOE Order 5632.2, Paragraph 8(1)].

E. Continual vigilance shall be maintained for procedural violations or practices inconsistent with physical protection measures afforded special nuclear material [DOE Order 5632.2, Paragraph 8(2)].

F. Any unauthorized attempts, suspected attempts, or actual removals of special nuclear material from a protected area or material access area shall be reported immediately to the responsible DOE Safeguards and Security Office [DOE Order 5632.2, Paragraph 8(3)].

G. Reports, plans, and data relating to the protection and control of special nuclear material shall be classified in accordance with Classification Guide CG-S-1, and other applicable classification guides [DOE Order 5632.2, Paragraph 8(4)].

H. Protected areas shall be subject to a system of access controls administered by security inspectors who meet the standards contained in DOE 5632.1 [DOE Order 5632.2, Paragraph 8(b)(1)].

I. SECURITY AND SAFEGUARDS shall, in combination with other 1.2.5 SUPPORT functions, meet the radiation protection requirements in 1.2.5 C#B.

J. All systems, structures, and components associated with SECURITY AND SAFEGUARDS functions that are important to safety shall continue to perform their safety functions to meet the requirements in 1.2.5 C#A.

K. SECURITY AND SAFEGUARDS systems, structures, and components important to safety shall meet the monitoring, control, inspection, testing, and maintenance requirements identified in 1.2.5 C#E.

INTERACTIONS:

	Function Interacted With	1.2.5.4 Requirement
	SOCIETAL	C#D
1.2.5.1	INFORMATION	C#G,M,R
1.2.5.2	ADMINISTRATION	C#B
1.2.5.3	PERSONNEL SERVICES	C#H
1.2.5.6	MAINTENANCE	C#K
1.2.5.9	MONITORING	C#J,K
1.2.5.9.1	RADIOLOGICAL MONITORING	C#I
1.2.5.10	EMERGENCY PREPAREDNESS	C#J

This page intentionally left blank.

1.2.5.5 SUPPLY

DEFINITION:

The function that procures, stores, and dispenses equipment, parts, and materials required to support repository operations.

FUNCTIONAL REQUIREMENTS:

1. To purchase, store, inventory, and dispense equipment and materials.

PERFORMANCE CRITERIA:

1. a. The inventory of equipment, parts, and materials shall be adequate to sustain construction, operation, and decommissioning of the repository as dictated by the radioactive waste receival rates specified in Appendix B of this document [GR 1.2.4.6 PC#1a].

   b. Adequate storage capacity (excluding radioactive waste storage) shall be available in the repository area to store equipment, parts, and materials required for repository operations [GR 1.2.4.6 PC#1b].

CONSTRAINTS:

A. The SUPPLY function shall assist in ensuring that, to the extent practicable, the geologic repository operations area shall use noncombustible and heat-resistant materials [10 CFR 131(b)(3)(ii)].

B. The SUPPLY function shall comply with those design requirements of 30 CFR 57 necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended function [1.2.5 C#D]. Specific provisions include but are not limited to areas listed below:

FLAMMABLE LIQUIDS AND GASSES

1. Use Restriction [57.4400]
2. Storage Tank Foundation [57.4401]
3. Safety Can Use [57.4402]
4. Surface Storage Facilities and Restrictions [57.4430-31]
5. Storage of Flammable and Combustible Liquids Underground [57.4460 and .4462]
6. Gasoline and Liquified Petroleum Gas Use Underground [57.4461 and .4463]
7. Heat Sources [57.4500]
8. Fuel Lines and Fuel Lines to Underground Areas [57.4501 and .4505]
9. Surface Flammable or Combustible Liquid Storage Buildings or Rooms [57.4531]
10. Oxygen Cylinder Storage [57.4601]

MATERIALS STORAGE AND HANDLING

1. Stacking and Storage of Materials [57.16001].
2. Bins, Hoppers, Silos, Tanks, and Surge Piles [57.16002].
3. Storage of Hazardous Materials [57.16003].
4. Containers for Hazardous Materials [57.16004].
5. Securing Gas Cylinders [57.16005].
6. Protection of Gas Cylinder Valves [57.16006].
7. Taglines, Hitches, and Slings [57.16007].
8. Suspended Loads [57.16009].
9. Dropping Materials from Overhead [57.16010].

10. Riding Hoisted Loads or On the Hoist Hook [57.16011].
11. Storage of Incompatible Substances [57.16012].
12. Working With Molten Metal [57.16013].
13. Operator Carrying Overhead Cranes [57.16014].
14. Work or Travel on Overhead Crane Bridges [57.16015].
15. Lift Trucks [57.16016].
16. Hoisting Heavy Equipment or Material [57.16017].

OTHER REQUIREMENTS

1. Restricted Use of Chemicals [57.5006]
2. Carbon Tetrachloride [57.5006]
3. Combustible Waste [57.4104]
4. Surface and Underground Electric Substation and Liquid Storage Facilities [57.4130 and .4160]
5. Surface Fan Installations and Mine Openings [57.4131]

C. All systems, structures, and components associated with SUPPLY functions that are important to safety shall continue to perform their safety functions as required by 1.2.5 C#A.

D. SUPPLY structures, systems, and components important to safety shall meet the monitoring, control, inspection, testing, and maintenance requirements identified in 1.2.5 C#F.

E. SUPPLY shall, in combination with other 1.2.5 SUPPORT functions, meet the radiation protection requirements in 1.2.5 C#B.

F. Discharges of nonradioactive, hazardous materials to the environment by SUPPLY shall be managed such that, in combination with discharges from all other 1.2.5 SUPPORT functions, applicable federal, state, and local requirements are met [1.2.5 C#G].

INTERACTIONS:

	Function Interacted With	1.2.5.5 Requirement
1.2.1	MINING	PC#1a; C#A,B
1.2.2	WASTE HANDLING	PC#1a: C#A,B
1.2.3	PERFORMANCE CONFIRMATION	PC#1a; C#A,B
1.2.4	DECOMMISSIONING	PC#1a: C#A,B
1.2.5.6	MAINTENANCE	C#D
1.2.5.9	MONITORING	C#C,D
1.2.5.9.1	RADIOLOGICAL MONITORING	C#E
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#F
1.2.5.10	EMERGENCY PREPAREDNESS	C#C

1.2.5.6 MAINTENANCE

DEFINITION:

The function that provides the materials and services required for the maintenance and operation of the repository.

FUNCTIONAL REQUIREMENTS:

1. To provide maintenance for all structures, facilities, equipment, grounds, buildings, and other facilities under normal and emergency conditions.

PERFORMANCE CRITERIA:

1. Maintenance under normal conditions shall be adequate to support repository operations [GR 1.2.4.7 PC#1a].

2. Maintenance of structures, systems, and components important to safety shall be sufficient to ensure their continued functioning and readiness [10 CFR 60.131(b)(6)].

CONSTRAINTS:

A. Applicable requirements of Public Law 95-619, DOE Orders 4330.4 and 6430, Chapter I.3.M and XIX shall be complied with [GR 1.2.4.7 C#A].

B. An area should be provided for the decontamination and maintenance of contaminated equipment which cannot be remotely repaired in place. With respect to ventilation, confinement provisions, shielding, and liquid and solid waste control, this area should have all the features of the remote operating areas [GR 1.2.4.7 C#B]).

C. Applicable requirements of 30 CFR 31.9(b) and (e); 30 CFR 32.9(b) and (e); 10 CFR 50, Appendix B, NQA-1, and 10 CFR 20 and state and local codes shall be satisfied [GR 1.2.4.7 PC#1b].

D. MAINTENANCE shall comply with all design and maintenance requirements of 30 CFR 57 necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2.5 C#D]. Specific provisions include, but are not limited to, those requirements identified below:

1. Repair of Storage Facilities [57.6012]
2. Main Fan Maintenance [57.8525]
3. Tire Repair and Inflation [57.9069]
4. Procedures for Inspection, Testing, and Maintenance of Shaft and Hoisting Equipment [57.19120]
5. Records of Maintenance and Inspection [57.19121]
6. Replacement Parts for Hoists [57.19122]
7. Hoist Testing After Maintenance [57.19130(a)]
8. Housekeeping [57.2003]
9. Maintenance and Inspection of Firefighting Equipment [57.4200(b)(2), .4201, .4203]
10. Maintenance of Underground Fire Alarm Systems [57.4360]
11. Fuel Lines [57.4501, .4505]
12. Automatic Fire Suppression System for Underground Shops [57.4761(d)]
13. Repair and Maintenance of Transport Vehicles [57.6046-47]
14. Construction and Maintenance of Ventilation Doors [57.8531]
15. Rail Trackage [57.9016]
16. Aerial Tramway Maintenance [57.10002]
17. Construction and Maintenance of Ladders [57.11003]

18. Work on Electrically Powered Equipment and Power Circuits [57.12013, 16-17]
19. Pressure System Repairs [57.13019]
20. Construction and Maintenance of Machine Guards [57.14007]
21. Machinery Repair and Maintenance Procedures [57.14029]
22. Maintenance of Self-Rescue Devices [57.15030]
23. Shaft Inspection and Repair [57.19108-109]
24. Repair and Maintenance of Vehicles Containing Explosive or Detonators [57.6045-46]
25. Preparation of Pipelines or Containers [57.4604]
26. Gages and Regulations for Oxygen or Acetylene [57.4602-3]

E. All systems, structures, and components associated with MAINTENANCE functions that are important to safety shall continue to perform their safety functions as required by 1.2.5 C#A.

F. MAINTENANCE structures, systems, and components important to safety shall meet the monitoring, control, inspection, testing, and maintenance requirements identified in 1.2.5 C#F.

G. MAINTENANCE shall, in combination with other 1.2.5 SUPPORT functions, meet the radiaton protection requirements in 1.2.5 C#B.

H. Discharges of nonradioactive hazardous materials to the environment by MAINTENANCE operations shall be managed such that, in combination with discharges from all other 1.2.5 SUPPORT functions, applicable federal, state, and local requirements are met [1.2.5 C#G].

INTERACTIONS:

	Function Interacted With	1.2.5.6 Requirement
1.2.1	MINING	PC#1,2; C#D2, D4, D6, D7, D8, D11, D12, D14, D15, D16, D17, D18, D19, D20, D21, D23, D24, D25, D26
1.2.2	WASTE HANDLING	PC#1,2; C#A, B, D15
1.2.2.8	CONTAMINATION CONTROL	C#B
1.2.3	PERFORMANCE CONFIRMATION	PC#1,2; C#A
1.2.4	DECOMMISSIONING	PC#1,2; C#A
1.2.5	SUPPORT	PC#1,2; C#A
1.2.5.1	INFORMATION	C#D5
1.2.5.2	ADMINISTRATION	C#C
1.2.5.5	SUPPLIES	C#D1,D25,D26,D17,D6
1.2.5.6	MAINTENANCE	C#F
1.2.5.9	MONITORING	C#E,F
1.2.5.9.1	RADIOLOGICAL MONITORING	C#G
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#H
1.2.5.10	EMERGENCY PREPAREDNESS	C#D9,D10,D12,D22,E

1.2.5.7 UTILITIES

DEFINITION:

The function that provides and/or distributes commodities or services such as electricity, water, fuel, compressed air, steam, gas, or sanitation within the repository.

FUNCTIONAL REQUIREMENTS:

1. To provide water, fuel, sanitary and solid waste disposal, electric power, communications, and other utility services to meet the construction, operation, closure, and decommissioning needs of the repository.

2. To provide ventilation to surface facilities that are not covered by 1.2.2.7 WASTE-HANDLING VENTILATION and 1.2.1.6 MINING VENTILATION.

PERFORMANCE CRITERIA:

1. Utilities shall be provided to support repository operations under normal and accident conditions. Utility systems important to safety shall be designed so that essential safety functions can be performed under both normal and accident conditions [10 CFR 60.131(b)(5)(i)].

2. The quality and quantity of the conditioned or unconditioned fresh air supplied to surface facilities excluding those covered under 1.2.1.6 MINING VENTILATON and 1.2.2.7 WASTE-HANDLING VENTILATION shall provide a safe, effective, work environment for operating personnel. Air exhausting from such facilities shall be treated, if necessary, to meet environmental requirements [GR 1.2.4.8 PC#2].

CONSTRAINTS:

A. Applicable requirements of DOE Order 6430.1, Chapters I.3, V, VI, VII, VIII, IX, XIII, XVII, XXV, and XXVI and state and local codes shall be satisfied [GR 1.2.4.8 C#A].

B. UTILITIES services important to safety shall include redundant systems to the extent necessary to maintain, with adequate capacity, the ability to perform their safety functions [10 CFR 60.131(b)(5)(ii)].

C. Provisions shall be made so that, if there is a loss of the primary electric power source or circuit, reliable and timely emergency power can be provided to instruments, utility service systems, and operating systems, including alarm systems, important to safety [10 CFR 60.131(b)(5)(iii)].

D. An uninterruptible power supply system shall be available to ensure continuous operation of equipment and instrumentation related to critical safety functions and data processing needs [GR 1.2.4.8 PC#1f].

E. Effective communications capability in and between the surface and the subsurface facilities shall be established along with suitable safety alarm systems, where required. Closed-circuit television monitoring systems shall be provided in the critical areas of the waste-handling system and where necessary in other areas, such as rockhandling system [GR 1.2.4.8 PC#1g].

F. Power distribution system, including the primary and secondary substations, transmission lines, and feeder cables at the repository, shall be adequately designed with sufficient redundancy to meet the load requirements at points of usage throughout the operations. Suitable switching and protective devices shall be provided in the electrical system to prevent damage to the equipment in case of power failure or

faults. Sufficient metering shall be provided to establish the demand and consumption of power. Adequate surge protection on the system and a well engineeered grounding system shall be provided in order to maximize personnel and equipment safety [GR 1.2.4.8 PC#1e].

G. Water rights shall be obtained as may be needed to accomplish the purpose of the geologic repository operations area [10 CFR 60.121(c)].

H. Effluents discharged from facilities where radioactive contamination may lead to discharges in excess of 10 CFR 20 limits for discharges to unrestricted areas [10 CFR 20.106] shall meet the requirements for disposal in 10 CFR 20.303.

I. Solid waste disposal shall meet the requirements in 1.2.4 C#F.

J. Discharges of nonradioactive hazardous materials to the environment by UTILITIES operations shall be managed such that, in combination with discharges from all other 1.2.5 SUPPORT FUNCTIONS, applicable Federal, State, and local requirements are met [1.2.5 C#G].

K. UTILITIES design and operation shall comply with all requirements of 30 CFR 57 necessary to protect workers in such a way that systems, strucutures, and components important to safety can perform their intended functions [1.2.5 C#D]. Specific provisions for UTILITIES include, but are not limited to those areas identified below:

1. Potable Water [57.20002]
2. Underground Trailing Cables [57.4057]
3. Location of Transformer Stations Underground [57.4462]
4. Lightning Protection of Conductor or Telephone Line [57.12069]
5. Trailing Cable Installation [57.12038-39]
6. Refuse and Waste Receptacles [57.20013]
7. Emergency Telephone Numbers, Communications System, Medical Assistance, and Transportation [57.18012-14]
8. Illumination of Working Areas [57.1700]
9. Moving of Energized Power Cables [57.12014]

10. Work on and Around Electrical Equipment: Signs, Clearance: Deenergizing and Securing [57.12016-17, 19, 21-22]
11. Identification of Power Switches [57.18018]
12. Grounding [57.12025-28]
13. Protection of Persons at Switchgear [57.12020]
14. Installation of Overhead Powerlines, Guywires, and Communication Conductors to Meet National Electrical Code [57.12045, 47-48]
15. Installation of Operating Controls [57.0040]
16. Correction of Dangerous Conditions [57.12030]
17. Electrical Cover and Inspection Plates [57.12032]
18. Outlets, Sockets, or Connectors Exposed to Weather [57.12035]
19. Fuses [57.12036-37]
20. Location and Securing of Electrical Transformers [57.12067, 68, 85]
21. Locating High-Voltage Power Lines Above Roadways [57.12071]
22. Pressure Vessel Construction, Installation, and Maintenance to Specifications of American Society of Mechanical Engineers Boiler and Pressure Vessel Code [57 Subpart L]
23. Battery-Charging Stations [57.4020]
24. Size, Insulation, and Protection of Electrical Circuits, Trailing Cables, and Power Cables [57.12001-008, 0111, 014, 041]
25. Communication Conductors Insulation From Powerlines [30 CFR 57.12010]
26. Voltage in Bare Signal Wires [57.12012]
27. Signaling Between Shaft Stations and Hoist Room [57.19090]
28. Splices and Repairs in Power Cables [57.12013]
29. Telephones or Other Two-Way Communication Between Surface and Underground [57.2032]
30. Track Bonding for Trolley Circuit [57.12042]
31. Guards Around Lights [57.12034]
32. Guarding Trolley Wires and Bare Power Lines [57.12066]
33. Branch Circuit Disconnecting Devices [57.12084]
34. Splices in Trailing Cables [57.12088]
35. Individual Electric Lamps Underground [57.17010]
36. Communication With Refuge Chambers, Independence From Mine Power Supply [57.11054]

37. Shaft Station Waterlines for Fire-Fighting [57.4200, 4261]
38. Construction of Water Retaining Dams [57.20010]
39. Insulation and Isolation of Heat Sources [57.4500]
40. Abandoned Electrical Circuits [57.4011]
41. Insulation of Power Wires and Cables Through Walls and Doors or Where a Fire Hazard [57.4010]

L. All systems, structures, and components associated with UTILITIES functions that are important to safety shall continue to perform their safety functions to meet the requirements of 1.2.5 C#A.

M. UTILITIES structures, systems, and components important to safety shall meet the monitoring, control, inspection, testing, and maintenance requirements identified in 1.2.5 C#F.

N. UTILITIES shall, in combination with other 1.2.5 SUPPORT functions, meet the radiation protection requirements identified in 1.2.5 C#B.

O. Necessary offsite utility services, such as power, water, and communications capable of meeting repository needs, shall be available to meet the schedules of construction and operation of the repository [GR 1.2.4.2 PC#1b].

INTERACTIONS:

	Function Interacted With	1.2.5.7 Requirement
	SOCIETAL	PC#1; C#D, K7
1.2.1	MINING	PC#1; C#A, D, K2, K3, K5, K8, K9, K21,K22, K23, K26, K27, K29, K30, K32
1.2.2	WASTE HANDLING	PC#1,2; C#A,D,H, K2, K3, K5, K8, K9, K21, K22, K23, K26, K27, K29, K30, K32

	Function Interacted With	1.2.5.7 Requirement
1.2.2.8	CONTAMINATION COONTROL	C#H
1.2.3	PERFORMANCE CONFIRMATION	PC#1,2; C#K8
.2.4	DECOMMISSIONING	PC#1,2; C#A,K2, K3, K5, K8, K22, K23
1.2.5.2	ADMINISTRATION	C#G, K16
1.2.5.3	PERSONNEL SERVICES	C#K7, K36
1.2.5.6	MAINTENANCE	C#M
1.2.5.8	TRANSPORTATION	C#K7
1.2.5.9	MONITORING	C#L,M
1.2.5.9.1	RADIOLOGICAL MONITORING	C#H,N
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#O
1.2.5.10	EMERGENCY PREPAREDNESS	C#K37, K38, L
2.0	POSTCLOSURE WASTE DISPOSAL	C#G

1.2.5.8 SURFACE TRANSPORTATION

DEFINITION:

The function that provides facilities and equipment for onsite surface movement of personnel, equipment, and materials, excluding radioactive waste or any excavated rock from underground operations.

FUNCTIONAL REQUIREMENTS:

1. To provide operation and maintenance of surface transportation for personnel, equipment, and materials during the construction operation, closure, and decommissioning of the repository.

2. To provide transport of personnel and materials during emergency conditions.

PERFORMANCE CRITERIA:

1. SURFACE TRANSPORTATION shall be sufficient to support preclosure operations [1.2 PC#1].

2. SURFACE TRANSPORTATION shall provide features for ease of evacuation and shall be capable of evacuating personnel to safety within a reasonable period of time [GR 1.2.4.9 PC#2].

CONSTRAINTS:

A. SURFACE TRANSPORTATION shall meet the applicable requirements of DOE Orders 1540.1 and 5480.1A, Chapter 1.11, and other Federal, State, and local requirements [GR 1.2.4.9 C#A].

B. 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 [10 CFR 60.131(b)(4)].

C. SURFACE TRANSPORTATION design and operation shall comply with all requirements of 30 CFR 57 necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2.5 C#D]. Specific provisions for SURFACE TRANSPORTATION include, but are not limited to, those requirements identified below:

1. Transportation and Handling of Explosives [57.6040-6077, 6200]
2. Warning Devices for Parked Equipment [57.9068].

D. All systems, structures, and components associated with SURFACE TRANSPORTATION functions that are important to safety shall continue to perform their safety functions as required by 1.2.5 C#A.

E. SURFACE TRANSPORTATION structures, systems, and components important to safety shall meet the monitoring, control, inspection, testing, and maintenance requirements identified in 1.2.5 C#E.

F. SURFACE TRANSPORTATION shall, in combination with other 1.2.5 SUPPORT functions, meet the radiation protection requirements identified in 1.2.5 C#B.

G. Discharges of nonradioactive hazardous materials to the environment as a result of SURFACE TRANSPORTATION shall be limited such that, in combination with other 1.2.5 SUPPORT functions, applicable federal, state, and local limits are not exceeded [1.2.5 C#G].

H. Necessary offsite transportation facilities, such as roads and railroads in the vicinity of the repository site, shall be available and have the capacity to meet the scheduled start-up date and receipt rates [GR 1.2.4.2 PC#1a].

INTERACTIONS:

	Function Interacted With	1.2.5.8 Requirement
	SOCIETAL	C#B
1.2.1	MINING	PC#1,2; C#C1
1.2.2	WASTE HANDLING	PC#1,2
1.2.4	DECOMMISSIONING	PC#1,2
1.2.5	SUPPORT	PC#1,2
1.2.5.5	SUPPLIES	C#C1
1.2.5.6	MAINTENANCE	C#E
1.2.5.9	MONITORING	C#D,E
1.2.5.9.1	RADIOLOGICAL MONITORING	C#F
1.2.5.9.2	NONRADIOLOGICAL MONITORING	C#G
1.2.5.10	EMERGENCY PREPAREDNESS	PC#2; C#B,D,L

This page intentionally left blank.

1.2.5.9 MONITORING

Subfunctions are:

1.2.5.9.1 RADIOLOGICAL MONITORING
1.2.5.9.2 NONRADIOLOGICAL MONITORING

DEFINITION:

The function provides the capability to sense, measure, and report radiological and nonradiological conditions.

FUNCTIONAL REQUIREMENTS:

1. To detect, monitor, and report radiation exposure to individuals involved in repository operations, radiation levels and concentrations of radioactive materials in surface and underground portions of the repository, and concentrations of radioactive materials in effluents.

2. To detect, monitor, and report surface and subsurface nonradiological conditions in the repository that may affect the health and safety of the general public and repository workers.

3. To provide warning systems (e.g., alarms) to alert repository workers and 1.2.5.10 EMERGENCY PREPAREDNESS that potentially hazardous conditions exist.

4. To monitor natural and engineered systems and components required for repository operation.

PERFORMANCE CRITERIA

1. Radiological monitoring shall provide the capability to detect and record those radiation exposures, radioactivity levels, and concentrations of radioactive species in repository areas and in effluents that are necessary to meet the requirements of 10 CFR 60.131(a), the public exposure requirements in 40 CFR 191 Subpart A, and other applicable local, State, and Federal standards [GR 1.2 PC#3a].

2. Nonradiological monitoring shall conform with the requirements in 40 CFR 1505.2(c) and take into account the requirements of DOE Order 5480.4, "Environmental Protection, Safety, and Health Protection Standards," and shall meet the requirements of other applicable local, State, and Federal standards [GR 1.2 PC#3a; 1.2.3 PC#2]. The capability shall be provided to detect those conditions in effluents and the physical, chemical, and biological environment that are associated with hazards to repository workers and the general public.

3. Warning systems shall be sufficient to warn of significant increases in radiation levels, concentrations of radioactive materials in air, and of increased radioactivity released in effluents [10 CFR 60.131(a)(6)], and to meet health and safety requirements for protection from nonradiological hazards. Warning systems shall be sufficient to meet the requirements of 1.2.5.10 EMERGENCY PREPAREDNESS.

4. Data from routine monitoring of natural and engineered systems and components, required for repository operation shall be sufficent to to support the requirements of 1.2.3 PERFORMANCE CONFIRMATION [10 CFR 60.141(a)(2)].

CONSTRAINTS:

A. Monitoring, instrumentation and control of 1.2 REPOSITORY systems important to safety shall be provided to monitor behavior over anticipated ranges for normal operation and for accident conditions (to ensure contained function and readiness) [10 CFR 60.131(b)(8)].

B. The reporting of monitoring and other environmental, safety, or health-related information shall be done in accordance with the requirements of DOE Order 5484.1A and 5484.2 [GR 1.2.3 C#B].

C. Environmental protection, safety, and health protection measures shall be subject to the internal controls established under DOE Order 5482.1A [GR 1.2.3 C#C].

D. All MONITORING systems, structures, and components important to safety shall continue to perform their safety functions as required by 1.2.5 C#A.

E. MONITORING shall be sufficient in emergency situations to allow maintenance of control of radioactive waste and effluents; permit prompt termination of operations; and permit evacuation of personnel [10 CFR 60.131(b)(4)].

F. MONITORING structures, systems, and components important to safety shall meet the monitoring, control, inspection, testing, and maintenance requirements identified in 1.2.5 C#E.

G. Radiation protection requirements identified in 1.2.5 C#B shall apply to workers involved in MONITORING.

H. MONITORING shall comply with all requirements of 30 CFR 57 necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended fuctions [1.2.5 C#D].

I. Data from MONITORING shall be sufficient to determine whether 1.2 REPOSITORY functions are meeting the radiation protection requirements identified in 1.0 C#A.

J. Data from MONITORING shall be sufficient to determine whether 1.2 REPOSITORY functions meet the limits established in 1.2 C#C and applicable Federal, State, and local regulations for release of (hazardous) nonradioactive waste to the accessible environment.

K. MONITORING shall provide any additional data required for evaluation of the performance of 1.0 PRECLOSURE WASTE DISPOSAL functions relative to applicable Performance Criteria and Constraints.

L. MONITORING shall be sufficient to determine that 1.2 REPOSITORY functions meet the nuclear criticality requirements identified in 1.0 C#W.

M. MONITORING shall be sufficient to determine whether 1.2 REPOSITORY functions comply with the applicable requirements in 30 CFR Part 57 [1.0 C#BB].

INTERACTIONS:

	Function Interacted With	1.2.5.9 Requirement
1.2.5.10	EMERGENCY PREPAREDNESS	PC#1,2,3; C#D
1.2.1	MINING	C#A,I,J,K,M
1.2.2	WASTE HANDLING	C#A,I,J,K,L,M
1.2.3	PERFORMANCE CONFIRMATION	PC#4; C#A,I,J,K,M
1.2.4	DECOMMISSIONING	C#A,I,J,K,M
1.2.5	SUPPORT	C#A,I,J,K,M
1.2.5.1	INFORMATION	C#B
1.2.5.2	ADMINISTRATION	C#C
1.2.5.6	MAINTENANCE	C#F

1.2.5.9.1 RADIOLOGICAL MONITORING

DEFINITION:

The function that measures radiation exposure, radiation levels, and concentration of radioactive materials, and which alerts workers and 1.2.5.10 EMERGENCY PREPAREDNESS.

FUNCTIONAL REQUIREMENTS:

1. To monitor the radiation exposure of repository personnel and visitors within the restricted area.

2. To measure and report the amount and concentration of radionuclides in repository effluents.

3. To monitor radiation levels in selected surface and subsurface parts of the repository.

4. To activate alarm systems that notify EMERGENCY PREPAREDNESS of conditions that exceed established radiation limits.

PERFORMANCE CRITERIA:

1. Personnel monitoring shall be sufficient for all 1.2 REPOSITORY functions to determine compliance with the occupational dose requirements in 10 CFR 20.101.

2. Effluent monitoring systems shall measure the amount and concentrations of the radionuclides in any effluent with sufficient precision to determine whether releases from all 1.2 REPOSITORY functions conform to the

unrestricted area effluent release limits specified in 10 CFR 20.105, .106, and .303 [10 CFR 60.132(c)(2)]. Monitoring shall also be sufficient to support the monitoring requirements of 30 CFR 57.5.

3. Radiation level monitoring for all 1.2 REPOSITORY functions shall be of sufficient precision to determine whether an individual at the outer boundary of the restricted area receives a dose to the whole body in any one period of a calendar year in excess of .5 rem. Additionally, monitoring must be done with sufficient precision to determine whether the radiation level in an unrestricted area from licensed material will, if an individual were continuously present in the area result in his receiving a dose of 2 millirems in any one hour or 100 millirems in any seven consecutive days [10 CFR 60.132(c)(2)].

4. The radiation alarm system for all 1.2 REPOSITORY functions shall warn of significant increases in radiation levels, concentrations of radioactive material in air, and of increased radioactivity released in effluents [10 CFR 60.131(a)(6)].

CONSTRAINTS:

A. Personnel monitoring equipment shall be provided to the following personnel [10 CFR 20.202]:

   1. Each individual who enters a restricted area under such circumstances that he receives or is likely to receive a dose in any calendar quarter in excess of 25 percent of the applicable value specified in 10 CFR 20.101.

   2. Each individual under 18 years of age who enters a restricted area under such circumstances that he receives or is likely to receive a dose in any calendar quarter in excess of 5 percent of the applicable value specified in 10 CFR 20.101.

   3. Each individual who enters a high radiation area.

B. Monitoring systems shall be designed to include alarms that can be periodically calibrated and tested [10 CFR 60.131(a)(6), .132(c)(2)].

C. Radon daughter sampling shall be done using equipment and procedures equivalent to those described in the current version of ANSI Standard N13.8--1973, Section 14.3 [30 CFR 57.5037].

D. Ambient air and exhaust monitoring systems shall be located to permit monitoring of airborne releases. Monitors should be selected, tested, and calibrated in accordance with the most current version of ANSI Standard N13.1, "Guide to Sampling Airborne Radioactive Materials in a Nuclear Facility" [GR 1.2.3.1 PC#2b].

E. Radiation monitoring systems shall be selected, installed, tested, and calibrated following the recommendations of the most current version of ANSI Standard N42.18--1980, Reaffirmation of N13.10--1974, "Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents" [GR 1.2.3.1 PC#2c].

F. Effluents shall be monitored in accordance with DOE Order 5484.1 Chapter III - Section 5 which also references DOE Order 5480.1 Chapters I, XI, and XII and other Federal, State, and local standards where applicable [GR 1.2.3.1 PC#2d].

G. Portable instrumentation shall be available as needed and shall comply with the most current version of ANSI Standard N13142 WG4 "Radiation Protection Instrumentation and Calibration-Final" [GR 1.2.3.1 PC#3a].

H. Criticality safety and prevention shall be provided in accordance with DOE Order 5480.1A Chapter 5, Section 9 [GR 1.2.3.1 PC#3b].

I. Radiation levels in all 1.2 REPOSITORY functions shall be monitored to show compliance with any state and local standards that apply [GR 1.2.3.1 PC#3c].

J. Ambient air and exhaust monitoring systems shall include readout and present alarms [GR 1.2.3.1 PC#4a].

K. To provide for a nuclear accident, alarms shall meet the current versions of ANSI/ANS 8.3 "Criticality Accident Alarm System," and dosimetry shall meet ANSI NI3.3 "Dosimetry for Criticality Accidents" [GR 1.2.3.1 PC#4b].

L. Qualified health physics personnel shall be available to analyze exposure information and determine necessary actions [GR 1.2.3.1 PC#4c].

M. RADIOLOGICAL MONITORING for all 1.2 REPOSITORY functions shall comply with all requirements of 30 CFR 57 necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2.5.9 C#H]. Specific requirements for RADIOLOGICAL MONITORING include, but are not necessarily limited to, those requirements identified below:

1. Radon Daughter Exposure Monitoring [57.5037].
2. Annual Radon Daughter Exposure Limits [57.5038].
3. Maximum Permissible Radon Daughter Concentration [57.5039].
4. Exposure Records [57.5040].
5. Prohibition of Smoking in Areas Where Exposure Records are Required [57.5041].
6. Precedence of EPA Radon Daughter Exposure Levels [57.5042].
7. Wearing of Respirators [57.5044].
8. Posting of Inactive Areas [57.5045].
9. Protection Against Radon Gas [57.5046].
10. Gamma Radiation Surveys [57.5047].

N. The Safety Analysis Report that accompanies the license application shall contain a description of the program for control of monitoring of radioactive effluents and occupational radiation exposures to maintain such effluents in accord with the requirements of 10 CFR 20 [10 CFR 60.121(c)(7)].

O. All systems, structures, and components associated with RADIOLOGICAL MONITORING functions that are important to safety shall continue to perform their safety functions as required by 1.2.5.9 C#D.

P. RADIOLOGICAL MONITORING structures, systems, and components important to safety shall meet the monitoring, control, inspection, testing, and maintenance requirements in 1.2.5.9 C#F.

Q. RADIOLOGICAL MONITORING shall, in combination with other 1.2.5.9 MONITORING functions, meet the radiation protection requirements in 1.2.5.9 C#B.

R. Such surveys as may be necessary to comply with regulations in 10 CFR 20 and are reasonable under the circumstances to evaluate the extent of radiation hazards that may be present shall be made [10 CFR 20.201(b)].

S. RADIOLOGICAL MONITORING for nuclear criticality shall be sufficient to support the determination that the criticality requirements identified in 1.0 C#W are met for all applicable 1.2 REPOSITORY functions [1.2.5.9 C#L].

T. RADIOLOGICAL MONITORING shall be sufficient in emergency conditions to assist in maintaining control of radioactive waste and effluents; permit prompt termination of operations; and to permit excavation of personnel [10 CFR 60.131(b)(4)].

U. Loaded or unloaded transportation vehicles and components shall be checked for radiation and external radioactive contamination and decontaminated as necessary before further processing [GR 1.2.2.1 PC#3].

V. Waste canisters shall be inspected as necessary upon receipt to determine surface dose rates, heat output, gasses, and surface contamination [GR 1.2.2.1 PC#5].

INTERACTIONS:

	Function Interacted With	1.2.5.9.1 Requirement
	SOCIETAL	C#F,I
1.2.1	MINING	PC#1,2,3,4; C#D
1.2.2	WASTE HANDLING	PC#1,2,3,4; C#D,U,V
1.2.3	PERFORMANCE CONFIRMATON	PC#1,2,3,4; C#C,D,H,V
1.2.4	DECOMMISSIONING	PC#1,2,3,4; C#C,D
1.2.5	SUPPORT	PC#1,2,3,4
1.2.5.2	ADMINISTRATION	C#N
1.2.5.3	PERSONNEL SERVICES	C#A
1.2.5.6	MAINTENANCE	C#B,P
1.2.5.10	EMERGENCY PREPAREDNESS	PC#4; C#O,P,T

1.2.5.9.2 NONRADIOLOGICAL MONITORING

DEFINITION:

The function that measures physical, chemical, and biological characteristics of the repository and adjacent off-site areas, and alerts workers when measurements exceed safe limits.

FUNCTIONAL REQUIREMENTS:

1. To monitor air quality (which includes but is not limited to: the physical, chemical and biological characteristics of process air emissions, as well as such characteristics of the ambient air and meteorological parameters).

2. To monitor water quality (which includes but is not limited to: the physical, chemical, and biological characteristics of potable water and process wastewaters, any receiving water bodies, and any other water bodies that could potentially be affected by repository operations).

3. To monitor noise levels.

4. To monitor seismic and tectonic parameters.

5. To detect fires and explosions.

6. To monitor other environmental and operating parameters necessary to support safe operation of the repository and monitoring of repository performance.

7. To alert repository workers and 1.2.5.10 EMERGENCY PREPAREDNESS of potentially dangerous situations involving nonradioactive, hazardous material.

PERFORMANCE CRITERIA:

1. a. The air quality monitoring system must have the capability to sample, measure, and analyze physical and chemical conditions consistent with the requirements of the Clean Air Act (42 U.S.C. 7401). Such capability must also be compatible with the type and range of concentrations/occurrences of conditions specified in the governing regulations (e.g., 40 CFR 50, 40 CFR 60, and applicable State and local regulations) [GR 1.2.3.2 PC#1a].

   b. Flammable gases shall be monitored in accordance with DOE Order 5480.1A, Chapter I, Section 9 h.(1)(b) and any other applicable local, state, and federal regulations [GR 1.2.3.2 PC#1b].

   c. Explosive gases shall be monitored in accordance with 30 CFR 57.2039, 40, 80, 99, 100 (for Methane), 30 CFR 57.2065 (Carbon Monoxide and Methane), and any other applicable local, state, and Federal regulations [GR 1.2.3.2 PC#1c].

   d. Particulates in gases shall be monitored in accordance with 30 CFR 57.5001, 5002, 5005, and any other applicable local, state, and Federal regulations [GR 1.2.3.2 PC#1d].

   e. Noxious gases shall be monitored in accordance with 30 CFR 31.9(a)(4), 32.9(a)(4), and any other applicable local, state, and Federal regulations [GR 1.2.3.2 PC#1e].

2. The water quality monitoring system must have the capability to sample, measure, and analyze physical, chemical, and biological conditions consistent with the requirements of the Clean Water Act (33 U.S.C. 1251) and the Safe Drinking Water Act (42 U.S.C. 300f). Such capability must also be compatible with the type and range of concentrations/occurrences of conditions specified in the governing regulations (e.g., 40 CFR 122, 125, 141, 142, 143, and state and local regulations [GR 1.2.3.2 PC#2].

3. a. The noise-level monitoring system must be consistent with requirements of the Noise Pollution and Abatement Act (Title IV of the Clean Air Act) and shall be compatible with the types of measurements specified in the appropriate noise control regulations (40 CFR 204 and applicable state and local regulations) [GR 1.2.3.2 PC#3a].

   b. Noise levels shall be monitored in accordance with 29 CFR 1910.95(d), 29 CFR 1926.52, and 30 CFR 57.5-50 [GR 1.2.3.2 PC#3b].

4. a. A monitoring system to make any required seismic activity measurements to support repository operations shall be provided [GR 1.2.3.2 PC#4a].

   b. If first motion indication is required, a strong motion indicator should be used where necessary [GR 1.2.3.2 PC#4b].

   c. Monitoring shall be provided on a continual 7-day basis in order to estimate the amount of energy release of any seismic event along with its depth and location. Monitoring shall provide a sufficient number of stations to obtain event locations in three dimensions [GR 1.2.3.2 PC#4c].

5. Explosion and fire detection alarm systems shall be included in the geologic repository operations area with suppression systems with sufficient capacity and capability to reduce the adverse effects of fires and explosions on systems important to safety, [10 CFR 60.131(b)(3)]. Detection equipment for fires and explosions shall be in accordance with DOE Order 5480.1A, Chapter VII; DOE Order 6430.1, Chapter X.8; and any other applicable local, state, and Federal regulations [GR 1.2.3.2 PC#5].

6. Data from routine monitoring of other operating environmental parameters shall be sufficient to support the evaluation requirements of 1.2.3 PERFORMANCE CONFIRMATION Monitoring and would likely include the capability for detecting malfunction of selected equipment used in the operation of the repository such as hoists and transportation vehicles [GR 1.2.3.2 PC#6].

7. Alarm systems shall be sufficient to alert workers and 1.2.5.10 EMERGENCY PREPAREDNESS when the various monitored conditions exceed predetermined, specified limits. Redundant systems shall be as required by applicable regulations [GR 1.2.3.2 PC#7].

CONSTRAINTS:

A. NONRADIOLOGICAL MONITORING shall comply with all additional requirements of 30 CFR 57 necessary to protect workers in such a way that systems, structures, and components important to safety can perform their intended functions [1.2.5.9 C#H]. Specific requirements for NONRADIOLOGICAL MONITORING include, but are not necessarily limited to, those requirements identified below:

1. Monitoring for Re-entry to Blasting Areas [57.6139]
2. Oxygen Deficiency [57.5015]
3. Air Quality Monitoring [57.8518, 12, 34]
4. Dust, Gas, Mist, and Fume Surveys [57.5002]
5. Exposure Limits for Noise [57.5050]
6. Exposure Limits, Monitoring, and Control of Exposure to Airborne Contaminants [57.5001, 002, 005]
7. Toxic Materials [57.20812]
8. Control of Employee Exposure [57.5005]
9. Tests for Explosive Dusts [57.20009]
10. Pre-Shift Examinations [57.21059]
11. Permissible Testing Devices [57.21064]

12. Examination for Hazardous Conditions [57.21065]
13. Hazardous Condition Reports [57.21066]
14. Methane Monitors (if applicable) [57.21080]
15. Check-in Check-out Systems [57.16058]
16. Testing for Methane [57.21012]
17. Unsafe Methane Levels [57.21013]
18. Fan Operation and Inspection [57.21021]
19. Main Fan Failure [57.21024]
20. Failure of Main Ventilation [57.21025]
21. Booster Fan Safety Devices [57.21029]
22. Auxiliary Fan Requirements [57.21030]
23. Auxiliary Fan Inspection [57.21031]
24. Weekly Air Flow Measurements [57.21035]
25. Changes in Ventilation [57.21036]
26. Action if Methane is Present [57.21039-40, 45]
27. Blasting on Shift [57.21099]
28. Shaft Inspection [57.19133].

B. All systems, structures, and components associated with NONRADIOLOGICAL MONITORING functions that are important to safety shall continue to perform their safety functions as required by 1.2.5.9 C#D.

C. NONRADIOLOGICAL MONITORING structures, systems, and components important to safety shall meet the monitoring, control, inspection, testing, and maintenance requirements of 1.2.5.9 C#F.

D. NONRADIOLOGICAL MONITORING shall, in combination with other 1.2.5 SUPPORT functions, meet the radiation protection requirements in 1.2.5.9 C#I.

E. NONRADIOLOGICAL MONITORING shall be sufficient to support the determination that the nuclear criticality requirements identified in 1.0 C#W are being met by 1.2 REPOSITORY functions [1.2.5.9 C#L].

F. NONRADIOLOGICAL MONITORING shall be sufficient to determine that all applicable 1.2 REPOSITORY functions comply with the applicable mine safety requirements in 30 CFR Part 57.

G. NONRADIOLOGICAL MONITORING shall provide monitoring over the anticipated ranges for normal operation and accident conditions for all 1.0 PRECLOSURE WASTE DISPOSAL systems, structures and components important to safety [1.0 C#AA].

INTERACTIONS:

	Function Interacted With	1.2.5.9.2 Requirement
1.2.1	MINING	PC#1,3b,4,5,6,7; C#A,F,G
1.2.2	WASTE HANDLING	PC#1a,3a,4,5,6,7; C#E,F,G
1.2.3	PERFORMANCE CONFIRMATON	PC#1,2,3,4,5,6,7; C#E,G
1.2.4	DECOMMISSIONING	PC#1,3a,3b,7; C#A,G
1.2.5	SUPPORT	PC#1,2; C#G
1.2.5.1	INFORMATION	C#A13
1.2.5.2	ADMINISTRATION	C#A15
1.2.5.3	PERSONNEL SERVICES	C#A
1.2.5.6	MAINTENANCE	C#C
1.2.5.7	UTILITIES	PC#1a,2
1.2.5.9.1	RADIOLOGICAL MONITORING	C#
1.2.5.10	EMERGENCY PREPAREDNESS	PC#5,7; C#A,B

1.2.5.10 EMERGENCY PREPAREDNESS

DEFINITION:

The function that provides for the planning and implementation of activities to respond to radiological and nonradiological emergencies at the repository.

FUNCTIONAL REQUIREMENTS:

1. To develop and implement plans and procedures that provide for the safety of repository workers and the general public in the event of an emergency involving the release or potential release of radioactive materials.

2. To develop and implement plans and procedures that provide for the safety of repository workers and the general public in the event of an emergency involving a harmful or life-threatening occurrence or the release of toxic, nonradiological materials.

PERFORMANCE CRITERIA:

1. EMERGENCY PREPAREDNESS SYSTEM shall meet the requirements of DOE Order 5500.3, "Reactor and Nonreactor Nuclear Facility Emergency Planning and Response Program for Department of Energy Operations," and related guides or when issued the requirements in 10 CFR 60 Subpart I, "Emergency Planning Criteria" [10 CFR 960.5-2-1(d)].

2. EMERGENCY PREPARDNESS for nonradiological emergencies shall meet the applicable requirements of DOE Orders 5500.2 "Emergency Planning, Preparedness and Response for Operations," and 5480.1A "Environmental Safety, and Health Protection Program for DOE Operations," and 30 CFR Part 57.

CONSTRAINTS:

A. Radiological emergency response for protection of repository workers and the general public shall meet the requirements in the Radiologial Emergency Response Plan developed in accordance with DOE Order 5500.3, Attachment 1. Emergency response shall include, but not necessarily be limited to, the requirements identified below:

1. Protective measures as appropriate for the entire range of credible accidents that could occur shall be provided [DOE Order 5500.3, Attachment 1].

2. The parameters for which planning is recommended shall be based on site-specific technical analyses of the consequences of the potential accidents which could occur and the characteristics of the associated radioactivity release.

3. In planning, existing Safety Analysis Reports should be reviewed for appropriateness and used where appropriate.

4. Planned response shall be based on a set of Protective Response Recommendations (PRRs), projected off-site doses that trigger protective measures. [DOE Order 5500.3 Paragraph 5(q)]. DOE is developing PRRs for site specific guidelines. Until the PRRs are approved, the side criteria in 10 CFR Part 100 can be used.

5. Site-specific Emergency Planning Zones (EPZs) shall be developed with the concurrence of the Assistant Secretary for Environmental Protection, Safety, and Emergency Preparedness (EP-1) to ensure interaction and understanding between federal, state, and local emergency management officials. These radiological emergency planning zones are based on plume and ingestion exposure pathways [DOE 5500.3, (8)(a)].

6. Four emergency response levels shall be associated with emergency situations to be used in conjunction with site-specific PRRs provide for a graduated emergency response [DOE 5500.3(6)]:

   a. Unusual Event
   b. Alert
   c. Site Emergency
   d. General Emergency

7. Emergency preparedness should be developed and implemented with participation of State, and local governments [DOE 5500.3]. Generally, in operations:

   a. DOE will be responsible for radiological emergencies contained within site boundaries.

   b. Local governments will be responsible for protective actions in the area encompassed in the Plume Exposure Pathway EPZ.

   c. State governments are responsible for protective actions in the Ingestion Exposure Pathway EPZ.

8. Responsibilities of Federal, State, and local emergency response organizations shall be as defined in DOE 5500.3.

9. General form and content of site-specific Emergency Response Plans shall conform with DOE Order 5500.3, Attachment 1, Paragraph 1(f) and 2 and shall meet the requirements identified below:

   a. Organization and Assignment Responsibilities
   b. Emergency Response Support and Resources--both on- and off-site
   c. Emergency Response Level Plans
   d. Notification Methods and Procedures
   e. Emergency Communications

f. Public Information and Organization
g. Emergency Facilities and Equipment
h. Accident Assessment
i. Protective Response
j. Radiological Exposure Control
k. Medical and Health Support
l. Recovery and Reentry Planning and Postaccident Operations
m. Simulation exercises under simulated conditions that correspond to potential credible emergencies

10. Memoranda of Understanding and Letters of Agreement shall be entered into by the DOE field office with on-site non-DOE operators and off-site support organizations. These written agreements shall be contained as a reference in the site-specific written radiological emergency plan [DOE 5500.3].

11. Site-Specific Radiological Emergency Response Plans and associated documents shall be reviewed for the presence of classified information [DOE Order 5500.2, Attachment 2, Paragraph 9].

B. The geologic repository operations area shall be designed to include on-site facilities and services that ensure a safe and timely response to emergency conditions and that facilitate the use of off-site services (such as fire, police, medical, and ambulance service) that may aid in recovery from emergencies [10 CFR 60.131(b)(4)(ii)].

C. All 1.2 REPOSITORY structures, systems, and components important to safety shall be designed to maintain control of radioactive waste and radioactive effluents and permit prompt termination of operations and evacuation of personnel during an emergency [10 CFR 60.131(b)(4)(i)].

D. Nonradiological emergency preparedness shall be conducted in accordance with applicable provisions of DOE Order 5500.2, "Emergency Planning, Preparedness, and Response for Operations," and DOE Order 5480.1A, "Environmental Protection, Safety, and Health Protection Program for DOE Operations."

E. EMERGENCY PREPAREDNESS shall comply with the requirements of 30 CFR 57 necessary to protect workers in such a way that systems, stuctures, and components important to safety can perform their intended function [1.2.5 C#D]. Specific requirements for EMERGENCY PREPAREDNESS include, but are not necessarily limited to, the requirements identified below:

1. Surface Firefighting, Evacuation, and Rescue Procedures [57.4330]
2. New Employee Indoctrination [57.18006]
3. Designation of Person in Charge [57.18009]
4. Underground Evacuation Drills [57.4361]
5. Underground Evacuation Instruction [57.4363]
6. First Aid Materials [57.15001]
7. Escape and Excavation Plans [57.11051, 53]
8. Procedures for Welding, Cutting, Compressed Gasses [57.4600-.4603, .21012-13]
9. Flammable and Combustible Liquids and Gasses [57.4400, .4463, .4531]
10. Fuel Lines [57.4501]
11. Firefighting Equipment [57.4200-.4263]
12. Fire Protection [57.6042]
13. Location, Construction, and Operation of Ventilation Doors [57.4760]
14. Fire Doors [57.4760-61]
15. Escapeways and Refuges [57.11050]
16. Refuge Areas [57.11052]
17. Emergency Hoisting Equipment and Designated Escapeways [57.11055-56]
18. Approval Self-Rescue Device [57.15030]
19. Escape Route Inspection and Maintenance [57.11051]
20. Special Protective Equipment and Clothing [57.15006]
21. First Aid Training [57.18010]
22. Fire Alarm System [57.4430]
23. Escape Exits from Building or Structures [57.4530]
24. Emergency Medical Assistance and Transportation [57.4560]
25. Fire-retardant Treatment of Timber in Mine Entrances [57.4560]
26. Fire Protection in Underground Belt Conveyors [57.4263]
27. Stationary Diesel Equipment [57.4561]

F. EMERGENCY PREPAREDNESS shall, in combination with other 1.2.5 SUPPORT functions, meet the radiation protection requirements in 1.2.5 C#B.

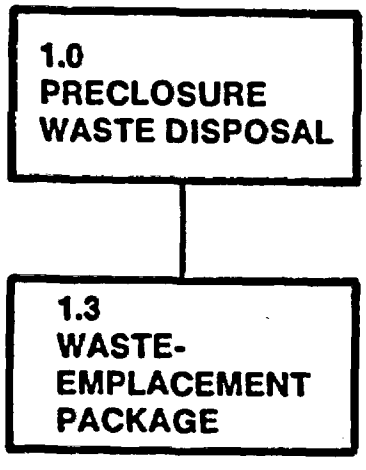
G. All systems, structures, and components associated with EMERGENCY PREPAREDNESS functions that are important to safety shall continue to perform their safety functions as required by 1.2.5 C#A.

H. EMERGENCY PREPAREDNESS structures, systems, and components important to safety shall meet the monitoring, control, inspection, testing, and maintenance requirements in 1.2.5 C#G.

INTERACTIONS:

	Function Interacted With	1.2.5.10 Requirement
	SOCIETAL	C#A7,A8,B
1.2.1	MINING	C#C
1.2.2	WASTE HANDLING	C#C
1.2.3	PERFORMANCE CONFIRMATION	C#C
1.2.4	DECOMMISSIONING	C#C
1.2.5	SUPPORT	C#C
1.2.5.2	ADMINISTRATION	C#A10,A11
1.2.5.3	PERSONNEL SERVICES	C#A9k,E2,E5,E18,E21,E24
1.2.5.5.	SUPPLIES	C#E20
1.2.5.6	MAINTENANCE	C#H
1.2.5.7	UTILITY	C#A9d,A9e
1.2.5.9	MONITORING	C#G,H
1.2.5.9.1	RADIOLOGICAL MONITORING	C#F

The sections that follow identify the mined geologic disposal system requirements that have been allocated to 1.3 WASTE EMPLACEMENT PACKAGE.



This page intentionally left blank.

1.3 WASTE EMPLACEMENT PACKAGE

DEFINITION:

The WASTE EMPLACEMENT PACKAGE consists of the radioactive-waste form, its support hardware, and a sealed container that surrounds it. The boundary of the WASTE EMPLACEMENT PACKAGE is the outer edge of the container.

FUNCTIONAL REQUIREMENTS:

1. To contain the radioactive waste materials during all normal handling operations and, in the event of accidents or other dynamic effects, either contain or limit their dispersal.

2. To provide a means for unique waste package identification.

PERFORMANCE CRITERIA:

1. The WASTE-EMPLACEMENT PACKAGE must be capable of maintaining waste containment during transportation, emplacement, and retrieval operations [10 CFR 60.135(b)(3)].

2. The package identification must be consistent with the permanent records maintained by 1.2.5.1 INFORMATION and remain attached and legible at least to the end of the period of retrievability [10 CFR 60.135(b)(4)].

CONSTRAINTS:

A. The WASTE-EMPLACEMENT PACKAGE must be compatible (physical, mechanical, chemical) with transportation, handling, emplacement, and retrieval equipment and operations [1.2.2 PC# 3,4, and 5].

B. The features of the WASTE-EMPLACEMENT PACKAGE must combine with those of the 1.2 REPOSITORY function to ensure that all operations can be conducted safely [1.0 C#CC]. This regulatory constraint will be satisfied by compliance with Functional Requirement #1 and the following specific safety-related regulations:

1. The WASTE-EMPLACEMENT PACKAGE must function together with the 1.2.2 WASTE HANDLING function and the 1.1.2 SUBSURFACE function to ensure that radiation exposures and releases of radioactive material are limited [1.0C#A].

2. Waste materials contained within the WASTE EMPLACEMENT PACKAGE must be solidified, made non-combustible, and stabilized (to limit the availability and generation of particulates) prior to placement within the WASTE-EMPLACEMENT PACKAGE [10 CFR 60.135(c)].

3. The potential for criticality of the waste contained within the WASTE-EMPLACEMENT PACKAGE must be limited. As such, the criticality parameter, Keff, shall not exceed 0.95 unless at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to criticality control [1.0 C#AA].

C. The configuration, handling, and emplacement of the WASTE-EMPLACEMENT PACKAGE must be such that the postclosure performance of all components of 2.2 ENGINEERED BARRIERS or 2.1 NATURAL BARRIERS is not compromised [10 CFR 60.135(a)].

D. The permanent waste package label or identification cannot impair the ability of the WASTE-EMPLACEMENT PACKAGE to satisfy its primary preclosure function (#1 above) or the postclosure functions of the 2.2.1 WASTE PACKAGE [10 CFR 60.135(b)(4)].

E. The WASTE-EMPLACEMENT PACKAGE cannot contain amounts of explosive, pyrophoric, or chemically reactive materials that could compromise the ability of 2.2.2 REPOSITORY ENGINEERED BARRIERS to contribute to waste

isolation or the ability of 2.1 NATURAL BARRIERS to satisfy the postclosure performance criteria objectives [10 CFR 60.135(b)(1)].

F. The WASTE-EMPLACEMENT PACKAGE shall not contain free liquids in an amount that could compromise its ability or the ability of the 2.2.1 WASTE PACKAGE to achieve their containment functions [10 CFR 60.135(b)(2)].

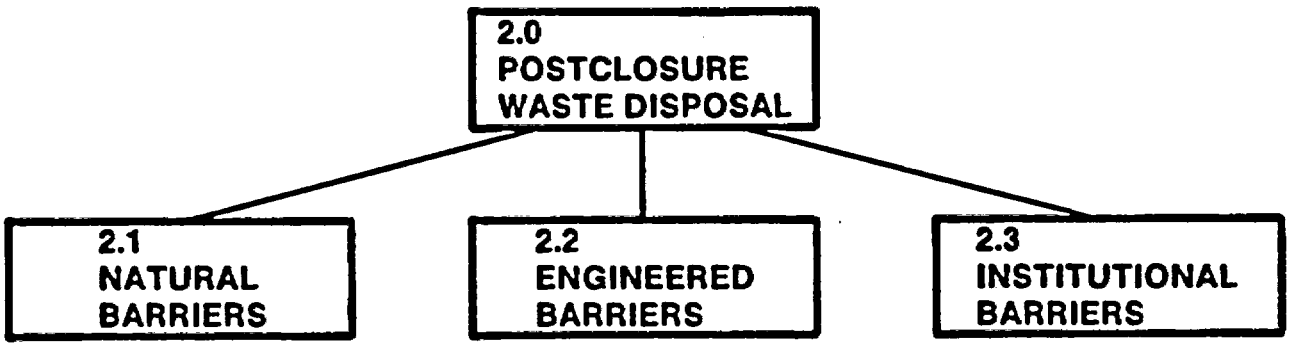
G. WASTE-EMPLACEMENT PACKAGE shall be compatible with the testing and evaluation requirements of 1.2.3.1 WASTE EVALUATION and 1.2.3.3 NATURAL- AND ENGINEERED-BARRIERS EVALUATION.

INTERACTIONS

	Function Interacted With	1.3 Requirement
	TRANSPORTATION	C#A
1.1.2	SUBSURFACE	C#B
1.2	REPOSITORY	PC#2; C#B
1.2.2	WASTE HANDLING	C#A,C
1.2.2.2	WASTE PREPARATION	C#B,E,F
1.2.3.1	WASTE EVALUATION	C#G
1.2.3.3	NATURAL AND ENGINEERED BARRIERS EVALUATION	C#G
1.2.5.1	INFORMATION	PC#2
2.1	NATURAL BARRIERS	C#G,E
2.2	ENGINEERED BARRIERS	C#C
2.2.1	WASTE PACKAGE	C#D,F
2.2.2	REPOSITORY ENGINEERED BARRIERS	C#E

This page intentionally left blank.

The sections that follow identify the mined geologic disposal system requirements that have been allocated to 2.0 POSTCLOSURE WASTE DISPOSAL. As shown below, 2.0 POSTCLOSURE WASTE DISPOSAL comprises 2.1 NATURAL BARRIERS, 2.2 ENGINEERED BARRIERS, and 2.3 INSTITUTIONAL BARRIERS. The requirements for the subfunctions are identified in subsequent sections.



This page intentionally left blank.

2.0 POSTCLOSURE WASTE DISPOSAL

Subfunctions are:

2.1 NATURAL BARRIERS
2.2 ENGINEERED BARRIERS
2.3 INSTITUTIONAL BARRIERS

DEFINITION:

POSTCLOSURE WASTE DISPOSAL includes all operations that take place during the period after permanent closure to isolate radioactive waste from the accessible environment.

FUNCTIONAL REQUIREMENTS:

1. To isolate the emplaced radioactive waste from the accessible environment.

PERFORMANCE CRITERIA:

1. POSTCLOSURE WASTE DISPOSAL shall provide a reasonable expectation, based on performance assessments, that the cumulative releases of radionuclides to the accessible environment for 10,000 years after disposal from all significant processes and events that may affect the disposal system shall:

   a. have a likelihood of less than 1 chance in 10 of exceeding the quantities calculated according to Table 1, Appendix A of 40 CFR 191 [40 CFR 191.13 (a)(1)].

   b. have a likelihood of less than 1 chance in 1000 of exceeding ten times the quantities calculated according to Table 1, Appendix A of 40 CFR 191 [40 CFR 191.13 (a)(2)].

And that, considering all potential pathways for exposure (including the assumption that individuals consume 2 liters per day of drinking water from any significant source of groundwater outside of the controlled area), for 1000 years after disposal, undisturbed performance of the disposal system shall not cause the annual dose equivalent from the disposal system to any member of the public in the accessible environment to exceed 25 millirems to the whole body or 75 millirems to any critical organ [40 CFR 191.15].

And that for 1000 years after disposal, undisturbed performance of the disposal system shall not cause the radionuclide concentrations averaged over any year in the water withdrawn from any portion of a special source of groundwater to exceed [40 CFR 191.16(a)]:

a. 5 picocuries per liter of radium-226 and radium-228

b. 15 picocuries per liter of alpha-emitting radionuclides (including radium-226 and radium-228) or

c. the combined concentrations of radionculides that emit either beta or gamma radiation that would produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem per year if an individual continuously consumed 2 liters per day of drinking water from such a source.

and [40 CFR 191.16(b)]:

If any of the average annual radionuclide concentrations in a special source of groundwater already exceed the limits in 40 CFR 191.15(a) before construction of the waste disposal system, POSTCLOSURE WASTE DISPOSAL shall provide a reasonable expectation that, for 1000 years after disposal, undisturbed performance of the disposal system shall not increase the existing average annual radionuclide concentrations in water withdrawn from that special source of groundwater by more than the limits established in 40 CFR 191.16(a).

CONSTRAINTS:

A. After closure, multiple engineered, natural and institutional barriers shall work together to control the release of radioactive material to the accessible environment [10 CFR 960.4-1(a)].

B. Considering permanent markers and records and reasonable projections of value, scarcity, and technology--the natural resources, including ground water suitable for crop irrigation or human consumption without treatment, present at or near the site shall not be likely to give rise to interference activities that would lead to radionuclide releases greater than those allowable under the requirements specified in 40 CFR 191 and 10 CFR 60 [10 CFR 960.4-2-8-1(a)].

C. Waste disposal shall not cause any unmitigable adverse effects that would seriously degrade the quality of the environment after permanent closure [10 CFR 960.5-2-5(a)].

D. Following the loss of containment from the engineered barriers, the release of radionuclides to the natural barriers shall be a gradual process resulting in small fractional releases over a long period of time [10 CFR 60.113(a)(1)(i)(B)].

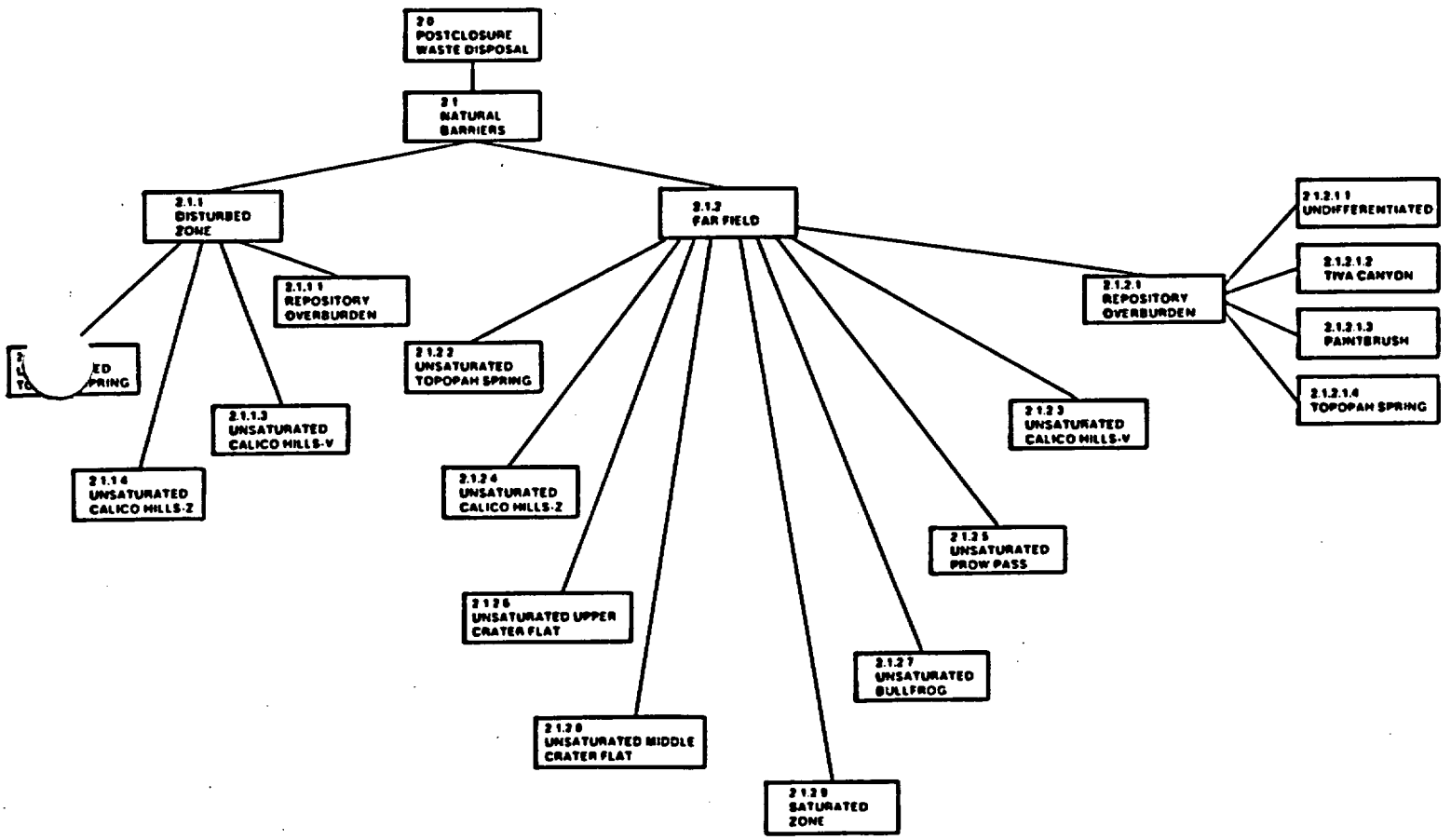
E. Substantially complete containment shall be provided by the engineered barriers during the period when radioactivity and thermal conditions are dominated by fission product decay [10CFR 60.113(a)(1)(i)(A)].

INTERACTIONS:

	Function Interacted With	2.0 Requirement
	ENVIRONMENTAL (postclosure)	C#C
	SOCIETAL (postclosure)	C
1.0	PRECLOSURE WASTE DISPOSAL	C#A
2.3	INSTITUTIONAL BARRIERS	C#B

This page intentionally left blank.

The following sections identify the mined geologic disposal system requirements that have been allocated to 2.1 NATURAL BARRIERS and its constituent subfunctions as shown below.



This page intentionally left blank.

2.1 NATURAL BARRIERS

Subfunctions are:

2.1.1 DISTURBED ZONE
2.1.2 FAR FIELD

DEFINITION:

NATURAL BARRIERS consist of the repository host rock, surrounding geologic structures and formations, and all of the groundwater flow, geochemical processes, and vapor-phase flow processes that occur therein. NATURAL BARRIERS extend from the boundary of the 2.2 ENGINEERED BARRIERS to the accessible environment.

FUNCTIONAL REQUIREMENTS:

1. To minimize or substantially delay movement of radionuclides to the accessible environment.

NOTE: Because the characteristics of the 2.1 NATURAL BARRIERS are not subject to change by engineering measures as are the engineered portions of the repository, Functional Requirements identified for 2.1 NATURAL BARRIERS are statements of the characteristics that are needed for the barrier to contribute to radionuclide isolation.

PERFORMANCE CRITERIA:

1a. NATURAL BARRIERS shall ensure that the 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 1000 years or such other travel time as may be approved or specified by NRC [10 CFR 60.113(b)].

1b. Radionuclide releases from NATURAL BARRIERS shall combine with the radionuclide retardation provided by 2.2 ENGINEERED BARRIERS to ensure that releases of radionuclides to the accessible environment do not exceed the 40 CFR 191 radionuclide release, groundwater protection, and individual protection requirements identified in 2.0 PC#1 [10 CFR 60.112].

CONSTRAINTS:

A. During the first 10,000 years after closure, active dissolution, as predicted on the basis of the geologic record, shall not result in a loss of waste isolation [10 CFR 960.4-2-6(d)].

B. The present and expected geochemical characteristics of a site shall be compatible with waste containment and isolation. Considering the likely chemical interactions among radionuclides, the host rock, and the groundwater, the characteristics of and the processes operating within the geologic setting shall permit compliance with: (1) the requirements specified by 10 CFR 960.4-1 regarding physical separation of radioactive waste from the accessible environment after closure and allowance by the geologic setting to allow engineered barriers to meet requirements in 40 CFR 191, Subpart B; and (2) the requirements specified in 10 CFR 60.113 for radionuclide releases from the engineered-barrier using reasonably available technology [10 CFR 960.4-2-2(a)].

C. The present and expected characteristics of the host rock and surrounding units shall be capable of accommodating the thermal, chemical, mechanical, and radiation stresses expected to be induced by repository construction, operation, and closure and by expected interactions among the waste, host rock, groundwater, and engineered components. The characteristics of and the processes operating within the geologic setting shall permit compliance with: (1) the requirements specified by 10 CFR 960.4-1 regarding physical separation of radioactive waste from the accessible environment after closure and allowance by the geologic setting to allow engineered barriers to meet requirements in 40 CFR 191, Subpart B; and (2) the requirements set forth in 10 CFR 60.113 for radionuclide releases from the engineered-barrier system using reasonably available technology [10 CFR 960.4-2-3(a)].

D. The site shall be located where future climatic conditions will not be likely to lead to radionuclide releases greater than those allowable under the requirements specified by 10 CFR 960.4-1 regarding physical separation of radioactive waste from the accessible environment after closure and allowance by the geologic setting to allow 2.2 ENGINEERED BARRIERS to meet requirements in 40 CFR 191, Subpart B [10 CFR 960.4-2-4(a)].

E. The site shall allow the underground facility to be placed at a depth such that erosional processes acting upon the surface will not be likely to lead to radionuclide releases greater than those allowable under the requirements specified by 10 CFR 960.4-1 regarding physical separation of radioactive waste from the accessible environment after closure and allowance by the geologic setting to allow engineered barriers to meet requirements in 40 CFR 191, Subpart B [10 CFR 960.4-2-5(a)].

F. Site conditions shall 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(d)].

G. The site shall be located such that any subsurface rock dissolution will not be likely to lead to radionuclide releases greater than those allowable under the requirements specified in 10 CFR 960.4-1 regarding physical separation of radioactive waste from the accessible environment after closure and allowance by the geologic setting to allow engineered barriers to meet requirements in 40 CFR 191, Subpart B [10 CFR 960.4-2-6(a)].

H. The site shall not be located where, 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(d)].

I. In accordance with 10 CFR 960.4-2-8-1(d), the site shall not be located where:

a. 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

b. 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.

J. In accordance with 10 CFR 60.121(a), radioactive waste disposal shall be located in, and on, lands that are either acquired lands under jurisdiction and control of the DOE, or lands permanently withdrawn and reserved for its use. These lands shall be held free and clear of all encumbrances, if significant, such as:

1. rights arising under the general mining laws,

2. easements for right-of-way, and

3. all other rights arising under lease, rights of entry, deed, patent, mortgage, appropriation, prescription, or otherwise. (Generic Requirements Document 2.1 Natural Barriers C#K)

K. The present and expected geohydrologic setting of the site shall be compatible with waste containment and isolation. The geohydrologic setting, considering the characteristics of and the processes operating within the geologic setting, shall permit compliance with (1) 10 CFR 960.4-1 regarding physical separations of radioactive waste from the accessible environment after the closure and allowance by the geologic setting to allow 2.2 ENGINEERED BARRIERS to meet requirements in 40 CFR 191 Subpart B and (2) the requirements specified in 10 CFR 60.113 for radionuclide releases from the engineered-barrier system using reasonably available technology [10 CFR 960.4-2-1(a)].

L. The pre-waste emplacement groundwater travel time from the disturbed zone to the accessible environment must not be expected to be less than 1000 years along any pathway of likely and significant radionuclide travel [10 CFR 960.4-2-1(d)].

M. 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 960.4-1 [10 CFR 960.4-2-7(a)].

INTERACTIONS:

	Function Interacted With	2.1 Requirement
2.2	ENGINEERED BARRIERS	PC#2; C#B,C

This page intentionally left blank.

2.1.1 DISTURBED ZONE

Subfunctions are:

- 2.1.1.1 REPOSITORY OVERBURDEN
- 2.1.1.2 UNSATURATED TOPOPAH SPRING
- 2.1.1.3 UNSATURATED CALICO HILLS-v
- 2.1.1.4 UNSATURATED CALICO HILLS-z

DEFINITION:

The DISTURBED ZONE is that portion of the 2.1 NATURAL BARRIERS the physical or chemical properties of which have changed as a result of underground facility construction or as a result of changes induced by the emplaced waste. The boundary of the DISTURBED ZONE for the Yucca Mountain MGDS is currently being defined. The primary purpose for defining a disturbed zone is to provide a boundary that can be used in NNWSI Performance Assessment calculations. One of these calculations is that for pre-waste-emplacement groundwater travel time to meet the 10 CFR 60.113(a)(2) requirement. If NRC chooses to arbitrarily define a Disturbed Zone boundary for purposes of this calculation, the NNWSI may require a different Disturbed Zone definition for use in other performance calculations e.g., 40 CFR 191.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow, radionuclide retardation, and vapor-phase transport characteristics compatible with isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

PERFORMANCE CRITERIA:

1. The groundwater flow, radionuclide retardation, and vapor-phase transport in the DISTURBED ZONE shall combine with the 2.1.2 FAR FIELD to meet the radionuclide release, groundwater protection, and individual protection requirements identified in 2.1 PC#2.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

Function Interacted With	2.1.1 Requirement
2.1.2 FAR FIELD	PC#1

2.1.1.1 REPOSITORY OVERBURDEN

DEFINITION:

The disturbed zone REPOSITORY OVERBURDEN is that portion of the 2.1.1 DISTURBED ZONE made up of thermal/mechanical unit TSw2 that overlies the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide vapor-phase transport and radionuclide retardation characteristics compatible with isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

PERFORMANCE CRITERIA:

1. The vapor-phase flow and radionuclide retardation in the REPOSITORY OVERBURDEN shall combine with other 2.1.1 DISTURBED ZONE components to meet the radionuclide release, groundwater protection, and individual protection requirements identified in 2.1.1 PC#1.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

Function Interacted With		2.1.1.1 Requirement
2.1.1.2	UNSATURATED TOPOPAH SPRING	PC#1
2.1.1.3	UNSATURATED CALICO HILLS-v	PC#1
2.1.1.4	UNSATURATED CALICO HILLS-z	PC#1
2.2	ENGINEERED BARRIERS	PC#1

This page intentionally left blank.

2.1.1.2 UNSATURATED TOPOPAH SPRING

DEFINITION:

The disturbed zone UNSATURATED TOPOPAH SPRING is that portion of the 2.1.1 DISTURBED ZONE made up of unsaturated Topopah Spring tuff from thermal/mechanical units TSw2 and TSw3 that lies laterally to and below the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow, radionuclide retardation, and vapor-phase transport characteristics compatible with isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

PERFORMANCE CRITERIA:

1. The groundwater flow, vapor-phase flow, and radionuclide retardation in the UNSATURATED TOPOPAH SPRING shall combine with other 2.1.1 DISTURBED ZONE components to meet the radionuclide release, groundwater protection, and individual protection requirements identified in 2.1.1 PC#1.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

	Function Interacted With	2.1.1.2 Requirement
2.1.1.1	REPOSITORY OVERBURDEN	PC#1
2.1.1.3	UNSATURATED CALICO HILLS-v	PC#1
2.1.1.4	UNSATURATED CALICO HILLS-z	PC#1
2.2	ENGINEERED BARRIERS	PC#1

2.1.1.3 UNSATURATED CALICO HILLS-v

DEFINITION:

The disturbed zone CALICO HILLS-v is that portion of the 2.1.1 DISTURBED ZONE made up of unsaturated Calico Hills vitric tuff from thermal/mechanical units CHn1v, CHn2v, CHn3v, and CHnv that lies below the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow, radionuclide retardation, and vapor-phase transport characteristics compatible with isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

PERFORMANCE CRITERIA:

1. The groundwater flow, vapor-phase flow, and radionuclide retardation in the UNSATURATED CALICO HILLS-v shall combine with other 2.1.1 DISTURBED ZONE components to meet the radionuclide release, groundwater protection, and individual protection requirements identified in 2.1.1 PC#1.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

Function Interacted With		2.1.1.3 Requirement
2.1.1.1	REPOSITORY OVERBURDEN	PC#1
2.1.1.2	UNSATURATED TOPOPAH SPRING	PC#1
2.1.1.4	UNSATURATED CALICO HILLS-z	PC#1
2.2	ENGINEERED BARRIERS	PC#1

This page intentionally left blank.

2.1.1.4 UNSATURATED CALICO HILLS-z

DEFINITION:

The disturbed zone UNSATURATED CALICO HILLS-z is that portion of the 2.1.1 DISTURBED ZONE made up of unsaturated Calico Hills zeolitized tuff from thermal/mechanical units CHn1z, CHn2z, and CHn3z, that lies below the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow, radionuclide retardation, and vapor-phase transport characteristics compatible with isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

PERFORMANCE CRITERIA:

1. The groundwater flow, vapor-phase flow, and radionuclide retardation in the UNSATURATED CALICO HILLS-z shall combine with other 2.1.1 DISTURBED ZONE components to meet the radionuclide release, groundwater protection, and individual protection requirements identified in 2.1.1 PC#1.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

	Function Interacted With	2.1.1.4 Requirement
2.1.1.1	REPOSITORY OVERBURDEN	PC#1
2.1.1.2	UNSATURATED TOPOPAH SPRING	PC#1
2.1.1.3	UNSATURATED CALICO HILLS-v	PC#1
2.2	ENGINEERED BARRIERS	PC#1

2.1.2 FAR FIELD

Subfunctions are:

- 2.1.2.1 REPOSITORY OVERBURDEN
- 2.1.2.2 UNSATURATED TOPOPAH SPRING
- 2.1.2.3 UNSATURATED CALICO HILLS-v
- 2.1.2.4 UNSATURATED CALICO HILLS-z
- 2.1.2.5 UNSATURATED PROW PASS
- 2.1.2.6 UNSATURATED UPPER CRATER FLAT
- 2.1.2.7 UNSATURATED BULLFROG
- 2.1.2.8 UNSATURATED MIDDLE CRATER FLAT
- 2.1.2.9 SATURATED ZONE

DEFINITION:

The FAR FIELD is that portion of 2.1 NATURAL BARRIERS that extends from the boundary of the 2.1.1 DISTURBED ZONE to the boundary of the accessible environment.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow, and radionuclide retardation characteristics that are compatible with isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

PERFORMANCE CRITERIA:

1. The groundwater flow, vapor-phase transport, and radionuclide retardation in the FAR FIELD shall combine with the 2.1.1 DISTURBED ZONE to meet the EPA radionuclide release, groundwater protection, and individual protection requirements identified in 2.1 PC#2.

2. The FAR FIELD shall ensure that the pre-waste-emplacement groundwater travel time along the fastest path of likely radionuclide travel from the outer boundary of the 2.1.1 DISTURBED ZONE to the accessible environment shall be at least 1000 years or such other travel time as may be approved or specified by the NRC [2.1 PC#1].

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

Function Interacted With	2.1.2 Requirement
2.1.1 DISTURBED ZONE	PC#1

2.1.2.1 REPOSITORY OVERBURDEN

Subfunctions are:

- 2.1.2.1.1 UNDIFFERENTIATED
- 2.1.2.1.2 TIVA CANYON
- 2.1.2.1.3 PAINTBRUSH
- 2.1.2.1.4 TOPOPAH SPRING

DEFINITION:

The far field REPOSITORY OVERBURDEN is the portion of the 2.1.1 FAR FIELD made up of thermal/mechanical units UO, TCw, PTn, TSw1, and TSw2 that overlies the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow, vapor-phase transport, and radionuclide retardation characteristics that are compatible with isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

PERFORMANCE CRITERIA:

1. The groundwater flow, vapor-phase transport, and radionuclide retardation in the FF-REPOSITORY OVERBURDEN shall combine with other 2.1.1 FAR FIELD components to meet the radionuclide release, groundwater protection, and individual protection requirements identified in 2.1.2 PC#1.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

	Function Interacted With	2.1.2.1 Requirement
2.1.1	DISTURBED ZONE	PC#1
2.1.2.2	UNSATURATED TOPOPAH SPRING	PC#1
2.1.2.3	UNSATURATED CALICO HILLS-v	PC#1
2.1.2.4	UNSATURATED CALICO HILLS-z	PC#1
2.1.2.5	UNSATURATED PROW PASS	PC#1
2.1.2.6	UNSATURATED UPPER CRATER FLAT	PC#1
2.1.2.7	UNSATURATED BULLFROG	PC#1
2.1.2.8	UNSATURATED MIDDLE CRATER FLAT	PC#1
2.1.2.9	SATURATED ZONE	PC#1

2.1.2.1.1 UNDIFFERENTIATED

DEFINITION:

The UNDIFFERENTIATED is that portion of the far field 2.1.2.1 REPOSITORY OVERBURDEN made up of thermal/mechanical unit UO that overlies the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow, vapor-phase transport, and radionuclide retardation characteristics that are compatible with the isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

PERFORMANCE CRITERIA:

1. The groundwater flow, vapor-phase transport, and radionuclide retardation in the UNDIFFERENTIATED component shall combine with other 2.1.2.1 REPOSITORY OVERBURDEN components to meet the radionuclide release, groundwater protection, and individual protection requirement identified in 2.1.2.1 PC#1.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

Function Interacted With		2.1.2.1.1 Requirement
2.1.2.1.2	TIVA CANYON	PC#1
2.1.2.1.3	PAINTBRUSH	PC#1
2.1.2.1.4	TOPOPAH SPRING	PC#1

This page intentionally left blank.

2.1.2.1.2 TIVA CANYON

DEFINITION:

The TIVA CANYON is that portion of the far field 2.1.2.1 REPOSITORY OVERBURDEN made up of moderately to densely welded, devitrified ashflow tuff from thermal/mechanical unit TCw that overlies the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow, vapor-phase transport, and radionuclide retardation characteristics that are compatible with the isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

PERFORMANCE CRITERIA:

1. The groundwater flow, vapor-phase transport, and radionuclide retardation in the TIVA CANYON shall combine with other 2.1.2.1 REPOSITORY OVERBURDEN components to meet the radionuclide release, groundwater protection, and individual protection requirement identified in 2.1.2.1 PC#1.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

Function Interacted With	2.1.2.1.2 Requirement
2.1.2.1.1 UNDIFFERENTIATED	PC#1
2.1.2.1.3 PAINTBRUSH	PC#1
2.1.2.1.4 TOPOPAH SPRING	PC#1

This page intentionally left blank.

2.1.2.1.3 PAINTBRUSH

DEFINITION:

The PAINTBRUSH is that portion of the far field 2.1.2.1 REPOSITORY OVERBURDEN made up of partially welded to nonwelded, vitric and occasionally devitrified tuffs from thermal/mechanical unit PTn that overlies the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow, vapor-phase transport, and radionuclide retardation characteristics that are compatible with the isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

PERFORMANCE CRITERIA:

1. The groundwater flow, vapor-phase transport, and radionuclide retardation in the PAINTBRUSH shall combine with other 2.1.2.1 REPOSITORY OVERBURDEN components to meet the radionuclide release, groundwater protection, and individual protection requirement identified in 2.1.2.1 PC#1.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

Function Interacted With	2.1.2.1.3 Requirement
2.1.2.1.1 UNDIFFERENTIATED	PC#1
2.1.2.1.2 TIVA CANYON	PC#1
2.1.2.1.4 TOPOPAH SPRING	PC#1

This page intentionally left blank.

2.1.2.1.4 TOPOPAH SPRING

DEFINITION:

The TOPOPAH SPRING is that portion of the far field 2.1.2.1 REPOSITORY OVERBURDEN made up of moderately to densely welded, devitrified ashflows from thermal/mechanical units TSw1 and TSw2 that overlies the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow, vapor-phase transport, and radionuclide retardation characteristics that are compatible with the isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

PERFORMANCE CRITERIA:

1. The groundwater flow, vapor-phase transport, and radionuclide retardation in the TOPOPAH SPRING shall combine with other 2.1.2.1 REPOSITORY OVERBURDEN components to meet the radionuclide release, groundwater protection, and individual protection requirement identified in 2.1.2.1 PC#1.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

Function Interacted With	2.1.2.1.4 Requirement
2.1.2.1.1 UNDIFFERENTIATED	PC#1
2.1.2.1.2 TIVA CANYON	PC#1
2.1.2.1.3 PAINTBRUSH	PC#1

This page intentionally left blank.

2.1.2.2 UNSATURATED TOPOPAH SPRING

DEFINITION:

The far field UNSATURATED TOPOPAH SPRING is that portion of the 2.1.2 FAR FIELD made up of unsaturated Topopah Spring tuff from thermal/mechanical units TSw2 and TSw3 that lies laterally to and below the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow and radionuclide retardation characteristics compatible with isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

2. To provide a pre-waste-emplacement groundwater travel time that is compatible with that of other 2.1.2 FAR FIELD components.

PERFORMANCE CRITERIA:

1. Groundwater flow and radionuclide retardation in the UNSATURATED TOPOPAH SPRING shall combine with other 2.1.2 FAR FIELD components to meet the radionuclide release, groundwater protection, and individual protection requirements identified in 2.1.2 PC#1.

2. Groundwater flow in the UNSATURATED TOPOPAH SPRING shall combine with other 2.1.2 FAR FIELD components to meet the pre-waste-emplacement groundwater travel time requirement identified in 2.1.2 PC#2.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

	Function Interacted With	2.1.2.2 Requirement
2.1.1	DISTURBED ZONE	PC#1
2.1.2.1	REPOSITORY OVERBURDEN	PC#1
2.1.2.3	UNSATURATED CALICO HILLS-v	PC#1,2
2.1.2.4	UNSATURATED CALICO HILLS-z	PC#1,2
2.1.2.5	UNSATURATED PROW PASS	PC#1,2
2.1.2.6	UNSATURATED UPPER CRATER FLAT	PC#1,2
2.1.2.7	UNSATURATED BULLFROG	PC#1,2
2.1.2.8	UNSATURATED MIDDLE CRATER FLAT	PC#1,2
2.1.2.9	SATURATED ZONE	PC#1,2

2.1.2.3 UNSATURATED CALICO HILLS-v

DEFINITION:

The far field UNSATURATED CALICO HILLS-v is that portion of the 2.1.2 FAR FIELD made up of unsaturated Calico Hills vitric tuff from thermal/mechanical units CHn1v, CHn2v, CHn3v, and CHnv that lies below the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow and radionuclide retardation characteristics compatible with isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

2. To provide a pre-waste-emplacement groundwater travel time compatible with that of other 2.1.2 FAR FIELD components.

PERFORMANCE CRITERIA:

1. Groundwater flow and radionuclide retardation in the UNSATURATED CALICO HILLS-v shall combine with other 2.1.2 FAR FIELD components to meet the radionuclide release, groundwater protection, and individual protection requirements identified in 2.1.2 PC#1.

2. Groundwater flow in the UNSATURATED CALICO HILLS-v shall combine with other 2.1.2 FAR FIELD components to meet the groundwater travel time requirement identified in 2.1.2 PC#2.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

	Function Interacted With	2.1.2.3 Requirement
2.1.1	DISTURBED ZONE	PC#1
2.1.2.1	REPOSITORY OVERBURDEN	PC#1
2.1.2.2	UNSATURATED TOPOPAH SPRING	PC#1,2
2.1.2.4	UNSATURATED CALICO HILLS-z	PC#1,2
2.1.2.5	UNSATURATED PROW PASS	PC#1,2
2.1.2.6	UNSATURATED UPPER CRATER FLAT	PC#1,2
2.1.2.7	UNSATURATED BULLFROG	PC#1,2
2.1.2.8	UNSATURATED MIDDLE CRATER FLAT	PC#1,2
2.1.2.9	SATURATED ZONE	PC#1,2

2.1.2.4 UNSATURATED CALICO HILLS-z

DEFINITION:

The far field UNSATURATED CALICO HILLS-z is that portion of the 2.1.2 FAR FIELD made up of unsaturated Calico Hills zeolitized tuff from thermal/mechanical units CHn1z, CHn2z, and CHn3z, that lies below the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow and radionuclide retardation characteristics compatible with isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

2. To provide a pre-waste-emplacement groundwater travel time compatible with that of other 2.1.2 FAR FIELD components.

PERFORMANCE CRITERIA:

1. Groundwater flow and radionuclide retardation in the UNSATURATED CALICO HILLS-z shall combine with other 2.1.2 FAR FIELD components to meet the radionuclide release, groundwater protection, and individual protection requirements identified in 2.1.2 PC#1.

2. Groundwater flow in the UNSATURATED CALICO HILLS-z shall combine with other 2.1.2 FAR FIELD components to meet the groundwater travel time requirement identified in 2.1.2 PC#2.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

	Function Interacted With	2.1.2.4 Requirement
2.1.1	DISTURBED ZONE	PC#1
2.1.2.1	REPOSITORY OVERBURDEN	PC#1
2.1.2.2	UNSATURATED TOPOPAH SPRING	PC#1,2
2.1.2.3	UNSATURATED CALICO HILLS-v	PC#1,2
2.1.2.5	UNSATURATED PROW PASS	PC#1,2
2.1.2.6	UNSATURATED UPPER CRATER FLAT	PC#1,2
2.1.2.7	UNSATURATED BULLFROG	PC#1,2
2.1.2.8	UNSATURATED MIDDLE CRATER FLAT	PC#1,2
2.1.2.9	SATURATED ZONE	PC#1,2

2.1.2.5 UNSATURATED PROW PASS

DEFINITION:

The UNSATURATED PROW PASS is that portion of the 2.1.2 FAR FIELD made up of unsaturated Prow Pass welded tuff from thermal/mechanical unit PPw that lies below the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow and radionuclide retardation characteristics compatible with isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

2. To provide a pre-waste-emplacement groundwater travel time compatible with that of other 2.1.2 FAR FIELD components.

PERFORMANCE CRITERIA:

1. Groundwater flow and radionuclide retardation in the UNSATURATED PROW PASS shall combine with other 2.1.2 FAR FIELD components to meet the radionuclide release, groundwater protection, and individual protection requirements identified in 2.1.2 PC#1.

2. Groundwater flow in the UNSATURATED PROW PASS shall combine with other 2.1.2 FAR FIELD components to meet the groundwater travel time requirement identified in 2.1.2 PC#2.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

	Function Interacted With	2.1.2.5 Requirement
2.1.1	DISTURBED ZONE	PC#1
2.1.2.1	REPOSITORY OVERBURDEN	PC#1
2.1.2.2	UNSATURATED TOPOPAH SPRING	PC#1,2
2.1.2.3	UNSATURATED CALICO HILLS-v	PC#1,2
2.1.2.4	UNSATURATED CALICO HILLS-z	PC#1,2
2.1.2.6	UNSATURATED UPPER CRATER FLAT	PC#1,2
2.1.2.7	UNSATURATED BULLFROG	PC#1,2
2.1.2.8	UNSATURATED MIDDLE CRATER FLAT	PC#1,2
2.1.2.9	SATURATED ZONE	PC#1,2

2.1.2.6 UNSATURATED UPPER CRATER FLAT

DEFINITION:

The UNSATURATED UPPER CRATER FLAT is that portion of the 2.1.2 FAR FIELD made up of unsaturated Crater Flat nonwelded zeolitized tuff from thermal/mechanical unit CFUn that lies below the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow and radionuclide retardation characteristics compatible with isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

2. To provide a pre-waste-emplacement groundwater travel time compatible with that of other 2.1.2 FAR FIELD components.

PERFORMANCE CRITERIA:

1. Groundwater flow and radionuclide retardation in the UNSATURATED UPPER CRATER FLAT shall combine with other 2.1.2 FAR FIELD components to meet the radionuclide release, groundwater protection, and individual protection requirements identified in 2.1.2 PC#1.

2. Groundwater flow in the UNSATURATED UPPER CRATER FLAT shall combine with other 2.1.2 FAR FIELD components to meet the groundwater travel time requirement identified in 2.1.2 PC#2.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

	Function Interacted With	2.1.2.6 Requirement
2.1.1	DISTURBED ZONE	PC#1
2.1.2.1	REPOSITORY OVERBURDEN	PC#1
2.1.2.2	UNSATURATED TOPOPAH SPRING	PC#1,2
2.1.2.3	UNSATURATED CALICO HILLS-v	PC#1,2
2.1.2.4	UNSATURATED CALICO HILLS-z	PC#1,2
2.1.2.5	UNSATURATED PROW PASS	PC#1,2
2.1.2.7	UNSATURATED BULLFROG	PC#1,2
2.1.2.8	UNSATURATED MIDDLE CRATER FLAT	PC#1,2
2.1.2.9	SATURATED ZONE	PC#1,2

2.1.2.7 UNSATURATED BULLFROG

DEFINITION:

The UNSATURATED BULLFROG is that portion of the 2.1.2 FAR FIELD made up of unsaturated Bullfrog welded tuff from thermal/mechanical unit BFw that lies below the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow and radionuclide retardation characteristics compatible with isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

2. To provide a pre-waste-emplacement groundwater travel time compatible with that of other 2.1.2 FAR FIELD components.

PERFORMANCE CRITERIA:

1. Groundwater flow and radionuclide retardation in the UNSATURATED BULLFROG shall combine with other 2.1.2 FAR FIELD components to meet the radionuclide release, groundwater protection, and individual protection requirements identified in 2.1.2 PC#1.

2. Groundwater flow in the UNSATURATED BULLFROG shall combine with other 2.1.2 FAR FIELD components to meet the groundwater travel time requirement identified in 2.1.2 PC#2.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

	Function Interacted With	2.1.2.7 Requirement
2.1.1	DISTURBED ZONE	PC#1
2.1.2.1	REPOSITORY OVERBURDEN	PC#1
2.1.2.2	UNSATURATED TOPOPAH SPRING	PC#1,2
2.1.2.3	UNSATURATED CALICO HILLS-v	PC#1,2
2.1.2.4	UNSATURATED CALICO HILLS-z	PC#1,2
2.1.2.5	UNSATURATED PROW PASS	PC#1,2
2.1.2.6	UNSATURATED UPPER CRATER FLAT	PC#1,2
2.1.2.8	UNSATURATED MIDDLE CRATER FLAT	PC#1,2
2.1.2.9	SATURATED ZONE	PC#1,2

2.1.2.8 UNSATURATED MIDDLE CRATER FLAT

DEFINITION:

The UNSATURATED MIDDLE CRATER FLAT is that portion of the 2.1.2 FAR FIELD made up of unsaturated Crater Flat nonwelded zeolitized tuff from thermal/mechanical unit CFMn that lies below the repository underground facilities.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow and radionuclide retardation characteristics compatible with the isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

2. To provide a pre-waste-emplacement groundwater travel time compatible with that of other 2.1.2 FAR FIELD components.

PERFORMANCE CRITERIA:

1. Groundwater flow and radionuclide retardation in the UNSATURATED MIDDLE CRATER FLAT shall combine with other 2.1.2 FAR FIELD components to meet the radionuclide release, groundwater protection, and individual protection requirements identified in 2.1.2 PC#1.

2. Groundwater flow in the UNSATURATED MIDDLE CRATER FLAT shall combine with other 2.1.2 FAR FIELD components to meet the groundwater travel time requirement identified in 2.1.2 PC#2.

CONSTRAINTS:

None identified at this level.

INTERACTIONS:

	Function Interacted With	2.1.2.8 Requirement
2.1.1	DISTURBED ZONE	PC#1
2.1.2.1	REPOSITORY OVERBURDEN	PC#1
2.1.2.2	UNSATURATED TOPOPAH SPRING	PC#1,2
2.1.2.3	UNSATURATED CALICO HILLS-v	PC#1,2
2.1.2.4	UNSATURATED CALICO HILLS-z	PC#1,2
2.1.2.5	UNSATURATED PROW PASS	PC#1,2
2.1.2.6	UNSATURATED UPPER CRATER FLAT	PC#1,2
2.1.2.7	UNSATURATED BULLFROG	PC#1,2
2.1.2.9	SATURATED ZONE	PC#1,2

2.1.2.9 SATURATED ZONE

DEFINITION:

The SATURATED ZONE is that portion of the 2.1.2 FAR FIELD that is below the water table.

FUNCTIONAL REQUIREMENTS:

1. To provide groundwater flow and radionuclide retardation characteristics compatible with the isolation of the radioactive waste emplaced in the Yucca Mountain MGDS.

2. To provide a pre-waste-emplacement groundwater travel time compatible with that of other 2.1.2 FAR FIELD components.

PERFORMANCE CRITERIA:

1. Groundwater flow and radionuclide retardation in the SATURATED ZONE shall combine with other 2.1.2 FAR FIELD components to meet the radionuclide release, groundwater protection, and individual protection requirements identified in 2.1.2 PC#1.

2. Groundwater flow in the SATURATED ZONE shall combine with other 2.1.2 FAR FIELD components to meet the groundwater travel time requirement identified in 2.1.2 PC#2.

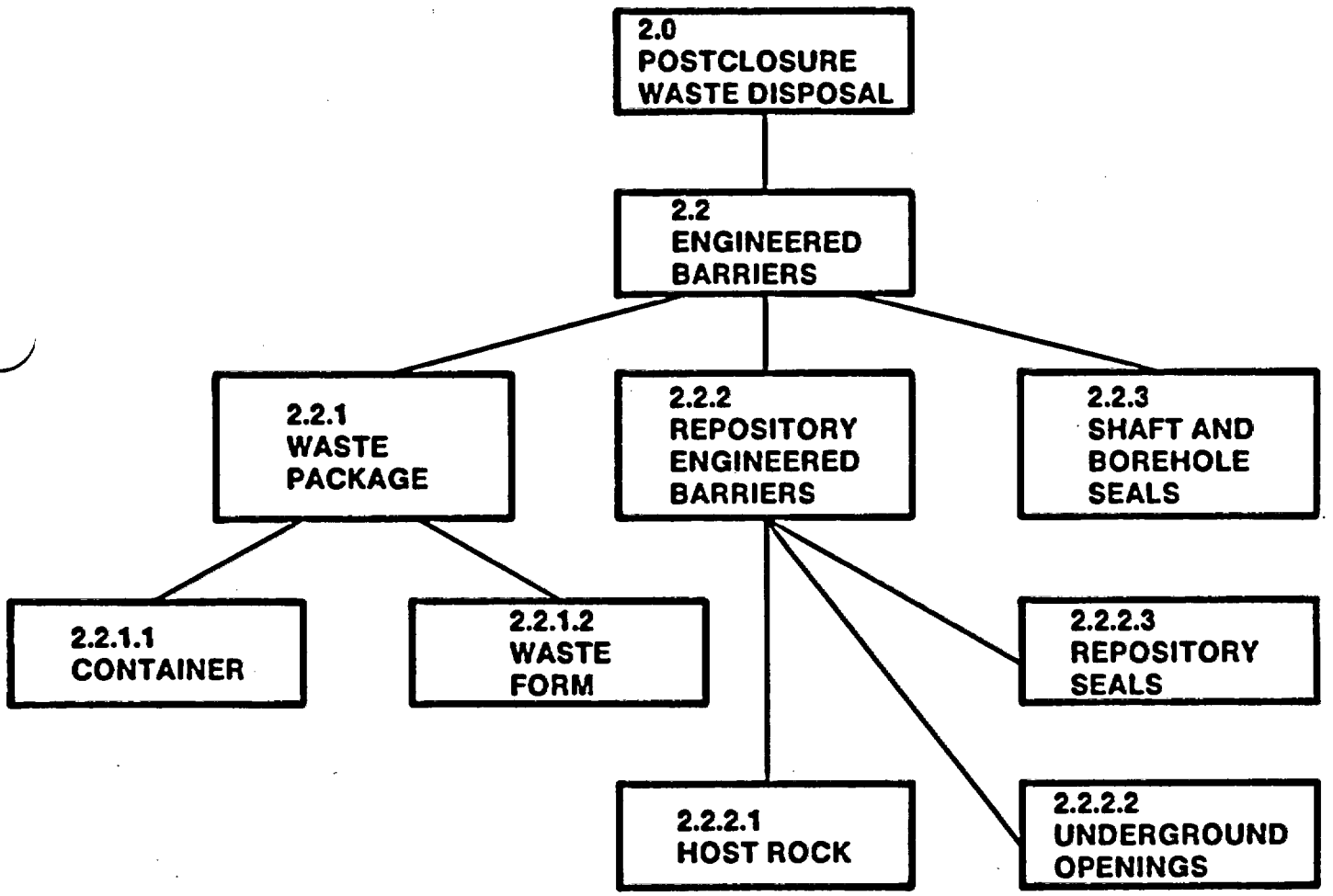
CONSTRAINTS:

None identified at this level.

INTERACTIONS:

	Function Interacted With	2.1.2.9 Requirement
2.1.1	DISTURBED ZONE	PC#1
2.1.2.1	REPOSITORY OVERBURDEN	PC#1
2.1.2.2	UNSATURATED TOPOPAH SPRING	PC#1,2
2.1.2.3	UNSATURATED CALICO HILLS-v	PC#1,2
2.1.2.4	UNSATURATED CALICO HILLS-z	PC#1,2
2.1.2.5	UNSATURATED PROW PASS	PC#1,2
2.1.2.6	UNSATURATED UPPER CRATER FLAT	PC#1,2
2.1.2.7	UNSATURATED BULLFROG	PC#1,2
2.1.2.8	UNSATURATED MIDDLE CRATER FLAT	PC#1,2

The sections that follow identify the mined geologic disposal system requirements that have been allocated to 2.2 ENGINEERED BARRIERS and its constituent subfunctions as shown below.



This page intentionally left blank.

2.2 ENGINEERED BARRIERS

Subfunctions are:

2.2.1 WASTE PACKAGE
2.2.2 REPOSITORY ENGINEERED BARRIERS
2.2.3 SHAFT AND BOREHOLE SEALS

DEFINITION:

ENGINEERED BARRIERS consist of the waste packages, the barriers associated with the underground facility, and the access shaft and exploratory borehole seals. The boundary of the ENGINEERED BARRIERS (excluding 2.2.3 SHAFT AND BOREHOLE SEALS) is defined as the locus of points five meters into the host rock along the direction of potential radionuclide travel from the surface of all underground facility openings.

NOTE: By NRC definition, any backfill and seals contained in access shafts or exploratory boreholes are specifically excluded from their engineered barrier system. Nevertheless, the requirements on any materials placed into shafts or exploratory boreholes are included as a part of the ENGINEERED BARRIERS because of the inappropriateness of their inclusion within either 2.1 NATURAL BARRIERS or 2.3 INSTITUTIONAL BARRIERS. To be consistent with the NRC, the 2.2.3 SHAFT AND BOREHOLE SEALS, will not contribute to satisfying any requirement the NRC has placed on ENGINEERED BARRIERS.

FUNCTIONAL REQUIREMENTS:

1. To contain the radioactive waste during the period when radiation and thermal conditions are dominated by fission product decay.

2. To limit the release of all radionuclides to a gradual process that results in small fractional release rates to 2.1 NATURAL BARRIERS.

PERFORMANCE CRITERIA:

1. The period of containment shall satisfy the requirements given in 10 CFR 60.113(a)(1)(ii)(A) or 60.113(b). According to the NRC in 10 CFR 60.113(a)(1)(i)(A), the function of achieving containment is placed on the ENGINEERED BARRIERS. In paragraph 60.113(a)(1)(ii)(A), the performance criterion for this function is allocated entirely to the 2.2.1 WASTE PACKAGE. Because the WASTE PACKAGE is a subfunction of the ENGINEERED BARRIERS, this performance criterion for containment is also applicable to this higher level function.

2a. The release rate of any radionuclide shall be less than the limits specified in 10 CFR 60.113(a)(1)(ii)(B) and 60.113(b).

2b. The actual radionuclide release rate from all ENGINEERED BARRIERS shall combine with the radionuclide retardation provided by 2.1 NATURAL BARRIERS to ensure that the ultimate release to the accessible environment conforms to EPA standards [10 CFR 60.112]. Note: See 2.2.1 Constraint #C.

CONSTRAINTS:

A. The performance of the engineered components designed to function as barriers after permanent closure must be determined, where practicable, by 1.2.3.3 NATURAL- AND ENGINEERED-BARRIERS EVALUATION, in order to indicate if their functions are being satisfied as expected [10 CFR. 60.140(a)(2)].

INTERACTIONS:

	Function Interacted With	2.2 Requirement
1.2.3.3	NATURAL- AND ENGINEERED-BARRIERS EVALUATION	C#A
2.1.	NATURAL BARRIERS	PC#2b

2.2.1 WASTE PACKAGE

Subfunctions are:

2.2.1.1 CONTAINER
2.2.1.2 WASTE FORM

DEFINITION:

The WASTE PACKAGE consists of those engineered components permanently placed into the emplacement boreholes that are necessary for containment of the radioactive waste and for contributing to the controlled release of radionuclides to the 2.1 NATURAL BARRIERS.

FUNCTIONAL REQUIREMENTS:

1. To confine the radioactive waste within its boundaries for a specified time period.

2. To contribute to controlling the release of radionuclides to 2.1 NATURAL BARRIERS following loss of containment.

PERFORMANCE CRITERIA:

1. The WASTE PACKAGE shall provide substantially complete containment for the period specified in 10 CFR 60.113(a)(1)(ii)(A) and 60.113(b).

2a. The individual radionuclide release rates must not exceed a value such that in combination with any retardation to transport provided by 2.2.2 REPOSITORY ENGINEERED BARRIERS, the overall engineered barrier release rate performance criterion is exceeded [2.2 PC#2a].

2b. The radionuclide release from the WASTE PACKAGE shall combine with releases from other 2.2 ENGINEERED BARRIERS to ensure that the radionuclide release requirement in 2.2 PC#2b is met.

CONSTRAINTS:

A. The WASTE PACKAGE must limit the potential for criticality of the waste contained within it [1.0C#AA].

B. The in-situ chemical, physical, and nuclear properties of the WASTE PACKAGE and its interactions with the emplacement environment cannot compromise the performance of any WASTE PACKAGE component, or 2.2.2 REPOSITORY ENGINEERED BARRIERS or 2.1 NATURAL BARRIERS [10 CFR 60.135(a)].

C. The waste package shall be designed, assuming anticipated processes and events, so that the release rate of any radionuclide from all of the waste packages following the containment period shall not exceed one part in 100,000 per year of the curie inventory of that radionuclide calculated to be present at 1000 years following permanent closure; 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 curie inventory of radioactive waste, originally emplaced in the underground facility, that remains after 1000 years of radioactive decay [GR 2.2.1 PC#2]. Note: this GR change issued April 16, 1985, places the engineered barrier system performance objective in 10 CFR 60.113 on the waste package as a goal for design purposes and a boundary for performance assessment at this time.

INTERACTIONS:

Function Interacted With		2.2.1 Requirement
1.2.1.3	BOREHOLE CONSTRUCTION	C#B
1.2.2.2	PREPARATION	PC#1,2; C#A,B

INTERACTIONS:

	Function Interacted With	2.2.1 Requirement
2.1	NATURAL BARRIERS	C#B
2.2.2	REPOSITORY ENGINEERED BARRIERS	PC#2; C#B
2.2.3	SHAFT AND BOREHOLE SEALS	PC#2b

This page intentionally left blank.

2.2.1.1 CONTAINER

DEFINITION:

The CONTAINER includes the canister in which the waste form is initially sealed, any additional metallic vessels or components that accompany the canister from the surface facility through emplacement and are also permanently disposed, and any additional structural support, dividers, or filler materials contained within the canister.

FUNCTIONAL REQUIREMENTS:

1. To prevent the release of radionuclides for a specified time period.

2. To contribute to controlling the release of radionuclides following loss of containment.

PERFORMANCE CRITERIA:

1. Radionuclide containment provided by the CONTAINER shall combine with containment by the 2.2.1.2 WASTE FORM to satisfy the requirements specified in 2.2.1 PC#1.

2. The radionuclide release from the CONTAINER shall combine with release from 2.2.1.2 WASTE FORM to meet the requirements identified in 2.2.1 PC#2a and 2b.

CONSTRAINTS:

A. The container must be constructed from materials that are both internally and externally compatible. That is, these materials cannot adversely affect the performance of other container components or any other engineered barrier component (e.g., canister and a borehole liner or the spent fuel-cladding) [2.2.1 C#B].

INTERACTIONS:

	Function Interacted With	2.2.1.1 Requirement
1.2.1.3	BOREHOLE CONSTRUCTION	C#A
1.2.2.2	PREPARATION	PC#1; C#A
2.2.1.2	WASTE FORM	PC#1,2; C#A
2.2.2	REPOSITORY ENGINEERED BARRIERS	C#A

2.2.1.2 WASTE FORM

DEFINITION:

The WASTE FORM consists of the radioactive waste material plus the cladding for spent fuel or any encapsulating/stabilizing matrix for defense high-level waste.

FUNCTIONAL REQUIREMENTS:

1. To prevent the release of radionuclides for a specified period of time.

2. To contribute to limiting the radionuclide release rate from the 2.2.1 WASTE PACKAGE following the containment period.

PERFORMANCE CRITERIA:

1. Radionuclide containment provided by the WASTE FORM shall combine with containment by the 2.2.1.1 CONTAINER to meet the requirements specified in 2.2.1 PC#1.

2. Following the containment period, WASTE FORM shall combine with the 2.2.1.1 CONTAINER to limit the individual radionuclide release rates to a level such that the rates required for the 2.2.1 WASTE PACKAGE are not exceeded [2.2.1PC#2a and 2b].

CONSTRAINTS:

A. The WASTE FORM shall be compatible with the 2.2.1.1 CONTAINER and thus not decrease its performance [2.2.1 C#B].

INTERACTIONS:

Function Interacted With		2.2.1.1 Requirement
1.2.2.2	PREPARATION	PC#1; C#A
2.2.1.1	CONTAINER	PC#1,2; C#A

2.2.2 REPOSITORY ENGINEERED BARRIERS

Subfunctions are:

2.2.2.1 HOST ROCK
2.2.2.2 UNDERGROUND OPENINGS
2.2.2.3 REPOSITORY SEALS

DEFINITION:

REPOSITORY ENGINEERED BARRIERS consist of (1) the volume of host rock defined by the locus of points five meters into the host rock along the direction of potential radionuclide travel from the surface of all underground facility openings, (2) the underground facility openings and any backfill materials associated with these openings, and (3) any seals associated with the underground facility.

FUNCTIONAL REQUIREMENTS:

1. To contribute to controlling the release rate of radioactive material from the 2.2 ENGINEERED BARRIERS to the accessible environment after the loss of containment.

2. To provide conditions compatible with the confinement of radioactive waste within 2.2 ENGINEERED BARRIERS.

PERFORMANCE CRITERIA:

1a. REPOSITORY ENGINEERED BARRIERS shall assist the 2.2.1 WASTE PACKAGE to meet the 2.2 ENGINEERED BARRIERS limited release requirement in 2.2 PC#2a.

1b. REPOSITORY ENGINEERED BARRIERS shall combine with the 2.2.1 WASTE PACKAGE and 2.2.3 SHAFT AND BOREHOLE SEALS to meet the 2.2 ENGINEERED BARRIERS radionuclide release requirement identified in 2.2 PC#2b.

2. REPOSITORY ENGINEERED BARRIERS shall provide conditions compatible with substantially complete containment of radioactive waste within the 2.2 ENGINEERED BARRIERS as required by 10 CFR 60.113(a).

CONSTRAINTS:

None identified

INTERACTIONS:

	Function Interacted With	2.2.2 Requirement
2.2.1	WASTE PACKAGE	PC#1a,1b,2
2.2.3	SHAFT AND BOREHOLE SEALS	PC#1b

2.2.2.1 HOST ROCK

DEFINITION:

The HOST ROCK is that portion of the 2.2.2 REPOSITORY ENGINEERED BARRIERS made up of the volume of rock defined by the locus of points five meters into the host rock along the direction of potential radionuclide travel from the surface of all underground facility openings.

FUNCTIONAL REQUIREMENTS:

1. To contribute to the control of radioactive release provided by 2.2.2 REPOSITORY ENGINEERED BARRIERS.

2. To contribute to providing conditions compatible with the confinement of radioactive waste within 2.2 ENGINEERED BARRIERS.

PERFORMANCE CRITERIA:

1. The HOST ROCK shall combine with 2.2.2.2 UNDERGROUND OPENINGS and 2.2.2.3 REPOSITORY SEALS and to meet the limited release requirement in 2.2.2 PC#1a.

   NOTE: Because of the requirements allocation scheme and definitions used in the SR, the HOST ROCK does not contribute to meeting the 2.2.2 REPOSITORY ENGINEERED BARRIERS portion of the 2.2 ENGINEERED BARRIERS total system release requirement in 2.2 PC#2b. Rather, the contribution of this volume of rock to limiting total system release is considered in the allocation of requirements to the 2.1.1 DISTURBED ZONE.

2. The HOST ROCK shall contribute, along with 2.2.2.2 UNDERGROUND OPENINGS and 2.2.2.3 REPOSITORY SEALS, to providing conditions compatible with substanitally complete containment of radioactive waste within the 2.2 ENGINEERED BARRIERS [2.2.2 PC#2].

CONSTRAINTS:

None identified

INTERACTIONS:

Function Interacted With		2.2.2.1 Requirement
2.2.2.2	UNDERGROUND OPENINGS	PC#1,2
2.2.2.3	REPOSITORY SEALS	PC#1,2

2.2.2.2 UNDERGROUND OPENINGS

DEFINITION:

UNDERGROUND OPENINGS consist of all underground facility openings and any backfill materials that may be associated with these openings. NOTE: Access shafts and ramps and exploratory boreholes and any seals associated with them are excluded from underground facility openings by 10 CFR 60.2. The requirements for these openings and their seals are included in 2.2.3 SHAFT AND BOREHOLE SEALS. UNDERGROUND OPENINGS includes any space between the 2.2.1 WASTE PACKAGE and the 2.2.2.1 HOST ROCK.

FUNCTIONAL REQUIREMENTS:

1. To contribute to the control of radioactive release provided by 2.2.2 REPOSITORY ENGINEERED BARRIERS.

2. To contribute to providing conditions compatible with the confinement of radioactive waste within 2.2 ENGINEERED BARRIERS.

PERFORMANCE CRITERIA:

1a. UNDERGROUND OPENINGS shall combine with 2.2.2.1 HOST ROCK and 2.2.2.3 REPOSITORY SEALS to meet the limited release requirement in 2.2.2 PC#1a.

1b. UNDERGROUND OPENINGS shall combine with 2.2.2.1 HOST ROCK and 2.2.2.3 REPOSITORY SEALS to meet the system radionuclide release requirement identified in 2.2.2 PC#1b.

2. UNDERGROUND OPENINGS shall contribute, along with 2.2.2.1 HOST ROCK and 2.2.2.3 REPOSITORY SEALS, to providing conditions capatible with substantially complete containment of radioactive waste within the 2.2 ENGINEERED BARRIERS [2.2.2 PC#2].

CONSTRAINTS:

None identified

INTERACTIONS:

Function Interacted With		2.2.2.1 Requirement
2.2.2.1	HOST ROCK	PC#1a,1b,2
2.2.2.3	REPOSITORY SEALS	PC#1a,1b,2

2.2.2.3 REPOSITORY SEALS

DEFINITION:

REPOSITORY SEALS include any material placed in the cross-sectional area of 2.2.2.2 UNDERGROUND OPENINGS and any engineering features to control the flow of water in the underground facilities. Note this definition includes any backfill material placed in 2.2.2.2 UNDERGROUND OPENINGS for purposes of controlling water movement. If backfill is placed in 2.2.2.2 UNDERGROUND OPENINGS for any other reason, it is considered to be part of 2.2.2.2 UNDERGROUND OPENINGS.

PERFORMANCE CRITERIA:

1a. REPOSITORY SEALS shall combine with 2.2.2.1 HOST ROCK and 2.2.2.2 UNDERGROUND OPENINGS to meet the limited release requirement in 2.2.2 PC#1a.

1b. REPOSITORY SEALS shall combine with 2.2.2.1 HOST ROCK and 2.2.2.2 UNDERGROUND OPENINGS to meet the system radionuclide release requirement identified in 2.2.2 PC#1b.

2. REPOSITORY SEALS shall contribute, along with 2.2.2.1 HOST ROCK and 2.2.2.2 UNDERGROUND OPENINGS, to providing conditions capatible with substantially complete containment of radioactive waste within the 2.2 ENGINEERED BARRIERS [2.2.2 PC#2].

CONSTRAINTS:

None identified

INTERACTIONS:

Function Interacted With		2.2.2.1 Requirement
2.2.2.1	HOST ROCK	PC#1a,1b,2
2.2.2.2	UNDERGROUND OPENINGS	PC#1a,1b,2

2.2.3 SHAFT AND BOREHOLE SEALS

DEFINITION:

The SHAFT AND BOREHOLE SEALS consist of the engineered materials placed inside the access shafts, ramps, and exploratory boreholes.

FUNCTIONAL REQUIREMENTS:

1. To seal access shafts and ramps along with exploratory boreholes, to the extent practicable, in order to reduce the quantity of water that can contact the 2.2.1 WASTE PACKAGE and to preclude a more rapid discharge or transport of contaminated groundwater to the accessible environment.

PERFORMANCE CRITERIA:

1. Following permanent closure, the seals for shafts, ramps, and exploratory boreholes shall be sufficient to not allow these openings to become pathways that could compromise the ability of 2.0 POSTCLOSURE WASTE DISPOSAL to meet its performance criteria [10 CFR 60.134(a,b)]. Pathways include those associated with both groundwater flow to the waste package and radionuclide transport to the accessible environment.

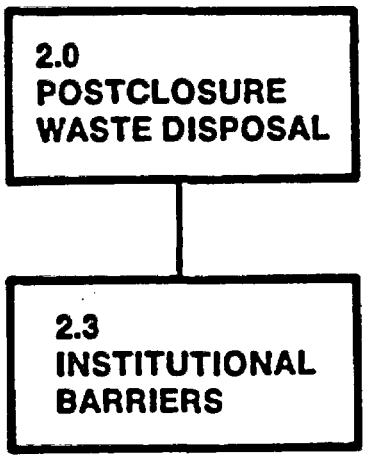
CONSTRAINTS:

A. Material and emplacement methods for shaft and borehole seals shall be selected to reduce, to the extent practicable: (1) the potential for creating a preferential pathway for groundwater to contact the waste package or (2) radionuclide migration through existing pathways [10 CFR 60.134(b)].

INTERACTIONS:

	Function Interacted With	2.2.3 Requirement
1.2.4.1	UNDERGROUND CLOSURE	PC#1; C#A
2.0	POSTCLOSURE	PC#1
2.1	NATURAL BARRIERS	PC#1
2.2.1	WASTE PACKAGE	PC#1
2.3	INSTITUTIONAL BARRIERS	PC#1

The section that follows identify the mined geologic disposal system requirements that have been allocated to 2.3 INSTITUTIONAL BARRIERS.



This page intentionally left blank.

2.3 INSTITUTIONAL BARRIERS

DEFINITION:

The function provides facilities, equipment, administrative controls, records, physical restraints, and markers that monitor the performance of POSTCLOSURE WASTE DISPOSAL and prevent or control human activities that are incompatible with containment and isolation of the emplaced waste.

FUNCTIONAL REQUIREMENTS:

1. To provide active institutional control of inadvertant human intrusion that may cause releases of radioactivity to the accessible environment after permanent closure.

2. To provide passive institutional controls to reduce the likelihood of inadvertant human intrusion that may cause releases of radioactivity to the accessible environment after the cessation of active control.

3. To provide monitoring of POSTCLOSURE WASTE DISPOSAL performance after permanent closure.

PERFORMANCE CRITERIA:

1-2. Active and passive institutional controls implemented at permanent closure shall conform with the license amendment for permanent closure required by 10 CFR 60.51 (a)(1).

3. The capability to monitor postclosure repository performance shall conform with the program described in the license amendment for permanent closure required by 10 CFR 60.51 (a)(1).

CONSTRAINTS:

A. After permanent closure, the controlled area shall be located on lands that are either acquired lands under the jurisdiction and control of DOE or lands permanently withdrawn and reserved. The lands shall be held free and clear of all encumbrances, if significant [10 CFR 60.121(a)].

B. Monitoring of POSTCLOSURE WASTE DISPOSAL shall be done with techniques that do not jeopardize isolation of the disposed radioactive waste [10 CFR 60.140(d)(1)].

C. Appropriate controls shall be established to prevent adverse human actions that could significantly reduce the radioactive waste isolation provided by POSTCLOSURE WASTE DISPOSAL [10 CFR 60.121(b)].

D. Assessments of inadvertant human intrusion after permanent closure and decommissioning shall be based on the assumptions in 10 CFR 60.2 "Unanticipated Processes and Events."

E. As a minimum, the written records intended to preserve long-term knowledge of the radioactive waste disposed at Yucca Mountain shall contain [10 CFR 60.51(a)(2)]:

1. The location of the surface and underground areas where radioactive waste was handled.

2. The location of the boundaries of the area where potentially disruptive human activities are to be controlled or prevented.

3. The location of exploratory boreholes and shafts.

4. Information concerning the nature of and hazards associated with the emplaced radioactive waste.

F. As a minimum, written records to preserve long-term knowledge of the radioactive waste disposed at Yucca Mountain shall be placed in archives and land-recording systems of Nye County, Nevada, the State of Nevada, and Federal government agencies and archives elsewhere in the world that would likely be consulted by potential human intruders [10 CFR 60.51(a)(2)(ii)].

INTERACTIONS:

	Function Interacted With	2.3 Requirement
	SOCIETAL (postclosure)	PC#1,2; C#B
1.2.5.1	INFORMATION	C#E,F
1.2.4.3	INSTITUTIONAL BARRIER IMPLEMENTATION	PC#1,2,3; C#B,C,E,F

This page intentionally left blank.

APPENDIX A

GLOSSARY

Accessible environment	The atmosphere, the land surfaces, surface waters, oceans, and the portion of the lithosphere that is outside the controlled area (10 CFR 960.2; 10 CFR 60.2; 40 CFR 191.12).
Barrier	Any material or structure that prevents or substantially delays the movement of water or radionuclides toward the accessible environment (10 CFR 960.12; 40 CFR 191.12; 10 CFR 60.2).
Canister	The metal vessel in which the waste form is initially sealed.
Closure	Final backfilling of the remaining open operational areas of the underground facility and boreholes after termination of waste emplacement, culminating in the sealing of shafts (10 CFR 960.2).
Constraints	Requirements and limitations that are placed on an MGDS function as a result of its interaction with other MGDS functions, the regulatory process, the design process, and the physical and chemical environment in which the MGDS function must be performed.
Container	The canister in which the waste form is initially sealed, any additional metallic vessels or components that accompany the canister from the surface facility through emplacement and are also permanently disposed, and any additional structural support, dividers, or filler materials contained within the canister.
Containment	The confinement of radioactive waste within a designated boundary (10 CFR 960.2; 10 CFR 60.2).
Controlled area	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 the subsurface underlying such a surface location (40 CFR 191.12).

Criticality (nuclear)	The condition of supporting a chain reaction that occurs when the number of neutrons present in one generation cycle equals the number generated in the previous cycle (GR Appendix A).
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).
Defense high-level waste (DHLW)	High-level radioactive wastes derived from atomic energy defense activities.
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, and the isolation of such waste from the accessible environment (10 CFR 960.2, NWPA 2(9)).
Effective multiplication factor (K_{eff})	The ratio of the number of neutrons from two successive generations present in an actual nuclear reactor where there is leakage (K_{eff})(Dictionary of Scientific and Technical Terms, 3rd ed.).
Engineered barrier	Waste packages, barriers associated with the repository underground facility, and the access shaft and exploratory borehole seals. The boundary of NNWSI engineered barriers has not been defined.
Functional requirements	Statements of what MGDS functions and subfunctions are supposed to accomplish.
Geologic repository	A system, requiring licensing by the NRC, that is intended to be used, or may be used, for the disposal of radioactive waste in excavated geologic media. A geologic repository includes the geologic repository operations area and the portion of the geologic setting that provides isolation of the radioactive waste and is located within the controlled area (10 CFR 960.2; 10 CFR 60.2).

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 960.2; 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 960.2; 10 CFR 60.2).
Heavy metal	All uranium, plutonium, or thorium placed in a nuclear reactor (40 CFR 191.12).
High-level radioactive waste	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 other highly radioactive materials that the NRC, consistent with existing law, determines by rule requires permanent isolation (10 CFR 960.2 NWPA 2(12); 40 CFR 191.02).
Important to safety	With reference to structures, systems, and components; the 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).
Isolate/Isolation	The inhibiting of 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 960.2; 10 CFR 60.2).
Mined geologic disposal system	A system, requiring licensing by the NRC, that is used for the disposal of high-level radioactive waste in excavated geologic media (GR Appendix A).
MTHM	Metric Tons of Heavy Metal
MTU	Metric Tons of Uranium

Natural barriers	The repository host rock, surrounding geologic structures and formations and all of the groundwater flow, geochemical processes, and vapor phase flow processes that occur therein. Natural barriers extend from the boundary of the engineered barriers to the accessible environment.
Performance criteria	Statements of how well an MGDS function must be performed.
Permanent closure	Synonymous with closure (10 CFR 960.2).
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.
Radioactive waste	High-level radioactive waste and other radioactive materials, including spent nuclear fuel, that are received for emplacement in a geologic repository (10 CFR 960.2; 10 CFR 60.2; 40 CFR 191.02).
Restricted area	Any area in which access 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 before repository closure from the underground location at which the waste had been previously emplaced for disposal (10 CFR 960.2; GR Appendix A).
Significant source of groundwater	A. An aquifer that: (1) is saturated with water having less than 10,000 milligrams per liter of total dissolved solids; (2) is within 2,500 feet of the land surface; (3) has a transmissivity greater than 200 gallons per day per square foot, provided that any formation or part of a formation included within the source of groundwater has a hydraulic conductivity greater than 2 gallons per day per square foot; and (4) is capable of continuously yielding at least 10,000 gallons per day to a pumped or flowing well for a period of at least a year. Or,

	B. An aquifer that provides the primary source of groundwater for a community water system as of the effective date of 40 CFR 191 Subpart B (40 CFR 191.12).
Special source of groundwater	Those Class I groundwaters identified in accordance with EPA's Groundwater Protection Strategy published in August 1984 that: (1) are within the controlled area encompassing a disposal system or are less than five kilometers beyond the controlled area; (2) are supplying drinking water for thousands of persons as of the date that the DOE chooses a location within that area for detailed characterization as a potential site for a disposal system; and (3) are irreplaceable in that no reasonable alternative source of drinking water is available to that population (40 CFR 191.12).
Spent nuclear fuel	Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing (NWPA 2(23); 10 CFR 960.2).
Transportation system	A system external to the geologic repository that transfers radioactive wastes from its source or from monitored-retrievable storage to or from the repository.
Underground facility	The underground structure and the rock required for support, including mined openings and backfill materials, but excluding shafts, boreholes, and their seals (10 CFR 960.2; 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	Synonymous with radioactive waste.
Waste-emplacement package (postclosure)	The radioactive waste form, its support hardware, and a sealed container that surrounds it. The boundary of the waste-emplacement package is the outer edge of the container.

Waste form	The radioactive waste materials plus the cladding for spent fuel or any encapsulating or stabilizing matrix for defense high-level waste.
Waste package (postclosure)	The waste form and any containers, shielding, packing, and other sorbent materials immediately surrounding an individual waste container (10 CFR 960.2).
WVHLW	West Valley High-Level Waste.

APPENDIX B

GR-SR REQUIREMENTS CORRELATION

This appendix section is a correlation between the "Generic Requirements for a Mined Geological Disposal System" document (GR) and this document (SR). The column on the left lists all the functional requirements (FR), performance criteria (PC), and constraints (C) of the GR by section. The column on the right is the corresponding entry found in the SR.

GR (section and requirement)	SR (requirement and section)	
MGDS		
PC#1	PC#1	YMMGDS
PC#2	PC#2	YMMGDS
C#A	C#X	1.0
C#B	C#A	YMMGDS
C#C	C#G	1.0
C#D	C#H	1.0
C#E	C#I	1.0
C#F	C#J	1.0
1.0 Waste Disposal Preclosure		
PC#1	PC#1	1.0
PC#2	PC#2	1.0
C#A	C#A	1.0
C#B	C#B	1.0
C#C	C#C	1.0
C#D	C#D	1.0
C#E	C#E	1.0
C#F	C#F	1.0
C#G	C#G	1.0
C#H	C#H	1.0
C#I	C#I	1.0
C#J	C#J	1.0
C#K	C#L	1.0
C#L	C#M	1.0
C#M	C#N	1.0
C#N	C#O	1.0
C#O	C#CC	1.0
C#P	C#K	1.0
C#Q	C#P	1.0
C#R	C#Q	1.0
C#S	C#R	1.0
C#T	PC#2	1.0
C#U	C#S	1.0

GR (section and requirement)	SR (requirement and section)	
1.1 Site		
PC#1a	PC#1a	1.1
PC#1b	PC#1b	1.1
C#A	C#A	1.1
C#B	C#B	1.1
1.1.1 Surface		
PC#1	PC#1	1.1.1
C#A	C#A	1.1.1
C#B	C#B	1.1.1
1.1.2 Subsurface		
PC#1	PC#1	1.1.2
C#A	C#A	1.1.2
C#B	C#B	1.1.2
C#C	C#C	1.1.2
C#D	C#D	1.1.2
C#E	C#E	1.1.2
1.2 Repository Preclosure		
PC#1	PC#1	1.2
PC#2	PC#2	1.2
PC#3a	PC#3	1.2
PC#3b	PC#1-2	1.2.5.9
PC#4	PC#5	1.2
C#A	C#A	1.2
C#A(1)	C#A1	1.2
C#A(2)	C#A2	1.2
C#A(3)	C#A3	1.2
C#A(4)	C#A4	1.2
C#A(5)	C#A5	1.2
C#A(6)	C#A6	1.2
C#A(7)	C#A7	1.2
C#A(8)	C#A8	1.2
C#A(9)	C#A9	1.2
C#A(10)	C#A10	1.2
C#A(11)	C#A11	1.2
C#A(12)	C#A12	1.2
C#B	C#F,G	1.2.1
C#C	C#H	1.2.1
C#D	C#I	1.2.1
C#E	C#J	1.2.1
C#F	C#K	1.2.1
C#G	C#M	1.2.1

GR (section and requirement)	SR (requirement and section)	
1.2 Repository Preclosure		
C#H	C#O	1.2
C#I	C#K	1.2
C#J	C#K	1.2
C#K	C#R	1.2
C#L	C#K	1.2
C#M	C#K	1.2
C#N	C#U	1.2
1.2.1 Mining		
PC#1a	PC#1,2	1.2.1
PC#1b	PC#1,2	1.2.1
PC#2a	PC#3	1.2.1
PC#2b	PC#4	1.2.1
PC#2c	PC#5	1.2.1
PC#3a	C#U	1.2.1
PC#3b	C#V	1.2.1
PC#3c	C#W	1.2.1
PC#3d	C#X	1.2.1
PC#3e	C#Y	1.2.1
PC#3f	C#Z	1.2.1
PC#3g	C#AA	1.2.1
C#A	C#E	1.2.1
C#B	C#CC	1.2.1
C#C	C#BB	1.2.1
1.2.1.1 Excavation		
PC#1a	PCs#1	1.2.1.1, 1.2.1.2
PC#1b	PCs#1	1.2.1.1, 1.2.1.2
PC#1c	PCs#1	1.2.1.1, 1.2.1.2
PC#2a	PCs#1	1.2.1.1, 1.2.1.2
PC#2b	C#DD	1.2.1
PC#3a	PCs#1	1.2.1.1, 1.2.1.2
PC#3b	PCs#1	1.2.1.1, 1.2.1.2
PC#3c	PCs#1	1.2.1.1, 1.2.1.2
PC#3d	C#E	1.2.1
PC#4a	C#K	1.2.1
PC#4b	C#E	1.2.1
PC#4c	C#EE	1.2.1
PC#4d	C#C	1.2.1
C#A	C#FF	1.2.1
C#B	C#GG	1.2.1
C#C	C#HH	1.2.1
C#D	C#H	1.2.1
C#E	C#II	1.2.1
C#F	C#I(17)	1.2.1.2

GR (section and requirement)	SR (requirement and section)	
1.2.1.1 Excavation		
C#G	C#JJ	1.2.1
C#H	C#I	1.2.1
C#I	C#N	1.2.1
C#J	C#J	1.2.1
C#K	PC#5	1.2.1
1.2.1.2 Rock Handling		
PC#1a	PC#1-4	1.2.1.4
PC#1b	PC#1-4	1.2.1.4
PC#1c	C#E	1.2.1.4
PC#2a	PC#1-4	1.2.1.4
PC#2b	C#E	1.2.1.4
PC#2c	C#E	1.2.1.4
PC#3a	PC#3	1.2.1
PC#3b	PC#1	1.2.1.2
PC#4a	PC#1-4	1.2.1.4
PC#4b	C#E	1.2.1.4
C#A	C#H	1.2.1
1.2.1.3 Ground-Water Control		
PC#1a	PC#1	1.2.1.5
PC#1b	C#D	1.2.1.5
PC#1c	PC#1	1.2.1.5
PC#1d	PC#1	1.2.1.5
PC#2	PC#2	1.2.1.5
PC#3	C#G	1.2.1.5
C#A	C#H	1.2.1.5
C#B	C#I	1.2.1.5
C#C	C#J	1.2.1.5
1.2.1.4 Ventilation		
PC#1a	PC#1	1.2.1.6
PC#1b	C#F	1.2.1.6
PC#2a	PC#1	1.2.1.6
PC#2b	C#F	1.2.1.6
PC#3	PC#1	1.2.1.6
PC#4	C#H	1.2.1.6
PC#5	C#I	1.2.1.6
C#A	C#J	1.2.1.6
C#B	C#K	1.2.1.6
C#C	C#D	1.2.1.6

GR (section and requirement)	SR (requirement and section)	
1.2.2 Waste Handling		
PC#1	PC#1a,1b	1.2.2
PC#2	PC#6,7	1.2.2
C#A	C#F	1.2.2
C#B	C#L	1.2.2
C#C	C#B	1.2.2
C#D	C#E	1.2.2
1.2.2.1 Receiving		
PC#1	PC#1	1.2.2.1
PC#2	PC#1a	1.2.5.4
PC#3	PC#2	1.2.5.4
PC#4	PC#2	1.2.2.1
PC#5	C#V	1.2.5.9.1
	C#G	1.2
C#A	PC#5a	1.2.2
1.2.2.2 Preparation		
PC#1	PC#1a,1b	1.2.2.2
PC#2	PC#2	1.2.2.8
PC#3	C#J	1.2.2.2
C#A	PC#5a	1.2.2
C#B	C#B	1.2.2.2
C#C	C#C	1.2.2.2
1.2.2.3 Storage		
PC#1a	PC#1a	1.2.2.3
PC#1b	PC#1b	1.2.2.3
PC#2	PC#1c	1.2.2.3
1.2.2.4 Transport/Emplacement		
PC#1	PC#1-2a	1.2.2.4
PC#2a	PC#1-2a	1.2.2.4
PC#2b	C#H,I	1.2.2.4
PC#3a	PC#1-2a	1.2.2.4
PC#3b	PC#2b	1.2.2.4
	C#F	1.2.2.4
PC#4a	C#L	1.2.2.4
	C#U	1.2.2.4
PC#4b	C#F	1.2.2.4
PC#4c	C#D	1.2.2.5
C#A	C#A	1.2.2.4

GR (section and requirement)	SR (requirement and section)	
1.2.2.4 Transport/Emplacement		
C#B	C#B	1.2.2.4
C#C	C#C	1.2.2.4
C#D	PC#2	1.3
	PC#1c,1d	1.2.5.1
C#E	C#D	1.2.2.5
C#F(i)	C#D	1.2.2.4
C#F(ii)	C#E	1.2.2.4
1.2.2.5 Ventilation		
PC#1	PC#1,2	1.2.2.7
PC#2	PC#1,2	1.2.2.7
C#A	C#A	1.2.2.7
C#B	C#B	1.2.2.7
C#C	C#D,H	1.2.2.7
1.2.2.5.1 Uncontaminated Area		
PC#1a	PC#1,2	1.2.2.7
PC#1b	C#B	1.2.2.7
PC#2	C#F	1.2.2.7
1.2.2.5.2 Contaminated Area		
PC#1	PC#1-2;	
	C#D	1.2.2.7
PC#2	C#F	1.2.2.7
C#A	C#D	1.2.2.7
1.2.2.5.3 Subsurface Area		
PC#1a	C#K	1.2.2.7
PC#1b-2	PC#1-2	1.2.2.7
	C#D,F	1.2.2.7
C#A	C#D,J	1.2.2.7
C#B	C#M	1.2.2.7
C#C	C#N	1.2.2.7
C#D	C#J	1.2.2.7
1.2.3 Monitoring and Confirmation		
PC#1	PC#1	1.2.5.9
PC#2a	PC#2	1.2.5.9
PC#2b	PC#2	1.2.5.9

GR (section and requirement)	SR (requirement and section)	
1.2.3 Monitoring and Confirmation		
PC#2c	PC#2	1.2.5.9
PC#3	PC#3	1.2
C#A	C#A	1.2.5.9
C#B	C#B	1.2.5.9
C#C	C#C	1.2.5.9
1.2.3.1 Radiological		
PC#1	PC#1	1.2.5.9.1
PC#2a	C#C	1.2.5.9.1
PC#2b	C#D	1.2.5.9.1
PC#2c	C#E	1.2.5.9.1
PC#2d	C#F	1.2.5.9.1
PC#2e	PC#2	1.2.5.9.1
PC#2f	PC#2	1.2.5.9.1
PC#3a	C#G	1.2.5.9.1
PC#3b	C#H	1.2.5.9.1
PC#3c	C#I	1.2.5.9.1
PC#4a	C#J	1.2.5.9.1
PC#4b	C#K	1.2.5.9.1
PC#4c	C#L	1.2.5.9.1
PC#4d	PC#4	1.2.5.9.1
1.2.3.2 Nonradiological		
PC#1a	PC#1a	1.2.5.9.2
PC#1b	PC#1b	1.2.5.9.2
PC#1c	PC#1c	1.2.5.9.2
PC#1d	PC#1d	1.2.5.9.2
PC#1e	PC#1e	1.2.5.9.2
PC#2	PC#2	1.2.5.9.2
PC#3a	PC#3a	1.2.5.9.2
PC#3b	PC#3b	1.2.5.9.2
PC#4a	PC#4a	1.2.5.9.2
PC#4b	PC#4b	1.2.5.9.2
PC#4c	PC#4c	1.2.5.9.2
PC#5	PC#5	1.2.5.9.2
PC#6	PC#6	1.2.5.9.2
PC#7	PC#7	1.2.5.9.2
1.2.3.3 Performance Confirmation		
PC#1a	C#G	1.2.3.2
PC#1b	C#A	1.2.3.2
PC#1c	PC#1f	1.2.3.3
PC#2	PC#3	1.2.3

GR (section and requirement)		SR (requirement and section)	
1.2.3.3	Performance Confirmation		
	PC#2a	C#B	1.2.3.3
	PC#2b	C#C	1.2.3.3
	PC#3a	C#D	1.2.3.3
	PC#3b	C#E	1.2.3.3
	PC#3c	C#F	1.2.3.3
	PC#3d	C#F	1.2.3.3
	PC#3e	C#G	1.2.3.3
	PC#4a	PC#1j	1.2.3.3
	PC#4b	C#J	1.2.3.3
	PC#4c	PC#3	1.2.3.4
	PC#5	PC#1f	1.2.3.3
	C#A	C#R	1.2.3
1.2.4	Support		
	PC#1	PC#1-10	1.2.5
1.2.4.1	Records Keeping		
	PC#1a	PC#1a,1b	1.2.5.1
	PC#1b(1-3)	PC#1c	1.2.5.1
	PC#2(a-k)	PC#1d	1.2.5.1
	PC#3(a-d)	PC#1e	1.2.5.1
	PC#4(a-f)	PC#1f	1.2.5.1
	PC#5(a-d)	PC#1g	1.2.5.1
	PC#6	PC#1h	1.2.5.1
	PC#7	PC#1i	1.2.5.1
	PC#8	PC#1j	1.2.5.1
	C#A	C#A	1.2.5.1
	C#B	PC#1m	1.2.5.1
1.2.4.2	Offsite Service		
	PC#1a	C#H	1.2.5.8
	PC#1b	C#P	1.2.5.7
	PC#1c	C#B	1.2.5.10
1.2.4.3	Administration		
	PC#1a	PC#1a	1.2.5.2
	PC#1b	PC#1e	1.2.5.2
	PC#1c	PC#1a	1.2.5.2
	PC#1d	PC#1b	1.2.5.2
	C#A	PC#1c	1.2.5.2

GR (section and requirement)		SR (requirement and section)	
1.2.4.4	Personnel Service		
	PC#1a	PC#1a	1.2.5.3
	PC#1b	PC#1b	1.2.5.3
	PC#1c	PC#1c	1.2.5.3
	C#A	C#A	1.2.5.3
	C#B	C#B	1.2.5.3
	C#C	C#C	1.2.5.3
	C#D	C#D	1.2.5.3
1.2.4.5	Security		
	PC#1	PC#1c	1.2.5.4
	C#A	C#A	1.2.5.4
1.2.4.6	Supplies		
	PC#1a	PC#1a	1.2.5.5
	PC#1b	PC#1b	1.2.5.5
	PC#1c	C#B	1.2.5.5
	C#A	C#A	1.2.5.5
1.2.4.7	Maintenance		
	PC#1a	PC#1	1.2.5.6
	PC#1b	C#C	1.2.5.6
	C#A	C#A	1.2.5.6
	C#B	C#B	1.2.5.6
1.2.4.8	Utilities		
	PC#1a	PC#1	1.2.5.7
	PC#1b	C#B	1.2.5.7
	PC#1c	C#C	1.2.5.7
	PC#1d	PC#1	1.2.5.7
	PC#1e	C#F	1.2.5.7
	PC#1f	C#D	1.2.5.7
	PC#1g	C#E	1.2.5.7
	PC#2	PC#2	1.2.5.7
	C#A	C#A	1.2.5.7

GR (section and requirement)	SR (requirement and section)	
1.2.4.9 Transportation		
PC#1	PC#1	1.2.5.8
PC#2	PC#2	1.2.5.8
C#A	C#A	1.2.5.8
C#B	C#B	1.2.5.8
1.3 Waste Emplacement Package		
PC#1a	PC#1	1.3
PC#1b	PC#1	1.3
PC#2	C#B3	1.3
PC#3	C#D	1.3
C#A	C#E	1.3
C#B	C#F	1.3
1.3.1.a Waste Form (Irradiated Reactor Fuel)		
PC#1	C#B2	1.3
1.3.1b Waste Form (Reprocessed Waste)		
PC#1	C#B2	1.3
1.3.2 Container		
PC#1	PC#2; C#A	1.3
2.0 Waste Disposal		
PC#1a	PC#1a	2.0
PC#1b	PC#1b	2.0
C#A	C#A	2.0
C#B	C#B	2.0
C#C	C#C	2.0
C#D	C#D	2.0
2.1 Natural Barriers		
PC#1	PC#1,2	2.1
C#A	C#A	2.1
C#B	C#B	2.1
C#C	C#C	2.1
C#D	C#D	2.1
C#E	C#E	2.1

GR (section and requirement)	SR (requirement and section)	
2.1 Natural Barriers		
C#F	C#F	2.1
C#G	C#G	2.1
C#H	C#N	2.1
C#I	C#I	2.1
C#J	C#J	2.1
C#K	C#K	2.1
2.2 Engineered Barriers		
PC#1a	PC#1,2a	2.2
PC#1b	PC#2b	2.2
C#A	C#A	2.2
2.2.1 Waste Package		
PC#1	PC#1	2.2.1
PC#2	PC#2	2.2.1
2.2.2 Repository Engineered Barriers		
PC#1	PC#1	2.2.2
2.2.3 Shaft and Borehole Seals		
PC#1a	PC#1	2.2.3
PC#1b	PC#1	2.2.3
2.3 Institutional Barriers		
PC#1a	C#H	2.3
PC#1b	C#F	2.3
PC#2	C#B,D	2.3
PC#3	PC#3	2.3
C#A	C#A	2.3

This page intentionally left blank.

APPENDIX C

NNWSI ISSUES HIERARCHY

Text to be added subsequent to policy review

This page intentionally left blank.

APPENDIX D

CORRELATION OF SR REQUIREMENTS WITH THE NNWSI ISSUES HIERARCHY

Text to be added subsequent to policy review

This page intentionally left blank.

REFERENCES AND BIBLIOGRAPHY

ANSI/ANS 8.3, "Criticality Accident Alarm System."

ANSI Standard N13.1, "Guide to Sampling Airborne Radioactive Materials in a Nuclear Facility."

ANSI Standard N13.3, "Dosimetry for Criticality Accidents."

ANSI Standard N13.8, Section 14.3, "American National Standards Radiation Protection in Uranium Mines," July 1973.

ANSI Standard N13142 WG4, "Radiation Protection Instrumentation and Calibration - Final."

ANSI Standard N42.18-1980, "Reaffirmation of N13.10-1974, Specifications and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents."

DOE (U.S. Department of Energy), October 1985. "Systems Engineering Management Plan for the Office of Civilian Radioactive Waste Management," Washington, D.C.

DOE (U.S. Department of Energy), October 1985. "Systems Engineering Management Plan for the Office of Geologic Repositories," OGR/B-7, Washington, D.C.

DOE (U.S. Department of Energy), September 1984. "Generic Requirements for a Mined Geologic Disposal System," OGR/B-2, Washington, D.C.

DOE (U.S. Department of Energy, Nevada Operations Office), in preparation, "Nevada Nuclear Waste Storage Investigations Reference Information Base," Las Vegas, Nevada.

DOE Order 1323.1, November 29, 1978. "Monitoring, Coordinating, and Transmitting Reports to the Congress."

DOE Order 1324.2, May 28, 1980. "Records Disposition."

DOE Order 1325.1A, June 18, 1981. "DOE Correspondence Manual."

DOE Order 1330.1A, July 15, 1983. "Automated Management Information Systems and Data Administration."

DOE Order 1340.1A, August 25, 1982. "Management of Public Communications Publications, and Scientific, Technical, and Engineering Publications."

DOE Order 1350.1, October 28, 1981. "Audiovisual and Exhibits Management."

DOE Order 1540.1, May 3, 1982. "Materials Transportation and Traffic Management."

DOE Order 1600.1, October 14, 1980. "Federal Women's Program."

DOE Order 1600.2A, February 16, 1983. "Secretary's Commitment to Equal Opportunity."

DOE Order 1600.3, June 15, 1981. "Policy on Sexual Harassment."

DOE Order 1600.4, February 22, 1982. "Hispanic Employment Program."

DOE Order 1600.5, May 26, 1982. "System for Processing Complaints of Discrimination."

DOE Order 1600.6, May 11, 1983. "Civil Rights Compliance in Federally Assisted Programs."

DOE Order 1700.1, November 19, 1979. "Freedom of Information Program."

DOE Order 1800.1, May 18, 1981. "Private Act."

DOE Order 2100.4A, April 29, 1983. "Administrative Control of Funds."

DOE Order 2200.1, November 9, 1979. "Accounting Policy and Practices."

DOE Order 2250.1A, November 9, 1982. "Cost and Schedule Control System Criteria for Contract Performance Measurement."

DOE Order 3220.1, March 4, 1981. "Management of Contractor Personnel Policies and Programs."

DOE Order 3220.2, April 1, 1981. "Equal Opportunity in Operating and Onsite Service Contractor Facilities."

DOE Order 3230.2A, March 4, 1982. "Contractor Personnel and Industrial Relations Reports."

DOE Order 3304.1, October 17, 1980. "Employment of Experts and Consultants."

DOE Order 3400.1, April 7, 1982. "Executive Development."

DOE Order 3410.1A, April 28, 1983. "Training."

DOE Order 3410.2, February 3, 1981. "Upward Mobility Program."

DOE Order 3710.1, January 16, 1981. "Labor-Management Relations Program for Federal Employees."

DOE Order 3750.1, March 23, 1983. "Work Force Discipline."

DOE Order 3771.1, July 2, 1981. "Grievance Policy and Procedures."

DOE Order 3790.1, December 11, 1980. "Occupational Safety and Health Program for Federal Employees."

DOE Order 4200.3A, April 5, 1983. "Management of Support Services Contract Activity."

DOE Order 4200.4, September 6, 1983. "Selection, Appointment, and Termination of Contracting Officers."

DOE Order 4220.3A, November 4, 1981. "Administration of Offsite Contracts."

DOE Order 4320.1A, March 17, 1983. "Site Development and Facility Utilization Planning."

DOE Order 4330.4, March 25, 1982. "Real Property Maintenance Management."

DOE Order 5031.1, June 19, 1978. "Administration of Policy Coordination Instruments with Government Agencies."

DOE Order 5100.1, January 21, 1980. "Programming, Budgeting, and Accounting for the Acquisition of Low Value Capitol Equipment."

DOE Order 5300.1A, November 16, 1981. "Telecommunications."

DOE Order 5420.1, August 10, 1978. "Environmental Development Plans."

DOE Order 5440.1B, May 14, 1982. "Implementation of NEPA."

DOE Order 5480.1A, August 13, 1981. "Environmental Protection, Safety, and Health Protection Program for Department of Energy Operations."

DOE Order 5480.4, "Environmental Protection, Safety, and Health Protection Standards."

DOE Order 5481.1A, August 13, 1981. "Safety Analysis and Review System."

DOE Order 5482.1A, August 13, 1981. "Environmental, Safety, and Health Appraisal Program."

DOE Order 5483.1A, June 22, 1983. "Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities."

DOE Order 5484.1, February 24, 1981. "Environmental Protection, Safety, and Health Protection Information Reporting Requirements."

DOE Order 5484.2, August 13, 1981. "Unusual Occurrence Reporting System."

DOE Order 5500.1, July 24, 1981. "Vital Records Protection Program."

DOE Order 5500.2, August 18, 1981. "Emergency Planning, Preparedness, and Response for Operations."

DOE Order 5500.3, August 13, 1981. "Reactor and Non-Reactor Facility Emergency Planning, Preparedness, and Response Program for Department of Energy Operations."

DOE Order 5500.4, August 13, 1981. "Public Affairs Policy and Planning Requirements for Emergencies."

DOE Order 5630.2, August 21, 1980. "Control and Accountability of Nuclear Materials, Basic Principles."

DOE Order 5630.7, July 8, 1981. "Control and Accountability of Nuclear Materials Survey."

DOE Order 5630.9, February 22, 1983. "Nuclear Materials Reporting and Data Submission Procedures Manual."

DOE Order 5630.10, August 15, 1983. "Nuclear Materials Transactions: Documentation and Reporting."

DOE Order 5631.1, July 28, 1980. "Safeguards and Security Awareness Program."

DOE Order 5631.2, November 30, 1980. "Personnel Security Program."

DOE Order 5631.3, February 3, 1981. "Issuance and Control of Credentials, Shields, and Courier Cards."

DOE Order 5632.1, September 10, 1979. "Physical Protection of Classified Matter."

DOE Order 5632.2, February 16, 1979. "Physical Protection of Special Nuclear Materials."

DOE Order 5632.3, November 18, 1981. "Operations Security."

DOE Order 5633.1, July 28, 1980. "Violations of Laws, Losses, and Incidents of Security."

DOE Order 5635.1, April 14, 1981. "Control of Classified Documents and Information."

DOE Order 5650.2, December 12, 1978. "Classification of Information."

DOE Order 5700.2B, August 5, 1983. "Independent Cost Estimating and Cost Standardization."

DOE Order 5700.4, January 8, 1981. "Project Management System."

DOE Order 5700.5, January 12, 1981. "Policy and Management Procedures for Financial Incentives Programs."

DOE Order 5700.6A, August 13, 1981. "Quality Assurance."

DOE Order 5700.7A, June 9, 1983. "Field Work Package Proposal and Authorization."

DOE Order 5900.1, March 23, 1979. "Management of Energy Data Resources."

DOE Order 5900.2, December 19, 1980. "Use of the Metric System of Measurement."

DOE Order 6410.1, May 26, 1983. "Management of Construction Projects."

DOE Order 6430.1, December 12, 1983. "General Design Criteria."

DOE (U.S. Department of Energy), July 25, 1984. "10 CFR 960 General Guidelines for Recommendation of Sites for Nuclear Waste Repositories" (proposed final rule), Washington, D.C.

DOL (U.S. Department of Labor), "29 CFR 1910 Occupational Safety and Health Standards," Washington, D.C.

DOL (U.S. Department of Labor), "29 CFR 1926 Safety and Health Regulations for Constructions," Washington, D.C.

DOL (U.S. Department of Labor), "30 CFR 31 Diesel Mine Locomotives," Washington, D.C.

DOL (U.S. Department of Labor), Mine Safety and Health Administration, "30 CFR 32.9 Recommendation on the Use of Mobile Diesel-Powered Equipment for Non-Coal Mines," Washington, D.C.

DOL (U.S. Department of Labor), "30 CFR 36 Mobile Diesel-Powered Transportation Equipment for Gassy Non-Coal Mines and Tunnels," Washington, D.C.

DOL (U.S. Department of Labor), Mine Safety and Health Administration, "30 CFR 57 Safety and Health Standards - Metal and Non-Metal Underground Mines," Washington, D.C.

DOT (U.S. Department of Transportation), Records and Special Programs Administration, "49 CFR 173 Shippers - General Requirements for Shipments and Packaging," Washington, D.C.

EPA (U.S. Environmental Protection Agency), December 29, 1982. "40 CFR 191 Environmental Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes, Proposed Rule," Federal Register 47, pp. 58196-58206, Washington, D.C.

EPA (U.S. Environmental Protection Agency), "40 CFR 50 National Primary and Secondary Ambient Air Quality Standards," Washington, D.C.

EPA (U.S. Environmental Protection Agency), "40 CFR 60 Standards of Performance for New Stationary Sources," Washington, D.C.

EPA (U.S. Environmental Protection Agency), "40 CFR 122 EPA Administered Permit Programs: The National Pollutant Discharge Elimination System," Washington, D.C.

EPA (U.S. Environmental Protection Agency), "40 CFR 125 Criteria and Standards for the National Pollutant Discharge Elimination System," Washington, D.C.

EPA (U.S. Environmental Protection Agency), "40 CFR 141 National Interim Primary Drinking Water Regulations," Washington, D.C.

EPA (U.S. Environmental Protection Agency), "40 CFR 142 National Interim Primary Drinking Water Regulations Implementation," Washington, D.C.

EPA (U.S. Environmental Protection Agency), "40 CFR 143 National Secondary Drinking Water Regulations," Washington, D.C.

EPA (U.S. Environmental Protection Agency), "40 CFR 162 Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act," Washington, D.C.

EPA (U.S. Environmental Protection Agency), "40 CFR 190 Environmental Radiation Protection Standards for Nuclear Power Operations," Washington, D.C.

EPA (U.S. Environmental Protection Agency), "40 CFR 204 Noise Emission Standards for Construction Equipment," Washington, D.C.

EPA (U.S. Environmental Protection Agency), "40 CFR 240 Guidelines for Thermal Processing of Solid Wastes," Washington, D.C.

EPA (U.S. Environmental Protection Agency), "40 CFR 241 Guidelines for the Land Disposal of Solid Wastes," Washington, D.C.

EPA (U.S. Environmental Protection Agency), "40 CFR 1505 NEPA and Agency Decision Making," Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), "10 CFR 19 Notices, Instructions, and Reports to Workers; Inspections," Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), "10 CFR 20 Standards for Protection Against Radiation," Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), "10 CFR 30 Rules of General Applicability to Domestic Licensing of Byproduct Material," Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), "10 CFR 40 Domestic Licensing of Source Material," Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), "10 CFR 50 Domestic Licensing of Production and Utilization Facilities," Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), "10 CFR 51 Licensing and Regulatory Policy and Procedures for Environmental Protection," Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), "10 CFR 60 Disposal of High-Level Radioactive Wastes In Geologic Repositories; Licensing Procedures," Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), "10 CFR 72 Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation (ISFSI)," Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), "10 CFR 73 Physical Protection of Plants and Materials," Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), "10 CFR 100 Reactor Site Criteria," Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), "10 CFR 150 Exemptions and Continued Regulatory Authority in Agreement States and in Offshore Waters Under Section 274," Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission), June 1974. Regulatory Guide 1-86, "Termination of Operating Licenses for Nuclear Reactors."

Pub. L. 88-206, December 17, 1963. "Clean Air Act," (42 U.S.C. 7401-7626).

Pub. L. 91-604, December 31, 1970. "Noise Pollution and Abatement Act," (42 U.S.C. 1858).

Pub. L. 95-190, November 16, 1977. "Safe Drinking Water Act," (42 U.S.C. 300f).

Pub. L. 95-217, December 27, 1977. "Clean Water Act," (33 U.S.C. 1251 - 1376).

Pub. L. 95-580, October 21, 1976. "Resource Conservation and Recovery Act," (42 U.S.C. 6901 - 6986).

Pub. L. 97-425, January 7, 1983. "Nuclear Waste Policy Act of 1982," (NWPA) (42 U.S.C. 10101).

Sandia National Laboratories, in preparation. "Subsystem Design Requirements for the Advanced Conceptual Design of the Yucca Mountain Mined Geologic Dispoal System," SAND85-0260, R. R. Hill et al., Albuquerque, NM.

This page intentionally left blank.

SAND85-0260
Unlimited Release
Initial Draft February 24, 1986
(Revision 1 September 15, 1987)*

SUBSYSTEM DESIGN REQUIREMENTS TO SUPPORT THE CONCEPTUAL DESIGN STUDIES FOR THE YUCCA MOUNTAIN MINED GEOLOGIC DISPOSAL SYSTEM

Compiled by R. R. Hill
Nuclear Waste Engineering Projects Division
Sandia National Laboratories
Albuquerque, New Mexico 87185

Bechtel National, Inc.
50 Beale Street
P.O. Box 3965
San Francisco, California 94119

Parsons Brinckerhoff Quade & Douglas, Inc.
1625 Van Ness Avenue
San Francisco, California 94109-3678

and

Los Alamos Technical Associates, Inc.
Los Alamos, New Mexico 87544

*Revision 1 applies to the title sheet only. The word "Advanced" has been deleted from the title. Even though the phrase "Advanced Conceptual Design Studies" may be found throughout the body of this report, the design requirements and criteria contained herein provide guidance and design control for all repository design activities, including work pertaining to the SCP-CDR.

Distribution
Category UC-70

SAND85-0260
Unlimited Release
Initial Draft February 24, 1986

SUBSYSTEM DESIGN REQUIREMENTS TO SUPPORT THE ADVANCED CONCEPTUAL DESIGN STUDIES FOR THE YUCCA MOUNTAIN MINED GEOLOGIC DISPOSAL SYSTEM

Compiled by R. R. Hill
Nuclear Waste Engineering Projects Division
Sandia National Laboratories
Albuquerque, New Mexico 87185

Bechtel National, Inc.
50 Beale Street
P.O. Box 3965
San Francisco, California 94119

Parsons Brinckerhoff Quade & Douglas, Inc.
1625 Van Ness Avenue
San Francisco, California 94109-3678

and

Los Alamos Technical Associates, Inc.
Los Alamos, New Mexico 87544

CONTENTS

CONTENTS
(CONTINUED)

Page

CONTENTS
(CONTINUED)

CONTENTS
(CONTINUED)

Page

CONTENTS
(CONTINUED)

Page

CONTENTS
(CONTINUED)

CONTENTS
(CONTINUED)

Page

CONTENTS
(CONCLUDED)

FIGURES

TABLES

P384

1.0 INTRODUCTION

1.1 Background

The Nuclear Waste Policy Act (NWPA) of 1982 assigns responsibility to the Department of Energy (DOE) for siting, designing, constructing, and operating geologic repositories for disposal of spent fuel and other high-level waste (HLW). The DOE program to meet the NWPA requirements is described in the Mission Plan for the Civilian Radioactive Waste Management Program (DOE, 1985). Four different geologic media, tuff, salt, basalt, and crystalline rock, are prime candidates for the disposal of these wastes, and a project has been organized to investigate each medium. The DOE has organized the Waste Management Project Office within the Nevada Operations Office to conduct the investigations in tuff. Yucca Mountain, which is located near the southwest corner of the Nevada Test Site (NTS), has been designated as a potentially acceptable site for the first repository.

The many tasks of these investigations are organized and directed by a set of plans, procedures, requirements, and information documents. Figure 1-1 pictures the broad relationship of these documents to each other as well as lists the ones known at this time. The Systems Engineering Management Plan (SEMP) (in preparation) provides the overall framework on the organization and control of the technical portions of the NNWSI project. The organization and conduct of the design itself is described in the Repository Design Plan (in preparation). This document, Subsystem Design Requirements (SDR), is highlighted on the chart to show its relationship to the others.

The design criteria contained here are derived from the various laws and Code of Federal Regulations through the simplified chains shown in Figure 1-2. This document is organized according to the official Work Breakdown Structure (WBS) and the Design Activities Structure (DAS) that were developed by the Repository Coordination Group. The system requirements have been mapped into this report at the start of appropriate sections and the entire matrix is shown in Appendix C. This matrix assures that all system requirements are included in this document.

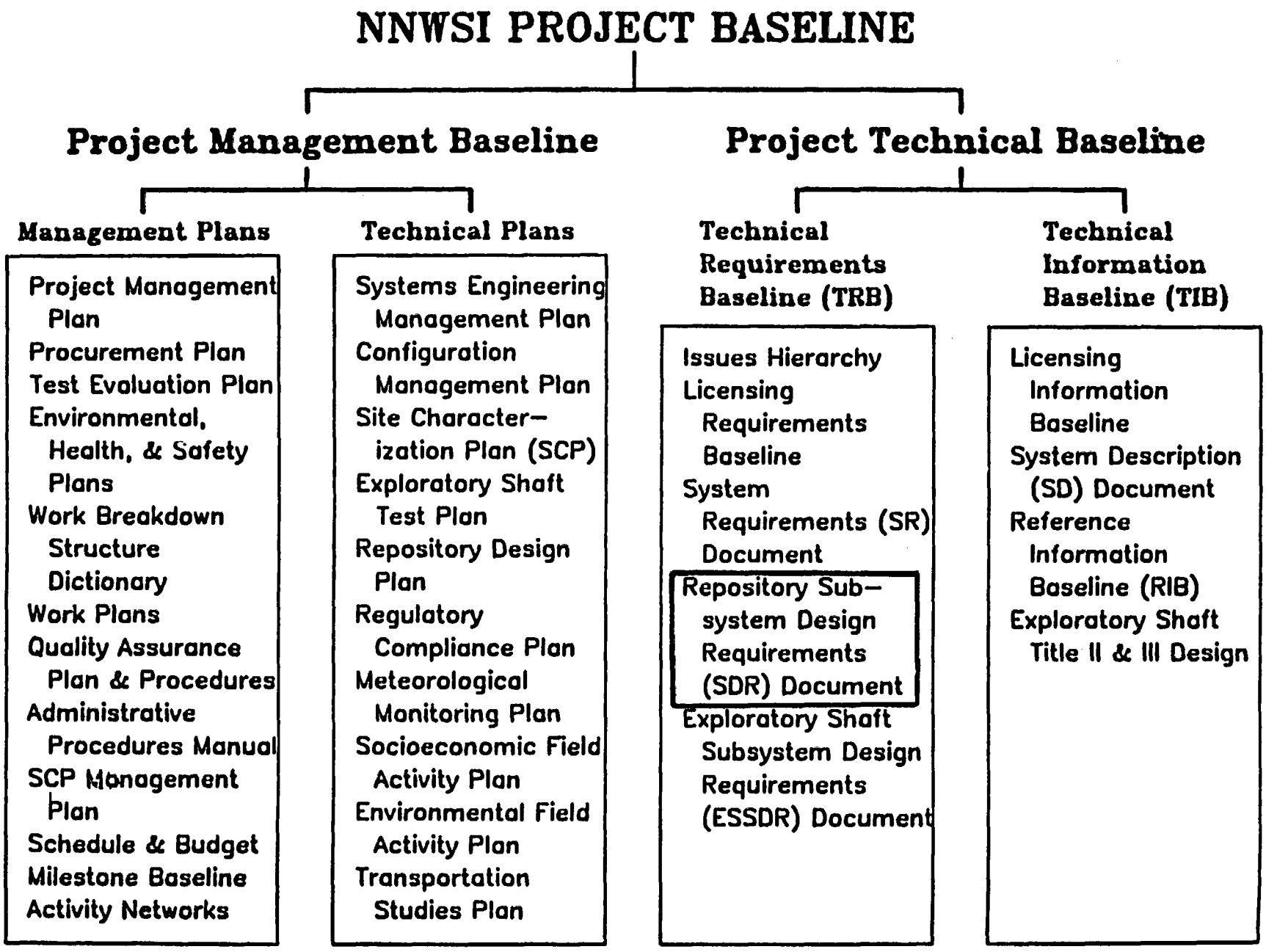


Figure 1-1. NNWSI Project Baseline

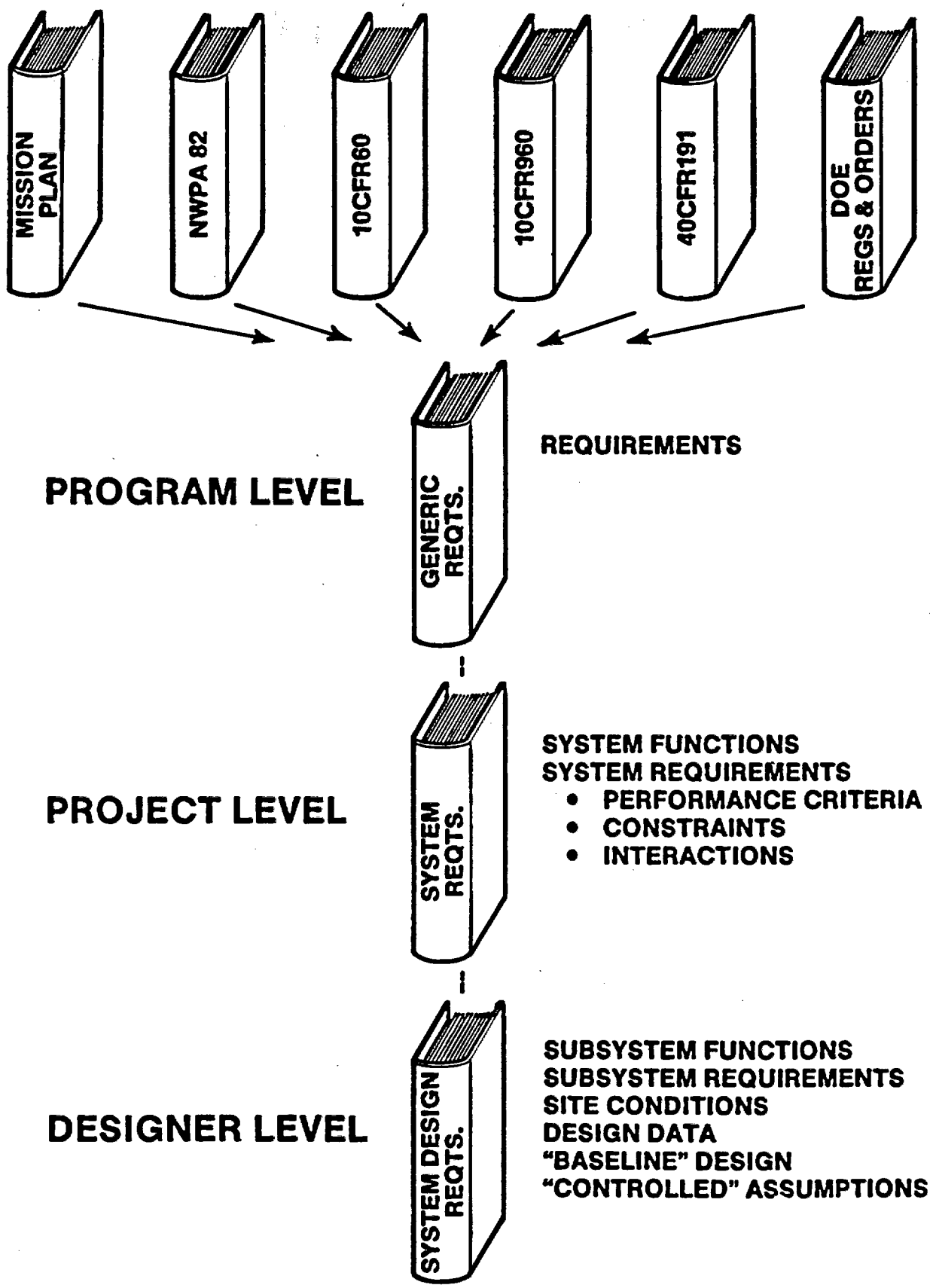


Figure 1-2. Document Hierarchy

Data to be used in design that describe the Yucca Mountain Site can be derived from the Reference Information Base (RIB). An example of the current content of the RIB has been included in Appendix A. More information will be provided as the RIB is further developed.

This SDR document presents the basic design criteria from which the design for a repository at Yucca Mountain will be developed. The design criteria include definitions of project scope, legal and functional requirements, site information, design parameters, applicable codes, standards, and regulations and other criteria. These criteria will be developed further as advanced conceptual design studies continue.

The advanced conceptual design studies will include further development of (1) a conceptual plan for the construction of repository facilities that will meet the requirements for a repository for HLW and will be technically feasible and compatible with the geotechnical characteristics of the site, (2) reliable construction and operations cost estimates, and (3) a schedule for construction and operation of the facilities. These activities will be guided by the technical parameters contained in this document.

The decision on where to construct a repository for radioactive waste has not been made. The Yucca Mountain site is being studied as one of several prospective sites in different areas of the nation for the first full-scale repository for HLW. For the sake of readability, the indicative mood is used in this report as though the Yucca Mountain site had been selected as the site for the first repository. Although the indicative mood indicates that an action is being or will definitely be taken, the reader should not conclude from this usage that the decision has been made to construct the first repository at Yucca Mountain.

This document is an information copy distributed by Sandia National Laboratories (SNL). A subsequent controlled distribution will be made for project participants. These copies will be maintained under change control procedures. As the SDR is updated, copies or replacement pages will be distributed to the individuals listed on the controlled distribution list, and only those individuals will receive updates.

1.1.1 Assignment of Regulatory Responsibility

The NWPA establishes a schedule for the selection of a location and a source of funding for the construction of the first two repositories. The act directs DOE to develop and implement methods of radioactive waste disposal and further directs DOE to develop guidelines for the selection of sites suitable for repository construction. The NWPA also directs the U.S. Environmental Protection Agency (EPA) to establish environmental standards for disposal of radioactive waste and the Nuclear Regulatory Commission (NRC) to develop technical requirements for licensing the disposal of radioactive waste.

The EPA standards are published in 40 CFR 191, "Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Waste," (EPA, 1985). The NRC licensing requirements are published in 10 Code of Federal Regulations (CFR) 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories" (NRC, 1984). The DOE guidelines for repository site selection, "Final General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories," are published in 10 CFR 960 (DOE, 1984).

The DOE program to meet the NWPA requirements is discussed in the "Mission Plan for the Civilian Radioactive Waste Management Program" (DOE, 1985). The mission plan identifies a hierarchy of technical questions. Answers to these questions will be necessary for the detailed design and operation of the repository.

1.1.2 Department of Energy Requirements

The functional requirements and performance criteria, organized by repository systems, are provided by the Generic Requirements for a Mined Geologic Disposal System (GR) (DOE, 1984). In addition, DOE Orders are written to establish policy and procedures for DOE activities. DOE Orders 6410.1 (DOE, 1983b), 6430.1 (DOE, 1983d), and 4320.1A (DOE, 1983a), which are applicable to the conceptual design process for the repository, are described below.

DOE Order 6410.1

"Management of Construction Projects" (DOE, 1983b) establishes policies and procedures to be followed during the planning and execution of DOE construction programs and projects. It includes an outline of the fundamental objectives of conceptual design and describes the content of a conceptual design report.

DOE Order 6430.1

The "General Design Criteria Manual" (DOE, 1983d) provides general criteria for the conceptual design of DOE facilities. The manual includes references to the codes, standards, guides, DOE Orders, and other directives that are to be followed.

DOE Order 4320.1A

"Site Development and Facility Utilization Planning" (DOE, 1983a) establishes policies and procedures for planning the site development and utilization of facilities at sites owned, leased, or controlled by DOE for production, separation, research, development, or demonstration.

1.1.3 Regulations of Other Federal Regulatory Agencies

Federal regulations not previously cited but that apply to the design, construction, and operation of a repository are described in this subsection. These regulations include additional EPA and NRC regulations, as well as Department of Transportation (DOT) regulations and Mine Safety and Health Administration (MSHA) regulations.

Environmental Protection Agency Regulations

In addition to 40 CFR 191, other EPA regulations contained in 40 CFR 1-799 shall be used as applicable.

Nuclear Regulatory Commission Regulations

In addition to 10 CFR 60, the other NRC regulations that are considered applicable to geologic repositories are those referenced by 10 CFR 60 or that address transportation of radioactive material. The NRC also publishes Regulatory Guides that describe methods acceptable to the NRC staff that can be used to show compliance with NRC regulations. NRC Regulatory Guide 4.17, "Standard Format and Content of Site Characterization Plans for High-Level Waste Geologic Repositories," is applicable to geologic repositories. Other NRC regulatory guides may be used as an aid for design to the extent deemed necessary or as referenced in this document.

Department of Transportation Regulations

Because the repository will receive shipments of materials classified as hazardous, certain DOT regulations will apply to the design and/or operation of the repository. Regulations applicable to hazardous materials will be found in 49 CFR 171-177.

Mine Safety and Health Administration Regulations

The NRC invokes MSHA regulations 30 CFR, Chapter I, Subchapters D, E, and N, and these MSHA regulations are only applicable as may be necessary to provide reasonable assurance that all structures, systems, and components important to safety can perform their intended functions.

1.1.4 State Regulations

State of Nevada regulations to be followed in the advanced conceptual design include water quality standards, air quality standards, and safety and fire protection regulations, including those pertaining to mining safety. Those state standards and regulations that have been identified as applicable are described in the following subsections. Also, as mandated by DOE order 5480.4, a California regulation applicable to mining safety has been identified (see Subsection 10.1.2).

Water Quality Standards

Nevada statutes (and the regulations issued pursuant to those statutes) that address water quality and must be addressed during repository design are

- the Nevada Water Pollution Control Law (NRS, Title 40, Chapter 445),
- the Nevada Solid Waste Disposal Law (NRS, Title 40, Chapter 444), and
- the Nevada Hazardous Waste Law (NRS, Title 40, Chapter 444).

Air Quality Standards

Nevada statutes (and the regulations issued pursuant to these statutes) that address air quality and must be addressed during repository design are

- the Nevada Air Pollution Control Law (NRS, Title 40, Chapter 445);
- the Nevada Solid Waste Disposal Law (NRS, Title 40, Chapter 444); and
- the Nevada Hazardous Waste Law (NRS, Title 40, Chapter 444).

In addition, in August 1983, the Nevada Division of Mine Inspection proposed standards (NRS, Title 46, Chapter 512) that address air quality in underground mines. The repository will be required to meet those standards as adopted.

Safety Standards

The state health and safety standards applicable to mining activities at the repository fall under "State of Nevada Health and Safety Standards for Open Pit and Underground Metal and Nonmetal Mines and Sand, Gravel, and Crushed Stone Operations" (NRS, Title 46, Chapter 512). These standards are administered by the Department of Industrial Relations, Division of Mine Inspection, State of Nevada. Both the state regulations and 30 CFR 57 must be observed. Also, pursuant to DOE order 5480.4, the California Administrative Code, Chapter 4, Subchapter 17, is applicable to mining activities as described in Section 9, 10 and 11.

1.1.5 Technical Baseline Documents

The many federal and state laws and regulations, and the codes, standards, and other references listed in Appendix B of this document, form a framework for the design, construction, operation, and closure of geologic repositories. The following discussion and the document hierarchy (Figure 1-2) provide a simplified schematic of the relationships between repository project documents and other documents.

At the Office of Civilian Radioactive Waste Management (OCRWM) (DOE, 1985) program level, the requirements from the NWPA and its implementing documents and regulations [Mission Plan (DOE, 1985), 10 CFR 60, 10 CFR 960, 40 CFR 191] have been synthesized, along with DOE Orders and Office of Geologic Repositories (OGR) programmatic guidance, in the GR (DOE, 1984). The GR sets forth the minimum set of qualitative and quantitative requirements that must be met by a mined geologic disposal system in any geologic medium. In addition to these requirements, the GR contains planning base information for the mined geologic disposal system's interactions with the production, storage, and transportation of radioactive waste.

Because each of the repository development projects operates in a unique environment, and because each geologic medium under investigation offers a unique physical environment in which a radioactive waste disposal system must be constructed and operated, a site-specific set of requirements, which expands on the requirements identified in the GR, must be developed to serve as the base for project design activities. The "Yucca Mountain Mined Geologic Disposal System Requirements" (SR) (in preparation) document identifies the requirements that must be met by a mined geologic disposal system in the tuff formation at Yucca Mountain.

The SR provides a functional definition of the systems, and specifies the functional requirements, performance criteria and constraints. Further, the SR identifies interactions between systems. Thus, the SR provides a framework for performance allocation, issue identification, and issue resolution by systematically identifying the system elements that can be relied upon to collectively interact to satisfy the system requirements.

The Subsystem Design Requirements for the Advanced Conceptual Design of the Yucca Mountain Mined Geologic Disposal System (SDR) provides instructions (design criteria) that will be used to develop a mined geologic disposal system in conjunction with the requirements set forth in the SR and the GR. The basis of the SDR is a statement of the functions that repository systems must perform and a specific statement of the functional parameters that the repository design must meet.

Recognizing the iterative nature of the design process, the SDR will eventually allocate the functions of systems identified in the SR to repository subsystems, facilities, and components that comprise the various systems defined in the SR. These requirements will be defined in sufficient detail, using numerical values with associate tolerances, to provide the basis for the detailed design or specifications development, and eventual testing of each subsystem. This version of the SDR provides this information at a level of detail consistent with the initiation of the advanced conceptual design.

To be of maximum benefit and correlation to the organizations involved in design, the SDR is organized to the format of the Work Breakdown Structure (WBS) with further subdivision according to the Design Activities Structures (DAS). This format follows the natural work breakdown of the design of surface and subsurface facilities, waste package, equipment, and operations and maintenance planning. It also ties the design and construction activities to the budget and milestone system which follow the WBS.

Interface Control Drawings (ICDs) will be added to the technical baseline of the SDR as they are developed. They will define the boundaries of various systems and/or facilities as well as identify any functional design requirements that transcend these interfaces. The SDR will act as a bridge between the systems requirements and the design of facilities. Included in the SDR (Appendix C) is a matrix which correlates the interactions of System Requirements to the design of repository facilities, equipment, and operational modes. In addition, at the beginning of each section, reference to the specific performance criteria and constraints are called out. The SR and SDR documents are being developed to satisfy the fundamental purposes of (1) the

establishment of requirements and design solutions on a total system basis and (2) to provide a clear and concise reference source for communication of system design requirements to the organizations responsible for the design.

A technical change control system will be an integral part of the SDR and will control the scope of the advanced conceptual design. As the design progresses to increasing levels of detail and as design decisions are "baselined," the SDR will also progress in increasing level of detail.

1.2 Organizations and Responsibilities

As directed by the NWPA, all federal radioactive waste management activities are directed by the DOE Office of Civilian Radioactive Waste Management (OCRWM). The OCRWM serves as the point of contact between the federal government and producers of radioactive waste. The OGR management within OCRWM directs mined geologic disposal activities.

The DOE Nevada Operations Office directs the waste disposal activities of the NNWSI Project at Yucca Mountain.

Development of the conceptual design of a repository in tuff is the responsibility of SNL. Bechtel National, Inc. (BNI) and Parsons Brinckerhoff Quade & Douglas, Inc. (PBQ&D) are the principal architects/engineers (A/E) responsible for the design of surface and subsurface facilities respectively at Yucca Mountain. Lawrence Livermore National Laboratory (LLNL) is responsible for waste package development.

1.3 Organization of This Document

Fourteen major sections follow this Introduction. Section 2 discusses the site location and the characteristics of the Yucca Mountain site. Waste types, containers, and transportation information is presented in Section 3. General design requirements are described in Section 4 and include collections of repetitive requirements identified in the SR that apply generally to the design of the repository and other requirements that apply to facilities in general.

Starting with Section 5, the document is organized along a form which has been developed from the WBS for the project. Section 5 discusses specialized equipment and instrumentation development requirements. Section 6 provides functional requirements for the design of sealing components of the underground facility. Section 7 provides requirements for the design of the site preparation, and Section 8 provides guidance for the design of surface facilities. Shafts and ramps are discussed in Section 9. Requirements for subsurface excavations and the underground service system are provided in Sections 10 and 11. Section 12 defines the operations and maintenance assumptions necessary for design, and Section 13 discusses permanent closure requirements. Section 14 contains repository performance assessment considerations.

Four appendices are provided. Detailed information on site characteristics is included in Appendix A, and principal codes, regulations, and standards are provided in Appendix B. Appendix C provides a matrix correlating the SR requirements to the SDR design content. Appendix D lists Interface Control Drawings which will be developed throughout the course of the ACD studies.

2.0 SITE LOCATION AND CHARACTERISTICS

This section describes the location of the site and repository facilities and briefly describes site characteristics pertinent to the design. Detailed information on the site characteristics and tabulations of site-specific design parameters are contained in the Reference Information Base (Appendix A).* A Nevada Nuclear Waste Storage Investigations (NNWSI) site characterization program will be conducted to obtain additional data as well as to confirm existing data used in the design. As the data from the site characterization program become available, they will be incorporated in the Reference Information Base on which the design is based.

SYSTEM REQUIREMENTS FOR SITE

Section Number	Section Title	Performance Criteria and Constraints
YMMGD	Yucca Mountain Mined Geologic Disposal System	C#A
1.0	Preclosure Waste Disposal	C#D,E,H,I,J,K,CC
1.1	Site	PC#1; C#A,B
1.1.1	Surface	PC#1; C#A,B
1.1.2	Subsurface	PC#1; C#A,B,C,D,E
1.2.3.2	Geologic Evaluation	PC#1; C#A,G,H,I,J
2.1	Natural Barriers	PC#1,2; C#B,C,D,E,F, H,I,L,M

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

*Appendix A is provided to support ACD studies but will be superseded when a collection of site data entitled the "Reference Information Base" (RIB) is produced. The site properties to be used for design will be provided only from the RIB and site modeling of these data will be provided in the Interactive Graphics Information System (IGIS).

2.1 Location of Site and Facilities

2.1.1 Site Location

The prospective site for a repository in tuff is located at Yucca Mountain, Nevada. The site is located entirely on federal land. Part of this land is managed by the Bureau of Land Management (BLM); part by the DOE, which manages the NTS; and part by the U.S. Air Force, which manages the Nellis Air Force Range (NAFR). A map of the proposed site and surrounding vicinity is presented in Figure 2-1.

Boundaries must be established for the "site" and the "controlled area." Critical boundary drawings of the Yucca Mountain site will be a part of the SDR interface control drawings (see Appendix D). These boundaries are important for the analyses that are performed to demonstrate compliance with the EPA requirements (40 CFR 191; EPA, 1985) for protection of the public and environment during both the preclosure and postclosure periods. The EPA definitions for the "site" and "controlled area" are

> "Site" means an area contained within the boundary of a location under the effective control of persons possessing or using spent nuclear fuel or radioactive waste that are involved in any activity, operation, or process covered by this Subpart (40 CFR 191, Subpart A) (EPA, 1985).
>
> "Controlled area" means (1) a surface location, to be identified by passive institutional controls, that encompasses no more that 100 km^2 and extends horizontally no more than 5 km 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, Subpart B).

The controlled area shall be located either on land controlled by the DOE or on land permanently withdrawn and reserved for use by the repository (10 CFR 60.121 a). The status and plans for land use and withdrawals at the proposed site are described in a DOE document prepared by the Nevada Operations Office (DOE, 1984). The highway and railroad to the Yucca Mountain site will cross the NTS to the eastern boundary of the repository.

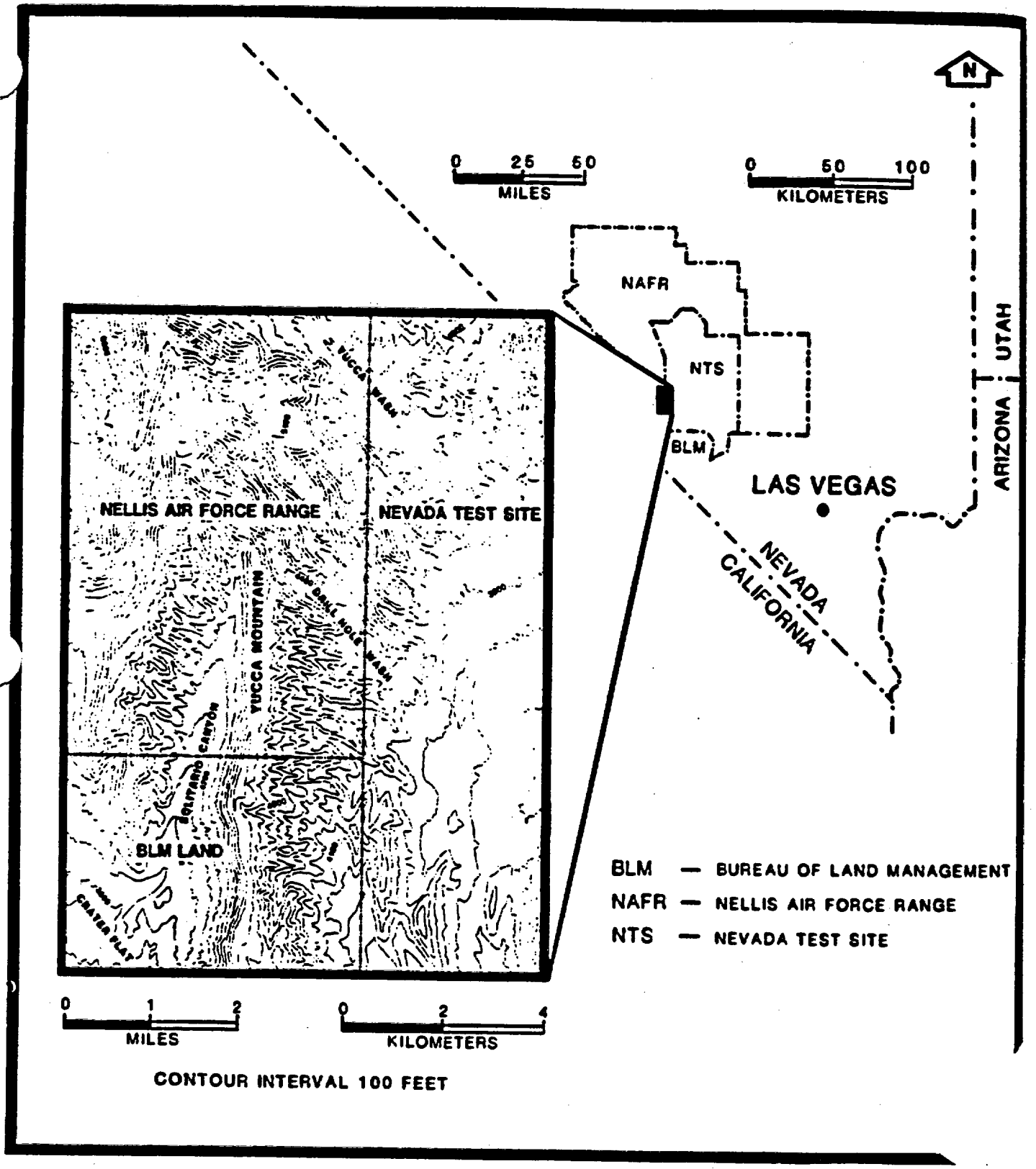


Figure 2-1. Prospective Site for a Repository in Tuff at Yucca Mountain, Nevada (Mansure and Ortiz, 1984)

2.1.2 Underground Facility Location

The process of selecting the Yucca Mountain site and the proposed host rock for a proposed geologic repository in tuff is described in detail in the draft Environmental Assessment (EA) (DOE, 1984b). From field investigations and studies involving subsurface drilling, sampling, and testing performed at the Yucca Mountain site, the Topopah Spring Member of the Paintbrush Tuff, which is in the unsaturated zone at the site, was selected as the host rock for the underground facility. In these studies, areas were delineated as possible locations for the underground facility (see Figure 2-2). From preliminary evaluations, the area designated as the central area (Area 1) (Figure 2-2) was determined to have adequate volume for disposal of 70,000 metric tons of uranium (MTU) of high-level waste (see Subsection 3.1.5). For the advanced conceptual design studies, this area constitutes the location of the underground facility. Other areas adjacent to the central area will be investigated during site characterization to determine their suitability for waste emplacement if additional area is needed. The boundaries of the underground facility will be determined in the design. "The boundaries on Figure 2.2 are not precise nor do they separate the area into regions of acceptable or unacceptable characteristics. Rather they are regions of similar characteristics delineated for ranking and discussion of uncertainties. The boundaries of the figure are not limits to development, but guidelines to prioritize development."

"The fault structure in Area 6 of Figure 2-2 is complex and makes it difficult to determine its subsurface structural qualities based on surface mapping and limited drill hole data. This area could be developed, however, as an extension of Area 1 depending on data obtained during actual mining of the southeastern edge of Area 1. In fact, portions of Area 6 are similar to Area 1 and it is difficult to define the boundary between Areas 1 and 6. In Figure 2.2 a smooth, general boundary between the two areas has been drawn. The underground facility development plan should include the flexibility to use the mining of Area 1 to explore how far development can extend into Area 6." Boundary constraints are discussed in Subsection 2.6.

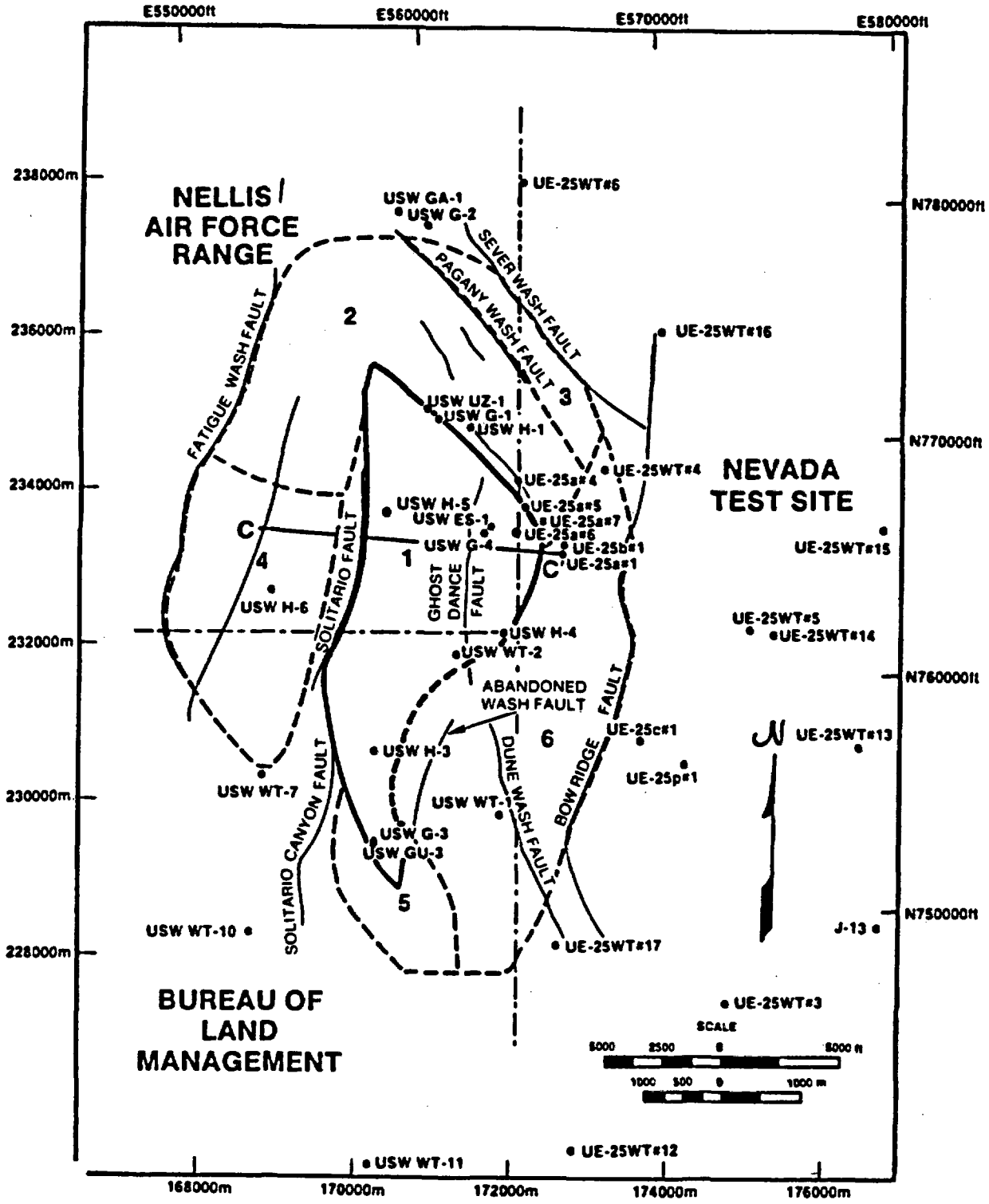


Figure 2-2. Potentially Useable Areas. Area 1 is the primary target area for the underground facility. Boundaries for all areas are approximate.

2.1.3 Surface Facilities Location

A study has been conducted by SNL (Neal, 1985) to select a location for the surface facilities for the purposes of conceptual design. The areas considered are on the eastern side of Yucca Mountain on the gradually sloping surfaces near the base of the mountain. After an initial screening, the six areas shown on Figure 2-3 were evaluated, and Area 3 was selected (Neal, 1985) as the reference conceptual site for the purposes of advanced conceptual design.

2.2 General Geology and Topography

Yucca Mountain is part of a large Miocene volcanic plateau composed of a series of Miocene extrusive volcanic rocks that unconformably overlie Devonian limestone and dolomite. The principal rock types at Yucca Mountain are tuffs formed by pyroclastic flows, ashfalls, and reworked materials emanating from a caldera complex to the north. Cooling characteristics of the pyroclastic ashflows determine the rock type and its properties. Deposits of reworked tuff occur in alluvial valleys and occasionally occur between flow units.

Three principal volcanic rock types are found at the Yucca Mountain site: nonwelded tuff, welded tuff, and vitrophyre. Variations within these major lithologic types include devitrification, zeolitization, lithophysal content, and degree of welding.

Yucca Mountain is a set of fault blocks that have been uplifted relative to the surrounding rocks and tilted to the east. Area 1 of Figure 2-2 is a north-to-south trending region bounded to the west by the steep scarp of Solitario Canyon Fault. Over 1,500 ft of relief occurs between the ridge crest and the prominent drainage channel (Fortymile Wash) with drainage on the east side. Generally easterly trending washes and canyons dissect the gentle eastern slope of Yucca Mountain and empty into Fortymile Wash. The flats cut through the alluvium and colluvium ranging in size from large boulders to sand.

Detailed descriptions of the general geologic features of the regional area have been presented in the draft EA (DOE, 1984) and United States Geological Survey (USGS) OFR 792 (Sinnock, 1982) (Note: New Ref.).

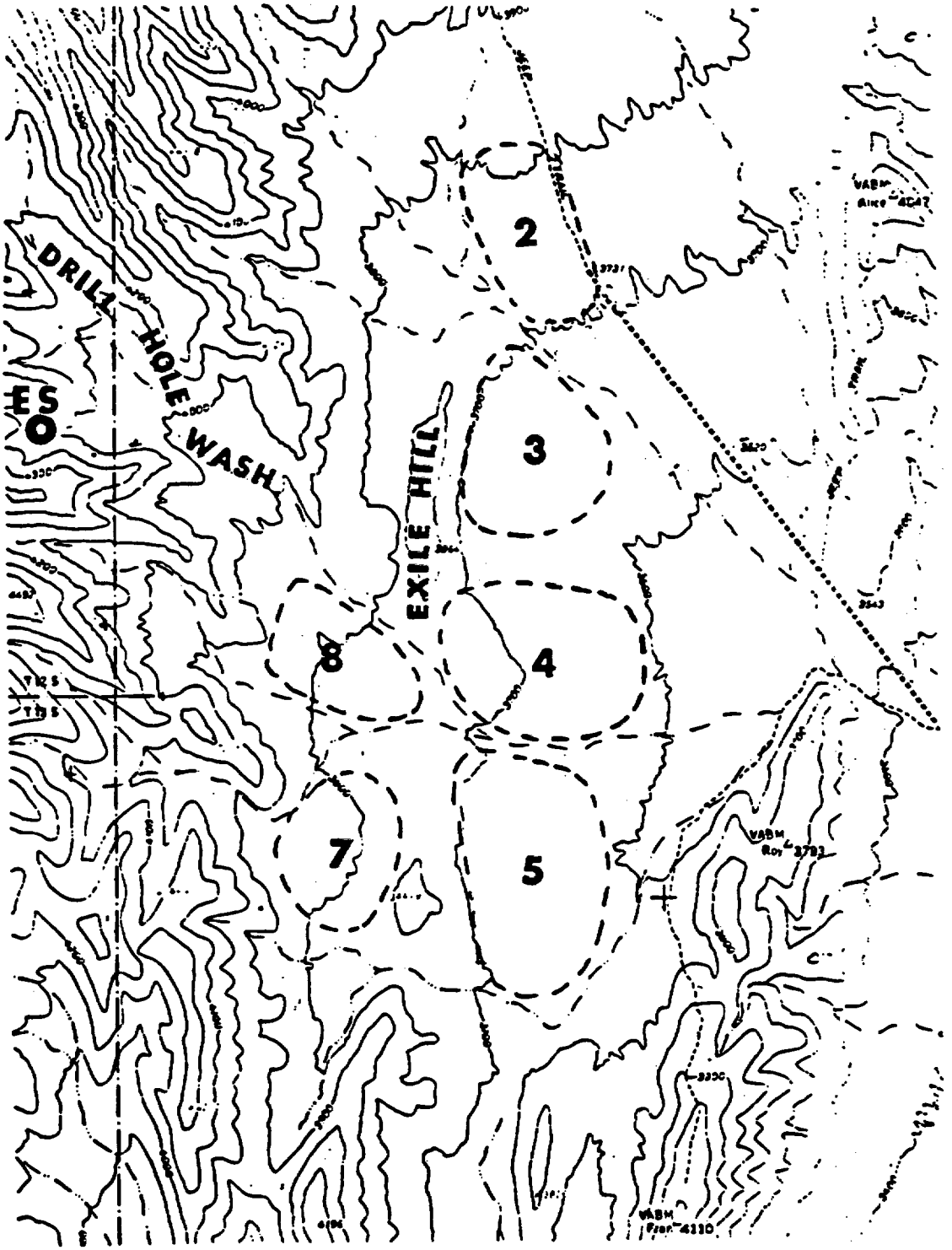


Figure 2-3. Locations of the Six Candidate Areas for Surface Facilities

2.3 Stratigraphy and Structure

The stratigraphy at the Yucca Mountain site consists of a sequence of Miocene volcanic rocks, which originated in a caldera complexes to the north and west. The cooling history of the ash flows strongly influenced the rock types and their properties. Five major formations have been identified in exploratory borings at Yucca Mountain (Scott et al., 1983). Each formation consists of several individual units or compound cooling units. From the top, the five principal formations are

- Timber Mountain Tuff, which contains the Ammonia Tanks and the Rainier Mesa Member;
- Paintbrush Tuff, including the Tiva Canyon, Yucca Mountain, Pah Canyon, and Topopah Spring members;
- Tuffaceous Beds of Calico Hills;
- Crater Flat Tuff, including the Prow Pass and Bullfrog members and the Tram Unit; and
- Tuff of Lithic Ridge.

The Tiva Canyon Member is the principal tuff exposed on the surface at Yucca Mountain. The Topopah Spring Member outcrops in areas where it has risen along normal faults.

The disposal horizon, defined as Unit TSw2, is the lower nonlithophysal tuff of the Topopah Spring Member (Johnstone et al., 1984). This unit is a densely welded, devitrified ash-flow tuff characterized by a low lithophysal porosity (less than 5%). Unit TSw2 is bounded above by Unit TSw1, a tuff from the same member but with the higher lithophysal porosity. Unit TSw2 is bounded below by Unit TSw3, a dark vitrophyre. Demarcation of Unit TSw2 has been established as tuff with a lithophysal content less than 15 to 20% (Mansure and Ortiz, 1984). Further descriptions of the major stratigraphic and functional units and their properties are provided in Appendix A.

Faults and fractures are the major structural features at Yucca Mountain. The attitude of the strata within the various fault-bounded blocks is generally uniform and characteristic of tilted blocks. Most of the faults

trend north-south- or northeast-southwest. They were probably formed by a northwest-southeast stress field. Faults to be considered in the design of the repository are the Solitario Canyon, Bow Ridge, Ghost Dance, and Paintbrush Faults and the Drill Hole Wash. Many closely spaced faults with small displacements are found along the eastern margin of the central and northern areas. Overall displacements on typical faults are variable, ranging from a fraction of an inch to 400 ft (e.g., Solitario Canyon Fault). The Solitario Canyon Fault and Ghost Dance Fault are hinge faults with offsets greatest toward the south and decreasing towards the north. Northwesterly trending strike/slip faults occupy Drill Hole Wash, Yucca Wash, and Sever Wash (Scott et al., 1983). Vertical displacements on these strike/slip faults are small; horizontal displacements are unknown. The dip on most faults is steep and is assumed to be between 65 and 90° to the west.

2.4 Seismicity

The seismic environment at the Yucca Mountain site is characterized by occasional ground motion generated by both natural seismicity (earthquakes) and underground nuclear explosions (UNEs) which are conducted periodically at the Nevada Test Site. A preliminary description of seismicity at the site and surrounding region was prepared by URS/John A. Blume & Associates (1985). In this report, preliminary probabilistic characterizations of the site are developed for both earthquakes and UNEs. Peak horizontal ground accelerations are derived from these probabilistic characterizations and estimates of appropriate return periods for preclosure and postclosure facility design. The preliminary predictions of ground accelerations from earthquakes are derived both from a broad tectonic region and from specific fault models. During site characterization, additional studies will provide additional probabilistic characterization of site-specific ground motion. These studies will include field investigations of faults in the site vicinity. Also, investigations will be continued to evaluate potential ground motions from UNEs.

Preliminary peak ground accelerations recommended for advanced conceptual design in the Blume report are summarized in Appendix A.2.3. Response characteristics of the site are also discussed.

2.5 Climate and Meteorology

The site is located in the southern Nevada desert, which is one of the most arid regions in the United States. The climate is classified as mid-latitude arid. Significant climatic features of this region are large diurnal and seasonal ranges in temperature, low relative humidity, strong insolation, rapid radiative heat loss, infrequent precipitation, and generally low wind velocities, with diurnal reversals and seasonal shifts in direction.

A collection of meteorological data obtained at the site and surrounding vicinity is presented by Eglinton and Dreicer (1984). For additional information on meteorology and a discussion of design parameters, see Appendix A.2.4.

2.6 Underground Facility Boundary Constraints

Areas for repository development have been delineated based on information on geologic structure, stratigraphic and hydrologic characteristics, and rock mechanics data for Yucca Mountain. Potentially usable areas established by Mansure and Ortiz (1984) are shown in Figure 2.2. The limits of these areas will become better defined as more information becomes available.

To establish the boundaries of the area suitable for development of the underground facility within the reference areas, current constraints have been defined. These constraints are

- The disposal plane, referred to as a "slab," will have an associated thickness of 150 ft, which includes the height of the drift, emplacement depths, and an additional depth to ensure that the excavation will be stable.

- The slab for the underground facility is within Unit TSw2, the lower Topopah Spring Member of the Paintbrush Tuff Formation (DOE, in preparation). Fifteen percent to twenty percent lithophysal content has been used to distinguish between Units TSw1 and TSw2 (Mansure and Ortiz, 1984).

An overburden of about 200 m (656 ft) is a minimum requirement (10 CFR 960, 4-2-5, d). A minimum emplacement depth of 300 m (984 ft) is considered a "favorable condition" (10 CFR 60.122, b, 5) (NRC, 1984).

The usable portion of the Area 1 (Mansure and Ortiz, 1984) that meets all of the geologic constraints and guidelines given above is approximately 1,850 acres. This 1,850-acre area (slab) is approximately 650 to 1,300 ft above the water table and varies from 656 to more than 1,300 ft below the ground surface. Conservative assumptions for the slab thickness and single plane repository configuration result in a conservative estimate of development area. Layout of the underground drifts will conform to the local geometry of the disposal horizon and may provide more useable area. Additional studies may be performed to refine the boundaries of development space for advanced conceptual and license application designs. Preliminary geologic data indicate additional area is available within Unit TSw2 in surrounding areas, particularly those to the north and west. Additional exploratory borings will better define the sizes and characteristics of these surrounding areas.

This page intentionally left blank.

3.0 WASTE DESCRIPTIONS, RECEIVAL RATES, AND TRANSPORTATION CONSIDERATIONS

This chapter describes the reference waste forms, receival rates, and containers being used as a basis for the advanced conceptual design of the Yucca Mountain repository. In general, the waste characteristics reported here are taken from a DOE guidance document (OGR/B2) entitled "Generic Requirements for a Mined Geologic Disposal System," and some of the text is taken from "Reference Nuclear Waste Descriptions for a Geologic Repository at Yucca Mountain, Nevada," O'Brien, 1985. These documents should be used for additional information on other waste forms not addressed in this section.

Disposal scenarios are based on four assumptions: (1) the Yucca Mountain repository is the first repository for commercial waste, (2) the second repository begins operation in 2005, (3) waste disposal proceeds on an "oldest-waste-first" schedule*, and (4) there is no significant delay between the receipt of the waste at the repository and its emplacement in the underground disposal area.

SYSTEM REQUIREMENTS FOR WASTE PACKAGES

Section Number	Section Title	Performance Criteria and Constraints
1.3	Waste Emplacement Package	PC#1,2; C#A,D,G
2.2	Engineered Barriers	PC#1,2a,2b
2.2.1	Waste Package	PC#1,2; C#B
2.2.1.1	Container	PC#1; C#A
2.2.1.2	Waste Form	PC#1; C#A

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

*It is assumed that the mix of PWR and BWR will be controlled so that repository operations will not be adversely affected. This assumption will be further evaluated during the ACD.

3.1 Waste Form

3.1.1 Spent Fuel

Most of the waste to be disposed of in the first repository will be spent fuel from commercial light-water power reactors. The spent fuel will be received either as intact fuel assemblies or as consolidated fuel rods. Table 3-1, which was extracted from Table B-1 of the Generic Requirements document, shows the range of dimensions and weights for Pressurized Water Reactor (PWR) and Boiling Water Reactor (BWR) fuel assemblies. Figure 3-1, extracted from GR (DOE, 1984), shows the thermal power decay of the spent fuel. * (SEE 2-PAGE INSERT AT THE END OF THIS SECTION).

As a design basis for the Yucca Mountain repository, it is assumed that a typical PWR fuel element is a "17 by 17" assembly with an 8.4-in.-square fuel rod channel, 160 in. long, containing 264 fuel rods (each 0.37 in. in diameter and 151 in. long); the initial uranium loading is 0.4614 MTU, and the nominal burnup is 33 GWd/MTU [gigawatt-days (thermal) per MTU]. A typical BWR element is assumed to be an "8 by 8" assembly with a 5.5-in.-square fuel rod channel, 176 in. long, containing 62 fuel rods (each 0.48 in. in diameter and 160 in. long); the initial uranium loading is 0.1833 MTU, and the nominal burnup is 27.5 GWd/MTU. Approximately 60% (MTU Basis) of the spent fuel will be PWR assemblies, and 40% will be BWR assemblies.

In accordance with the guidance contained in the GR document, it is assumed that most of the spent fuel emplaced in the repository will be consolidated, either at the repository or before shipment to the repository. The alternative of no at-repository consolidation is to be evaluated. The fuel rods from 40% of the spent fuel delivered to the first repository in 1998 will have been consolidated at the reactor, i.e., before shipment to the repository. This percentage will decrease at the rate of 4% per year so that, beginning in 2008, all the spent fuel will be delivered to the repositories as intact fuel assemblies. Consolidated fuel rods will be shipped in metal canisters having the approximate dimensions of the fuel assemblies from which the fuel rods were removed. Each canister will contain the rods from two fuel assemblies. Among the categories of fuel assemblies that might not be consolidated at the repository are (1) assemblies that have suffered mechanical

TABLE 3-1

CHARACTERISTICS OF SPENT FUEL ASSEMBLIES*

Mechanical Characteristics	PWR	BWR
Overall Length-Range	149" to 186"	84" to 179"
Width (Square)	8.1" to 8.5"	4.3" to 6.5"
Fuel Rods/Assembly	100 to 264	48 to 81
Fuel Rod Diameter	.360" to .440"	.483" to .570"
Fuel Rod Length	91.5" to 171"	80.5" to 165"
Rod Pitch	.496" to .580"	.640" to .842"
MTU/Assembly	.11 to .52	.19 to .20
Assembly Weight (lb)	1280 to 1450	600
Typical Characteristics		
Age Out of Reactor	5 years	5 years
Burnup (Average Conditions) MWD/MTU	33,000	27,500
Actinides and Daughters (Ci/MTU)	104,000	93,000
Fission Products (Ci/MTU)	453,000	365,000
Decay Heat (Watts/MTU)	1,800	1,400
Photon Release (Photons/Sec/MTU)	1.3×10^{16}	1.0×10^{16}
Photon Energy Release (Mev/Sec/MTU)	4.8×10^{15}	3.6×10^{15}
Burnup (High Condition) MWD/MTU	50,000	
Actinides and Daughters (Ci/MTU)	155,000	
Fission Products (Ci/MTU)	640,000	
Decay Heat (Watts/MTU)	2,800	
Photon Release (Photons/Sec/MTU)	1.9×10^{16}	
Photon Energy Release (Mev/Sec/MTU)	7.3×10^{15}	
Age Out of Reactor	10 years	10 years
Burnup (Average Conditions) MWD/MTU	33,000	27,500
Actinides and Daughters (Ci/MTU)	83,000	75,000
Fission Products (Ci/MTU)	302,000	249,000
Decay Heat (Watts/MTU)	1,100	900
Photon Release (Photons/Sec/MTU)	7.7×10^{15}	6.2×10^{15}
Photon Energy Release (Mev/Sec/MTU)	2.6×10^{15}	2.0×10^{15}
Burnup (High Condition) MWD/MTU	50,000	
Actinides and Daughters (Ci/MTU)	124,000	
Fission Products (Ci/MTU)	442,000	
Decay Heat (Watts/MTU)	1,800	
Photon Release (Photons/Sec/MTU)	1.1×10^{16}	
Photon Energy Release (Mev/Sec/MTU)	3.8×10^{15}	

*Source: "Generic Requirements for a Mined Geologic Disposal System," Appendix B (DOE, 1984).

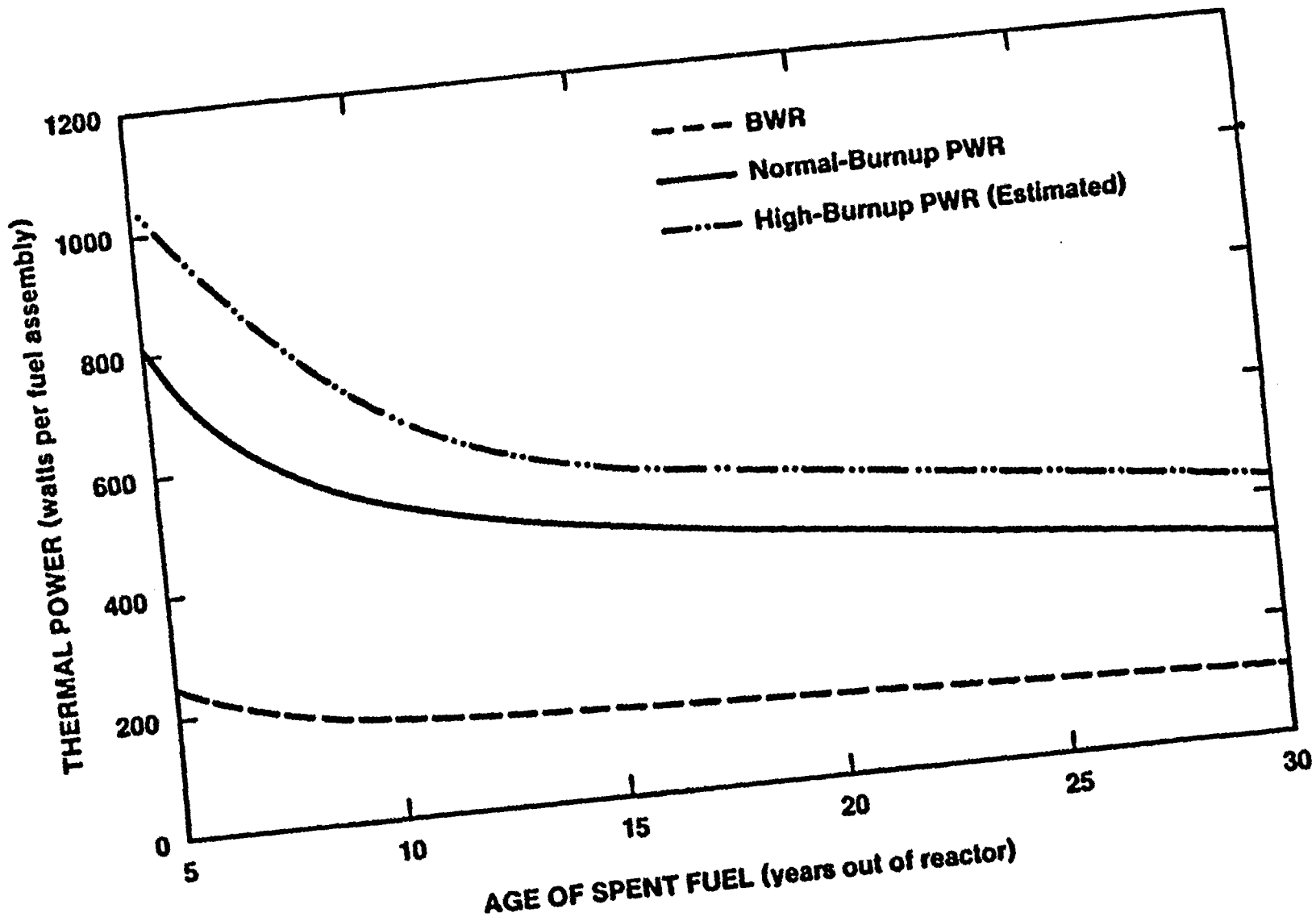


Figure 3-1 Thermal Power Decay of Spent Fuel

damage in a handling accident or thermal damage during irradiation; (2) assemblies containing high-burnup fuel, which might experience an unacceptable incidence of cladding failure during disassembly; and (3) low-production fuel assembly types for which the cost of disassembly tooling for consolidation may not be justifiable.

3.1.2 WVHLW (West Valley High-Level Waste)

This waste is presently stored at the reprocessing plant in West Valley, New York, as sludges and solutions, in tanks containing the equivalent of about 650 MTU. In preparation for disposal, the waste will be solidified and immobilized in a borosilicate glass waste form containing about 75% glass by weight and 25% actinide and fission product oxides.

Glass formulations and process canister configurations are being developed by the West Valley Nuclear Services Company (a subsidiary of the Westinghouse Electric Corporation). Under the present schedule, processing of the West Valley waste will begin in 1988 and end in 1990. The process, or "pour," canisters will be stored at West Valley until about 2003, when the first repository should be ready to accept West Valley High-Level Waste (WVHLW) for disposal. At the repository, process canisters will be overpacked in disposal containers. The WVHLW canister is described further in Section 3.3.2.2.

From Appendix B, Table B-2, O'Brien, 1984, each container of WVHLW emplaced in 2003 and 2004 will have a thermal power of about 200 W.

3.1.3 DHLW (Defense High-Level Waste)

DHLW is a borosilicate glass waste form similar to WVHLW. It will be produced at three DOE waste vitrification plants: the Hanford Waste Vitrification Plant (HWVP) at Hanford, Washington; the Defense Waste Processing Facility (DWPF) near Aiken, South Carolina (Savannah River); and at a plant to be built at the Idaho National Engineering Laboratory (INEL) near Idaho Falls. The Hanford and Savannah River waste is a by-product of DOE's plutonium production operation, while the INEL waste results from reprocessing Naval reactor fuel and DOE research reactor fuel.

Under the terms of the Nuclear Waste Policy Act of 1982, high-level wastes resulting from the defense activities of the United States government must be disposed of in an NRC-licensed repository. The estimated quantity of DHLW to be disposed of through the year 2022 is the equivalent of 7,350 MTU. It is reasonable to expect that this entire inventory of DHLW will be emplaced in the first civilian repository, where it will displace an equivalent amount (calculated on an MTU basis) of commercial spent fuel. The design of the Yucca Mountain repository is based on that assumption.

There is a problem in determining the "MTU equivalence" of DHLW. By definition, an MTU of waste is that which results from irradiating one metric ton of uranium (no matter what its enrichment or burnup) initially loaded in the core of a reactor. Differences in core design and irradiation cycle, and the decision for or against reprocessing, all have major effects on the actual volume of waste represented by 1 MTU. To compound the problem, security considerations make it difficult to quantify defense wastes in terms of core loadings or plant throughputs. The number of DHLW containers to be disposed of is approximately 15,000; it can be inferred, therefore, that each container will accommodate only 0.5 MTU of vitrified high-level waste like that which will be produced at the Savannah River Defense Waste Processing Facility. From O'Brien, 1985, on the average, the thermal power per canister of DHLW will be about 200 W.

3.1.4 Other Waste

Although Appendix B of the GR document emphasizes spent fuel, WVHLW, and DHLW, a number of other waste types will or may be disposed of in the first repository. These are discussed qualitatively:

Site-Generated Wastes: Site-generated wastes include expended air and water filters and decontamination materials. Under normal operating conditions and even under credible abnormal conditions, these will probably be in the "low-level" (non-transuranic, or non-TRU) radioactive waste category, i.e., they will contain less than 100 nanocuries of transuranic radionuclides per gram of waste. They would, therefore, qualify for disposal in a surface burial facility. No such facility will

be available at the Yucca Mountain repository, however, and the site-generated wastes will be disposed of in the same manner as transuranic (TRU) wastes. They will be packaged in metal boxes and drums--perhaps after mechanical compaction, but without incineration--and emplaced in a remote part of the underground disposal area.

"Hardware" Waste: Hardware waste is the highly radioactive (but non-TRU) metal scrap, such as end fittings, spacers, etc., remaining after the fuel rod consolidation operation. All the hardware waste produced in the repository consolidation operation will be disposed of in the spent fuel containers themselves; no additional containers of any kind will be required.

"Non-Fuel" Waste: Under 10 CFR 961, "Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste," utilities are permitted to transfer such non-fuel core components as control rods, instrument tubes, etc., to the DOE for disposal. This waste is currently being characterized and quantified and appropriate inputs will be provided when information becomes available.

CHLW and Commercial TRU Waste: Appendix B of the GR states that the first and second civilian repositories need not include provisions for the disposal of commercial high-level waste (CHLW) or commercial TRU (CTRU) waste but specifies that the designs of the repositories should not preclude a future decision to dispose of such wastes. The description of the reference CHLW is provided in O'Brien, 1984. The radiation levels associated with a CHLW container would be somewhat higher than for a spent fuel container; this should be considered in the design so that receipt of CHLW will not be precluded. The CTRU secondary wastes produced in reprocessing 3,000 MTU of spent fuel, for example, would include some 1,200 55-gallon drums of low-activity ("contact-handled") compacted TRU waste, 900 canisters (61-cm diameter by 300 cm) of high-activity ("remote-handled") compacted TRU waste, and 1,000 canisters (61-cm diameter by 300 cm) of compacted cladding hulls. In addition, mixed-oxide (MOX) fuel fabrication would produce another 4,700 55-gallon drums of low-activity compacted TRU waste. These numbers

represent the annual increment in the number of waste containers to be disposed of, if reprocessing were to be resumed. These secondary wastes are of relatively low activity, and their disposal introduces no new technical problems. The potential logistical problem, on the other hand, demands careful consideration in the design of the repository.

Miscellaneous Wastes: Regardless of how carefully the repository design parameters are formulated, there should be reasonable flexibility for handling and disposing of one-of-a-kind waste packages that are significantly different from those received (or generated on the site). Among the most important waste categories are those that will result from decommissioning the repository itself.

3.1.5 Total and Annual Waste Receipts

The Yucca Mountain repository will be designed to accommodate 70,000 MTU of high-level waste in the form of spent fuel, WVHLW, and DHLW. (The Nuclear Waste Policy Act permits loading beyond that limit, once a second repository becomes operational.) Table 3-2 shows the year-by-year receival rate for the three high-level waste forms. It is seen that after a five-year start-up period, WVHLW and DHLW are received at the constant rate of 400 MTU per year, and spent fuel is received at the constant rate of 3,000 MTU per year, until the year 2022 when the repository reaches its 70,000 MTU capacity. At that time, the waste inventory will include 62,000 MTU of spent fuel, 650 MTU of WVHLW, and 7,350 MTU of DHLW. Table 3-2 will be revised to include the number of waste containers of the different waste types.

3.2 Transportation

All materials containing radioactivity greater than 0.002 Ci/g are considered radioactive for regulatory purposes and are treated as hazardous (49 CFR 173.403, y). Hazardous materials are subject to stringent controls during transportation. Three federal agencies have major responsibility for regulating transport of radioactive materials. The responsibilities of the three organizations overlap somewhat but can be stated simply:

TABLE 3-2

WASTE RECEIVAL RATES FOR FIRST REPOSITORY

Year	MTU WVHLW and DHLW This Year	MTU WVHLW and DHLW Cumulative	MTU Spent Fuel This Year	MTU Spent Fuel Cumulative	Cum. MTU WVHLW/DHLW/ Spent Fuel	PWR This Year MTU	PWR This Year Assemblies	BWR This Year MTU	BWR This Year Assemblies
1998	0	0	400	400	400	240	519	160	860
1999	0	0	400	800	800	240	519	160	860
2000	0	0	400	1200	1200	240	519	160	860
2001	0	0	900	2100	2100	540	1169	360	1935
2002	0	0	1800	3900	3900	1080	2338	720	3871
2003	400	400	3000	6900	7300	1800	3896	1200	6452
2004	400	800	3000	9900	10700	1800	3896	1200	6452
2005	400	1200	3000	12900	14100	1800	3896	1200	6452
2006	400	1600	3000	15900	17500	1800	3896	1200	6452
2007	400	2000	3000	18900	20900	1800	3896	1200	6452
2008	400	2400	3000	21900	24300	1800	3896	1200	6452
2009	400	2800	3000	24900	27700	1800	3896	1200	6452
2010	400	3200	3000	27900	31100	1800	3896	1200	6452
2011	400	3600	3000	30900	34500	1800	3896	1200	6452
2012	400	4000	3000	33900	37900	1800	3896	1200	6452
2013	400	4400	3000	36900	41300	1800	3896	1200	6452
2014	400	4800	3000	39900	44700	1800	3896	1200	6452
2015	400	5200	3000	42900	48100	1800	3896	1200	6452
2016	400	5600	3000	45900	51500	1800	3896	1200	6452
2017	400	6000	3000	48900	54900	1800	3896	1200	6452
2018	400	6400	3000	51900	58300	1800	3896	1200	6452
2019	400	6800	3000	54900	61700	1800	3896	1200	6452
2020	400	7200	3000	57900	65100	1800	3896	1200	6452
2021	400	7600	3000	60900	68500	1800	1886	1200	6452
2022	400	8000	1100	62000	70000	660	1429	440	2366

- the DOT has primary jurisdiction over the transportation of radioactive materials and regulates shippers and carriers of these materials;

- the NRC adopts packaging standards and imposes administrative, procedural, and technical requirements; and

- the DOE has the authority to certify its own packagings for government shippers.

Spent fuel and other high-level wastes transported to the repository will arrive in casks that have been designed according to the standards of these agencies.

Conceptual engineering data sheets that describe several proposed shipping casks are provided in Figures 3-2 through 3-4. The information contained in these data sheets should be used as a basis for the design and specification of waste receipt systems of the repository.

As guidance for calculating the number of waste shipments to be received, it may be assumed that up to 80% of the spent fuel received at the repository will be shipped in 100-ton rail casks and that up to 70% will be shipped in truck casks. Provisions for expansion to 100% by rail or truck should not be precluded. For WVHLW and DHLW, the only shipping cask now under development is a truck cask with a capacity of one waste canister. By the year 2000, it is expected that a rail cask with a capacity of 5 to 7 canisters will have been developed.

3.3 Waste Package Requirements

3.3.1 Waste Package Design Considerations

As part of the engineered barrier system, the function of the waste package is to contain and prevent the release of radioactive materials in accordance with federal standards (10 CFR 60, 135). During the preclosure

100 TON RAIL/BARGE SPENT FUEL CASK CONCEPT

Overall Size:	Outside Diameter (top)	85 in.
	Outside Diameter (bottom)	83 in.
	Overall Length	235 in.
Weight:	Cask Weight—Empty (Max.)	162,000 lb.
	Cask Weight—Full (Max.)	190,000 lb.
Cavity Size:	Inside Diameter	57.0 in.
	Inside Length	176.5 in.
Shielding:	Gamma Type:	Steel
	Steel Thickness:	
	Cask Side	10.0 in.
	Cask Top	11.0 in.
	Cask Bottom	10.5 in.
	Neutron Type:	Solid, Organic Material
	Thickness:	3.0 in.
Type Of Containment:		Bolted Closure
Seals:		Double O-Ring
Cavity Atmosphere:		Dry Gas
Expected Thermal Output (Max.):		13 Kilowatts
Outer Surface Configuration:		Smooth
Trunnions:		
Lifting (Top)		4 @ 90°
Tie-Down (Bottom)		2 @ 180°

Waste Forms:	Intact Spent Fuel Assemblies (SFAs)		Square Canisters Of Consolidated Rods (2:1 Consolidation)		Small Diameter Canisters for Consolidated Rods		Large Diameter Canisters for Consolidated Rods	
	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR
Diameter (in.)	—	—	—	—	12.8	12.8	16.9	18.9
Side Of Square (in.)	8.4	5.5	8.4	5.5	—	—	—	—
Length (in.)	160	176	152	161	158	164	160	169
Equiv. Number Of SFAs(1)	1	1	2	2	3	7	6	17
Weight (lb.)	1450	700	2900	1400	5100	4900	10,700	13,400
Min. Age (yr.)(2)	10	10	10	10	10	10	10	10
Cask Capacity:								
Number Of Waste Forms(3)	14	36	10	20	6	6	2	2
Equiv. SFAs(4)	14	36	20	40	18	42	12	34
Total Cargo Weight (lb.)(5)	20,500	25,000	29,000	28,000	30,500	29,500	21,500	26,500
Cask Weight:								
Empty (lb.)(6)	160,000	161,500	160,000	161,500	159,000	159,500	158,500	159,000
Full (lb.)	180,500	186,500	189,000	189,500	189,500	189,000	180,000	185,500
Gross Vehicle Wt. (lb.)(7)	253,500	259,500	262,000	262,500	262,500	262,000	253,000	258,500
% Of Allowable Weight:(8)	96%	99%	100%	100%	100%	100%	96%	98%

Notes: (1) The waste form contains the rods from this number of spent fuel assemblies.
(2) See comment in text.
(3) Cask diameter is optimized for intact fuel assemblies. This cask may be weight, not quantity, limited for other waste forms.
(4) The cask can carry the rods from this number of spent fuel assemblies.
(5) Rounded to nearest 500 lb.
(6) Includes fuel assembly or canister support baskets which vary in weight with the waste form.
(7) Assumes weight of 73,000 lb. for rail car and tie-down equipment.
(8) Maximum weight for unrestricted interchange (4 axle car) is 263,000 lb.

Figure 3-2. 100-Ton Rail/Barge Spent Fuel Cask Concept

TRUCK SPENT FUEL CASK CONCEPT

Overall Size:	Outside Diameter (Top)	44 in.
	Outside Diameter (Bottom)	39 in.
	Overall Length	215 in.
Weight:	Cask Weight—Empty (Max.)	48,000 lb.
Cavity Size:	Inside Diameter (with shielding liner)	22.7 in.
	Inside Length (with shielding liner)	176.5 in.
Shielding:	Gamma Type:	Depleted Uranium/Steel
	Equivalent Steel Thickness:	
	Cask Side	9.3 in.
	Cask Top	10.0 in.
	Cask Bottom	9.5 in.
	Neutron Type:	Solid, Organic Material
	Thickness:	3.0 in.
Type Of Containment:		Bolted Closure
Seals:		Double O-Ring
Cavity Atmosphere:		Dry Gas
Expected Thermal Output (Max.):		2.8 Kilowatts
Outer Surface Configuration:		Smooth
Trunnions:		
Lifting (Top)		4 @ 90°
Tie-Down (Bottom)		2 @ 180°

Waste Forms:	Intact Spent Fuel Assemblies (SFAs)		Square Canisters Of Consolidated Rods (2:1 Consolidation)		Small Diameter Canisters for Consolidated Rods	
	PWR	BWR	PWR	BWR	PWR	BWR
Diameter (in.)	—	—	—	—	12.8	12.8
Side Of Square (in.)	8.4	5.5	8.4	5.5	—	—
Length (in.)	160	176	152	161	158	164
Equiv. Number Of SFAs(1)	1	1	2	2	3	7
Weight (lb.)	1450	700	2900	1400	5100	4900
Min. Age (yr.)(2)	10	10	10	10	10	10
Cask Capacity:						
Number Of Waste Forms(3)	2	5	2	4	1	1
Equiv. SFAs(4)	2	5	4	8	3	7
Total Cargo Weight (lb.)(5)	3000	3500	6000	5500	5000	5000
Cask Weight:						
Empty (lb.)(6)	47,500	48,000	47,500	48,000	47,500	47,500
Full (lb.)	50,500	51,500	53,500	53,500	52,500	52,500
Allowable Vehicle Weight:						
Without Cask (lb.)	29,500	28,500	26,500	26,500	27,500	27,500
Loaded (lb.)	80,000	80,000	80,000	80,000	80,000	80,000
% Of Allowable Weight:	100%	100%	100%	100%	100%	100%

Notes: (1) The waste form contains the rods from this number of spent fuel assemblies.
(2) See comment in text.
(3) Cask diameter is optimized for intact fuel assemblies. This cask may be weight, not quantity, limited for other waste forms.
(4) The cask can carry the rods from this number of spent fuel assemblies.
(5) Rounded to nearest 500 lb.
(6) Includes fuel assembly or canister support baskets which vary in weight with the waste form.

Figure 3-3. Truck Spent Fuel Cask Concept

DEFENSE HIGH LEVEL WASTE (DHLW) TRUCK CASK

Overall Size:	Outside Diameter (Top)	49.0 in.
	Outside Diameter (Bottom)	40.5 in.
	Overall Length	159.5 in.
Weight:	Cask Weight (Empty)	43,000 lb.
Cavity Size:	Inside Diameter (cask body)	32.5 in.
	Inside Length (cask body)	124.5 in.
	Inside Diameter (DHLW configuration)	25.0 in.
	Inside Length (DHLW configuration)	118.5 in.
Shielding:	Gamma Type:	Depleted Uranium/Steel
	Equivalent Steel Thickness:	
	Cask Side	10.0 in.
	Cask Top	9.3 in.
	Cask Bottom	10.0 in.
	Neutron Type:	None
Type Of Containment:		Bolted Closure
Seals:		Double Elastomer O-Ring
Cavity Atmosphere:		Dry Gas
Expected Thermal Output (Max.):		810 Watts
Outer Surface Configuration:		Smooth
Impact Limiters:		
External Type		Metal Fixed Ring
Internal Type		Crushable Honeycomb
Trunnions:		
Lifting (Top)		4 @ 90°
Tie-Down (Bottom)		2 @ 180°

Waste Forms:	Defense Waste Canister(1)	Other Forms
Diameter	24.0 in.	The cavity size and shielding flexibility offered by this cask should allow the accommodation of other waste forms, such as commercial high level waste canisters or remote-handled transuranic waste packages. The details of transporting these waste forms in the DHLW truck cask have not yet been developed.
Length	118.0 in.	
Weight (Maximum)	5200 lb.	
Waste Age (Minimum)	5 yr. (Sludge) 15 yr. (Supernate)	
Cask Capacity:		
Number Of Waste Forms	1	
Cargo Weight	5200 lb.	
Cask Weight:		
Empty	43,000 lb.	
Full	48,000 lb.	
Gross Vehicle Weight(2)	78,000 lb.	
% Of Allowable Weight(3)	97%	

Notes: (1) Reference DP-1606, Rev. 1, Description of Defense Waste Processing Facility Reference Waste Form and Canister, Richard G. Baxter, E.I. Du Pont Savannah River Plant, August 1983.

(2) Assumes weight of 30,000 lb. for tractor, semi-trailer, and tie-down equipment.

(3) Maximum allowable weight for legal weight truck mode is 80,000 lb.

Figure 3-4. Defense High-Level Waste (DHLW) Truck Cask

period, the waste package consists of the waste form (including any space frames, canisters, and other means of encapsulation and/or stabilization) and container (including any additional overpack materials) surrounding an individual waste form. During the postclosure period, the waste package consists of the emplaced waste form, container, any other packing, and absorbent materials immediately surrounding an individual waste container (DOE, 1984).

Waste package design requirements are primarily derived from the federal regulations 10 CFR 60 (NRC, 1984). These requirements are summarized below.

Waste packages shall be designed to meet the following requirements:

- Contain the waste for 300 to 1,000 yr.
- Maintain a release rate less than 10^{-5}/yr of the radionuclide inventory present at 1,000 yr.
- Maintain retrievability for 50 yr after emplacement of the first waste package.
- Control criticality so as not to exceed an effective multiplication factor (k_{eff}) of 0.95 unless at least 2 unlikely, independent, and concurrent or sequential changes occur.
- Prevent release of radioactive material in excess of applicable federal standards under expected loads during or after transportation, handling, emplacement, retrieval, and seismic events. Further, these loads must not compromise long-term performance.
- Retain legible, externally labeled identification as long as retrievability is required.

3.3.2 Containers

3.3.2.1 Spent Fuel Container

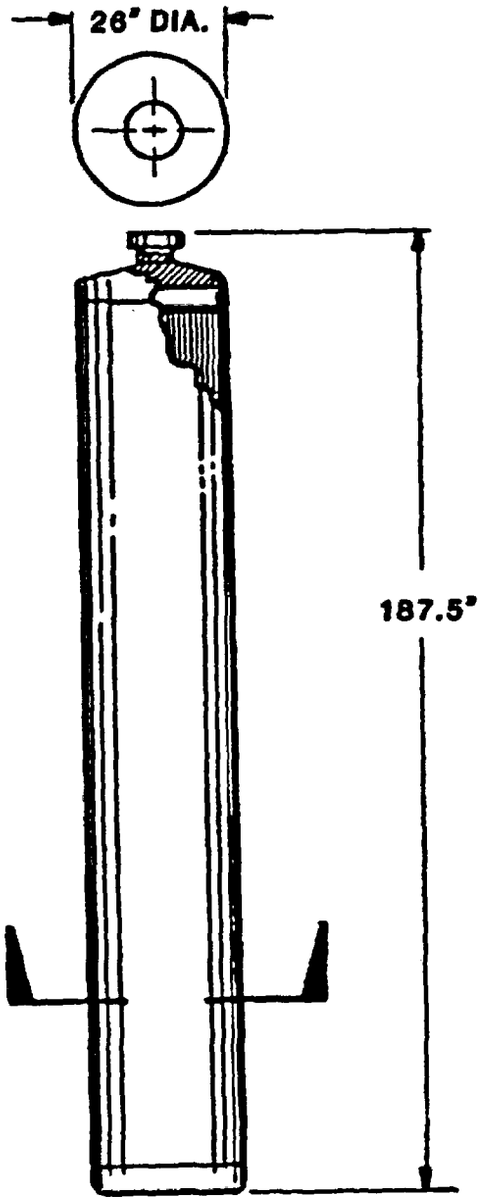
The reference NNWSI spent fuel container is 26 in. in diameter and 187.5 in. in length. Configured for PWR fuel, it will accommodate three intact assemblies (1.38 MTU), or six consolidated assemblies (2.77 MTU) plus all the hardware waste from the disassembly operation. Configured for BWR fuel, the container will hold 6 intact assemblies (1.10 MTU) or 12 consolidated assemblies (2.20 MTU) plus the hardware waste. Figures 3-5, 3-6, and 3-7 show the details of the reference container in the two conceptual configurations.

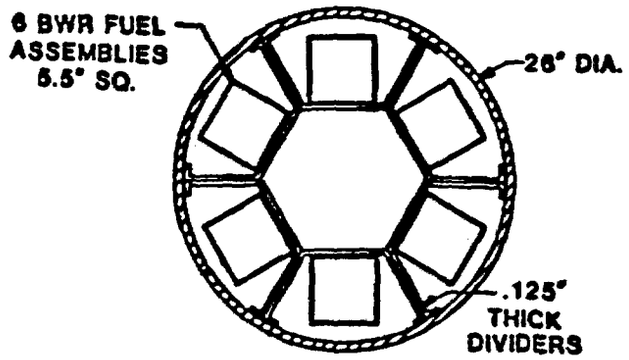
If the decision is made not to consolidate spent fuel, a so-called "3/4 hybrid" container could alternatively be considered as a means of improving the economics of intact fuel disposal. This container is 28 in. in diameter, 187.5 in. long, and accommodates three PWR assemblies and four BWR assemblies. Since the normal ratio of PWRs to BWRs is somewhat less than 3:4, the hybrid container may be fitted with an alternative spacer grid so that it holds nine BWR assemblies (and no PWR assemblies) as shown in Figure 3-8.

3.3.2.2 WVHLW and DHLW Container

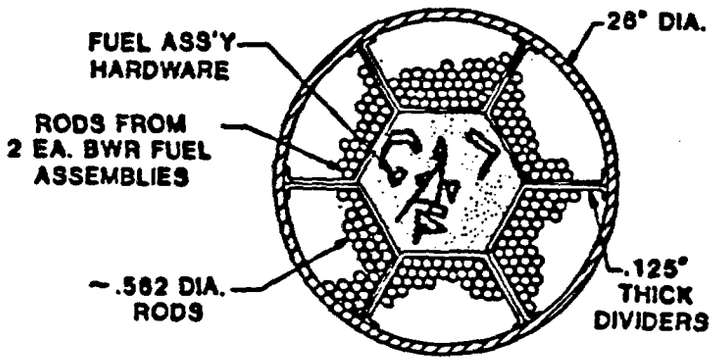
The total amount of WVHLW available for disposal in the first repository is 650 MTU. It will be received in 304L stainless steel canisters 24 in. in diameter by 118 in. long, each containing the equivalent of 2.1 MTU of vitrified high-level waste.

The DHLW waste will also be received in 24-in. diameter by 118-in. long, 304L stainless-steel canisters. While the WVHLW and DHLW canisters differ in some details of mechanical design, their external dimensions are similar, and most of the handling equipment designed for WVHLW canisters can be used for DHLW.

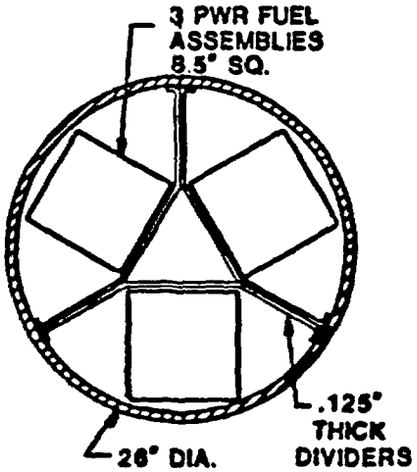




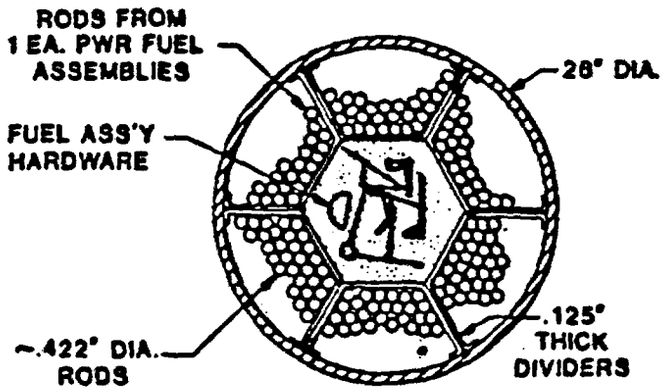
Configuration 1. 6 Intact BWR Assemblies



Configuration 2. 12 Consolidated BWR Assemblies

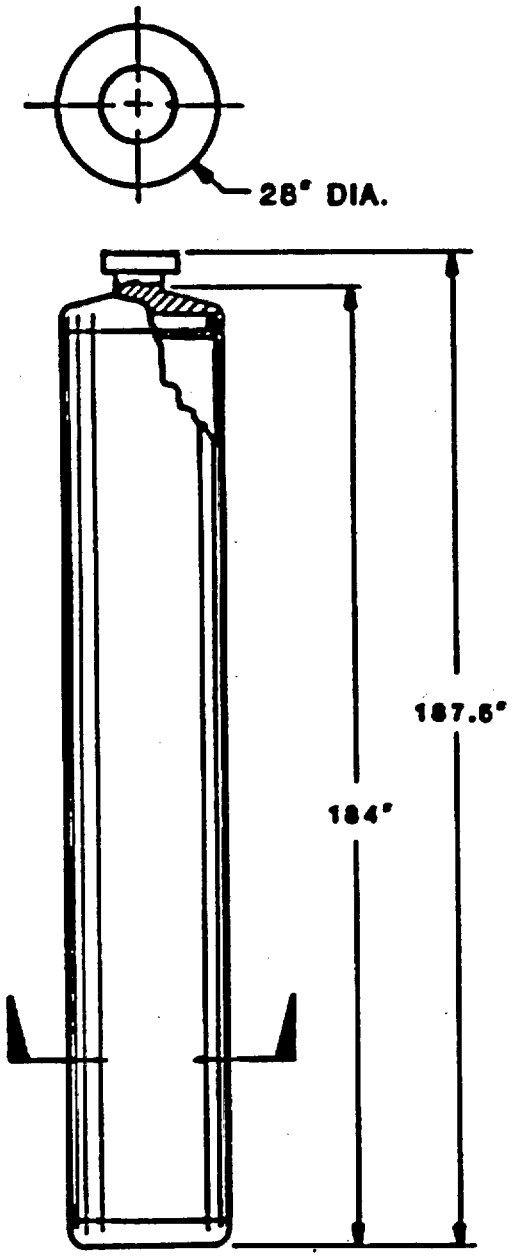


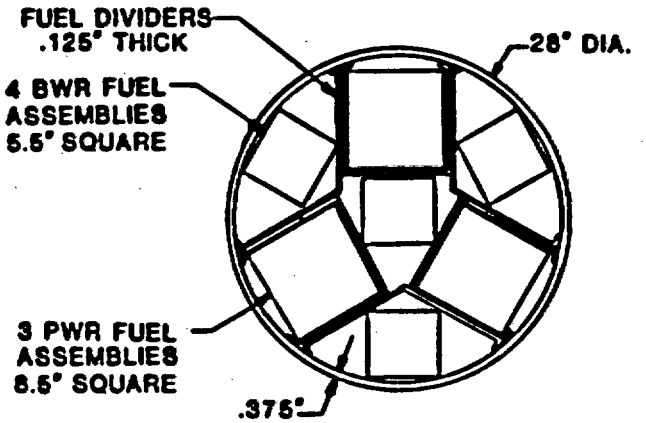
Configuration 4. 3 Intact PWR Assemblies



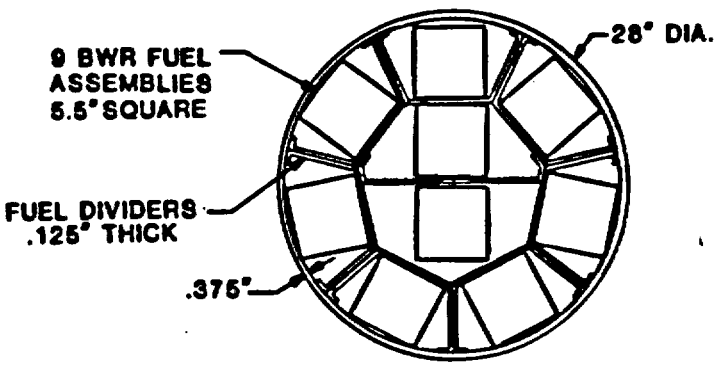
Configuration 3. 6 Consolidated PWR Assemblies

Figure 3-5. NNWSI Reference Spent Fuel Container





Configuration 1. 3 Intact PWR Assemblies and 4 Intact BWR Assemblies



Configuration 2. 9 Intact BWR Assemblies

Figure 3-6. NNWSI Hybid Spent Fuel Container

All DHLW and WVHLW canisters will be overpacked before emplacement. The overpack is yet to be designed, but it will probably be about 26 in. in diameter and 11 ft in length and will be made of austenitic stainless steel. By the criterion discussed earlier, approximately 15,000 canisters will be required for the 7,350 MTU of DHLW in the first repository, and 310 canisters will be required for the 650 MTU of WVHLW.

* INSERT PG.

For ACD studies, the equation used for the power per MTU is

$$P(t) = SUM\ [An*Exp(-Bn*t)] \qquad (1)$$

where the coefficients An and Bn are given in Table 3-2. The time in equation (1) is time since discharge from the reactor. The power as a function of time since emplacement of waste of age A at emplacement is given by

$$Pa(t) = SUM\ [(An*Exp(-Bn*A))*Exp(-Bn*t)] \qquad (2)$$

If it is necessary to normalize the power function to power at emplacement, then equation (2) is divided by Pa(A).

* INSERT PG.

Table 3-2. Spent Fuel Thermal Decay Curve Fit Coefficients

PWR		BWR	
An	Bn	An	Bn
5 years to 500 years fit			
185.53	-.0013643	165.88	-.0013366
855.96	-.019105	700.97	-.019212
308.25	-.052712	206.57	-.050186
4958.1	-.43326	3735.6	-.44773
5 years to 50,000 years fit			
11.451	-.000028177	10.889	-.000028453
17.559	-.00012938	15.792	-.00012967
162.58	-.0017612	145.59	-.0017556
909.21	-.019899	748.89	-.020189
268.39	-.063514	157.84	-.060477
5112.6	-.44224	3756.0	-.44994

60% PWR plus 40% BWR	
An	Bn
5 years to 500 years fit	
177.67	-.0013539
793.93	-.019142
267.46	-.051888
4462.4	-.43768
5 years to 50,000 years fit	
11.226	-.000028283
16.852	-.00012949
155.78	-.0017590
844.97	-.019999
224.14	-.062594
4567.4	-.44460

4.0 GENERAL DESIGN REQUIREMENTS

This section provides general design requirements applicable to many of the repository facilities and is divided into two major subsections.

The first subsection, Subsection 4.1, describes in general terms the collections of repetitive requirements identified in the SR document and as tabulated in Appendix C. In some cases, functional information has been included with the requirement descriptions.

The second subsection, Subsection 4.2, contains other requirements that apply generally to the design of repository facilities.

4.1 Repetitive Requirements Derived from the SR

The SR takes many of the "top-level" repository performance safety programmatic requirements and allocates them to low-level systems. Since these lower level requirements are repetitive and general in nature, and pertain to similar repository features, they have been combined into the following 14 general categories of requirements. Refer to Appendix C for a complete listing of SR requirements and correlation to the applicable repository facilities.

4.1.1 Waste Receival Rates and Throughputs (A1)*

The overall facility design and pertinent subsystems must meet the annual waste receipt rate and total throughput. It must also accommodate planned down time, maintenance and unexpected interruptions, waste handling cycles, static and dynamic loads on equipment, equipment fatigue, or replacement schedules (SR-1.2 PC#2).

*Refer to Appendix C for symbol legend.

SYSTEM REQUIREMENTS FOR WASTE HANDLING

Section Number	Section Title	Performance Criteria and Constraints
YMMGD	Yucca Mountain Mined Geologic Disposal System	PC#1
1.0	Preclosure Waste Disposal	PC#1
1.2	Repository	PC#1,2
1.2.1	Mining	PC#1,2,3; C#V
1.2.1.1	Access Construction	PC#1
1.2.1.4	Rock Handling	PC#1-4
1.2.2	Waste Handling	PC#1a,1b,2a,2b,3,4b, 5b,6
1.2.2.1	Receiving	PC#1; C#A
1.2.2.2	Preparation	PC#1a
1.2.2.4	Emplacement	PC#1-2a,3-4
1.2.2.8	Contamination Control	PC#1
1.2.3.1	Waste Evaluation	C#A
1.2.5.8	Transportation	PC#1

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

4.1.2 Retrievability (A2)*

The repository design shall preserve the option to retrieve the emplaced waste through the period of waste emplacement and thereafter until the completion of the confirmation program and NRC review of the operating license. Requirements concerning retrievability include SR 1.0 - PC#2, NWPA 122, 40 CFR 191.14.f, 10 CFR 60.111.b, GR 1.0 PC#2, and 10 CFR 60.133.c. Refer to Subsection 12.1.1 for additional information.

*Refer to Appendix C for symbol legend.

SYSTEM REQUIREMENTS FOR RETRIEVABILITY

Section Number	Section Title	Performance Criteria and Constraints
1.0	Preclosure Waste Disposal	PC#2
1.1.2	Subsurface	C#F
1.2	Repository	C#I
1.2.1	Mining	C#C,J
1.2.1.1	Access Construction	PC#2; N
1.2.1.2	Drift Construction	PC#1
1.2.1.3	Borehole Construction	PC#1
1.2.2	Waste Handling	C#M
1.2.3	Performance Confirmation	C#R
1.2.4.1	Underground Closure	C#A

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

4.1.3 Radiological Protection Requirements A(3)*

This subsection provides general design requirements for radiological protection of members of the public and repository workers under normal operating conditions. The design shall be based on the objective of reducing radiation exposures to as low as reasonably achievable (ALARA) and within the limits prescribed below. This subsection describes the provisions for controlling radiation levels, radioactive releases, and exposures; whereas Subsections 4.2.8 and 11.3 describe the provisions for monitoring these conditions. The facility design requirements discussed in this section are to meet the requirements as stated in the SR 1.0 C#A.

*Refer to Appendix C for symbol legend.

4.1.3.1 Area Definitions, Permissible Doses, and Radiation Levels

The design of the site and facility arrangements shall be based on the areas defined and on the permissible doses and radiation levels described below. The definitions of the areas are taken from the regulations cited. For design purposes, additional explanations are also included.

Site means an area contained within the boundary of a location under the effective control of licensed persons possessing or using spent nuclear fuel or radioactive waste and who are involved in any activity, operation, or process covered by 40 CFR 191, Subpart A (EPA, 1985).

General environment means the total terrestrial, atmospheric, and aquatic environments outside sites within which any activity, operation, or process associated with the management and storage of spent nuclear fuel or radioactive waste is conducted (40 CFR 191, Subpart A).

The design of the site and facilities shall ensure that under normal operating conditions there is reasonable assurance that the combined annual dose equivalent to any member of the public in the general environment will not exceed the limits specified in 40 CFR 191, Subpart A, (SR-1.0 C#A.1).

Unrestricted area means any area to which access is not controlled by the licensee for the purposes of protection of individuals from exposure to radiation and radioactive materials and any area used for residential quarters (10 CFR 20) (NRC, _____).

An unrestricted area is anywhere outside a restricted area. The design of the site and facilities shall ensure that under normal operation conditions the radiation levels in unrestricted areas do not exceed the permissible levels set forth in 10 CFR 20.105 and DOE Order 5480.1A, (SR-1.0 C#A.4).

Restricted area means any area to which access is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials. This term does not include any areas used as residential quarters (10 CFR 20).

Where required by 10 CFR 20.202 and DOE Order 5480.1A, individuals within the restricted area are monitored to determine the amount of dose they receive. Provisions for controlling the access to the restricted area are described in Subsections 4.1.3.3 and 4.2.4, and provisions for monitoring personnel are contained in Subsection 4.2.8.

The facilities and systems in the restricted area shall be designed and arranged so that under normal operating conditions no individual within the area will receive a total occupational dose exceeding the limits specified in 10 CFR 20.101 and DOE Order 5480.1A. No individual will inhale or absorb through the skin a quantity of radioactive material exceeding the limits specified in 10 CFR 20.103 and DOE Order 5480.1A. Other requirements in 10 CFR 20 concerning permissible doses and levels of radiation shall also govern the design of facilities and systems in the restricted area (SR-1.0 C#A.3, .5, and .6).

Waste operations area means 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). For design purposes, it is assumed this encompasses all areas within the restricted area in which radioactive materials are located and in which the potential for contamination may exist.

All individuals entering the waste operations area are required to be continuously monitored for potential radiation exposure. The repository design shall ensure that radiation doses in areas outside the waste operations area are less than 10% of the quarterly dose limits specified in DOE Order 5480.1, Chapter XI, to preclude the requirement for personnel dosimetry and monitoring equipment in those areas.

4.1.3.2 Radiological Zoning

Zones shall be established to classify areas within the restricted area on the basis of the radiation levels and potential for contamination in each area. Radiation zone designations shall be used to establish design requirements for minimizing radiation exposures, and contamination zone designations for minimizing the potential for spread of radioactive contamination.

In accordance with DOE Order 5480.1A, facility design shall ensure that annual personnel radiation doses are less than 1 rem in the restricted area and less than 0.17 rem in unrestricted areas. Accordingly, maximum dose rates established for radiation zones within accessible areas shall be such that with the anticipated occupancy times, personnel doses will not exceed the annual dose objectives. Rotation of workers between differing job classifications cannot be used to minimize worker doses. Shielding and separation distances shall be designed to reduce radiation levels below limits for the radiation zones designated.

Facility design shall incorporate confinement barriers and other features to prevent the uncontrolled spread of radioactive contamination. Contamination control features such as contamination check points, decontamination facilities, ventilation air flow directions, and exhaust air filtration requirements shall be provided between areas with different potentials for radioactive contamination.

4.1.3.3 Access Control

This section describes provisions for controlling access to protect personnel from exposure to radiation. These provisions shall be compatible with the access control provisions for the security and safeguards described in Subsection 4.2.4.

The design shall include provisions to control access to the restricted area, including fences (or other barriers), and access control stations at each entrance. The design shall include additional provisions to control access to contaminated areas and areas in which radiation levels are high.

The design of the provisions for access control shall comply with 10 CFR 20 with the objective of conforming to standards for permissible doses and the levels of radiation specified in Subsection 4.1.3.1. The design shall include provisions (1) for inspection and control of the flow of personnel and materials to ensure that only authorized personnel enter the restricted area and areas with higher radiation levels and (2) to prevent the uncontrolled spread of radioactive contamination.

4.1.3.4 Radiation Shielding

Radiation shielding shall be provided to ensure compliance with radiation zoning and to minimize personnel exposure. The shielding design shall be based on the characteristics of the radioactive materials handled at the facility (see Section 3) and on the maximum quantity and radioactivity of the waste expected during normal operating conditions. The type and thickness of shielding that surrounds sources of radioactivity shall be determined by approximating the actual geometry and physical condition of the source or sources. Shielding thicknesses shall ensure that the scattered dose rate, plus the transmitted dose rate through each shielding wall from all contributing sources, is below the upper limit for the radiation zone specified for the respective area.

The concrete shielding shall conform to the requirements and recommended practices described in ANSI/ANS-11.13/N101.6/N, "Concrete Radiation Shields" (ANSI, _____) and NRC Regulatory Guide 3.9, "Concrete Radiation Shields for Nuclear Power Plants" (NRC, _____).

4.1.3.5 Effluent Control

The design shall preclude the release to unrestricted areas of radioactive material in concentrations that exceed the limits for both air and water prescribed in 10 CFR 20.106. Other requirements in 10 CFR 20 concerning levels of concentrations in air and water in the restricted area shall also govern the design. Discharges of radioactive materials to the general environment shall comply with the dose limits set in 40 CFR 191 (see Subsection 4.1.3.2). Specific provisions incorporated in the design of

subsurface and surface ventilation systems for meeting these requirements are discussed in Subsections 8.1.5 and 11.1.5, respectively. Additional provisions for monitoring such releases are covered in Subsection 4.2.8.4.

SYSTEM REQUIREMENTS FOR EFFLUENT CONTROL

Section Number	Section Title	Performance Criteria and Constraints
1.0	Preclosure Waste Disposal	C#A,C
1.1.2	Subsurface	C#G
1.2	Repository	C#C
1.2.1	Mining	C#B
1.2.1.1	Access Construction	C#B
1.2.1.2	Drift Construction	C#B
1.2.1.3	Borehole Construction	C#B
1.2.1.4	Rock Handling	C#B
1.2.1.5	Water Removal	C#B
1.2.1.6	Mining Ventilation	C#B
1.2.2	Waste Handling	C#B
1.2.2.1	Receiving	C#C
1.2.2.2	Preparation	C#E
1.2.2.3	Storage	C#C
1.2.2.4	Emplacement	C#L
1.2.2.5	Retrieval	C#C
1.2.2.6	Shipping	C#B
1.2.2.7	Waste-Handling Ventilation	C#D
1.2.2.8	Contamination Control	C#B
1.2.3	Performance Confirmation	C#A
1.2.3.1	Waste Evaluation	C#B
1.2.3.2	Geologic Evaluation	C#B
1.2.3.3	Natural and Engineered Barriers Evaluation	C#L
1.2.4	Decommissioning	C#I
1.2.4.2	Surface Facility Decommissioning	C#A
1.2.4.3	Institutional-Barrier Implementation	C#B

SYSTEM REQUIREMENTS FOR EFFLUENT CONTROL (Continued)

Section Number	Section Title	Performance Criteria and Constraints
1.2.5	Support	C#B
1.2.5.1	Information	C#E
1.2.5.2	Administration	C#E
1.2.5.3	Personnel Services	C#P
1.2.5.4	Security and Safeguards	C#I
1.2.5.5	Supplies	C#E
1.2.5.6	Maintenance	C#G
1.2.5.7	Utilities	C#N
1.2.5.8	Transportation	C#F
1.2.5.9	Monitoring	C#G
1.2.5.9.1	Radiological Monitoring	C#Q
1.2.5.9.2	Nonradiological Monitoring	C#D
1.2.5.10	Emergency Preparedness	C#F

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

4.1.4 Nonradiological Protection Requirements (A4)*

Releases or potential exposures of toxic substances, chemicals, or dusts shall be below the maximum-permissible-concentrations (MPCs) or threshold-limit-values (TLVs) as specified by the EPA or the ACGIH (American Conference of Governmental Industrial Hygienists). These standards are implemented in DOE Order 5480.1A and 5480.4 and Executive Order 12088, (SR-1.0 C#N and 1.2 C#A).

*Refer to Appendix C for symbol legend.

The facility design shall incorporate the latest proven monitoring and hazard mitigation technology in all areas where releases or exposures to toxic substances, chemicals, or dusts will occur. Design features shall either entrap, isolate, dilute, or neutralize. Sludge and waste-water treatment facilities shall be designed to meet the toxic level release limit for discharged effluents or these materials shall be prepared for off-site shipment. The operator shall monitor hazards and limit personnel exposure to acceptable levels by appropriate methods.

SYSTEM REQUIREMENTS FOR NONRADIOLOGICAL PROTECTION

Section Number	Section Title	Performance Criteria and Constraints
1.0	Preclosure Waste Disposal	C#M,N
1.2	Repository	C#A
1.2.1	Mining	C#A
1.2.1.1	Access Construction	C#A
1.2.1.2	Drift Construction	C#A
1.2.1.3	Borehole Construction	C#A
1.2.1.4	Rock Handling	C#A
1.2.1.5	Water Removal	C#A
1.2.1.6	Mining Ventilation	C#A
1.2.2	Waste Handling	C#A
1.2.2.1	Receiving	C#B
1.2.2.2	Preparation	C#D
1.2.2.3	Storage	C#B
1.2.2.4	Emplacement	C#K
1.2.2.5	Retrieval	C#B
1.2.2.6	Shipping	C#A
1.2.2.7	Waste-Handling Ventilation	C#C
1.2.2.8	Contamination Control	C#A
1.2.3	Performance Confirmation	C#Q
1.2.3.2	Geologic Evaluation	C#C
1.2.3.3	Natural and Engineered Barriers Evaluation	C#N

SYSTEM REQUIREMENTS FOR NONRADIOLOGICAL PROTECTION (Continued)

Section Number	Section Title	Performance Criteria and Constraints
1.2.4	Decommissioning	C#K
1.2.4.1	Underground Closure	C#C
1.2.5	Support	C#G
1.2.5.5	Supplies	C#F
1.2.5.6	Maintenance	C#H
1.2.5.7	Utilities	C#J
1.2.5.8	Transportation	C#G
1.2.5.9.2	Nonradiological Monitoring	C#F,G

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

4.1.5 Structures, Systems, and Components Important to Safety (A5)*

All structures, systems, and components important to safety shall continue to perform their safety functions under (1) anticipated natural phenomena and environmental conditions (10 CFR 60.131.b, 1); (2) dynamic effects of equipment failure and other similar events (10 CFR 60.131.b, 2); (3) credible fires and explosions (10 CFR 60 131.b, 3); (4) emergency situations to maintain control of radioactive waste and effluents shall permit prompt termination of operations, and permit evacuation of personnel (10 CFR 60.131.b, 4). Systems, structures, and components shall permit periodic inspection, testing, and maintenance sufficient to ensure continued readiness and functions (10 CFR 60.131.b, 6) and shall be monitored and controlled over their anticipated ranges for normal operation and for accident conditions (10 CFR 60.131.b, 8), (SR-1.0 C#Y,Z, and AA and 30 CFR Parts D, E, and N).

*Refer to Appendix C for symbol legend.

The structures, systems, and components of the geologic repository shall be classified according to their importance to public safety, waste isolation, and worker safety. The specific class definitions and the methodology for determining the proper class for each of the structures, systems, and components shall be developed in accordance with requirements being established by the DOE OCRWM. The definition of structures, systems, and components important to safety is found in 10 CFR 60.2.

To assess which structures, systems, and components are important to achieve the established performance objectives of each class, other than Class III, consequence analyses for various failure modes shall be performed. The structures, systems, and components shall be designed to ensure that they will meet the established performance objectives of their respective classes under normal conditions and, as specified, during and after unusual events, such as accidents, equipment failures, loss of offsite power, and natural phenomena. The selection of the unusual events for the basis of design shall, as appropriate, be based on probability or recurrence intervals.

The structures, systems, and components that are identified as being important to safety as defined in 10 CFR 60.2 shall be designed in accordance with 10 CFR 60.131.b and other applicable design requirements.

SYSTEM REQUIREMENTS FOR STRUCTURES, SYSTEMS, AND COMPONENTS IMPORTANT TO SAFETY

Section Number	Section Title	Performance Criteria and Constraints
1.0	Preclosure Waste Disposal	C#Y,Z,AA,BB
1.2	Repository	PC#5; C#K,N,O,P,R
1.2.1	Mining	C#D,E,S
1.2.1.1	Access Construction	C#C,E,I,M
1.2.1.2	Drift Construction	C#C,D,I,M
1.2.1.3	Borehole Construction	C#C,L
1.2.1.4	Rock Handling	C#C,D,E

SYSTEM REQUIREMENTS FOR STRUCTURES, SYSTEMS, AND COMPONENTS IMPORTANT TO SAFETY (Continued)

Section Number	Section Title	Performance Criteria and Constraints
1.2.1.5	Water Removal	C#C,F
1.2.1.6	Mining Ventilation	C#C,D,G
1.2.2	Waste Handling	C#D,E,G
1.2.2.1	Receiving	C#D,E
1.2.2.2	Preparation	C#G,H
1.2.2.3	Storage	C#E,F
1.2.2.4	Emplacement	C#A,H,O,P
1.2.2.5	Retrieval	C#F,G,H
1.2.2.6	Shipping	C#D,E,F
1.2.2.7	Waste-Handling Ventilation	C#F,G,H
1.2.2.8	Contamination Control	C#C,D,E
1.2.3	Performance Confirmation	C#C,D,E
1.2.3.1	Waste Evaluation	C#D,E,F
1.2.3.2	Geologic Evaluation	C#D,E,F
1.2.3.3	Natural and Engineered Barriers Evaluation	C#O,P,Q
1.2.3.4	Design Modification	C#L,N,O
1.2.4.1	Underground Closure	C#B,G,H
1.2.4.2	Surface-Facility Decommissioning	C#C,D
1.2.5	Support	PC#7; C#A,D,E
1.2.5.1	Information	C#B,C,D
1.2.5.2	Administration	C#F,G
1.2.5.3	Personnel Services	C#Q,R
1.2.5.4	Security and Safeguards	C#J,K
1.2.5.5	Supplies	C#B,C,D
1.2.5.6	Maintenance	PC#2; C#D,E,F
1.2.5.7	Utilities	PC#1; C#B,K,L,M
1.2.5.8	Transportation	C#C,D,E
1.2.5.9	Monitoring	C#A,D,F,H,M

SYSTEM REQUIREMENTS FOR STRUCTURES, SYSTEMS, AND COMPONENTS IMPORTANT TO SAFETY (Concluded)

Section Number	Section Title	Performance Criteria and Constraints
1.2.5.9.1	Radiological Monitoring	C#M,O,P
1.2.5.9.2	Nonradiological Monitoring	C#A,B,C
1.2.5.9.10	Emergency Preparedness	C#C,E,G,H

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

4.1.6 Containment and Isolation (A6)*

The repository be designed with engineered barriers to enhance the radionuclide containment and isolation functions after permanent closure. These portions (engineered barrier system plus shafts, boreholes and their seals) must work together with the natural barriers provided by the geologic setting to limit releases of radionuclides to the accessible environment, as required by 10 CFR 60.112.

The requirements for the postclosure performance of the repository are found in Section 2 (and subsections) of the SR. The design of facilities intended for preclosure operations must accommodate the possibility that the preclosure system may also be required to function as a barrier after permanent closure. If preclosure facilities are not to be used as postclosure barriers, their design must not compromise the performance of postclosure natural and engineered barriers.

*Refer to Appendix C for symbol legend.

Repository design shall ensure compliance with the containment, individual protection, and groundwater protection requirements as specified in 40 CFR 191, (SR-YMMGD PC#2). The use of introduced fluids during construction and preclosure operations shall not unfavorably affect containment and isolation functions of the repository. Refer to 4.1.8, "Preferential Pathways," for further information.

SYSTEM REQUIREMENTS FOR CONTAMINATION AND ISOLATION

Section Number	Section Title	Performance Criteria and Constraints
YMMGD	Yucca Mountain Mined Geologic Disposal System	PC#2
1.0	Preclosure Waste Disposal	C#T
1.2.1	Mining	C#F
1.2.1.1	Access Construction	C#O
1.2.1.2	Drift Construction	C#N
1.2.1.3	Borehole Construction	C#D
2.0	Preclosure Waste Disposal	C#A
2.1	Natural Barriers	C#K

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

4.1.7 Mitigation of Disruptive Events (A7)*

As required by 10 CFR 60.133.a, 2, (SR-1.2.1 C#G), the subsurface shall be designed to ensure that credible disruptive events such as fires, flooding, or explosions will not spread through the facility. Surface facilities shall also be designed to this requirement.

*Refer to Appendix C for symbol legend.

Flooding refers to uncontrolled influx of water from any source which will result in standing water, the shutdown of operations, or the capability of causing equipment failure or personnel injury or death.

Fires refers to any major uncontrolled release of heat, smoke, toxic fumes, or airborne agents generated from combustibles.

Explosions refers to the controlled underground mining blasts or the uncontrolled blasts which might result from fuel stocks, powder magazines, rock dusts, or chemical stores.

SYSTEM REQUIREMENTS FOR MITIGATION OF DISRUPTIVE EVENTS

Section Number	Section Title	Performance Criteria and Constraints
1.2.1	Mining	C#G
1.2.1.1	Access Construction	C#J
1.2.1.2	Drift Construction	C#J
1.2.1.3	Borehole Construction	C#G
1.2.1.5	Water Removal	C#D
1.2.1.6	Mining Ventilation	C#E

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

4.1.8 Preferential Pathways (A8)*

The subsurface design shall ensure that the selected excavation method will limit the potential for creating a preferential pathway for groundwater or radioactive waste migration to the accessible environment as defined by 10 CFR 60.133.f, (SR-1.2 C#K).

*Refer to Appendix C for symbol legend.

The selection of excavation methods at the present time will be based on the results of studies of repository stability, economics, scheduling, and technical feasibility as specified by other sections of this document.

SYSTEM REQUIREMENTS FOR THE LIMITING OF PREFERENTIAL PATHWAYS

Section Number	Section Title	Performance Criteria and Constraints
1.2.1	Mining	C#K
1.2.1.1	Access Construction	C#K
1.2.1.2	Drift Construction	C#K
1.2.1.3	Borehole Construction	C#H
1.2.1.5	Water Removal	C#E

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

4.1.9 Quality Assurance Requirements (A9)*

The design and other activities related to the prospective geologic repository shall be performed in accordance with quality assurance plans and procedures that are in effect when the activities are performed as supplemented by the requirements of 10 CFR 60, Subpart G, (SR-YMMGD C#B).

SYSTEM REQUIREMENTS FOR QUALITY ASSURANCE

Section Number	Section Title	Performance Criteria and Constraints
YMMGD	Yucca Mountain Mined Geologic Disposal System	C#B
1.0	Preclosure Waste Disposal	C#V

SYSTEM REQUIREMENTS FOR QUALITY ASSURANCE (Continued)

Section Number	Section Title	Performance Criteria and Constraints
1.2	Repository	C#J
1.2.5.2	Administration	C#A

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

4.1.10 Nuclear Criticality (A10)*

The facility design and processes shall be designed to ensure that a nuclear criticality accident is not possible under normal or accident conditions unless two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety (10 CFR 60.131.b, 7). The design shall provide adequate separation clearances for waste containers, water, humidity, or vapor control, and or other means to reduce below unity the effective multiplication factor by a 5% margin after allowance for the bias in the method of calculation and the uncertainty in the experiments used to validate the method of calculation, (SR-1.0 C#W).

Design provisions for prevention of nuclear criticality shall comply with DOE Order 5480.1A, Chapter V (DOE, ____). A monitoring and alarm system shall be provided to detect accidental criticality conditions.

*Refer to Appendix C for symbol legend.

SYSTEM REQUIREMENTS FOR PREVENTION OF NUCLEAR CRITICALITY

Section Number	Section Title	Performance Criteria and Constraints
1.0	Preclosure Waste Disposal	C#W
1.2	Repository	C#Q
1.2.2	Waste Handling	C#F
1.2.2.1	Receiving	C#F
1.2.2.2	Preparation	C#I
1.2.2.3	Storage	C#G
1.2.2.4	Emplacement	C#Q
1.2.2.5	Retrieval	C#I
1.2.2.6	Shipping	C#G
1.2.3	Performance Confirmation	C#F
1.2.3.1	Waste Evaluation	C#G
1.2.3.3	Natural and Engineered Barriers Evaluation	C#R
1.2.4	Decommissioning	C#P
1.2.4.1	Underground Closure	C#I
1.2.4.2	Surface Facility Decommissioning	C#E
1.2.5	Support	C#F
1.2.5.9	Monitoring	C#L
1.2.5.9.1	Radiological Monitoring	C#H,S
1.2.5.9.2	Nonradiological Monitoring	C#E
2.2.1	Waste Package	C#A

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

4.1.11 Decontamination and Dismantlement Requirements (All)*

The facility design shall ensure that the components, buildings, structures, or features will be compatible with the decontamination or dismantlement requirements as specified in 10 CFR 60.132.e, (SR-1.2 C#U).

Dismantlement is defined as the tear down and/or off-site removal of the facility systems, in whole or in part, for the purpose of salvage, interim storage, mothballing, off-site reuse, or safety considerations.

See Section 13, Decommissioning, for information on closure and decommissioning. See Subsection 8.1.1.8 for considerations in the design to simplify decontamination and ultimate decommissioning of the facilities.

SYSTEM REQUIREMENTS FOR DECONTAMINATION AND DISMANTLEMENT

Section Number	Section Title	Performance Criteria and Constraints
1.2	Repository	C#U
1.2.2	Waste Handling	C#K
1.2.2.1	Receiving	C#H
1.2.2.2	Preparation	C#J
1.2.2.3	Storage	C#I
1.2.2.4	Emplacement	C#T
1.2.2.5	Retrieval	C#K
1.2.2.6	Shipping	C#H
1.2.2.7	Waste-Handling Ventilation	C#I
1.2.2.8	Contamination Control	C#F

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

*Refer to Appendix C for symbol legend.

4.1.12 Site-Generated Waste Management (A12)*

The facility design shall ensure that all radioactive waste generated from on-site processes shall be disposed in accordance with the requirements of 10 CFR 20.301 and 10 CFR 60.132.d, (SR-1.2 C#E).

SYSTEM REQUIREMENTS FOR SITE-GENERATED WASTE MANAGEMENT

Section Number	Section Title	Performance Criteria and Constraints
1.2	Repository	C#E
1.2.2	Waste Handling	PC#7; C#C
1.2.2.1	Receiving	C#I
1.2.2.2	Preparation	C#F
1.2.2.3	Storage	C#D
1.2.2.4	Emplacement	C#M
1.2.2.5	Retrieval	C#E
1.2.2.6	Shipping	C#C
1.2.2.7	Waste-Handling Ventilation	C#E
1.2.2.8	Contamination Control	PC#2
1.2.3	Performance Confirmation	C#B
1.2.3.1	Waste Evaluation	C#C
1.2.3.3	Natural and Engineered Barriers Evaluation	C#M
1.2.4	Decommissioning	C#J
1.2.4.1	Underground Closure	C#E
1.2.5	Support	C#C

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

*Refer to Appendix C for symbol legend.

Design considerations shall include collection methods, treatment methods, handling methods, packaging methods, storage, and disposal. The design considerations shall be integrated into the waste handling facility where possible. Protection from radioactive materials and contamination of equipment shall meet all requirements specified in Subsection 4.1.3.

4.1.13 Interface With External Transportation (A13)*

The facility design shall ensure that the receiving, shipping, and inspection functions of the repository interact with the external transportation systems in an efficient and cost-effective manner as defined in Appendix B.2 of the GR, (SR-1.2 C#T).

SYSTEM REQUIREMENTS FOR INTERFACE WITH EXTERNAL TRANSPORTATION

Section Number	Section Title	Performance Criteria and Constraints
1.2	Repository	C#T
1.2.2	Waste Handling	C#I
1.2.2.1	Receiving	C#G
1.2.2.3	Storage	C#H
1.2.2.6	Shipping	C#I
1.2.2.8	Contamination Control	C#G

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

*Refer to Appendix C for symbol legend.

4.1.14 Technical Feasibility and Cost Effectiveness (A14)*

The design shall be based on the use of technology that has been successfully used in operating nuclear facilities or has been demonstrated for use in a repository or comparable facility. However, in the case of equipment and systems that exceed the state of the art and whose development could result in major cost savings, such equipment and systems, shall be identified and may be used in the design, if approved, (SR-1.0 C#B). For equipment and information that require development, refer to Section 5.

Cost Effectiveness

The design shall minimize the present value of total costs, including constructing, operating, and decommissioning costs, provided all safety, health, and regulatory requirements are included in the design. Because emplacement, caretaking, and decommissioning (or retrieval) will occur over several decades, special attention shall be given to operating costs, including but not limited to, the required number of operating personnel, and energy consumption (electricity and fuel).

SYSTEM REQUIREMENTS FOR TECHNICAL FEASIBILITY AND COST EFFECTIVENESS

Section Number	Section Title	Performance Criteria and Constraints
1.0	Preclosure Waste Disposal	C#B

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

*Refer to Appendix C for symbol legend.

4.2 Other Requirements

4.2.1 Department of Energy and Other Regulatory Requirements

The design shall comply with applicable federal regulations, DOE requirements, and State of Nevada regulations discussed in Section 1 and listed in Appendix B.

The primary federal regulation developed for repository design is 10 CFR 60 (NRC, 1984). The DOE has issued a generic requirements document (DOE, 1984) that specifically defines the technical requirements for design and operation of geologic repositories. DOE Order 6430.1 (DOE, 1983) provides the basic criteria for all DOE facilities.

4.2.2 Codes and Standards

The design shall comply with applicable design codes and standards listed in Appendix B.

4.2.3 Units of Measurement

The design shall be based on English units, except where quoting published data or in circumstances in which the relevant scientific disciplines customarily use metric units.

4.2.4 Physical Protection Requirements

4.2.4.1 Safeguards

Physical security systems shall be designed to provide protection against radiological sabotage. The design shall conform to the applicable requirements of DOE Order 5632.2 (DOE, _____), SR Subsection 1.2.5.4, and other appropriate guides (such as NRC Regulatory Guide 5.7), based on the types and quantities of special nuclear material kept at the site.

4.2.4.2 Protection of Property

Physical security systems shall be designed to protect property and personnel in accordance with relevant DOE requirements. The design shall be based on estimates of potential for threat and loss.

4.2.4.3 Design of Physical Security Systems

Pursuant to the requirements for physical protection provided in Subsections 4.2.4.1 and 4.2.4.2, the design shall, as a minimum, incorporate the following physical security systems:

- barrier systems,
- access control systems,
- security communications systems,
- guard and response force systems,
- surveillance and alarm systems, and
- intrusion detection systems.

4.2.5 Emergency Preparedness

The design shall 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 (10 CFR 60.131.b, 4).

The design shall consider an emergency preparedness plan that describes the activities during both radiological and nonradiological emergencies. The design shall provide the capability of handling radiological emergencies in accordance with the applicable requirements of DOE Order 5500.3, and non-radiological emergencies in accordance with DOE Orders 5500.2 and 5480.1A and any other requirements identified in SR Subsection 1.2.5.10. The emergency preparedness plan shall be based on estimates of worst-case accident scenarios and required levels of response. The response time and capabilities of offsite facilities, such as those at the Nevada Test Site, shall be evaluated and possibly integrated with the onsite capabilities.

Additional requirements for fire, medical, and emergency facilities are covered in Subsections 8.2.1 and 8.2.2. Design requirements for monitoring systems and alarms are included in Subsection 8.2.23. Additional requirements concerning communications and fire alarms are in Subsections 4.2.7.4 and 4.2.7.5.

4.2.6 Occupational Health and Safety

The design shall meet the intent of the applicable MSHA and Office of Safety and Health Administration (OSHA) regulations listed in Appendix B. It shall also meet the intent of other applicable health and safety standards.

4.2.7 General Engineering Discipline Requirements

This section contains general requirements for the design of facilities, services, and utilities. For additional design requirements on a specific facility or system, refer to the section that covers that particular facility or system.

4.2.7.1 Architectural/Building Design

In general, the architectural design of buildings shall be simple and shall conform to standard industrial design practices taking into consideration requirements for the handicapped, fire protection, energy conservation, and other requirements as defined in DOE Order 6430.1. Individual buildings shall be architecturally compatible. The requirement for compatibility does not preclude the use of different construction materials to satisfy the functional requirements of individual buildings.

Interior spaces shall be designed to comply with operational and functional requirements. Where practical, similar operations shall be combined in a single building to permit joint usage of rest rooms, change rooms, etc. Multipurpose buildings shall be designed to provide reasonable separation of operations without disrupting efficient circulation of personnel. Modular design elements shall be used where possible.

The buildings shall be designed to conserve energy, taking into account climatic conditions, the building envelope, building orientation, thermal mass, and the design and operation of mechanical and electrical systems.

The Uniform Building Code (UBC) and applicable sections of DOE Order 6430.1 shall be used in the design of buildings and standard building interior systems.

4.2.7.2 Civil/Structural Design

Structural design shall be in accordance with the UBC and applicable sections of DOE Order 6430.1, except where more stringent requirements or site specific design parameters are applicable as described below.

The design parameters defined in Appendix A for unusual events, including earthquakes, UNEs, extreme winds, tornadoes, and storms shall be used in the design of surface and subsurface facilities if they are impacted by the effects of these events and are required to perform their necessary functions during and after such events (see Subsection 4.1.5). The probable maximum flood (PMF), resulting from the probable maximum precipitation (PMP), shall be determined in accordance with ANSI/ANS-2.8. The underground openings (shaft collars and ramp portals) shall be protected against the PMF.

The design of foundations on soil shall be based on the parameters defined in Appendix A.2.2.

4.2.7.3 Mechanical Design

The selection and design of heating, venting, and air conditioning (HVAC) systems shall be based on safety, reliability, and cost and shall be in accordance with standard environmental regulations. The HVAC systems shall provide controlled atmospheric conditions for operation to ensure the safety and comfort of personnel and to maintain the integrity and operability of equipment and components. Additional requirements for ventilation and cooling of the surface waste handling facilities and the waste emplacement areas are discussed in Subsections 8.1.5 and 8.3, respectively. The applicable

requirements contained in Subsection 8.1.5.1 (Ventilation of Uncontaminated Areas) shall be used in the HVAC design for other facilities, in addition to the waste handling facilities.

Provisions shall be included in the design for generating hot water for personnel and process use. In addition, provisions for generating steam shall be included if steam is required for heating or other purposes.

Compressed air systems shall provide dry, filtered, plant and instrument air. Air compressors shall be centrally located where feasible, and remote facilities shall be served by separate compressors. Air compressors shall be provided underground to serve demands of the underground facility. Oil-free compressed air may be required of some locations.

Storage and distribution systems shall be provided for any gases that may be needed, including but not limited to gases needed for welding and for testing of shipping casks.

Plumbing and piping systems shall be provided for all fluids necessary to support repository operations and processes.

4.2.7.4 Electrical Design

Communications

The communications network shall provide a telephone system, two-way radio communications system, public address and paging system, and an alarm system for both surface and subsurface facilities. The telephone system shall provide direct communication between the repository, the existing NTS network, and the off-site commercial system. A central communications center shall be provided with an on-site telephone system that interconnects all parts of the repository. The radio system shall provide communication between security stations and guardhouses, patrol vehicles, waste emplacement equipment, fire and medical facilities, and off-site emergency service agencies. The public address and paging system shall provide voice paging throughout the repository and an alarm system to inform personnel of abnormal situations. For design requirements concerning emergency preparedness, see Subsection 4.2.5.

Uninterruptible Power

Systems such as computers and data-handling systems, communications, security and radiation monitors, and emergency lighting, which cannot tolerate an interruption in service, shall be provided with uninterruptible power supplies (UPS) to allow continuous operation. Each UPS system shall be located as close as possible to the system it serves.

Lighting

The lighting design shall provide the foot candles of illumination necessary to ensure safe working conditions within facilities and outdoor areas of the repository and to meet security requirements. UPS systems shall be provided for designated underground lighting, security lighting, and emergency lighting.

Lightning Protection and Grounding

Lightning protection, including lightning arrestors and static wires, shall be provided at all overhead supply and distribution lines and at the yard substations. Lightning protection shall be provided for all major buildings and surface facilities. State-of-the-art lightning protection methods should not be precluded from design consideration.

The surface and underground electrical power supply and distribution system and the communications systems shall be grounded using methods that comply with applicable codes (see Appendix B).

4.2.7.5 Fire Protection Design

Facilities and equipment shall be provided to detect, suppress, and extinguish fires. In general, fire protection systems, as well as facility design features that minimize the occurrence or spread of fires, shall conform to DOE Order 6430.1, Section X and to the national fire codes published by the National Fire Protection Association (NFPA). Fire protection of the subsurface facilities shall conform to 30 CFR 57.

Loops for distribution of water shall be provided to accommodate all flow demands for sprinklers, hose streams, and outside protection. Additional requirements for storage and distribution of water for fire protection are discussed in Subsection 7.2.9.1.

A halon extinguishing system shall be considered to protect areas where the use of water could result in undesirable consequences (such as where nuclear criticality is a concern or where expensive electronic equipment is located). A fire alarm system shall be installed in each major facility, including the underground, to warn occupants of a fire, to activate the automatic fire protection systems, and to alert the fire station on the site.

Fire barriers and doors shall be installed as necessary to provide a protected means of egress and to prevent the spread of fire from one area to another. Air conditioning and exhaust systems shall be designed to limit the spread of smoke, gases, and flames. In addition, the design shall take into account potential radioactive releases during the occurrence of a fire.

4.2.8 Preclosure Radiological Monitoring Requirements

To ensure consistency with the ALARA requirements for radiation exposure, a radiological monitoring system (RMS) shall be provided to supplement the personnel and area radiation survey provisions. The radiological monitoring system shall measure radiation levels and concentrations of airborne radioactive material and shall alert workers of measurements that exceed specific limits. The design shall include portable instruments in addition to the installed components of the RMS.

An alarm system shall be provided to warn of significant increases in radiation levels, concentrations of radioactive material in the air, and increased radioactivity released in effluent. The alarm system shall be designed with provisions for calibration and for testing its operability (10 CFR 60.131.a, 6). All RMS alarms shall annunciate locally and at centralized areas in the repository facilities. All alarms shall give visual and audible signals.

The RMS shall be supplied with uninterruptible power and shall be designed with a self-diagnostic capability to detect operational anomalies. Back-up equipment shall be provided for certain RMS equipment where the lack of availability for repair or replacement would adversely affect facility operations.

Monitoring of the waste package (direct dose and surface contamination) is covered in Subsection 8.1.1, and monitoring directly related to criticality safety and prevention is described in Subsection 4.1.10.

4.2.8.1 Personnel Monitoring

Personnel shall be monitored in accordance with 10 CFR 20 and DOE Order 5480.1A. DOE Order 5480.1A (DOE, 1981) requires personnel monitoring [e.g., film badges, thermoluminescent dosimeters (TLDs), and portable monitors] where the potential exists for an individual to receive a dose in any calendar quarter in excess of 10% of the quarterly limits listed in Section XI of the Order.

4.2.8.2 Area Radiation Monitoring

Area radiation monitors shall be provided to continuously monitor radiation levels in accessible surface and underground areas where there is a possibility that personnel could receive excessive radiation doses in off-normal situations. Monitors that are equipped with interlocks shall also be provided in hot cells to prevent access to these areas when the radiation levels are too high for occupancy, such as when unshielded waste is present.

Upon detection of abnormally high radiation levels, the monitoring systems shall be capable of annunciating audible and visual alarms both locally and remotely at a centralized location. In-place calibration design and malfunction detection features shall be provided for the area radiation monitors.

TLDs shall be provided as radiation monitors at various locations within the restricted area and at the boundary of the restricted area.

The area radiation monitoring systems shall be designed in accordance with ANSI/ANS - HPSSC-6.8.1 (ANSI, 198__). The selection of monitor types for various facilities shall be based on the radiation source(s) anticipated in a given area.

4.2.8.3 Monitoring of Airborne Radioactivity

Airborne radioactivity shall be monitored by a continuous air-monitoring system (CAMS) and fixed air samplers. The air-monitoring systems shall be designed in accordance with the requirements set forth in ANSI N13.1 (ANSI, 198__). Air-sampling stations shall be installed in all potentially contaminated areas.

In areas with a high potential for contamination, air collection probes shall be located near personnel breathing zones. The probes shall continuously monitor the air for concentrations of radioactive materials. The instruments shall be capable of transmitting data to a centralized location and annunciating audible and visual alarms, both locally and remotely, once a preset value is reached.

4.2.8.4 Monitoring of Effluents

The effluent-monitoring systems shall be designed to measure the amount and concentration of radionuclides in any effluent with sufficient precision to determine whether releases conform to the design requirements for effluent control (10 CFR 60.132.c, 2). Effluents shall be monitored in accordance with DOE Order 5484.1, Chapter III, Section 5, and any other applicable federal or state standards.

Effluent-monitoring equipment shall be selected, installed, tested, and calibrated following the recommendations of ANSI Standard N42.18-1980, Reaffirmation of N13.10-1974, "Specification and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents" (ANSI ____).

Monitoring of Ventilation Exhaust

The ventilation exhaust from contaminated or potentially contaminated areas shall be continuously monitored for airborne radioactivity releases. All gaseous discharges to the atmosphere that may contain airborne radioactivity shall be continuously monitored to determine the concentration of radioactive materials in the effluent streams. Monitors shall be selected, tested, and calibrated in accordance with ANSI Standard N13.1. Exhaust stacks shall be isokinetically sampled in accordance with ANSI Standard N13.1. The exhaust-monitoring systems shall include readout and preset alarm capabilities.

All data received from the exhaust monitors shall be logged by a computer. When preset radioactivity levels are reached, alarms shall be activated locally and remotely in a centralized location.

Monitoring of Liquid Effluents

Provisions shall be included for retention and sampling of potentially radioactive liquid effluents before release so that the concentration of specific radionuclides can be determined.

This page intentionally left blank.

5.0 EQUIPMENT AND INSTRUMENTATION DEVELOPMENT

SYSTEM REQUIREMENTS FOR EQUIPMENT DEVELOPMENT

Section Number	Section Title	Performance Criteria and Constraints
1.2.2.4	Emplacement	C#F,R,U

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

5.1 Equipment Development

This section describes the requirements for excavation equipment and other equipment that will be specifically developed for repository operations. Some equipment requirements cannot be met with commercially available equipment and, therefore, will require special development to meet the requirements set forth below.

5.1.1 Subsurface Excavation Equipment

Except for the waste emplacement boreholes, which will be drilled, all drifts, entries, ramps, and other subsurface openings may be excavated by drill-and-blast methods, mechanical excavation, or a combination of these methods (see Subsection 4.1.8).

5.1.2 Waste Handling Equipment

5.1.2.1 Waste Transporters

Waste transporters shall be used to move the containers of waste from the waste-handling building to the waste emplacement boreholes. Prototype waste

transporters should be designed, fabricated, and tested before this equipment is needed at the repository.

The transporter functions shall be to (1) accept the waste containers at the surface facility, (2) transport them to an underground waste disposal drift, and (3) place them into the emplacement holes. If retrieval becomes necessary, the transporter will be used to retrieve the waste container and return it to the surface facility. General characteristics are

- adequate power to climb grades up to 10% routinely and up to 15% for distances less than 400 ft;
- diesel/electric or total electric drive;
- a fail-safe braking system;
- a minimum turning radius of 25 ft;
- forward and reverse drive capability;
- cab with controls for driving and emplacement;
- communication system;
- lights for driving and emplacement operations;
- cab shielding to 1 R/yr operator exposure;
- cask shielding to 50 Mrem/hr;
- a fire-suppression system; and
- appropriate controls, indicators, clearance lights, and other safety features.

Table 5-1 provides preliminary assumptions for the design of the waste transporter.

TABLE 5-1

CONCEPTUAL WASTE TRANSPORTER DESIGN PARAMETERS

	Horizontal Emplacement	Vertical Emplacement
Length	27 ft 6 in.	25 ft
Width	10 ft (21 ft 6 in.)*	10 ft
Height	11 ft	9 ft (21 ft)*
Weight	170,000 lb	120,000 lb
Horse Power (diesel)	300 HP	300 HP

*During emplacement operations

5.1.2.2 Spent Fuel Consolidation Equipment

The fuel consolidation equipment (if used) must accomplish the following tasks:

- Disassembly of the fuel elements.
- Configure the disassembled fuel rods into a compact geometry for efficient loading into the waste disposal containers.
- Load the fuel elements into the waste disposal container.
- Load the nonfuel components of the fuel assembly into disposal containers. If size reduction of these components is advantageous, the fuel consolidation equipment must provide this capability.

In accomplishing the above tasks, other requirements must be considered:

- Disassembly of the fuel assemblies must be done in a manner that minimizes the potential for damage to the fuel rods.
- All fuel consolidation equipment must be designed for remote maintenance.
- Provisions must be made for the control of radioactive waste resulting from the disassembly process.
- Provisions must be included to accommodate fuel rods damaged during disassembly. Provisions must include methods to collect spilled fuel pellets.
- Fuel consolidation studies are being performed by the Office of Geologic Repositories and additional information can be found on the following NNWSI Fuel Consolidation Equipment Conceptual Design (BEI-198_).

5.1.2.3 Container Welding and Inspection Equipment

The function of container welding and inspection equipment is to weld closures on disposal containers, test and inspect the closed container, and decontaminate the containers if necessary.

The equipment required will include welding machines, leak test equipment, and a decontamination station.

5.1.3 Backfill and Packing Equipment

If backfill is used, it is assumed that the backfill will consist of tuff previously excavated from the underground facility crushed to a suitable particle size distribution. Standard, commercially available equipment should meet the requirements for backfilling, which is similar to some mining industry programs to stabilize mined out areas or increase extraction percentage.

5.1.4 Emplacement Support Equipment

In addition to the transporter, other equipment needed for emplacement and retrieval will include

- temporary shielding mechanism (shielding collar or closure);
- a special forklift to transport, handle, install, and tow various items of equipment used for waste emplacement;
- a hoisting adapter to transport, install, and remove the temporary shielding device or material; and
- a hoisting adapter for shield plug handling and installation.

Basic requirements for this equipment are

- A safety factor of 4, based on failure, shall be used in the design of all waste and equipment hoisting systems.

- Interlocks shall be provided as required to prevent potential for inadvertent radiation release.

- All equipment shall be designed to facilitate decontamination.

- Alternate, backup operators shall be installed to provide a means of overcoming failures of the main drives systems on hardware items such as hoists and shielding doors.

5.1.5 Borehole Drilling Equipment

Two emplacement borehole configurations are currently being considered for the emplacement of waste: (1) vertical emplacement, and (2) horizontal emplacement. It is believed the drilling equipment for vertical emplacement will be (modified) off-the-shelf items as described below. The drilling equipment for horizontal emplacement is a new development using industry-proven components. Development of this equipment is being coordinated by SNL.

Vertical Emplacement Borehole Drill Requirements

The vertical emplacement borehole drill shall be capable of drilling a 29 in. diameter hole vertically into the floor of the emplacement drift to a depth of 25 ft.

Horizontal Emplacement Borehole Drill Requirements

The horizontal drilling system shall be capable of drilling and lining a 33 in. diameter hole, 700 ft long into the wall (rib) of the emplacement drift. The liner is to be 32 in. in outside diameter and 1/2 in. thick. The maximum deviation of the hole from straight shall not exceed 12 in.

A more detailed description of the drilling equipment and operations used in horizontal emplacement is provided by Robbins (1984), White (in preparation), and Stinebaugh (1985).

5.2 Instrumentation Development

Instrumentation and monitoring systems will be an integral part of ensuring regulatory compliance. It is anticipated that development of instrumentation will not be required for repository operations. It is likely, however, that as part of the performance confirmation program (see Subsection 14.3), instrumentation will be developed to monitor the conditions of the waste packages while in their emplaced state. Requirements for the design of this instrumentation will be developed as design concepts evolve.

6.0 SEALING

This section describes functional design requirements for the sealing of the Yucca Mountain Repository. Sealing refers to activities associated with permanent closure of the underground facility, shafts, ramps, and boreholes. Sealing includes emplacing backfill, seals, and plugs in shafts, ramps, drifts, and boreholes, isolating discrete water zones from waste packages, and emplacing a surface cover and core at the entry points of shafts and boreholes. Backfilling of the waste emplacement holes is considered part of the waste package design and therefore, is, not part of the sealing activity.

Much of this discussion of sealing requirements and concepts has been taken from "Repository Sealing Concepts for the Nevada Nuclear Waste Storage Investigations Project" by Fernandez and Freshley, 1984. The requirements presented in this section are functional in nature and will be quantified for future Advanced Conceptual Design Studies and other engineering activities.

SYSTEM REQUIREMENTS FOR SEALING

Section Number	Section Title	Performance Criteria and Constraints
1.2.1.5	Water Removal	C#J
1.2.3.3	Natural and Engineered Barriers Evaluation	C#C
2.2.3	Shaft and Borehole Seals	PC#1

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

6.1 Federal and State Regulations

Requirements for sealing underground openings have been developed to assist in the identification of an acceptable site for the geologic disposal of high-level radioactive wastes.

Draft guidelines developed by the DOE in 10 CFR 960 include consideration of repository sealing. Section 960.4-1 states that the geologic setting at the site shall allow for the physical separation of radioactive waste from the accessible environment in accordance with the requirements of 40 CFR 191, Subpart B.

The environmental standards proposed by the EPA (EPA, 1982) specify the amount of radionuclides that may enter the accessible environment for 10,000 years after closure of the repository.

The technical criteria provided by the NRC (NRC, 1983) are the most comprehensive of the federal regulations/guidelines with respect to sealing a repository, but they do not specifically address sealing in the unsaturated zone. The technical criteria in 10 CFR 60 incorporate the multibarrier philosophy. Part of this philosophy includes the engineered barriers.

The most important criterion for the design of engineered barriers is one that requires containment and isolation of radionuclides (10 CFR 60.133a and h). For the design of seals for shafts and boreholes, the most important criterion is one that prohibits their being "pathways that compromise the geologic repository's ability to meet the performance objectives for the period following permanent closure" (10 CFR 60.134.a, b). An additional design consideration is the retrievability of waste (10 CFR 60.111).

Other regulations that may apply to the sealing of boreholes or the abandonment of underground openings are

- the federal guidelines (43 CFR 3800, Subpart 3809) relating to the surface management of public lands from mining operations (US Bureau of Land Management) (BLM, 1980); and

- the state rules and regulations relating to the plugging of abandoned wells (Nevada Department of Conservation and Natural Resources, 1979 and 1981).

The primary objectives of the 43 CFR 3800, Subpart 3809, Surface Management, are to assure that unnecessary and undue degradation of federal lands is prevented, nonmineral resources are protected, and disturbed areas are reclaimed. Section 3809.3.5, which pertains to marking of hazardous surface conditions, such as those which may exist from an open shaft, may apply to repository sealing.

The Nevada Department of Conservation and Natural Resources has adopted regulations for plugging abandoned oil, gas, and water wells. These regulations will be complied with as applicable.

6.2 Functional Requirements

The following functional requirements illustrate the logic that should be considered in developing the designs for the sealing components. In developing the sealing concepts, emphasis is placed on the containment and isolation requirement. It is assumed that radionuclides are transported through the geologic system and to the accessible environment by groundwater flow. If groundwater flow can be inhibited or controlled, the potential for radionuclide transport can be reduced.

6.2.1 Containment and Isolation

As part of the requirement to reduce the potential for radionuclide release, it is the intent to preclude groundwater from reaching the waste package by (1) preventing water from entering the underground facility through vertical shafts, ramps, or other vertical or horizontal penetrations, and (2) if water does enter into the vicinity of the waste package, diverting the groundwater around the waste package. If radionuclides should reenter the drifts, it would be desirable to retain radionuclides in the geologic system by retarding flow and sorbing radionuclies downgradient from the waste package. However, because of the predominant vertical gradient in the unsaturated zone, it is not anticipated that radionuclides contained in groundwater could reenter drifts. Therefore, the requirements to absorb radionuclides and retard flow downgradient from the waste package may have limited applicability.

Fernandez and Freshley (1984) provide a table showing a correlation between federal and state regulations and the functional requirements. The criteria developed specifically for radioactive waste disposal are general and can be correlated to many of the functional requirements.

6.2.2 Human Intrusion

It is required that the potential for radionuclide release caused by human intrusion be discouraged.

This requirement addresses radionuclide release through human intrusion, either deliberate or inadvertent. This objective can be achieved by closing shafts, ramps, and boreholes in a manner that would deter reentry.

6.2.3 Longevity

Sealing components must perform acceptably and with a high degree of confidence over a long period. Their long-term performance may include a progressive but acceptable deterioration with time. An increase in confidence can be achieved by (1) properly designing sealing components to static and dynamic loadings (2) reducing the uncertainties associated with material properties and emplacement techniques, and (3) selecting different materials and designs serving the same or overlapping functions. The need for redundancy in seal functions will be determined through engineering analyses.

7.0 SITE PREPARATION

SYSTEM REQUIREMENTS FOR SITE PREPARATION

Section Number	Section Title	Performance Criteria and Constraints
1.0	Preclosure Waste Disposal	C#L
1.2.2.3	Storage	PC#2
1.2.5.4	Security and Safeguards	PC#2
1.2.5.7	Utilities	C#0
1.2.5.8	Transportation	PC#2; C#A,B,H
1.2.5.9.1	Radiological Monitoring	PC#3

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

7.1 Site Arrangement

Section 2.0 describes the location of the site and repository facilities and briefly describes site characteristics pertinent to the advanced conceptual design. Detailed information on the site characteristics and tabulations of site-specific design parameters are contained in Appendix A. The waste handling and adjacent surface facilities (hereinafter called the "central surface facilities") is currently planned to be located east of Exile Hill (Area 3 on Figure 2-3). Other surface facilities that directly support underground development and ventilation may be located at the appropriate underground access locations.

7.2 On-Site

The central surface facilities area shall be divided into three functional areas: (1) waste receiving and inspection area, (2) waste

operations area, and (3) general support facilities area. The waste receiving and inspection area shall provide the function of transferring the waste shipments from the offsite transportation system to the repository operator. The waste operations area is defined in Subsection 4.1.3.1. The general support facilities area constitutes the remainder of the central surface facilities area and is where most of the balance-of-plant facilities are to be located.

The layout and arrangement of surface facilities shall take into account the following factors:

- Buildings shall be sited in a manner that facilitates flow of personnel, waste, and materials.

- Buildings shall be sited in a manner that provides adequate space for major functions and does not prohibit reasonable future expansion.

- To the extent practicable, utility distribution systems shall be located so that access for maintenance or other purposes is not hampered by surface facilities.

- Emergency access and evacuation routes for vehicles and personnel shall be provided. Roads, gates, and fence lines should permit full access for fire-fighting and other emergency equipment and should accommodate the largest turning radii and operating space required by emergency vehicles.

- Requirements for permanent closure.

For additional requirements that govern the onsite design for the waste receiving and inspection and waste operations area, refer to Subsection 8.1.1.

7.2.1 Roads

Paved access roads shall be provided to surface facilities and underground accesses. Additionally, paved roads shall be provided within surface facility areas. Paved parking shall be provided for employees,

visitors, and service vehicles. Patrol roads and clear zones shall be provided as necessary to meet the physical security requirements set forth in Subsection 4.2.4.

7.2.2 Rail

Rail siding and switching shall, as a minimum, be provided in accordance with the functional design requirements found in Subsection 8.1.1.

7.2.3 Communications

See Subsection 4.2.7.4 for requirements applicable to the onsite communciations system.

7.2.4 Clearing

The areas where surface facilities are to be located shall be cleared of all vegetation.

7.2.5 Grading

Areas for the surface facilities and underground accesses shall be graded as necessary for accommodating the facilities and performing the required functions. Topsoil that is unsuitable for grading purposes shall be disposed of at an onsite location where the effects on local drainage patterns are minimized.

7.2.6 Landscaping

Native vegetation and materials will be used for erosion control and to maintain the natural appearance of the site and any offsite areas impacted by construction. Vegetation will be selected that requires little maintenance and little or no irrigation or fertilizers.

7.2.7 Storm Drainage Control

Surface drainage, including culverts, ditches, and swales, shall be used. Berms and ditches shall be provided around the graded areas to divert runoff. Additional design requirements for flood protection are described in Subsection 4.2.7.2.

7.2.8 Fencing

Fencing shall be provided in accordance with the physical and radiological protection requirements contained in Subsections 4.2.4 and 4.1.3.3, respectively.

7.2.9 Utilities

7.2.9.1 Water

The use of water at the repository during the construction, waste emplacement, caretaking, and closure periods falls in the following categories:

- fire protection;
- mining operations and associated dust control;
- air conditioning requirements;
- potable use (showers, etc.);
- process use (cask decontamination, health-physics, etc.); and
- miscellaneous (landscaping, etc.).

The repository peak demand is estimated to be approximately 612 gpm. The estimated average daily use is approximately 450,000 gallons.

Source

Water shall be obtained from the underground aquifer by the use of wells located on the NTS reserved for the use of the repository. Redundancy shall be provided as required to ensure a continuous supply of water. Existing wells shall be utilized for construction purposes only. The wells, and

associated pumping and piping systems, shall be capable of supplying water to the storage reservoirs at a flow rate based on the estimated peak demands of the various loads.

Storage and Distribution

Storage capacity shall be based on the estimated 24-hr demand plus the required reserve for fire protection. Two separate storage reservoirs, each with a capacity for a two-hr fire flow, shall be provided for the storage of water for fire protection. The flow rate shall be based on the maximum credible fire. Storage reservoirs may contain water for uses other than fire protection, provided the design ensures that the reserve capacity for fire protection is not affected by the other uses.

Looped distribution systems shall be provided. Distribution pumps shall be provided where adequate pressure head is unavailable from the storage reservoirs. Water distribution for fire protection shall be separate from distribution of water for other uses. Distribution pumps for fire protection, including accessories such as standby power, shall conform to NFPA 20. Outside fire protection systems shall conform to NFPA 24. Water shall be supplied to the underground facility via pipelines in the men and materials shaft and the tuff ramp.

Treatment

Water shall be treated as required to meet federal and state health standards. Based on water quality reports and standard practice at wells serving the NTS, it is expected that only chlorination will be required to meet the standards.

7.2.9.2 Sewage

Sanitary sewage from surface sources shall be delivered to a treatment facility through a sanitary sewer/collection system. Sewage from subsurface sources shall be placed in containers and brought to the surface for treatment. The design of the sewage collection and treatment systems shall

comply with DOE Order 6430.1, Section XII. The treated effluent shall be discharged to evaporation pond(s) and shall conform to the requirements of the Nevada State Board of Health. The selection of the method of treatment shall take operating costs into account. Also, provisions for the disposal of sludge shall be considered in the design. Septic tanks with leach fields may be used for remote facilities.

Any process liquid wastes except from the underground facility that conform to the requirements of 10 CFR 20.303 may be discharged to the sanitary sewage treatment system after monitoring unless the flows are such that economic or operability considerations indicate that separate collection, treatment, and disposal systems are warranted. Refer to Subsection 8.1.8 for collection, treatment, and disposal of liquid radioactive wastes.

7.2.9.3 Electrical Power

Incoming power shall terminate at a central substation, located near the center of load. Redundancy shall be incorporated in the substation to ensure reliability of power distribution. Power shall be distributed to the underground via two independent routes: one via the men and materials shaft and one via the tuff removal ramp. Local transformers shall be provided at individual facilities to transform voltages to optimum operating levels. The buildings shall be equipped with raceways that provide physical protection and fire containment. The electrical systems shall conform to the applicable codes listed in Appendix B.

For standby power provisions, see Subsection 8.2.9. For general requirements of UPS, lighting, grounding, and lightning protection, see Subsection 4.2.7.4.

7.2.9.4 Steam

The use of a central steam generating facility will be evaluated. Steam and hot water will be provided locally at the individual facilities as required (see Subsection 4.2.7.3).

7.2.9.5 Compressed Air

See Subsection 4.2.7.3 for general requirements for compressed air.

7.2.9.6 Fuel

Systems for storing and dispensing fuel shall be provided in accordance with applicable safety regulations to serve two categories:

- mobile equipment, facility vehicles, and mining equipment; and
- standby diesel generators, including diesel fire pumps.

Adequate storage capacity shall be provided to preclude delay of normal operations. For additional requirements applicable to the supply of diesel fuel for standby power generators, see Subsection 8.2.9.

Fuel storage tanks shall be designed and located in accordance with applicable regulations and shall be accessible by tank truck or tank railcar. Fuel shall be transferred to the underground facility from a storage tank located on the surface via a pipeline in the men and materials shaft. The pipeline shall be emptied when not in use.

7.2.9.7 Process Gas

See Subsection 4.2.7.3 for general requirements.

7.2.10 Explosives Distribution System

See Subsection 8.2.11 for the explosive storage facility.

7.2.11 Mined Material Handling and Storage

The location and planned configuration of the surface tuff stockpile, as well as preparation of the stockpile site, shall meet the following requirements:

- Adequate land area for the estimated volume of excavated tuff, assuming vertical waste emplacement and no backfilling of the underground facilities.

- Visibility of the stockpile from the central surface facility and any location accessible to the public shall be minimized.

- The excavated tuff shall be stockpiled in an environmentally acceptable manner.

- Pile location, width, and length shall be based on economic considerations such as conveyor length and haulage distance. Maximum pile height and side slopes shall be based on stability considerations, as well as economic considerations.

- Windborne dust shall be kept at a minimum.

- The effects on local drainage patterns and sedimentation in drainages shall be minimized.

- An evaluation shall be made as to whether or not the runoff from the pile should be contained, taking into account the characteristics of the excavated tuff.

- Access for use as backfill shall be provided.

7.2.12 Nonradioactive Solid Waste Disposal

Nonradioactive solid wastes shall be disposed at a landfill located on the site. The design and operation of the landfill shall conform to applicable State of Nevada regulations.

7.2.13 Heliport

Provisions for rapid access by helicopter for emergency first-aid and medical service shall be included in the design. A heliport shall be located

near the main entrance to the central surface facilities area and shall be designed in accordance with "Heliport Design Guide," Federal Aviation Administration (FAA).

7.3 Off-Site

Requirements identified in Subsection 7.2 shall govern the design of off-site facilities (such as clearing, grading, landscaping, etc.) as applicable.

7.3.1 Roads

Highway access shall be provided for the transport of radioactive waste, personnel, and materials from U.S. Highway 95 to the repository site. The new highway shall be designed in accordance with the applicable requirements of the American Association of State Highway and Transportation Officials (AASHTO). The route and geometric design shall be in accordance with "A Policy on Geometric Design of Highways and Streets" (AASHTO, 1984). The widths of the traffic lanes and shoulders and the design of the pavement shall be based on the estimated volume and types of traffic, particularly the trucks transporting the radioactive waste. The structural design of the highway shall be based on shipping cask truck loads of 80,000 lb gross vehicle weight (GVW) (see Subsection 3.2).

7.3.2 Rail

Rail access shall be provided for the transport of radioactive waste (in specially designed cask cars) and other materials, if necessary, from an existing mainline railroad to the repository site and includes a spur to Mercury, Nevada. The design shall conform to the applicable requirements of the Manual for Railway Engineering, American Railway Engineering Association (AREA). Trackage and track beds shall be designed for railcar loads of 263,000 lb GVW on 4 axles and loads of 349,000 lb GVW on 6 axles. The design shall include provisions for rail switching and sidings (as well as other required facilities) at the mainline railhead, locomotive turnaround at each end of the branchline, and maintenance sidings along the branchline.

7.3.3 Communications

See Subsection 4.2.7.4 for general requirements for communications systems.

7.3.4 Storm Drainage

Offsite drainage requirements shall be as described in Subsection 7.2.7.

7.3.5 Utilities

The existing 138-kV distribution loop at the NTS, which is supplied by 2 power utility companies with transmission lines coming from different directions, is a likely possibility for the main power source of the repository. The 138-kV distribution loop passes within 3 miles of the repository and could be tapped to provide a single radial feed to the repository. A dual radial feed with a tap on each side of the supply side of the loop could be the future arrangement for system reliability (for dual feed the lines would be approximately 3 and 12 miles in length). Studies have yet to be completed to determine if the NTS distribution loop and the two power company transmission lines have sufficient capacity to supply the demand of the repository, as well as the current and projected demands of the NTS and other areas serviced by the power companies.

8.0 SURFACE FACILITIES

SYSTEM REQUIREMENTS FOR SURFACE FACILITIES

Section Number	Section Title	Performance Criteria and Constraints
1.2	Repository	C#L
1.2.1	Mining	C#U,W
1.2.2	Waste Handling	PC#6; C#L
1.2.2.1	Receiving	PC#2
1.2.2.2	Preparation	PC#1b,2; C#A,B,C,K
1.2.2.3	Storage	PC#1a,1b,1c; C#A
1.2.2.6	Shipping	PC#1,2
1.2.2.7	Waste-Handling Ventilation	C#A
1.2.3.1	Waste Evaluation	PC#1,2; C#H
1.2.5	Support	PC#9
1.2.5.2	Administration	C#D
1.2.5.4	Security and Safeguards	PC#1; C#H
1.2.5.5	Supplies	PC#1; C#A
1.2.5.6	Maintenance	C#B
1.2.5.7	Utilities	PC#2; C#A,C,D,E,F,H,I
1.2.5.8	Transportation	C#B
1.2.5.9.1	Radiological Monitoring	PC#2,4; C#D,F,I,K,T,U,V
1.2.5.9.2	Nonradiological Monitoring	PC#1,2,3,4,5,6,7
1.2.5.10	Emergency Preparedness	C#B
1.3	Waste Emplacement Package	C#B,E,F

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

8.1 Waste-Handling Facilities

This section describes the functional design requirements for the systems and facilities needed for the handling of waste from its receipt from the offsite transportation system to its transfer to the waste-handling ramp (see Subsection 9.4). Requirements for waste retrieval and for handling site-generated waste are also included. Those facilities determined to be important to safety shall be designed in accordance with the requirements listed in Subsection 4.1.5.

8.1.1 Schematic Definition/Specification

This subsection contains the requirements for the principal waste-handling processes, as well as requirements generally applicable to waste-handling facilities. Figure 8-1 is a schematic diagram of the major functional areas on the surface. The diagram shows the flow of the waste from receipt at the repository to transfer to the underground facility.

8.1.1.1 Waste Description and Throughput

The waste-handling facilities shall be designed to accommodate an annual waste throughput rate of 3,000 MTU of spent fuel and 400 MTU of DHLW. During the initial years of repository operation, occasional shipments of WVHLW, totaling 650 MTU, will be received. No provisions shall be made for receiving and handling commercial HLW nor commercial transuranic waste.

The waste receiving facilities shall be designed to accept a maximum of 80% of the spent fuel in rail casks and a maximum of 70% in truck casks. The design shall not preclude future conversion to 100% of either. The facilities shall be designed to accept the DHLW and WVHLW under the assumption that all of it will arrive in truck casks. The design shall not preclude future conversion to 100% by rail.

More detailed waste characteristics and throughput requirements are discussed in Section 3 of this document and in Appendix B of the GR (DOE, 1984).

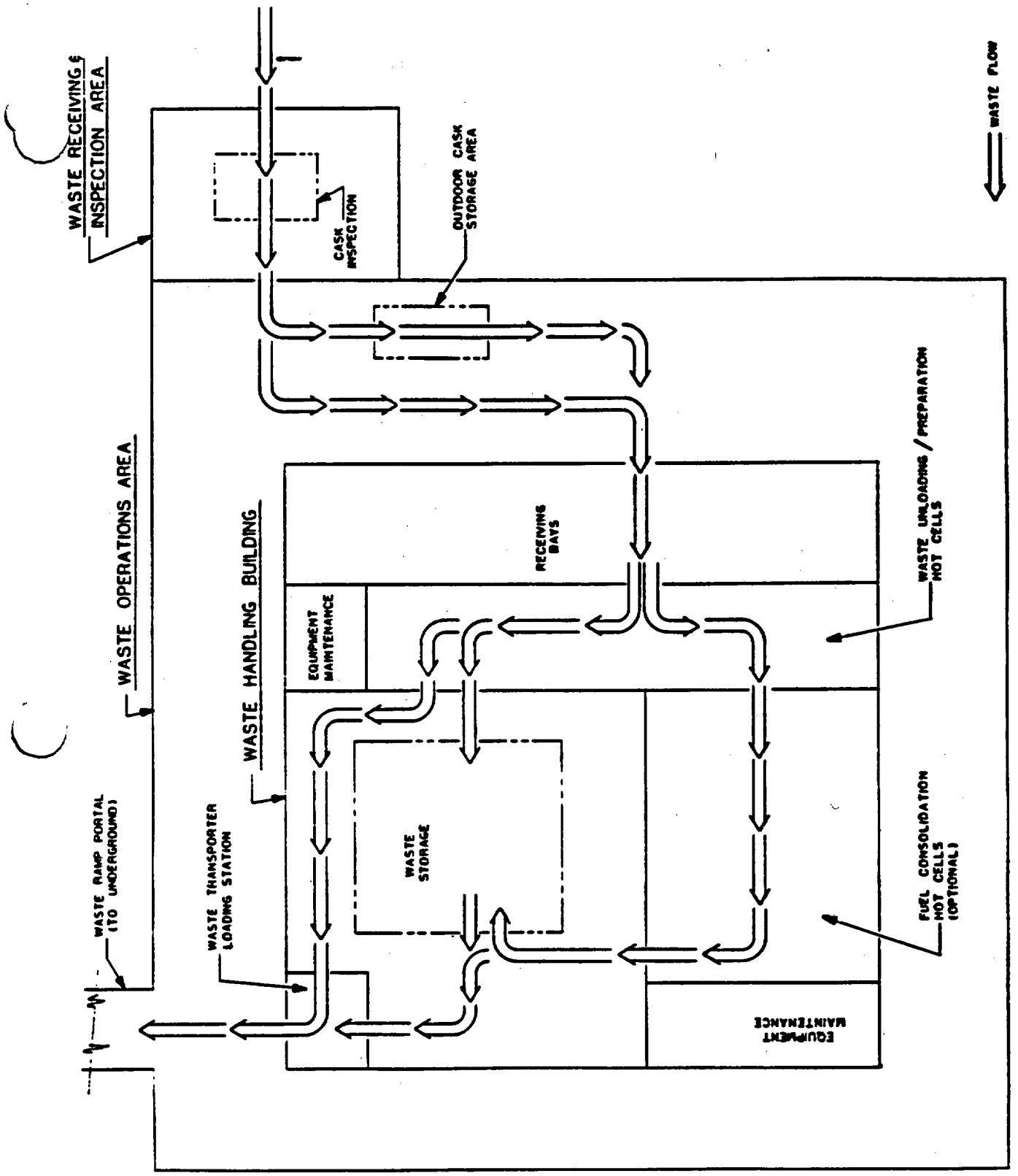


Figure 8-1. Waste Operations Area

8.1.1.2 Waste Receival

Incoming rail cars and trucks shall be received at an entrance to the waste-receiving and inspection area. A security and inspection station shall be located at the entrance to allow identification and inspection of all incoming shipments and to control access to the waste-receiving and inspection area.

Rail sidings and truck parking areas shall be provided in the waste-receiving and inspection area to provide storage for shipping casks until they can be inspected and transferred to the waste operations area. Space shall also be provided for storage of empty shipping casks before they are returned to the offsite transportation system. Capability shall be provided for temporary storage and recovery of any contaminated shipping casks received from the offsite transportation system. The waste-receiving and inspection area shall include provisions for inspecting incoming shipping casks, including provisions for radiological surveys and security or safeguards checks. There shall be sufficient distance or barriers between the inspection area and major waste-handling facilities to avoid any damage to the latter from any explosives or hazardous materials that may be on the incoming vehicles.

8.1.1.3 Cask Handling

Onsite dedicated transfer vehicles shall be used for moving shipping casks into and within the waste operations area. Rail sidings and truck trailer parking areas shall be provided in the waste operations area for interim storage of shipping casks before they are transferred to the waste handling building for unloading. To avoid affecting the transportation system during any extended interruptions at the repository, the total outside storage areas shall be designed to accommodate the equivalent of three months waste receipts, less the surface storage capacity inside the waste handling building(s). Capabilities shall be provided for decontamination of shipping truck trailers or railcars in the unlikely event that one of the vehicles arrives in a contaminated condition or becomes contaminated on the site. The

design shall provide collection systems for contaminated liquids and solids produced during the decontamination process. In addition, capabilities shall be provided for removing ice, snow, and road dirt from shipping casks.

Onsite transfer vehicles shall be used to move the shipping casks to receiving bays in the waste-handling building(s) where shipping casks are unloaded from incoming trailers and railcars and where empty casks are loaded onto outgoing trailers and railcars. The receiving bays shall accommodate both truck and rail casks and shall be sized to accommodate the largest railcar (without the transfer vehicle) as described in Section 3. Laydown space and equipment shall be provided for components that must be removed from the shipping casks. The receiving bays shall be equipped with cranes that have sufficient capacity for handling the heaviest cask described in Section 3. The cranes shall be capable of lifting and moving shipping casks between the truck trailers or railcars, decontamination station(s), and transfer devices (carts). The design of the cranes shall preclude lifting casks above the maximum drop height determined from safety assessments to be performed for the repository.

Provisions shall be included for sampling and venting the shipping cask cavity and for any other cask preparations that must be performed before the waste is unloaded.

Transfer devices shall be provided to move the casks to and from the unloading areas of the hot cells. Remotely operated handling equipment shall be provided for removing and transferring the waste from the cask to the hot cells (see Subsection 8.1.1.4) and for inspecting the casks and lids.

Decontamination station(s) shall be provided in the waste-handling building to permit removal of exterior surface contamination from the casks, if necessary, and to permit removal of contaminated material from the interior of the cask after the waste has been removed. A collection system shall be provided to collect contaminated solid wastes and liquids produced during cask decontamination. The decontamination station(s) shall include provisions for performing minor repairs (such as replacing seals) and for final inspection of the casks, before release for shipment, in accordance with the applicable requirements of 10 CFR 71 and 49 CFR 173.

8.1.1.4 Waste Packaging

Shielded hot cells shall be provided with remotely operated equipment for the functions described below. The hot cells shall include provisions for interim storage of unloaded waste before its transfer to the waste packaging and/or storage area(s).

Equipment shall be provided to remove waste from the interim storage locations and to transfer the waste to canister-overpack or inspection stations. Equipment shall be provided for loading spent fuel into waste package containers (see Subsection 3.3.2), for installing closures on the containers, and for sealing the closures. Waste received in canisters (CHLW and DHLW) shall be inspected and overpacked (see Subsection 3.3.2). Capabilities shall be included for verifying the integrity of the waste package containers, including inspection of any welds. Equipment shall be provided for checking the exterior surfaces of the container for radioactive contamination and for decontaminating the container, if necessary, before transfer to storage areas (see Subsection 8.1.9) or to the transporter loading station. The design shall include provisions for the receipt and temporary storage of empty waste disposal containers to be used as described herein.

The design shall also include provisions for the laydown or storage of any special tooling hardware, or equipment, necessary for container handling. Systems for inventory control and accountability will be provided in the design of these facilities.

If spent fuel assemblies are consolidated at the repository (see Subsection 5.1.3.2), remotely operated equipment shall be provided for moving the assemblies into the consolidation areas, removing the end fittings, and separating the fuel rods from the fuel assembly hardware. A device shall be included that arranges the fuel rods and loads them into the waste disposal containers. Provisions shall be included for collecting and reducing the volume of all remaining fuel assembly hardware and for loading this waste into containers. Capabilities shall be provided for accommodating fuel rod failures that may occur during the consolidation process, including recovery of failed fuel fragments. Provisions shall be included for the collection,

handling, and disposal of Chalk River Undefined Deposits (CRUD) and other contaminants resulting from the consolidation process. The design and layout of hot cell facilities shall be based on the forthcoming NNWSI Fuel Consolidation Equipment Design (BEI 198_).

In the event that certain waste packaging equipment fails or requires maintenance, redundancy shall be included in the design of the equipment as necessary to ensure that the required annual waste throughput rate will be maintained.

A separate control room shall be provided in the waste-handling building for remotely controlling operations in the hot cells. Galleries shall be located adjacent to the hot cells for the maintenance of hot cell equipment and for any locally controlled operations (see Subsection 8.1.1.6).

The waste packages shall be transferred to the surface storage facility (see Subsection 8.1.9) or to the waste transporter loading station (see Subsection 8.1.1.5).

8.1.1.5 Waste Transport

Waste transporters (see Subsection 5.1.2.1) shall be used to move the containers of waste from the waste-handling building to the waste emplacement boreholes. A loading station shall be provided for remotely loading containers into the cask that is mounted on the waste transporter. The loading station shall be designed to receive retrieved canisters in case retrieval becomes necessary. The design shall allow for the waste transporter to travel between the loading station and the waste-handling ramp (see Subsection 9.4) without any obstructions.

8.1.1.6 Maintenance of Remote Handling Equipment

Facilities shall be provided for decontamination and maintenance of the equipment and components located in the remotely operated areas of the waste-handling building. To facilitate removal and replacement, equipment shall be of modular design to the maximum extent possible.

Shielded areas, separate from hot cell operations, shall be provided to perform remote decontamination and to perform contact decontamination and maintenance of equipment. The capability of remotely monitoring the equipment for contamination and radiation levels shall be included. Capabilities shall be provided, where required, for complete remote maintenance and repair of items that cannot be sufficiently decontaminated to allow contact handling. Viewing stations equipped with remotely operated manipulative devices should be provided to assist with decontamination operations.

Areas shall be provided in or adjacent to the hot cells to permit isolation of overhead cranes for periodic maintenance and decontamination. Provisions for shielding doors and remote decontamination of the overhead cranes shall be designed so that it is not necessary to remove the cranes from the rails before performing maintenance operations.

Space shall be provided for an equipment repair shop for the disassembly and repair of manipulators and other remotely operated equipment. The location shall be readily accessible from the contact decontamination areas. The shop shall also have provisions for further decontamination of equipment during disassembly and repair. Remotely operated lifting and moving devices shall be provided for positioning equipment in the repair and maintenance stations.

Galleries shall be provided adjacent to all hot cells for the maintenance of hot cell equipment and for any locally controlled operations. Each hot cell shall have at least one gallery along the entire length of the longest cell wall. Provisions shall be made for remote viewing via closed-circuit television systems and periscopes and for direct viewing of hot cell operations via shielded windows. The galleries shall be provided with remotely operated manipulative devices for assisting in the required operations.

8.1.1.7 Retrievability

The facilities and equipment used for waste-handling operations shall be designed so that waste transfer and operational steps (except consolidation and certain other waste packaging activities) can be performed in reverse

order to permit retrieval of emplaced waste packages. These facilities and equipment shall allow transfer of the waste packages to the waste-handling facilities, inspection and overpack, if necessary, and loading into shipping casks for transport to an offsite location. Should retrievability be necessary, additional facilities or differing operational considerations may be used.

8.1.1.8 Decommissioning Considerations

The design of facilities in which radioactive materials will be handled shall incorporate measures to limit dispersion of radioactivity and to simplify decontamination and ultimate decommissioning of the facilities.

The following shall be considered in the design to simplify future decommissioning:

- coatings or liners in potentially contaminated areas to facilitate decontamination;
- sealing or eliminating cracks, crevices, and joints to prevent accumulation and spread of contamination;
- ventilation and contamination barriers to prevent or reduce the spread of contamination;
- use of modular equipment to facilitate removal from contaminated areas;
- location of ventilation exhaust filters at or near major sources of airborne contamination to reduce contamination of long sections of exhaust ductwork and downstream exhaust equipment;
- minimizing the length of embedded or buried piping used for contaminated liquids;

- provisions for access to areas with the potential for contamination to facilitate ultimate decontamination and, if required, dismantlement;

- placing curbs around tanks containing contaminated liquids to confine releases in the event of inadvertent overflow or leaks from the tanks.

See Section 13 for additional information concerning decommissioning.

8.1.2 Building/Structures

See Subsection 8.1.1 for functional design requirements applicable to buildings and structures. Refer to Subsection 4.2.7.2 for general structural design requirements.

8.1.3 Hot Cells

Hot cells are required at all locations where the spent fuel and high-level waste are outside shielded casks and where remote handling is required. Refer to Subsection 4.1.3.4 for shielding requirements and to Subsection 8.1.1 for additional hot cell design requirements.

8.1.4 Utilities

Requirements for utilities necessary to support the surface facilities, including the waste-handling facilities, are described in Subsections 4.2.7.3, 4.2.7.4, 4.2.7.5, and 7.2.9.

8.1.5 HVAC

This subsection describes the design requirements for ventilation of the waste-handling facilities. Two types of ventilation systems shall be provided: (1) recirculation systems for ventilation of uncontaminated areas, and (2) once-through systems for ventilation of potentially contaminated areas. For additional HVAC requirements, see Subsection 4.2.7.3.

8.1.5.1 Ventilation of Uncontaminated Areas

Uncontaminated areas shall be provided with HVAC systems that include recirculation. Air conditioning, including temperature and humidity control, shall be provided in normally occupied areas. Selected areas, such as control rooms, shall be provided with high-efficiency filtration of the supply air and precise temperature and humidity control.

Uncontaminated areas shall be maintained at pressures higher than pressures in potentially contaminated areas. Some air transfer may be permitted from uncontaminated areas into the potentially contaminated areas.

8.1.5.2 Ventilation of Contaminated Areas

Areas with higher potentials for contamination shall be kept at pressures lower than adjacent areas in which the potential for contamination is lower. Supply and exhaust pressures shall be continually monitored and controlled to ensure that air flow is in the direction of greater potential for contamination. Air locks shall be provided between areas with high pressure differentials.

The design shall include provisions that minimize the potential for spread of contamination. Close-capture exhaust systems shall be provided at locations where the potential for generating contaminants is high.

High-efficiency particulate air (HEPA) filters shall be provided in the ventilation exhaust systems that serve contaminated or potentially contaminated areas. The design of the filtration system ducting and plenums shall include provisions for testing, removing, and replacing contaminated HEPA filters. For filters that can be severely contaminated, provisions for remote testing, removal and replacement shall be incorporated into the design. Redundancy shall be provided for the filter assemblies and associated exhaust fans to allow continuous exhaust during filter replacement and in the event of component failure or maintenance.

Air shall not be recirculated in the HVAC systems that serve contaminated or potentially contaminated areas. Filters shall be provided on the inlets to contaminated areas where the frequency of replacing contaminated exhaust filters and volumes of contaminated wastes can be reduced by such prefiltering.

Requirements for monitoring airborne radioactivity and ventilation exhaust air are discussed in Subsection 4.2.8. Requirements for maximum levels of airborne radioactivity are discussed in Subsection 4.1.3.

8.1.6 Handling and Packaging Equipment

See Subsection 8.1.1 for design requirements applicable to handling and packaging equipment.

8.1.7 Support Facilities

8.1.7.1 Cask Washdown and Decontamination

See Subsection 8.1.1.3 for requirements applicable to cask washdown and decontamination.

8.1.7.2 Performance Confirmation

A central facility or location shall be provided for personnel involved in performance confirmation activities (see Section 14).

To maintain the option of retrieving waste packages for visual inspection, measurements, and testing, a performance confirmation facility shall be provided that includes at least the following capabilites:

- Remote handling of the waste package, including removal of the waste from the original container and transferring it into another container for disposal.

- Remote visual inspection of the waste package before removing the waste.

- Nondestructive, and possibly destructive, examinations of the emptied containers. (Note: Major metallographic examinations will be performed at an off-site laboratory).

8.1.8 Site-Generated Waste Treatment

Secondary solid and liquid radioactive wastes will be generated during waste-handling operations. The repository design shall include provisions for managing site-generated liquid and solid wastes, including collection, temporary storage, treatment, and recycling or disposal. If the amount of radioactive gases generated from waste-handling or waste-treatment operations could result in releases that exceed the limits discussed in Subsection 4.1.3, then provisions shall be included for the collection, treatment, and disposal of radioactive gases. Specific functional requirements for the collection, treatment, and disposal of solid and liquid radioactive wastes are discussed below.

8.1.8.1 Collection

The design shall include provisions for the collection, transfer, and temporary storage of solid wastes. Such wastes include, but are not limited to, contaminated clothing, ventilation filters, filter frames, swipes, and discarded equipment.

The design shall include provisions for drainage and collection of all potentially contaminated liquids. Areas in which contaminated liquids could accumulate shall have drainage systems separate from those for uncontaminated areas. The primary source of contaminated liquid waste is from decontamination operations associated with cleaning remotely operated equipment and shipping casks. Substances in the liquid waste include, but are not limited to, detergents, chemicals, dirt, road grime, and salt.

The design shall include provisions for monitoring and sampling the collected liquids and for transferring the liquids either to the sanitary drain system or to the waste treatment area. Effluent concentration limits

and monitoring provisions are discussed in Subsections 4.1.3.5 and 4.2.8, respectively. Provisions shall also be included for transferring liquid waste sludges to the waste treatment area.

8.1.8.2 Treatment

Contaminated solids and liquids that cannot be decontaminated and recycled feasibly or economically shall be treated for disposal. Means shall be provided for solidifying liquids unsuitable for recycling by fixing the residues in a solid matrix. The wastes shall be treated and packaged according to the criteria developed for waste of similar radionuclide content.

Shielded interim storage area(s) and associated waste-handling equipment shall be provided.

8.1.8.3 Disposal

Loading facilities shall be provided for transferring packaged waste to the final disposal locations. Shielding of transfer vehicles and casks shall be included as necessary for radiation protection. Site-generated waste shall be packaged for shipment and disposal off-site.

8.1.9 Storage Facilities

Shielded storage areas shall be provided for storage of waste packages before transport to the underground. Sufficient storage space shall be provided to accommodate three months waste receipts, less the capacity of the outdoor storage areas for loaded shipping casks (see Subsection 8.1.1.3) and the storage capacity where unloaded waste normally will be kept before packaging (see Subsection 8.1.1.4). Capability shall be provided for cooling the waste where necessary to maintain temperatures within the limits specified (current maximum cladding temperature limit is 350°C). See Subsection 8.1.5 for ventilation requirements. Passive cooling methods shall be considered.

Transfer devices shall be provided for moving the waste containers from the shielded hot cells to the storage area(s) and from the storage area(s) to the loading station(s).

Crane(s), or other remotely operated equipment, capable of moving canisters between the transfer devices and storage locations, shall be provided in the storage area(s). The equipment must be able to handle the heaviest waste packages and any shielding materials used.

Crane operations and transfer devices in the storage area shall be controlled remotely from the separate control room in the waste-handling building (see Subsection 8.1.1.4).

8.2 Balance of Plant Facilities

This section covers the functional design requirements for surface facilities provided (1) to support underground development and waste-handling operations, (2) to perform services for operating personnel and visitors, and (3) to enable compliance with requirements involving monitoring, radiological, and physical protection. The comparable underground facilities are described in Section 11; however, the designs of surface and subsurface facilities that perform the same functions shall be integrated. The support facilities on the surface may or may not be in one central location, depending upon the location of underground accesses for waste emplacement, personnel and materials, and removal of mined rock. In general, balance-of-plant facilities on the surface will be located outside the waste operations area; however, certain facilities may be located in that area to perform the functions described in this section. The requirements for surface facilities that are directly associated with underground operations (such as ventilation and hoisting) are described in Subsection 8.3 and Section 9.

8.2.1 Health/Medical Facilities

First-aid stations shall be provided in selected locations and in any location where potentially hazardous operations may be performed.

A medical center shall be provided on the surface. As a minimum, space shall be provided for examination rooms and medical supplies. In addition, office space for any full-time medical personnel, record keeping and housing for medical emergency vehicles shall be provided.

8.2.2 Fire Protection Facilities

A fire station shall be provided in the central surface facilities area. Fire station facilities shall include garage space for fire and emergency rescue vehicles and storage space for fire-fighting equipment. Living quarters shall be provided for any full-time fire fighters.

General fire protection requirements are described in Subsection 4.2.7.5.

8.2.3 Security Facilities

Security stations shall be located throughout the repository to control access and egress, to protect against sabotage, and to protect property in accordance with the requirements in Subsection 4.2.4. Where health-physics (HP) functions are required at access control points (see Subsection 8.2.22), the security functions shall be integrated with the HP functions. A security station shall be located at the main personnel entrance to the waste operations area to provide access control for personnel and vehicular traffic. A security station shall also be located at the entrance to the waste-receiving and inspection area to control access of truck and rail shipments of radioactive waste.

The security stations shall provide space for security personnel, monitoring and communications systems, records storage, and administrative offices.

8.2.4 Maintenance Facilities

8.2.4.1 General

Facilities for the maintenance and repair of vehicles and equipment shall be provided to ensure the continued safe and effective operation of the repository according to the established waste emplacement schedule and underground development rate. Cranes or hydraulic lifts of appropriate capacity shall be provided in maintenance areas to handle equipment that requires periodic repair. Garage space shall be provided for vehicles that require indoor storage. Space shall also be provided for facility maintenance (carpentry, electrical, painting, welding, plumbing, etc.). Maintenance requirements for hot cell equipment are discussed in Subsection 8.1.1.6.

8.2.4.2 Maintenance and Storage of Mobile Equipment for Waste Transport and Cask Handling

This subsection describes the design requirements for the facilities in which mobile equipment generally used in the waste operations area are stored and maintained. Capabilities for decontamination of this equipment shall be provided in separate facilities.

Maintenance and storage facilities shall be provided for

- equipment used to move truck and rail shipping casks;
- waste transporters, including spares;
- vehicles that collect and transport site-generated waste; and
- miscellaneous support vehicles used for conducting health physics activities, security inspections, inspection of the waste-handling ramp, and other functions.

These facilities shall include space and provisions for routine maintenance and minor repairs of this equipment. No provisions for major

overhauls are needed because the equipment or associated components will be disassembled and sent to commercial facilities for repair or exchange. Facilities to refuel transporters shall be provided on the surface (see Subsection 7.2.9.6).

8.2.5 Administration/Personnel Facilities

8.2.5.1 Administration

Facilities shall be provided for the offices of personnel, maintenance of records, and for the control of repository operations, services, and support functions. Space that is adequate for the staffing requirements defined in Subsection 12.1 shall be provided for the following support activities:

- operations management,
- secretarial services,
- record keeping,
- safety and emergency planning,
- quality assurance,
- engineering,
- administrative services,
- finance and accounting,
- contracts administration,
- legal and insurance services,
- purchasing and inventory control,
- information services,
- public relations,
- training,
- transportation, and
- maintenance.

Space shall be provided for supervisors' offices, staff offices, file rooms, data-processing equipment, and conference and training rooms.

The administrative facilities shall be adequate to provide for the support and effective management of the safe, economical, and timely performance of all facets of repository operation.

8.2.5.2 Personnel Training/Mock-up

A mock-up facility shall be provided for use in training personnel in equipment use and for simulating waste-handling operations. A crane, remotely operated manipulators, and mock-ups of hot cells shall be provided to simulate normal operating and off-normal operating conditions. In addition, areas for personnel training shall be provided where appropriate, such as in the administration or change room facilities.

8.2.5.3 Food Service

A main food service facility shall be located in the central surface facilities area, providing a kitchen, serving area, and dining room. In addition, vending machines and lunchroom areas shall also be provided in the major buildings and work areas of the repository.

8.2.6 Laboratory and Testing Facilities

See Subsection 8.1.7.2 for performance confirmation facilities and 8.2.22 for health-physics facilities.

8.2.7 Warehousing and Receiving Facilities

Buildings, equipment, and yard areas shall be provided for the purchasing, receiving, storing, and dispensing of materials, parts, and equipment. The warehouse facilities shall have storage capacity for consumables and spare parts adequate to ensure that the scheduled waste throughput and underground development rate will be maintained. Space and facilities shall be provided for inspection and other quality control functions of equipment and components (such as empty containers to be used for waste packages) requiring such verification before their use. Space shall be provided adjacent to the warehouse buildings to allow for future expansion.

Additional provisions shall be made for the supply of materials not normally stored in a central warehousing facility. Reinforcing steel, rock bolts, etc., used for development of the underground facility, shall be stored

near the men and materials shaft. Open laydown areas shall be used whenever possible; however, covered storage shall be provided as required to protect materials from the elements. A sufficient supply of materials shall be coordinated with scheduled work progress to prevent delays resulting from material shortages. For requirements concerning storage of explosives and bulk materials for concrete, refer to Subsections 8.2.11 and 8.2.24, respectively.

8.2.8 Visitors' Center Facility

A visitors' center shall be provided to serve as an information center for visitors to the repository, with space for displays and presentations. An overlook area shall be provided at the visitors' center or elsewhere.

8.2.9 Backup Power Generation Facilities

The design shall include diesel generator systems to provide standby power for all systems and components critical to safety and operations. Redundancy shall be included in the design of the standby power systems. The standby systems shall be designed to activate automatically after power interruptions. The transfer from standby power back to normal power shall be performed manually except in the case of loads equipped with automatic control circuits designed to execute the necessary switching.

The storage capacity of diesel fuel for standby power generators shall comply with the applicable regulations or requirements governing the design of the generators. For additional requirements on diesel fuel storage, see Subsection 7.2.9.6.

8.2.10 Change Room Facilities

Facilities shall be provided so that both men and women may change into protective clothing. The function of the change facilities, in addition to allowing for a change of clothing, is to provide waste handling and underground personnel with areas in which to prepare for their work shift and to provide staging areas for arriving and departing workers. Change rooms

shall provide locker space, showers, and toilet facilities. In addition to the change rooms, first aid, training rooms, and office space for superintendents shall be provided.

The change house for underground personnel shall include standard facilities required for underground mining operations, including a mine rescue station. At change facilities for waste-handling personnel, space shall also be provided for necessary health physics functions (see Subsection 8.2.22).

8.2.11 Explosive Storage Facility

Magazines designed and located in accordance with 30 CFR 57 requirements shall be provided for the storage of explosives. The requirements for security and safeguards (see Subsection 4.2.4) shall also govern the location of the magazines.

8.2.12 Compressed Air and Steam Facilities

The use of centralized compressed air or steam facilities will be evaluated. See Subsection 4.2.7.3 for general requirements.

8.2.13 Cooling Tower and Chilled Water Facilities

Provisions for storage, distribution, and recirculation of cooling water shall be included in the design as needed for cooling purposes. Chillers shall be included in the design to provide chilled water for air conditioning of the surface and subsurface facilities.

8.2.14 Excavated Material/Storage/Backfill Facility

See Subsection 7.2.11.

8.2.15 Fuel Storage Facility

For equipment fuel supply see Subsection 7.2.9.6.

8.2.16 Chemical Storage Facility

Storage facilities for chemicals shall be provided.

8.2.17 Control Facility

For control of remote waste-handling operations, see Subsection 8.1.1. For any other control facilities, refer to applicable sections.

8.2.18 Potable Water Facility

For potable water supply see Subsection 7.2.9.1.

8.2.19 Sewage Facility

For sanitary sewage treatment requirements, see Subsection 7.2.9.2.

8.2.20 Backfill Facility

For any requirements pertaining to backfilling, see Subsections 7.2.11 and 10.3.

8.2.21 Packing Facility

Not Applicable

8.2.22 Health-Physics Facilities

Health-physics facilities shall be provided as required to ensure compliance with the requirements for radiological protection described in Subsection 4.1.3 and the requirements for radiological monitoring described in Subsection 4.2.8. The HP facilities shall support or provide access control, radiological monitoring, effluent monitoring, personnel dosimetry management, and HP record keeping.

An HP station shall be provided at the main personnel access to the waste operations area. This station shall be integrated with the security station (see Subsection 8.2.3) for access control and shall provide surveys of egressing personnel for radioactive contamination. Another, similar HP station shall be located at the controlled entrance between the underground development area and the waste emplacement area.

The main HP facilities shall be located at or near the waste-handling building. These facilities shall provide office space and rooms for HP personnel who perform radiological surveys, administer the dosimetry and exposure tracking systems, perform radiological analyses of samples, and perform other HP functions. A console for radiological monitoring in the waste-handling building shall be included in this station. The following provisions shall be included:

- a laboratory (equipped with hoods and sinks that drain to the liquid radioactive waste collection system) for sample preparation and analyses;
- a counting room in an area where background radiation is low and in which instrumentation is provided for counting swipes and other samples;
- space for instrument calibration and repair;
- space for dosimetry equipment; and
- an area for fitting, testing, and cleaning respiratory protection equipment.

Other local HP stations shall be provided at locations in the waste operations area where frequent HP activities are necessary.

Change rooms shall be provided at locations where personnel enter contaminated areas, or areas with a high potential for contamination, for the purpose of changing into or out of protective clothing. These change rooms

shall be equipped with decontamination showers that drain to the liquid radioactive waste collection system.

8.2.23 Monitoring Facilities

This subsection contains functional design requirements for major monitoring systems located on the surface. For design requirements of preclosure radiological monitoring systems, refer to Subsection 4.2.8.

8.2.23.1 Central Monitoring

A separate facility, or a space within a facility that performs other functions (such as administration), shall be provided for a central monitoring system. The central monitoring system shall be used to acquire data and to monitor major parameters associated with repository facility operations, mechanical and electrical equipment, and major information from other monitoring systems such as radiological protection, fire detection, and seismic ground motion. The central monitoring system shall also include an Energy Management System (EMS) for the purpose of monitoring energy consumption and controlling certain usages, such as air conditioning for balance-of-plant facilities.

The central monitoring system shall provide displays, alarms, and permanent logs and shall indicate the operational status of systems and equipment. Audible and visual alarms shall be generated when an off-normal condition or major change in operational status occurs. Logs and historical records shall be maintained for major operating parameters, alarms, status changes, and operator actions.

8.2.23.2 Meteorological Monitoring

A meteorological tower shall be provided to establish site-specific meteorological data for use in repository design, as well as in radiological assessments during operations. The tower will support a program to develop local data to be used in estimating offsite concentrations of airborne radioactivity released during normal operations and under accident

conditions. Applicable requirements developed for licensed nuclear facilities, such as Regulatory Guide 1.23, shall be used in designing the system for collecting meteorological data. (This system is currently designed and operating at Yucca Mountain.)

8.2.23.3 Environmental Monitoring

Environmental monitoring shall adhere to the requirements of DOE Order 5480.4, "Environmental Protection, Safety and Health Protection Standards." Environmental monitoring equipment shall be provided to acquire baseline data for site characterization and performance confirmation. TLDs shall be provided as radiation monitors for monitoring radiation levels at various locations surrounding the site.

Wells provided for monitoring underground water quality for radioactive contamination shall be provided as required.

8.2.23.4 Seismic Monitoring

A seismic monitoring system shall be provided to detect seismic events and record associated ground motions. The regional and local detection provisions will be satisfied by an array of continuously recording, high-gain instruments distributed regionally at the ground surface and locally at both the ground surface and depths below the anticipated repository levels. These instruments will provide microseismic coverage, both regionally and locally. Seismic monitoring shall also be provided for structures, systems, and components important to safety to determine structural response of these facilities to ground motion.

Adequate instrumentation shall be provided to monitor ground motions due to earthquakes and UNEs at surface and at depth.

8.2.24 Concrete Batch Plant

A concrete batch plant shall be provided near the men and materials shaft to supply concrete for underground development. Adequate space shall be provided for the storage of cement and aggregates.

8.2.25 Other Facilities

Other facilities such as landfills, process evaporation ponds, etc., shall be provided as required.

8.3 Exhaust Shaft Filtration Facility

8.3.1 Building and Structures

The functions of the waste emplacement exhaust building are

- house the axial fans which draw fresh air through the waste emplacement area,
- house the filter bank, and
- provide the stack to disperse the air to the environment.

Fan Area: The fan area shall contain the exhaust fans, non-reversible with sufficient capacity to ventilate the underground facility continuously during normal operations.

Filter Area: The filter area shall provide space for the filter banks which would remove potential radioactive particles during off-normal conditions. During this condition the airflow is at a reduced capacity. A primary objective in the design of this area will be (1) appropriate provisions for changing of potentially contaminated and radioactive filters, (2) sealing of the plenums for contamination control, and (3) provisions for monitoring and testing the filter banks for leakage, pressure drops, etc.

The exhaust airflow shall be forced by the fans through a noise attenuator, a tornado damper and finally the stack which shall be designed to effectively disperse the air into the environment. The stack shall be designed such that the radioactive effluent concentration levels shall not exceed the regulatory limits under normal operating conditions.

8.3.2 Utilities/Support

Refer to Subsections 4.2.7 and 7.2.9.

8.3.3 Equipment

Refer to Subsection 8.3.1. For additional ventilation system design requirements, see Subsection 11.1.5.

This page intentionally left blank.

9.0 SHAFTS/RAMPS

SYSTEMS REQUIREMENTS FOR SHAFTS/RAMPS

Section Number	Section Title	Performance Criteria and Constraints
1.2.1	Mining	C#H,X,Y
1.2.1.1	Access Construction	C#F,L

NOTE: The above requirements form a subset of the applicable requirements derived from the SR document which are to be addressed during the ACD. The complete set of system requirements is listed in Appendix C with background information and explanation of the abbreviations.

9.1 General Design Parameters

Following are the principal engineering design parameters for shafts and ramps that must be determined or confirmed in the advanced conceptual design studies:

- number of accesses,
- type of access (shaft or ramp) best suited to each function,
- surface location of access entry points and site topography,
- interface required with surface facility,
- detailed functions of each access,
- outfitting required for each access, and
- method of construction.

The selection of the principal engineering design parameters for accesses shall be based on trade-off studies in which the advantages and disadvantages of several feasible options are weighed. As a minimum, the following factors shall be considered:

- personnel and operations safety;
- environmental impact;

- water inflow potential and control measures;
- efficiency and effectiveness of operations, including transport and ventilation functions;
- capital and operational cost impact;
- schedule impact; and
- security.

Access designs shall not preclude future sealing and backfilling that may be required for repository decommissioning.

The sizes of the ramps and shafts shall be determined by an analysis of the functional requirements of each access. The Exploratory Shaft (ES), the small diameter emergency shaft and associated facilities shall be utilized in the repository.

The design shall incorporate sufficient flexibility to allow changes in the waste operations area and in procedure in accordance with 10 CFR 60.44, a.1. Such changes may be based on the results of tests, monitoring, or observations. The design shall also allow for the acquisition and use of construction data, including at least the items listed in 10 CFR 60.72, b. In accordance with 10 CFR 60.73, the design shall, to the extent possible, define abnormal geological characteristics or behaviors that could credibly be expected to occur at the site and that could be substantial safety hazards or that could represent potentially unacceptable deviations from the design basis or the conditions stated in the construction authorization or the license. Potential design alterations and mitigation measures shall be developed for these credible out-of-design-range conditions.

9.1.1 Performance Requirements

The design and construction of the shafts/ramps shall employ analyses and incorporate features and components that will provide reasonable assurance of satisfactory performance and safety. Demonstration of compliance with objectives and criteria will involve the use of data from accelerated tests and predictive models that are supported by field and laboratory tests and monitoring data (10 CFR 60.101.a, 2).

In order to assure a high level of operating efficiently and satisfaction of the performance requirements of the access facilities, the construction of the accesses and equipment installed in the shafts and ramps should utilize tested or proven methods or technology. As stated in Subsection 4.14, prototype equipment may be used if justified by major cost savings or the equipment is not otherwise available.

9.1.2 Access Functions

A combination of ramps and shafts shall provide the access routes and ventilation paths between the surface and underground operations. These facilities must meet the following functional requirements:

- Nuclear waste access:
  - transport of waste from the surface facilities to the underground disposal areas; and
  - transport of retrieved waste from the underground to the surface, if required.

- Personnel and materials access:
  - transport of personnel;
  - transport of equipment, supplies, and fuel to support all underground operations;
  - transport of excavated tuff to the surface;
  - transport of bulk construction materials to the underground facilities; and
  - transport of explosives.

- Emergency provisions:
  - alternative personnel egress from the subsurface; and
  - life support services.

- Utilities, services, and support systems:
  - provisions for utility, power, and communication lines; and
  - ventilation air supply and exhaust for development and emplacement areas.

In the conceptual design, these functions are allocated to two ramps and four shafts, as shown in Figure 9-1 and described in the following paragraphs.

9.1.2.1 Men and Materials Shaft

Except for the operators of the waste transporter, all personnel will enter and leave the underground facilities through this shaft during normal operations. It will also serve as an access for supplies and explosives and as an air intake for the development area.

9.1.2.2 Waste Ramp

This ramp will provide access and egress for the waste transporters. It will also be the route for waste retrieval, should retrieval become necessary.

9.1.2.3 Tuff Ramp

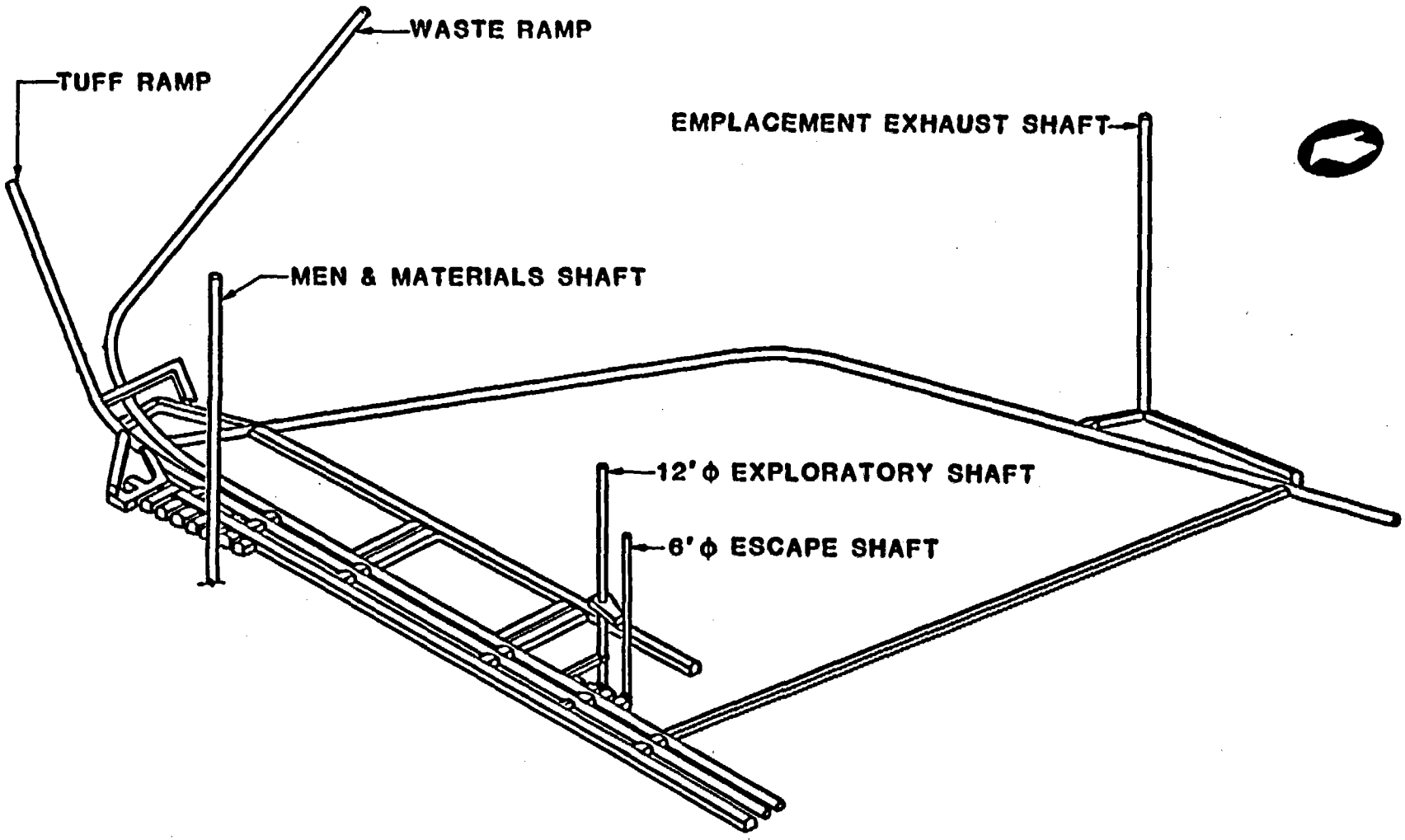
This ramp will provide for the removal of excavated tuff and also will serve as the ventilation exhaust system for the development area. Material for repository backfill may also be transported down the ramp. Consideration should also be given to use for movement of hole liner sections in the advent of horizontal emplacement.

9.1.2.4 Ventilation Intake (Exploratory) Shafts

The main 12-ft-diameter exploratory shaft and the secondary 6-ft-diameter escape shaft will serve as primary air intakes for the waste emplacement area. One or both also will serve as emergency escape routes.

9.1.2.5 Emplacement Exhaust Shaft

The only function of this shaft will be exhausting air from the waste emplacement area.



GENERAL LAYOUT UNDERGROUND FACILITY ACCESS

9.1.3 Access Restrictions

Access of personnel into the subsurface facility shall be restricted by 30 CFR 48 and 30 CFR 57, which requires training for personnel working in the underground facilities. Visitors shall also complete a minimum training session before entering the subsurface facilities and be under the supervision and control of a qualified individual at all times.

Access for the transport of nuclear waste shall be separate from all other accesses. This access shall not be used for functions other than waste transport during the operating (emplacement or retrieval) periods. Limited exceptions may be made for transport of oversized equipment or materials into the subsurface or as an escapeway during an emergency.

Except for inspection or repair and emergency conditions, no access shall be made through the emplacement exhaust shaft, perimeter drifts, or emplacement drifts after waste emplacement operations have begun.

Access control provisions shall comply with the security requirements described in Subsections 4.1.3.3 and 4.2.8.

9.2 Generic Design Requirements

Design, construction, and outfitting shall meet the intent of the applicable state, federal and local regulations and shall be compatible with the required functions of the shafts and ramps.

9.2.1 Excavation

The shafts and ramps may be excavated by drill and blast or mechanical excavation methods. For the shafts, the mechanical methods may include blind boring or raise boring techniques or a combination of these methods with drill and blast. For the ramps, the mechanical methods include tunnel boring machines (TBMs) or other mechanical mining machines.

Excavation methods shall be employed that limit the potential for creating a preferential pathway for groundwater or radioactive waste migration to the accessible environment (10 CFR 60.133.f). The choices of excavation method shall be based on layout, costs, and consideration of the following additional factors:

- compatibility with ground support installation;
- effect of excavation on the surrounding rock mass and impact on sealing design;
- wall smoothness accomplished by mechanical excavation and the resulting effects on air friction and fan pressures;
- quantities of excavated rock to be handled and stored;
- distribution of rock fragment sizes;
- relative safety of construction;
- relative reliability of operation;
- labor requirements;
- dust control and the amount of water used for suppression;
- schedule considerations (mobilization, restriction of access during blasting, and venting of fumes); and
- requirements for inspection of the rock strata before installation of permanent ground support and lining.

9.2.2 Ground Support/Lining

Support of openings in the subsurface facility shall be designed so that operations can be carried out safely and to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock (10 CFR 60.133.e, 2). These openings must remain stable to permit retrieval of waste on a reasonable schedule starting at any time up to 50 years after waste emplacement operations are initiated (10 CFR 60.111.b). The total design life of the openings shall be 100 yr.

The ground support design shall take into account the predicted behavior of the rock, personnel safety, and long-term stability. Adequate temporary support will be provided. The advanced conceptual design of the ground support system shall consider

- the type, size, and shape of the opening;
- rock mass characteristics;
- the spatial distribution of joints and the orientation of openings relative to joint pattern directions; and
- rock stresses induced by excavation and by the thermal load.

Provisions shall be made, as required, for special ground support in fault zones.

Ground support shall be installed, as necessary, to maintain the safety of operations during all phases. The ground support installed shall be

- compatible with the excavation method and the operating requirements,
- safe and adequate for the ground conditions, and
- maintenance free or easily maintained.

The ground support shall be readily accessible for inspection, and testing shall be scheduled as necessary to ensure continued performance. Deteriorating components shall be replaced or repaired as necessary.

Lining will be provided in the shafts and ramps as part of the permanent ground support system. The linings will also provide the following functions:

- reduce air friction and power requirements;
- control water inflow, if present;
- restrain loose material;
- provide a regular surface for attachment of equipment and utilities; and
- provide transitional support at cutouts and intersections.

The shaft liner may be constructed of unreinforced concrete, however, a suitable steel reinforcement shall be considered to limit the tendency of the shaft lining to fail due to dynamic structural response during a seismic event. The lining will be of sufficient thickness to contain stresses and nonuniform loading that may result from excavation. Additional reinforcement shall be applied, as necessary at the collar, at breakouts, and at locations where ground conditions dictate. The guidelines for structural design

discussed in Subsection 4.2.7.2 shall apply. Shotcrete or other support methods should be considered instead of concrete in lining the ramps.

9.2.3 Clearances, Dimensions, and Grades

9.2.3.1 Shafts

All shaft fixtures are permanently installed. Clearances shall comply with 30 CFR 57 and industry practices. Dimensions shall reflect the functional requirements, including hoisting and ventilation.

9.2.3.2 Ramps

The ramps will be used for several functions, so consideration must be given to the multiple fixtures that may be installed and to the travelway for equipment. The clearances discussed in Subsection 10.1.4 have been set to ensure the safety of the operation by separating the travelway from the installed equipment. Overall dimensional analysis will consider the travelway space, clearance area, installed equipment or fixtures, and the requirements for ventilation flows through the ramp.

9.2.4 Underground Safety

Safety provisions for design, construction, and operation of the shafts and ramps are defined in the regulations listed in Subsection 10.1.2. The federal MSHA standards (30 CFR), the State of California Mine Safety Order, and the State of Nevada Health and Safety Standards for Open Pit and Underground Metal and Non-Metal Mines shall be applied. Additional discussion of the safety requirements for the subsurface operation is contained in Subsection 10.1.2.

9.3 Men and Materials Shaft

Except for the operators of the waste transporter, all underground workers will enter and leave the underground facilities through this shaft during normal operations. It will also serve as an access for supplies and explosives and as an air intake for the development area.

9.3.1 Design Definition/Specification

The men and materials shaft will be located at the north central part of the repository.

Except as noted in Subsection 9.1.3, no access restrictions apply to the men and materials shaft.

The shaft diameter shall be determined by the quantity of intake air required in the mine development operation.

9.3.2 Excavation

The shaft may be excavated by drill and blast or mechanical excavation methods, as discussed in Subsection 9.2.1.

9.3.3 Lining

A temporary ground support system may be installed, if necessary, to stabilize the shaft walls until the permanent lining can be installed.

The shaft lining will be constructed as discussed in Subsection 9.2.2. If significant water inflow is encountered at any depth, provisions shall be made to reduce the inflow to a minimum.

9.3.4 Fixtures

The men and materials shaft will be equipped with a single personnel and materials cage operated with a counterweight from a ground mounted hoist. The cage will be sufficiently large to accept most of the equipment, materials, and supplies used in the underground operation. Oversized machinery can enter the underground repository through either the tuff or waste ramps.

In addition, a small passenger-operated service elevator should be considered for personnel access to the underground facilities. The service elevator will be operated by passenger-activated push buttons independent of the hoist operator.

9.3.5 Utilities

The shaft configuration will accommodate the utility lines which are required to support the underground operation. These lines include fresh water, chilled water, fuel, high-voltage electrical power, signaling, light, and communication.

9.3.6 Hoists and Headframes

A construction headframe and hoists may be employed during the sinking of shafts. This headframe may be removed after the shaft has been completed and shall be replaced by the permanent headframe. Consideration shall be given to designing the construction headframe to serve also as the permanent headframe. The permanent headframe will be designed for a safe and efficient operation.

9.3.7 Other

The shaft collar will include provisions for loading of men and materials onto the main cage and access to the service elevator. Also, the subcollar structure will be designed to provide intake development air under positive pressure. Included in the collar will be a buried ventilation duct that will extend to the ventilation fan facility on the surface.

A personnel access tunnel with appropriate air locks will connect the shaft to the change house on the surface.

9.4 Waste Ramp

The principal purpose of the waste ramp is to provide access and egress for the waste transporters during the emplacement or retrieval processes. Major underground equipment or large materials for the subsurface operations that are too large to be transported in the men and materials shaft may enter the repository through this ramp. Ventilation requirements are based on the amount of air needed for safe operation of the diesel-electric powered waste transporter.

9.4.1 Design Definition/Specification

The waste ramp will descend from a portal located just west of the central surface facility site to the north central part of the repository. The ramp slope shall not exceed 10%, which is considered the safe operating limit for the waste transporter.

The dimensions of the ramp are determined by the dimensions of the waste transporter. Additionally, the equipment which excavates the waste main will probably be used to excavate the waste ramp.

9.4.2 Excavation

The ramp may be excavated by drill and blast or mechanical excavation methods, as discussed in Subsection 9.2.1.

9.4.3 Lining

The ramp may be lined with reinforced shotcrete, as discussed in Subsection 9.2.2.

9.4.4 Fixtures

The ramp must have a relatively flat travelway surface (across the section). If a TBM is used to excavate the ramp, compacted fill will be placed and the surface paved. Other excavation methods may also require some surface preparation, including paving.

9.4.5 Communication

A system that allows continuous communications between the operators of the waste transporters and the surface control room shall be provided in the ramp.

A traffic control system will be installed to satisfy the requirement that only one waste transporter be on the ramp at a time. This system may

include signals at the top and bottom, a sensing system to tell where the transporter is in the ramp at any time, and traffic status display boards which may be located at surface and underground control points.

9.4.6 Utilities

Lighting will be provided along the length of the ramp.

9.4.7 Other

A portal structure will be provided that will prevent unauthorized personnel from entering the ramp. Provisions for controlled check-in/ check-out of waste transporters will be provided.

The portal structure will be designed to prevent surface water flows and wind-blown debris from entering the ramp, as discussed in Subsection 4.2.7.2.

9.5 Tuff Ramp

The tuff ramp shall serve as the primary path for removal of all excavated tuff produced during the repository excavation. The ramp may also be used for any combination of

- emergency escape for personnel;
- ventilation return from the development area;
- electrical, communication, water and dewatering lines;
- secondary access and egress for mining equipment; and
- access for the transport of bulk materials.

9.5.1 Design Definition/Specification

The tuff ramp will descend to the north central part of the repository from a portal located adjacent to the tuff storage facility. This portal is located to the west of the central surface facility site.

The dimensions of the ramp are defined by the cross sectional area required for the flow of exhaust air from the underground development area.

The ramp slope shall not exceed the lower of 20% or the maximum allowable grade which the excavation equipment used during construction can safely climb or descend.

9.5.2 Excavation

The ramp may be excavated by drill and blast or mechanical excavation methods, as discussed in Subsection 9.2.1.

9.5.3 Lining

The ramp may be lined with reinforced shotcrete or any other suitable lining, as discussed in Subsection 9.2.2.

9.5.4 Fixtures

The tuff ramp will contain the main conveyor belt for transporting the excavated tuff to the surface tuff storage facility. An adequate roadway will be provided for equipment access and the conveyor maintenance and inspection vehicles. The conveyor belt and support frame shall be sufficiently suspended above the roadbed to permit ease of cleanup.

9.5.5 Communication

Communication lines will be installed in the tuff ramp to connect the surface and underground facilities. Continuous communication with the service and maintenance crews working on the conveyor shall be provided.

9.5.6 Utilities

Water, electrical lines, and a redundant high-voltage feeder will be installed in the tuff ramp to supply the underground facilities. Water and electrical lines shall also be provided to service the conveyor.

9.5.7 Other

A portal structure that will prevent unauthorized access will be provided, as discussed in Subsection 9.4.7.

9.6 Ventilation Intake (Exploratory) Shafts

The main 12-ft-diameter exploratory shaft and the secondary 6-ft-diameter escape shaft will serve as air intakes for the waste emplacement area. They may also serve as emergency escape routes.

9.6.1 Design Definition/Specification

In this facility, two shafts shall be constructed for the Exploratory Shaft Facility (ESF). The main shaft will provide access for men and materials and hoisting for removal of excavated tuff during development and operations, and the second shaft will provide ventilation exhaust and emergency escape.

The design of the two shafts for the ESF will be determined by the functional requirements of that program. As a minimum, however, the main shaft will be 12 ft in diameter, lined with concrete; the escape shaft will be 6 ft in diameter and lined.

Upon completion of the ESF program, or with connection of the ESF to the rest of the underground development, the equipment in the ESF shafts will be removed and the two shafts converted to use as ventilation intake for the waste emplacement area.

The main shaft will be located at approximate coordinates N765995, E563265. The second shaft will be located near the first, close enough so that the shafts can be connected underground and the ventilated circuit established in an efficient manner.

9.6.2 Excavation

The main 12-ft-diameter shaft will be excavated by drill and blast methods. The walls of the shaft shall be exposed for a period before lining, to allow geologists to map geological features. The second (6-ft) shaft can be constructed conventionally or by mechanical methods.

9.6.3 Lining

A concrete liner will be installed in the main shaft, as discussed in Section 9.2.2. The liner must be capable of supporting the fixtures required for the ESF operation and the fixtures required for duty as a ventilation intake shaft as discussed in the next section.

9.6.4 Fixtures

During the ESF construction, fixtures will be installed to satisfy the requirements of that operation. For the main shaft, these fixtures will include hoist and hoist head frames, service cages, production skips, and the guides and supports required for the utility lines.

All of the fixtures installed during the ESF will be removed in converting these shafts to duty as ventilation shafts.

9.6.5 Utilities

During the ESF construction, utility lines will be installed in the main shaft for water, power, communication, and ventilation. These utility lines will be removed during the conversion of the shaft to intake air duty.

9.6.6 Other

During repository operation, suitable shaft covers will be required to protect the repository from the effects of storm water and from accidental or intentional intrusion by either people, animals, or birds, while imposing minimum restriction on the quantity and velocity of air required.

Shaft stations will be constructed at several horizons in the main shaft for the exploratory activities of the ES program. Some of these stations will connect to the repository facilities or to the secondary shaft. During conversion, adequate fencing and/or doors will be provided at each shaft station which can be accessed from the repository (or other underground facility) to prevent entry into the shafts.

A sump with a small water discharge capability will be established at the bottom of the 12-ft shaft.

9.7 Emplacement Exhaust Shaft

The only function of this shaft will be exhausting air from the waste emplacement area.

9.7.1 Design Definition/Specification

The emplacement exhaust shaft will be located outside the underground facilities boundary on the east side of the repository. The exhaust shaft will be connected on the repository level with the perimeter drift, which acts as a collecting drift for the return air from the repository.

No access shall be permitted through the exhaust shaft after waste emplacement operations have begun, except for inspection and maintenance.

The shaft dimension shall be determined by the quantity of exhaust air required in the emplacement operation.

9.7.2 Excavation

The shaft may be excavated by drill and blast or mechanical methods, as discussed in Subsection 9.2.1.

9.7.3 Lining

The shaft lining may be constructed of concrete, as discussed in Subsection 9.2.2.

The durability of ground support and lining components subjected to high temperatures, such as the emplacement exhaust shaft, may be adversely affected. The design must consider this temperature cycling.

9.7.4 Fixtures

The only fixtures to be installed in the ventilation exhaust shaft are those necessary for inspection.

9.7.5 Utilities

A water collecting sump and pump station will be installed near the bottom of the exhaust shaft.

9.7.6 Communication

A communication system may be installed from the shaft bottom to the surface for use by the inspection and maintenance crews in the shaft.

9.7.7 Surface Facilities

Access to the inspection elevator will be provided through a series of secure airlocks in the shaft collar to maintain the ventilation pressures.

On the surface, the shaft will connect to the ventilation fan housing. Suitable monitoring equipment will test the exhaust air for contamination and either discharge the air to the atmosphere or divert the contaminated air through the HEPA Filters. The HEPA Filters and the fan facilities on the surface are discussed further in Subsection 8.3.

9.7.8 Other

A shaft station will be provided only at the repository level.