WBS: 1.2.1, 1.2.2, 1.2.4
SCPB: N/A
QA: L

Civilian Radioactive Waste Management System
Management & Operating Contractor

MINED GEOLOGIC DISPOSAL SYSTEM ADVANCED CONCEPTUAL DESIGN REPORT

VOLUME II OF IV
REPOSITORY

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March 1996

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1. INTRODUCTION

During the early phases of the Yucca Mountain design program, a three-phase approach for the development of the first Mined Geologic Disposal System (MGDS) was established:

- Conceptual Design Phase

  - Site Characterization Plan Conceptual Design (SCP-CD)
  - Advanced Conceptual Design (ACD)

- License Application Design Phase

- Final Procurement and Construction Design Phase.

The Conceptual Design for the Site Characterization Plan for a potential MGDS at Yucca Mountain, Nevada, was completed with the issuance of the *Site Characterization Plan Conceptual Design Report* (SCP-CDR) (SNL 1987). The report covered the following:

- Repository surface and subsurface facilities design
- Waste package design
- Material handling equipment
- Waste package fabrication equipment
- Waste treatment system
- Transportation, decontamination, and storage facilities
- All necessary support facilities and equipment.

The SCP-CD used the known site data and identified additional data needs to be obtained during the site characterization activities. Basically, this design demonstrated the feasibility of a potential repository at the Yucca Mountain site and was used as a basis for the repository input to a Total System Life Cycle Cost estimate.

The next step of the conceptual design phase, which is ACD, is intended to develop appropriate solutions to all identified design-related licensing issues, and explores repository and waste package design alternatives identified in the SCP-CDR and during subsequent studies. Several recommendations made by various external agencies and by the Nuclear Waste Technical Review Board are being considered for further investigation. New data from the site characterization and laboratory testing programs are being used. The ACD helped develop and, in some cases, refined the design criteria and concepts to be finalized in later design phases. Input for the Total System Life Cycle Cost estimate will be updated and revised using the design developed by ACD.

This design phase will be completed by the issuance of an MGDS ACD Summary Report, scheduled for March 1996.

The *Advanced Conceptual Design Work Plan* (CRWMS M&O 1992a) calls for a series of reviews to be performed on the progress of ACD at reasonable intervals prior to the development of the final summary report. To facilitate this action, the Initial Summary Report for Repository/Waste Package Advanced Conceptual Design was developed in September 1994, and acts as the first progress report representing a comprehensive compilation of ACD category work. The report is a compendium of input from Waste Package Development, Repository Surface Design, Repository Subsurface Design, and Systems Engineering. Input from each organization was not at an equal stage of maturity. The report was structured to include subject matter areas for all necessary areas of information, regardless of the amount of information available to date.

As mentioned above, the ACD effort which was originally planned to end in March 1997 is being closed out in March 1996 with the issuance of the MGDS ACD Report. Volume II of this report represents the Repository Segment design description, and contains a description of all repository design information that has been developed as of December 1995. The repository description is integrated with information presented in Volumes III and IV of the report through internal reviews and constant interaction of design staffs and other departments that may have an influence on designs and schedules.

2. SCOPE AND METHODOLOGY

2.1 REPORT SCOPE

The scope of Volume II of this Mined Geologic Disposal System (MGDS) Advanced Conceptual Design (ACD) Report is to provide a summary of all ACD work produced to date for the repository, and to ensure that all material included represents a fully integrated product not only between surface and subsurface design departments, but also with other program departments. These other departments include waste package, performance assessment, systems engineering, transportation, cost and schedule, and site investigation.

As implied by its title, the MGDS ACD Report is intended to put forth a compilation of integrated concepts in a form and format that can be used to review technical progress and adequacy as well as programmatic status. The report is formatted to include sections of technical and programmatic information that corresponds to issues identified for investigation in the *Advanced Conceptual Design Work Plan* (CRWMS M&O 1992a). Information for each of the identified areas may not be available at this time in the MGDS ACD Report; however, by structuring the report in this way, the reader will be able to assess both the progress of work and the level of effort required in all areas while planning for future design phases.

Volume II presents the ACD for the Repository Segment, consisting of surface and subsurface facilities at the repository, and the transportation systems within Nevada. The design and construction aspects of the Underground Facility Subsystem of the Engineered Barrier Segment are described in this volume.

The Repository Segment includes:

- An underground facility
- Site civil improvements
- Waste handling facilities
- Surface support facilities to house support functions such as:
    - Administration
    - Maintenance
    - Personnel support
    - Visitor center
    - Security
    - Safety
    - Health physics
    - Offices for the:
        - Nuclear Regulatory Commission (NRC)
        - Other oversight organizations

- Subsystems to supply, distribute, and control various utilities and services such as:
  - Electric power
  - Water
  - Communications.

Volume II provides a conceptual description of the repository, including an introduction, concept of operations, presentation of design inputs (e.g., requirements and assumptions), descriptions of surface and subsurface repository facilities and the Nevada transportation system, a discussion of design considerations for all operating modes and phases (e.g., emplacement, caretaker, retrieval, and closure), a preliminary hazards analysis, a discussion of driving design uncertainties and issues, and supporting references and appendices. All documents produced for ACD work will not be included in their entirety; but summaries of this work will be provided with reference to more comprehensive documents if necessary.

While Volume II deals with repository design details, information regarding other project elements can be found in Volumes I, III, and IV.

Volume I presents an executive summary of all report material, and an overview of program history, design evolution, description of requirements interpretation and allocation, discussion of major issues and interfaces, and explanation of other program structures.

Volume III presents the conceptual design of the Waste Package Subsystem within the Engineered Barrier Segment, including criteria, design bases, requirements, assumptions, material selections, performance, and interfaces with other segments and subsystems.

Volume IV provides life cycle cost data and associated life cycle schedules for the MGDS Segment including design, construction, startup, operations, and closure. More detailed outlines specific to each volume are included in the volumes themselves.

During ACD an emphasis is placed on the description of nuclear-related facilities, systems, subsystems, and operations. More general descriptions of balance of plant facilities are provided, but to a less detailed extent due to the understanding that these items can be designed using common industry practice and do not impact the nuclear safety or integrity of the project. The level of design work varied from area to area reflecting the funding limitations and ACD design priorities. As a result, the level of detail presented in the report also varies from section to section.

2.2 ACD DESIGN METHODOLOGY

The general methodology for the ACD begins with reference to the *Site Characterization Plan Conceptual Design Report* (SNL 1987). Information contained therein was developed to provide initial concepts from which further work would proceed. ACD re-examines requirements, criteria, and constraints, and combines the application of that input with the most recent available site data in developing new designs. Design alternatives are established through these new designs to incorporate the latest program developments and information. From these alternative designs, a selection is made of one or more designs to carry forward to the next design phase. In some cases, a single design selection may not be prudent due to need for design flexibility (e.g., thermal loading, backfill). This report contains some unqualified data that must be resolved and/or verified in future design phases. Before using data contained in this report for final design, procurement, fabrication, or construction, controls are required to be placed on that data in accordance with current procedures.

Throughout this design phase, close integration with other program elements was established. Particular emphasis was placed on integration with the waste package element for physical and performance design details on those items that affect the capability to handle the package in a confined environment, and also to establish shielding requirements for worker safety and performance requirements for the subsurface environment. The type of waste package and receipt schedule have major impacts on surface repository design. Information needs from the Performance Assessment group require a constant communication stream in which design information is provided to that organization and performance parameters were used to influence the design. Integration with Systems Engineering provides a dialogue on issues that impact several different groups, or have a programmatic impact such as thermal loading, transportation, and regulatory constraints.

3. DESIGN REQUIREMENTS AND STANDARDS

The primary source of requirements guiding design of the Mined Geologic Disposal System (MGDS) is 10 CFR 60, *Disposal of High-Level Radioactive Wastes in Geologic Repositories.* The requirements of 10 CFR 60, as well as those from many other sources, are captured in the *Civilian Radioactive Waste Management System Requirements Document* (CRD) (DOE 1995a) and from there flow down into the various systems requirements documents. For the MGDS Element, this system document is the *Mined Geologic Disposal System Requirements Document* (DOE 1995b), and from that document requirements are allocated to specific design requirements documents. Requirements for the design of the Repository Segment and Underground Facility portion of the Engineered Barrier Segment are presented in this volume. The input documents for Volume II are the *Repository Design Requirements Document* (RDRD) (YMP 1994a) and the *Controlled Design Assumptions Document* (CDA Document) (CRWMS M&O 1995a).

3.1 QUALITY ASSURANCE

Material presented in this volume has been developed in accordance with procedures that comply with the *Quality Assurance Requirements and Description* (DOE 1995c) and CRWMS M&O procedures designated as quality administrative procedures. The content of the report is conceptual in nature, and reflects work that may exist elsewhere in more detailed reports and analyses. Figures contained in technical documents are not required to be developed under QAP-3-10, *Engineering Drawings.*

3.1.1 Evaluation of Activities

Design activities described in this report have been evaluated in accordance with QAP-2-0, *Control of Activities.* These evaluations are described in this section.

The evaluation of the task of preparing this *Mined Geologic System Advanced Conceptual Design Report* (MGDS ACD Report) is documented in *Develop Repository Technical Documents and Reports* (CRWMS M&O 1995b). The results of that evaluation indicated that the activity was subject to the quality assurance (QA) program. In addition to those QA procedures applicable to all QA work, QAP-3-5, *Development of Technical Documents,* is cited as appropriate for this activity.

This MGDS ACD Report has been prepared in accordance with QAP-3-5. In accordance with that procedure, a Technical Document Preparation Plan (TDPP) has been prepared for this activity. The TDPP for the MGDS ACD Report, entitled *Technical Document Preparation Plan for the Mined Geologic Disposal System Advanced Conceptual Design (Revised) Report* (CRWMS M&O 1995c), contains the information required of TDPPs by QAP-3-5.

In addition to the activity of preparing the report, several other activities are represented in this work. These activities have been evaluated in accordance with QAP-2-0, and are listed below.

- Cost Estimating (CRWMS M&O 1995d)
- Scoping technical documents for Q-Items (CRWMS M&O 1995e)

- Design Basis Accident and Design Analyses (CRWMS M&O 1995f)
- Design Basis Accident for Non-Q Items (CRWMS M&O 1995g)
- Technical documents for Non-Q Items (CRWMS M&O 1995h)

The quality assurance procedures found to be applicable for each activity are noted in the referenced Activity Evaluations.

3.1.2 Classification of Systems, Structures, and Components

Prior to licensing, all systems, structures, and components (SSCs) of the repository must be evaluated to assess their importance to the nuclear safety of the operation. Depending on the outcome of that evaluation, the SSCs may be placed in one or more of the following classes:

- QA-1 – Items important to public radiological safety as described in 10 CFR 60; 10 CFR 71, *Packaging and Transportation of Radioactive Material*; and 10 CFR 72, *Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste.*

- QA-2 – Items and natural barriers important to waste isolation as described in 10 CFR 60.

- QA-3 – Items required for the control and management of site-generated radioactive waste other than spent fuel and high-level waste.

- QA-4 – Items required for the protection of items important to safety (IITS) and items important to waste isolation (IITWI) from the hazards of fire.

- QA-5 – Items not intended to perform a safety function but whose failure could impair the capability of other items to perform their intended safety or waste isolation functions.

- QA-6 – Items required for physical protection as defined by 10 CFR 73, *Physical Protection of Plants and Materials.*

- QA-7 – Items required to control occupational radiological exposure.

Exploratory Studies Facility (ESF) SSCs that may become a part of the repository have been classified in a number of classification analyses (CRWMS M&O 1995i, CRWMS M&O 1995j, CRWMS M&O 1995k, CRWMS M&O 1995l, and CRWMS M&O 1995m). These analyses were performed in accordance with QAP-2-3, *Classification of Permanent Items.* The SSCs were analyzed; results of these analyses are listed in Table 3-1.

Table 3-1. Classification of Repository-related ESF Configuration Items

Configuration Item	Classification
Ground Support Systems	QA-1, QA-5
Main Access Openings	QA-2
Test Support Areas	N/A
Operations Support Areas	N/A
Tunnel Boring Machine Starter Tunnel	QA-2

Preliminary classification analyses of repository SSCs have also been performed, but these analyses have not yet been released. The *Q-List* (YMP 1994b) contains QA classification information for repository SSCs. The *Q-List* discusses only IITS and IITWI, which are essentially synonymous with "QA-1" and "QA-2." All repository items placed on the *Q-List* were done so by "Direct Inclusion" as opposed to the more rigorous evaluation process of QAP-2-3. Such evaluation requires specific design information and an understanding of the credible Design Basis Accidents (DBAs) and their initiating Design Basis Events (DBEs). DBA and DBE issues are discussed in Section 10.

Those items considered Important To Radiological Safety are listed below. The reader is referred to the *Q-List* for a more detailed listing of the make-up of these items.

- Waste Package
- Surface Service and Utility Systems
- Surface Facilities
- Balance of Plant
- Waste Ramp/Topopah Spring North Ramp
- Men-and-Materials Shaft*
- Tuff Ramp
- Emplacement Area Exhaust Shaft
- Exploratory Studies Modifications for Waste Emplacement Area Air Intake
- Underground Excavations
- Underground Service and Utility Systems
- Seals
- ESF Starter Tunnel Drill-and-Blast Section.

  * The current repository configuration does not incorporate a shaft having "Men-and-Material" functions.

Those items considered IITWI are listed below. Refer to the *Q-List* for a more detailed listing of the make-up of these items.

- Waste Package
- Institutional Barriers
- Waste Ramp/Topopah Spring North Ramp

- Men-and-Materials Shaft*
- Tuff Ramp
- Emplacement Area Exhaust Shaft
- Exploratory Studies Modifications for Waste Emplacement Area Air Intake
- Underground Excavations
- Seals
- ESF Starter Tunnel Drill-and-Blast Section.

* The current repository configuration does not incorporate a shaft having "Men-and-Material" functions.

3.1.3 Use of Computer Software

Several computer software packages have been used in the repository conceptual design work performed through early FY 1996. Computer programs have been used to model:

- The three-dimensional geologic structure of the site

- The geotechnical response of underground openings to stresses caused by thermal loading as well as the presence of the openings themselves

- The ventilation flow networks for the subsurface repository

- The thermal effects of the presence of heat producing waste packages in the repository emplacement drifts.

LYNX

A geologic model, Lynx Version 3.06 geologic modeling software (LYNX), running on a Silicon Graphics Indigo R4000 XS24Z workstation with an IRIX 5.2 operating system, is used in the development of the ESF and Geologic Repository Operations Area (GROA) layouts. LYNX Version 3.06 was qualified for quality affecting work and has been assigned the computer software configuration item number B00000000-01717-1200-30018. The LYNX geologic modeling software is appropriate for this application and was run within its range of validation. The use of the LYNX package, including its inputs, operation, and results, is described in *Definition of Potential Repository Block* (CRWMS M&O 1995n).

FLAC and UDEC

Two commercially available computer programs, Fast Lagrangian Analysis of Continua (FLAC) and Universal Distinct Element Code (UDEC), have been used for the numerical analysis of opening stability. Both codes are command-driven and run on a 90 MHZ Pentium microcomputer with 16 megabytes random access memory. Although these two programs are approved for use in design in accordance with CRWMS M&O computer software quality assurance procedures, and carry the appropriate computer software configuration item numbers as given below, their installation on the machines used for these analyses has not been documented. Additional documentation would be required before these computer results would be considered qualified.

FLAC is a two-dimensional, explicit finite difference code that simulates the behavior of structures built of soil, rock, and other materials and subjected to static, dynamic, and thermally-induced loads (Itasca 1993a). Modeled materials respond to applied forces or boundary restraints according to prescribed linear or non-linear stress/strain laws and undergo plastic flow when a limiting yield condition is reached. FLAC is based on a Lagrangian calculation scheme, especially suited for modeling large displacements, and has several built-in constitutive models that permit the simulation of highly non-linear, irreversible responses typical of many geologic materials. The FLAC program was initially developed by Dr. Peter Cundall and Itasca Consulting Group, Inc. in 1986, and the version of the program used for the analysis of opening stability is Version 3.22 (computer software configuration item number 20.93.3001-AAu3.22), which has been verified and validated according to applicable CRWMS M&O procedures.

UDEC is a two-dimensional numerical program based on the distinct element method of discontinue modeling (Itasca 1993b). The program was initially introduced by Dr. Peter Cundall and Itasca Consulting Group, Inc., in 1985. It simulates the response of discontinuous media (such as a jointed rock mass) subjected to thermal, static, or dynamic loading. The discontinuous medium is represented as an assemblage of discrete blocks. The discontinuities between blocks are treated as boundary conditions that permit block rotations and large displacements along the discontinuities. Individual blocks behave as either rigid or deformable material.

Deformable blocks are subdivided into a mesh of finite difference elements that respond according to a prescribed linear or non-linear force-displacement relation in both normal and shear directions. UDEC has several built-in material behavior models, for both intact blocks and discontinuities, which simulate discontinuous geologic materials. UDEC is also based on a Lagrangian calculation scheme which is suitable for modeling large deformations in a blocky system. The UDEC code used in the analysis of opening stability is Version 2.0 (computer software configuration item number B00000000-01717-1200-30004), which has been verified and validated according to applicable CRWMS M&O procedures.

VNETPC

A ventilation network simulation program, VNETPC Version 3.1, was used to provide examples for the air flow distribution and network balance. The program has already been verified and validated under QA procedures (CRWMS M&O 1993a). The application of the software to the study is appropriate and is used only within the validated range as described in the verification and validation documentation of VNETPC software (CRWMS M&O 1993a).

The VNETPC program ran on a Gateway 2000 computer equipped with an Intel P54C Pentium central processing unit operating at 90 MHZ. The computer has 8 megabytes of random access memory. The software was used within its verified range, and is appropriate for this application.

ANSYS

The commercially available computer code, ANSYS Revision 5.1, developed by Swanson Analysis Systems, Inc., was used to generate the thermal modeling examples to illustrate the concepts being examined.

The ANSYS finite element analysis program is a large-scale, general purpose software package used worldwide. It can be used to perform a variety of analyses, including thermal, structural, magnetic field, electric field, fluid, and coupled-field.

The thermal analysis phase of the software was used in this scoping analysis to calculate temperature distributions in the host rock under the influences of radioactive decay of the nuclear waste emplaced in an underground repository. It was used because of its capabilities of performing transient analysis, accommodating temperature-dependent material properties, explicitly modeling thermal radiation, and because of its acceptance by the nuclear industry and the Nuclear Regulatory Commission (NRC) (CRWMS M&O 1994). Two- and three-dimensional visualizations for verifying preprocessing data and reviewing postprocessing solution results were produced using ANSYS interactive graphics.

The thermal modeling examples presented in this report were generated from the ANSYS program installed on a Silicon Graphics IRIS Indigo^2 R4600SC graphics workstation running internally at 133 MHZ. The software was used within its verified range and is appropriate for this application.

3.2 DESIGN INPUT

Design inputs contained in this volume have been used to generate the repository MGDS ACD Report. For the repository, the design inputs consist of a combination of requirements from the RDRD (YMP 1994a) and assumptions from the CDA Document (CRWMS M&O 1995a). This report contains some unqualified data yet to be verified.

3.2.1 Design Requirements

The source of requirements guiding the RDRD (YMP 1994a) is the *Mined Geological Disposal System Requirements Document* (DOE 1995b), which is one of four system requirements documents obtaining requirements directly from the CRD (DOE 1995a). The CRD is the primary program source of requirements used in the design requirements documents and in system requirements. The CRD obtains its requirements (identified in its Section 2) from CFRs, DOE Orders, the *Nuclear Waste Policy Act of 1982*, and other sources.

3.2.2 Source Documents

The codes, regulations, standards, and guides applicable to the design of the repository are defined in Section 2 of the RDRD (YMP 1994a). The principal regulatory requirements are the technical requirements for repository operation provided in 10 CFR 60 and 10 CFR 960 and the environmental standards provided in the currently remanded 40 CFR 191. The primary sources of regulations that drive repository design requirements are those listed in Table 3-2.

Table 3-2. Repository Related Federal Regulations

Identifier	Title or Description
10 CFR 20	Standards for Protection Against Radiation
10 CFR 60	Disposal of High-Level Radioactive Wastes in Geologic Repositories
10 CFR 71	Packaging and Transportation of Radioactive Material
10 CFR 960	General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories
10 CFR 961	Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste
29 CFR 1926	Safety and Health Regulations for Construction
30 CFR 57	Safety and Health Standards Underground Metal and Nonmetal Mines
40 CFR 191	Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes (remanded for a Yucca Mountain Repository)

3.2.3 Design Requirements Summary

The RDRD (YMP 1994a) describes the functions to be performed by, and establishes the requirements for, the Repository Segment. The Repository Segment is one of the segments of the MGDS for the permanent disposal of spent nuclear fuel (SNF), including SNF loaded in multi-purpose canisters (MPCs), commercial high-level radioactive waste, and defense high-level radioactive waste (DHLW). The primary function of the Repository and Engineered Barrier Segments is to isolate waste, first by containing waste within the waste package and then, together with the geologic setting, isolating waste from the accessible environment. The major components of the Repository Segment consist of the surface and subsurface facilities.

The requirements identified in this summary (see Table 3-3) are those requirements appropriate for the level of design detail necessary to support the ACD. For this stage of design, key performance requirements, listed below, have been identified to provide additional selection criteria for design requirements in this summary. Requirements and assumptions associated with the key performance requirements have been included in this summary.

Table 3-3. Repository Design Requirements

Description	Identifier	Requirement
Waste Receipt Rate	RDRD 3.2.1.2.B	The repository shall be capable of receiving waste according to the schedule shown in Table 3-4 of this document. Note: Refer to requirement assumption RDRD 3.2.1.2.B and Key Assumptions 001 and 002 for further clarification on project approach.
Radiation Limits	RDRD 3.2.1.2.C RDRD 3.2.1.3 RDRD 3.2.1.4.C RDRD 3.2.2.1.C	The GROA shall be designed so that until permanent closure has been completed, radiation exposures, radiation levels, and releases of radioactive materials to unrestricted areas will at all times be maintained within the limits specified in 10 CFR 20 and applicable environmental standards for radioactivity established by the EPA[1], as listed in Section 3.2.2. [10 CFR 60.111(a)]
Retrieval	RDRD 3.2.1.4.A	The repository shall be designed and constructed to permit the retrieval of any SNF and DHLW emplaced in the repository, during an appropriate period of operation of the facility, as specified by the Secretary of Energy. Note: Refer to Key Assumptions 016, 017, and 055 for further clarification on project approach.
Retrieval	RDRD 3.2.1.4.B	The GROA shall be designed to preserve the option of waste retrieval throughout the period during which wastes are being emplaced and thereafter until the completion of a performance confirmation program and NRC review of the information obtained from such a program. To satisfy this objective, the geologic repository shall be designed so that any or all of the emplaced waste could be retrieved on a reasonable schedule starting at any time up to 50 years after waste emplacement operations are initiated, unless a different time period is approved or specified by the NRC. 10 CFR 60.111(b)(3) gives guidance for developing the schedule. [10 CFR 60.111(b)(1)] Note: Refer to Key Assumptions 016 (extends retrievability period "up to 100 years") and 017 for further clarification on project approach.

[1] U.S. Environmental Protection Agency

Table 3-3. Repository Design Requirements (Continued)

Description	Identifier	Requirement
Releases of Radionuclides to the Accessible Environment	RDRD 3.2.1.6C	The disposal system shall be designed to provide a reasonable expectation, based upon 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 have a likelihood of less than one chance in 10 of exceeding the quantities calculated according to Table A-1 of Appendix A of 40 CFR 191; and have a likelihood of less than one chance in 1,000 of exceeding ten times the qualities calculated according to Table A-1 of Appendix A of 40 CFR 191. [TBR] [140 CFR 191.13(a)[TBR]] Note: Refer to requirement assumption RDRD 3.2.1.6C for further clarification on project approach.
Off-Normal Events	RDRD 3.2.1.7.A	The GROA design shall include explosion and fire detection alarm systems and appropriate suppression systems with sufficient capacity and capability to reduce the adverse effects of fires and explosions on SSCs important to safety. [10 CFR 60.131(b)(3)(iii)]
Off-Normal Events	RDRD 3.2.1.7B	The SSCs 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)]
Off-Normal Events	RDRD 3.2.1.7C	The SSCs important to safety shall be designed to perform their safety functions during and after credible fires or explosions in the GROA repository. [10 CFR 60.131(b)(3)(I)]
Radiological Protection	RDRD 3.2.2.1.A	The GROA shall, to the extent practicable, be designed and constructed to use procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as reasonably achievable (ALARA). ALARA principles shall be based on the applicable sections of NRC Regulatory Guides 8.8 and 8.10. [10 CFR 20.1101(b)] Note: Refer to Key Assumption 013 for further clarification on project approach.

Table 3-3. Repository Design Requirements (Continued)

Description	Identifier	Requirement
Radiological Protection	RDRD 3.2.2.1.B	The GROA design and operations shall include provisions for controlling doses such that, when approved operational procedures are followed, the exposure dose limits specified in 10 CFR 20.1201 for occupational doses, and 10 CFR 20.1301 for individual members of the public, are not exceeded. [10 CFR 20] Note: Refer to Key Assumption 013 for further clarification on project approach.
Radiological Protection	RDRD 3.2.2.1.D	The GROA shall provide means to limit the levels of radioactive materials in effluents, during normal operations, anticipated occurrences, and under accident conditions. [10 CFR 60.131(b)(4)(I)]
Radiological Protection	RDRD 3.2.2.1.D.1	Releases shall be limited as follows: Under normal operations and anticipated occurrences, the annual dose equivalent to any real individual who is located beyond the controlled area must not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ as a result of exposure to: planned discharges of radioactive materials, radon and its decay products excepted, to the general environment; direct radiation from repository operations; and any other radiation from uranium fuel cycle operations within the region. [TBR] [40 CFR 191.03(a)(1)[TBR]] Note: Refer to Key Assumption 013 for further clarification on project approach.
Radiological Protection	RDRD 3.2.2.1.E	The disposal system shall be designed to meet the individual protection requirements specified by 40 CFR 191.15 [TBR]. [40 CFR 191.15 [TBR]] Note: Refer to Key Assumption 013 for further clarification on project approach.

Table 3-3. Repository Design Requirements (Continued)

Description	Identifier	Requirement
Public Protection	RDRD 3.2.2.2.A	Repository facilities shall be designed to operate so that the total EDE[2] to individual members of the public from the licensed operation does not exceed 0.1 rem (1 mSv) in a year, exclusive of the dose contribution from the facility's disposal of radioactive material into sanitary sewerage in accordance with 10 CFR 20.2003. However, the facility may apply for prior NRC authorization to operate up to an annual dose limit for an individual member of the public of 0.5 rem (5 mSv) in accordance with 10 CFR 20.1301(c). [10 CFR 20.1301(a),(c)]
Public Protection	RDRD 3.2.2.2.B	If members of the public have access to controlled areas, the limits for members of the public shall continue to be applicable to those individuals. [10 CFR 20.1301(b)]
Public Protection	RDRD 3.2.2.2.C	Repository facilities shall be designed to operate so that the dose in any unrestricted area from external sources does not exceed 0.002 rem (0.02 mSv) in any one hour. [10 CFR 20.1301(a)(2)]
Airborne Radioactive Material Control	RDRD 3.2.2.3.A	Concentrations of radioactive material in air shall to the extent practicable be controlled through the use of process or other engineering controls (e.g., containment or ventilation). [10 CFR 20.1701]
Airborne Radioactive Material Control	RDRD 3.2.2.3.B	When it is not practicable to apply process or other engineering controls in restricted areas to control the concentrations of radioactive material in air to values below those that define an airborne radioactivity area, the repository shall, consistent with maintaining the total EDE ALARA, have the capability to increase monitoring and limit intakes by one or more of the following: control of access, limitation of exposure times, use of respiratory protection equipment, or other controls. [10 CFR 20.1702]
Airborne Radioactive Material Control	RDRD 3.2.2.3.C	The GROA shall be capable of implementing and maintaining air sampling sufficient to identify potential hazards, to permit proper protective equipment selection, and to estimate exposures. [10 CFR 20.1703(a)(3)(I)]

[2] effective dose equivalent

Table 3-3. Repository Design Requirements (Continued)

Description	Identifier	Requirement
Criticality Protection	RDRD 3.2.2.5.A	All systems for processing, transporting, handling, storing, retrieving, emplacing, and isolating radioactive waste shall be designed to ensure that a nuclear criticality accident is not possible unless at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. Each system shall be designed for criticality safety under normal and accident conditions. The calculated effective multiplication factor must be sufficiently below unity to show at least 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. [10 CFR 60.131(b)(7)]
Low-Level Waste Disposal	RDRD 3.2.2.6.A	If the design of the Repository Segment provides for the disposal of licensed low-level waste material into sanitary sewerage, the requirements of 10 CFR 20.2003 shall be met. [10 CFR 20.2003] Note: Refer to Key Assumption 024 for further clarification on project approach.
Low-Level Waste Disposal	RDRD 3.2.2.5.B	If the design of the Repository Segment provides for the treatment or disposal of licensed low-level waste material by incineration, only the amounts and forms specified in 10 CFR 20.2005, or specifically approved by the NRC pursuant to 10 CFR 20.2002, shall be allowed. [10 CFR 20.2004] Note: Refer to Key Assumption 024 for further clarification on project approach.
Repository Segment-Geologic Setting Interfaces	RDRD 3.2.3.2.3.A	The underground facility shall assist the geologic setting in meeting the performance objectives for the period following permanent closure. [10 CFR 60.133(h)]
Repository Segment-Geologic Setting Interfaces	RDRD 3.2.3.2.3.B	The ...[3] underground facility shall be designed to assure that releases of radioactive materials to the accessible environment following permanent closure conform to applicable environmental standards for radioactivity established by the EPA with respect to both anticipated processes and events and unanticipated processes and events. [10 CFR 60.112]

[3] The requirements for the geologic setting and the accesses, boreholes, and their seals are addressed in 3.7.1 and 3.7.5. Requirements for waste packages are in the *Engineered Barrier Design Requirements Document* (EBDRD).

Table 3-3. Repository Design Requirements (Continued)

Description	Identifier	Requirement
Repository Segment-Geologic Setting Interfaces	RDRD 3.2.3.2.3.C	The underground facility shall be designed, assuming anticipated processes and events, so that the release rate of any radionuclide from the underground following the containment period shall not exceed one part in 100,000 per year of the inventory of that radionuclide calculated to be present at 1,000 years following permanent closure, or such other fraction of the inventory as may be approved or specified by the NRC; provided that this requirement does not apply to any radionuclide that is released at a rate less than 0.1% of the calculated total release rate limit. The calculated total release rate limit shall be taken to be one part in 100,000 per year of the inventory of radioactive waste, originally emplaced in the underground facility, that remains after 1,000 years of radioactive delay. [10 CFR 60.113(a)(1)(ii)(B)]
Security of Licensed Material	RDRD 3.2.4.3.1.4	The Repository Segment shall provide the capability to control and maintain constant surveillance over licensed material that is in a controlled or unrestricted area and that is not in storage. [10 CFR 20.1802]
High Radiation Area Access Control	RDRD 3.2.4.3.2.A	Access to high and very high radiation areas shall be controlled in accordance with the requirements specified by 10 CFR 20.1601 and 20.1602. [10 CFR 20.1601][10 CFR 20.1602]
Radioactive Materials Monitoring	RDRD 3.2.4.4	The Repository Segment shall be equipped to monitor the external surfaces of packages and casks known to contain radioactive material for radioactive contamination and radiation levels in compliance with 10 CFR 20.1906. [10 CFR 20.1906]
Structure, System, and Component Reliability	RDRD 3.2.5.1.3	SSCs that are important to safety shall be designed and located so that they continue to perform their safety functions effectively during and after credible fire and explosion conditions in the GROA. [10 CFR 60.131(b)(3)]
Utilities Reliability	RDRD 3.2.5.1.4.A	Each utility service system that is 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)]
Utilities Reliability	RDRD 3.2.5.1.4.B	The design of utility services and distribution systems that are important to safety shall include redundant systems to the extent necessary to maintain, with adequate capacity, the ability to perform safety functions. [10 CFR 60.131(b)(5)(ii)]

Table 3-3. Repository Design Requirements (Continued)

Description	Identifier	Requirement
Maintenance in Radioactive Environments	RDRD 3.2.5.2.6	Equipment which normally operates in a radioactive environment or in the vicinity of radioactive components shall be designed to be moved to a non-radioactive environment for maintenance or repair, whenever possible. When that is not possible, the design shall allow for installation of temporary shielding, permit minimizing radiation exposure times, and provide sufficient space for ease of operation, maintenance, and repair. [10 CFR 60.131(a)(2)]
Fire, Explosion, and Other Disaster Protection	RDRD 3.2.6.2.1.A	Repository Segment SSCs important to safety shall be designed to perform their safety functions during and after credible fire or explosion conditions at the repository. [10 CFR 60.131(b)(3)(I)]
Fire, Explosion, and Other Disaster Protection	RDRD 3.2.6.2.1.B	The Repository Segment shall be designed to include means to protect SSCs important to safety against the adverse effects of either the operation or failure of the fire suppression system. [10 CFR 60.131(b)(3)(iv)]
Fire, Explosion, and Other Disaster Protection	RDRD 3.2.6.2.1.C	Repository Segment SSCs important to safety shall be designed to withstand dynamic effects, such as missile impacts, that could result from equipment failure, and similar events and conditions that could lead to loss of their safety functions. [10 CFR 60.131(b)(2)]
Fire Resistance	RDRD 3.2.6.2.2.D	To the extent practicable, the Repository Segment facilities shall be designed to incorporate the use of noncombustible and heat resistant materials. [10 CFR 60.131(b)(3)(ii)]
General Design Criteria	RDRD 3.3.1.E	All design bases shall be consistent with the results of site characterization. [10 CFR 60.130]
General Design Criteria	RDRD 3.3.1.H	An assessment shall be provided to document the predicted effectiveness of engineered and natural barriers, including barriers that may not be themselves a part of the GROA, against the release of radioactive material from the waste package to the environment. The analysis will also include a comparative evaluation of alternatives to the major design features that are important to waste isolation, with particular attention to the alternatives that would provide longer radionuclide containment and isolation. [10 CFR 60.21(c)(1)(ii)(D)]

Table 3-3. Repository Design Requirements (Continued)

Description	Identifier	Requirement
General Design Criteria	RDRD 3.3.1.I	The performance of the major design SSCs, both surface and subsurface, shall be analyzed to identify those that are important to safety. For the purposes of this analysis, it will be assumed that operations at the GROA will be carried out at the maximum capacity and rate of receipt of radioactive waste stated in the application. [10 CFR 60.21(c)(1)(ii)(E)]
General Design Criteria	RDRD 3.3.1.J	A description and analysis of the design and performance requirements for SSCs of the geologic repository which are important to safety shall be provided. This analysis will consider: 1. The margins of safety under normal conditions and under conditions that may result from anticipated operational occurrences, including those of natural origin, and 2. The adequacy of SSCs provided for the prevention of accidents and mitigation of the consequences of accidents, including those caused by natural phenomena. [10 CFR 60.21(c)(3)]
Geologic Setting	RDRD 3.7.1.A	The geologic setting shall be selected ...[4] to assure that releases of radioactive materials to the accessible environment following permanent closure conform to applicable environmental standards for radioactivity established by the EPA with respect to both anticipated processes and events and unanticipated processes and events. [10 CFR 60.112]
Groundwater Travel Time	RDRD 3.7.1.B	The geologic repository shall be located so 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 1,000 years, or such other travel time as may be approved or specified by the NRC. [10 CFR 60.113 (a)(2)]

[4] The requirements for the Engineered Barrier System and accesses, boreholes, and their seals are addressed in 3.7.5 and in the EBDRD.

Table 3-3. Repository Design Requirements (Continued)

Description	Identifier	Requirement
Groundwater	RDRD 3.7.1.C	If any of the average annual radionuclide concentrations existing in a special source of groundwater, if one exists, before construction of the disposal system already exceed the limits in 40 CFR 191.16 (a), the disposal system shall be designed to provide a reasonable expectation that, for 1,000 years after disposal, undisturbed performance of the disposal system shall not increase the existing average annual radionuclide concentrations in water withdrawn from the special source of groundwater by more than the limits established in 40 CFR 191.16(a). [TBR] [40 CFR 191.16 (b) [TBR]] Note: Refer to requirement assumption RDRD 3.7.1.C further clarification on project approach.
Adverse Effects	RDRD 3.7.1.D	Assuming the site has been found suitable and to meet the requirements specified in 10 CFR 60.122(a), the Repository Segment design organization shall account for the effects of any of the potentially adverse conditions listed in 10 CFR 60.122 (c) if they are found to be characteristic of the planned controlled area. 10 CFR 60.122(a) specifies that the effects of the potentially adverse conditions can be addressed by analysis, by compensation by favorable conditions (10 CFR 60.122(b)), or remedied [by engineering design]. [10 CFR 60.122]
Site Generated Waste Treatment	RDRD 3.7.3.9.A	Radioactive waste treatment facilities shall be designed to process any radioactive waste generated at the GROA into a form suitable to permit safe disposal at the GROA or to permit safe transportation and conversion to a form suitable for disposal at an alternative site in accordance with any regulations that are applicable. [10 CFR 60.132(d)]
Waste Handling	RDRD 3.7.4.1.A.1	Surface facilities in the GROA shall be designed to allow safe handling and lag storage (if needed) of wastes at the GROA, whether these wastes are temporarily on the surface before emplacement or as a result of retrieval from the underground facility. [10 CFR 60.132(a)]
Surface Facility Ventilation	RDRD 3.7.4.1.C	Surface facility ventilation systems supporting waste transfer, inspection, decontamination, processing, or packaging shall be designed to provide protection against radiation exposures and off-site releases as provided in 10 CFR 60.111(a). [10 CFR 60.132(b)]

Table 3-3. Repository Design Requirements (Continued)

Description	Identifier	Requirement
Underground Openings	RDRD 3.7.5.E.1	Openings in the underground facility shall be designed so that operations can be carried out safely and the retrievability option maintained. [10 CFR 60.133(e)(1)]
Underground Openings	RDRD 3.7.5.E.2	Openings in the underground facility shall be designed to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock. [10 CFR 60.133(e)(2)]
Facility Orientation	RDRD 3.7.5.E.3	The orientation, geometry, layout, and depth of the underground facility, and the design of any engineered barriers that are part of the underground facility shall contribute to the containment and isolation of radionuclides. [10 CFR 60.133(a)(1)]
Underground Facility Performance Requirements	RDRD 3.7.5.E.7	The underground facility shall be designed so that the performance objectives will be met taking into account the predicted thermal and thermomechanical response of the host rock, and surrounding strata, and groundwater system. [10 CFR 60.133(I)]
Rock Excavation	RDRD 3.7.5.G.2	The design of the underground facility shall incorporate excavation methods that will limit the potential for creating a preferential pathway for groundwater to contact the waste packages or radionuclide migration to the accessible environment. [10 CFR 60.133(f)]
Flexibility	RDRD 3.7.5.H	The underground facility shall be designed to allow adjustments to accommodate specific site conditions identified through in situ monitoring, testing, or excavations. [10 CFR 60.133(b)]
Water and Gas	RDRD 3.7.5.I	The underground facility shall be designed to control water and gas intrusion. [10 CFR 60.133 (d)]
Seals	RDRD 3.7.5.J.1	Seals for accesses and boreholes shall be designed so that following permanent closure they do not become pathways that compromise the geologic repository's ability to meet the performance objectives for the period following permanent closure. [10 CFR 60.134(a)]

Table 3-3. Repository Design Requirements (Continued)

Description	Identifier	Requirement
Seals	RDRD 3.7.5.J.2	Materials and placement methods for seals shall be selected to reduce, to the extent practicable, (a) the potential for creating a preferential pathway for groundwater to contact the waste packages; or (b) for radionuclide migration through existing pathways. [10 CFR 60.134(b)(1) and (2)]
Seals	RDRD 3.7.5.J.3	The ...[5] seals for accesses and boreholes shall be designed to assure that releases of radioactive materials to the accessible environment following permanent closure conform to applicable environmental standards for radioactivity established by the EPA with respect to both anticipated processes and events and unanticipated processes and events. [10 CFR 60.112]
Radiological Protection	RDRD 3.7.7.A	The GROA shall be designed to maintain radiation doses, levels, and concentrations of radioactive material in air in restricted areas within the limits specified in 10 CFR 20. Design shall include: 1. Means to limit concentrations of radioactive material in air. 2. Means to limit the time required to perform work in the vicinity of radioactive materials, including, as appropriate, designing equipment for ease of repair and replacement and providing adequate space for ease of operation. 3. Suitable Shielding.
Radiological Protection (continued)	RDRD 3.7.7.A	4. Means to monitor and control the dispersal of radioactive contamination. 5. Means to control access to high radiation areas or airborne radioactivity areas. 6. A radiation alarm system to warn of significant increases in radiation levels, concentrations of radioactive material in air, and of increased radioactivity released in effluent. The alarm system shall be designed with provisions for calibration and for testing its operability. [10 CFR 60.131(a)]

[5] The requirements for the geologic setting and the Engineered Barrier System accesses and boreholes are addressed in 3.7.1A and 3.7.5 and in the EBDRD.

Table 3-3. Repository Design Requirements (Continued)

Description	Identifier	Requirement
Radiological Protection	RDRD 3.7.7.F	Surface facilities shall be designed to control the release of radioactive materials in effluents during normal operations so as to meet the perform objectives of 10 CFR 60.111(a). [10 CFR 60.132(c)(1)]
Radiological Protection	RDRD 3.7.7.G	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 requirement for effluent control. The monitoring systems shall be designed to include alarms that can be periodically tested. [10 CFR 60.132(c)(2)]

Key Performance Requirements

- Substantially complete containment for 1,000 years with no more than 1 percent of waste packages failing within 1,000 years.
- Release rate of any radionuclide shall not exceed 1 part in 100,000 per year of the inventory of radionuclides calculated to be present at 1,000 years
- Nuclear criticality event not possible unless at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety.
- GROA radiation levels and releases to unrestricted areas are within 10 CFR 20 and Environmental Protection Agency standards until completion of closure.

Table 3-4. Waste Delivery Schedule (In Metric Tons of Initial Uranium or Equivalent) [TBR]

Year	Spent Nuclear Fuel		DHLW		Cumulative SNF and DHLW
	From MRS*	Cumulative	Annual	Cumulative	
2010	300	300	0	0	300
2011	600	900	0	0	900
2012	1,200	2,100	0	0	2,100
2013	2,000	4,100	0	0	4,100
2014	3,000	7,100	0	0	7,100
2015	3,000	10,100	400	400	10,500
2016	3,000	13,100	400	800	13,900
2017	3,000	16,100	400	1,200	17,300
2018	3,000	19,100	400	1,600	20,700
2019	3,000	22,100	400	2,000	24,100
2020	3,000	25,100	400	2,400	27,500
2021	3,000	28,100	400	2,800	30,900
2022	3,000	31,100	400	3,200	34,300
2023	3,000	34,100	400	3,600	37,700
2024	3,000	37,100	400	4,000	41,100
2025	3,000	40,100	400	4,400	44,500
2026	3,000	43,100	400	4,800	47,900
2027	3,000	46,100	400	5,200	51,300
2028	3,000	49,100	400	5,600	55,700
2029	3,000	52,100	400	6,000	58,100
2030	3,000	55,100	400	6,400	61,500
2031	3,000	58,100	400	6,800	64,900
2032	3,000	61,100	200	7,000	68,100
2033	1,900	63,000	0	7,000	70,000
2034	0	63,000	0	7,000	70,000

*Note: In years when SNF is shipped directly from the purchasers to the MGDS, the sum of the waste shipped directly and waste shipped from the monitored retrievable storage facility will be as stated in this column.

4. DESIGN BASIS ASSUMPTIONS AND DEVELOPMENT

The *Controlled Design Assumptions Document* (CDA Document) (CRWMS M&O 1995a) is a key element in the advanced conceptual design (ACD) approach that uses management decisions and/or assumptions, as necessary, based on the best available information or engineering judgment, to advance the design. The CDA Document (CRWMS M&O 1995a) contains these assumptions, as well as the rationale for the assumptions and references to plans and schedules to substantiate the assumptions, if necessary. The CDA Document (CRWMS M&O 1995a) also provides a concept of operations for the repository surface and subsurface operations. A key feature of the ACD approach is to allow assumptions regarding requirements, design concepts, and technical data to be made prior to the existence of qualified data. Such assumptions are considered to be of indeterminate quality and, therefore, may require substantiation activities to validate, qualify, and/or determine their suitability as design input. Refer to the CDA Document (CRWMS M&O 1995a) for a discussion of control of assumptions and resolution of key issues.

Assumptions are categorized as key assumptions, requirements assumptions, design concept assumptions, and technical data assumptions. Key assumptions include assumptions identified by Project Engineering and Systems Engineering staff. Requirement assumptions include requirements in the *Repository Design Requirements Document* (RDRD) (YMP 1994a) identified as TBD (to be determined), TBV (to be verified), and TBR (to be resolved). Design concept assumptions include identification of design judgments and/or decisions that have been made to move forward with the design. Design concepts included in the CDA Document (CRWMS M&O 1995a) are typically those that do not have sufficient technical data to support a final decision on the design. Technical data assumptions include data selected from ranges of data specified in the *Reference Information Base* (YMP 1995a) and elsewhere, as necessary, to support the MGDS ACD Report.

4.1 KEY ASSUMPTIONS

Repository key assumptions were identified by the Yucca Mountain Site Characterization Office Repository Project Engineering and Systems Engineering staff. The basic rationale for identifying an assumption as a key assumption is if the assumption involves a highly controversial issue that lacks a clear consensus among the DOE and participants or if the assumption cuts across more than one program element. Key assumptions that impact repository design are shown in Table 4-1.

Table 4-1. Key Assumptions

Description	Key Assumption Identifier	Assumption
Cask Arrival Scenario	001	The cask arrival scenario at the MGDS is as indicated in Table 4-2. Rail shipments total approximately 5,000 (MPC[1] = 4,400; HLW[2] = 600). There is a maximum of three railcars per spent nuclear fuel (SNF) shipment or five railcars per HLW shipment, with one transportation cask per railcar. Truck shipments total approximately 1,000; all uncanistered SNF. The following table is consistent with MGDSRD[3] Table 3-3. Rationale: The original source of data is from Jim Davis, Mark Fleming, John King, and Mark Rose (CRWMS M&O 1995af) and Jim Davis, Mark Fleming, and John King (CRWMS M&O 1995az). The assumption is in accordance with the Nuclear Waste Policy Act, OCRWM Mission Plan (DOE 1991), MPC concept, Proposed Program Approach (DOE 1994b), and MGDSRD and supporting requirements documents.
Waste Form Arrival Scenario	002	The waste form arrival scenario at the MGDS is as indicated in Table 4-3. The following table is consistent with MGDSRD Table 3-3. Rationale: The original source of data is from Jim Davis, Mark Fleming, John King, and Mark Rose (CRWMS M&O 1995af). The assumption is in accordance with the Nuclear Waste Policy Act, OCRWM Mission Plan (DOE 1991), MPC concept, Proposed Program Approach (DOE 1994b), and MGDSRD and supporting requirements documents.

[1] multi-purpose canister

[2] high-level waste

[3] *Mined Geologic Disposal System Requirements Document* (DOE 1995b)

Table 4-1. Key Assumptions (continued)

Description	Key Assumption Identifier	Assumption
Waste Package Emplacement Scenario Note: See Section 8 for a description of waste package	003	The waste package emplacement scenario at the MGDS for the reference thermal load is as indicated in Table 4-4. The table is compatible with the tables in Key Assumptions 001 and 002 for higher thermal loads. Total commercial SNF - 63,000 MTU[4] in about 9,000 MPCs and about 200 uncanistered fuel waste packages. The following table is consistent with MGDSRD Table 3-3. Rationale: The original source of data is from Jim Davis, Mark Fleming, John King, and Mark Rose (CRWMS M&O 1995af). The assumption is in accordance with the Nuclear Waste Policy Act, OCRWM Mission Plan (DOE 1991), MPC concept, Proposed Program Approach (DOE 1994b), and MGDSRD and supporting requirements documents.
Average SNF Characteristics	004	The average SNF characteristics upon receipt at the repository and based on the Oldest Fuel First acceptance strategy, no MRS[5], deferred dry storage, derated canisters, and four truck sites: 26.4 years old with 39.65 Gwd/MTU burnup and 3.68 wt.% enrichment [pressurized water reactor (PWR)]. 26.1 years old with 31.19 Gwd/MTU burnup and 2.97 wt.% enrichment [boiling water reactor (BWR)]. Table 4-5 provides the total repository emplacement decay heat by waste package type as a function of time. Rationale: These data have been provided by Interoffice Correspondence (CRWMS M&O, 1995az). The assumption is in accordance with the Nuclear Waste Policy Act, OCRWM Mission Plan (DOE 1991), MPC concept, Proposed Program Approach (DOE 1994b), and MGDSRD and supporting requirements documents.
Subsurface Waste Package Transport	010	Integrated rail transport will be used for subsurface transport of waste packages. Rationale: The subsurface transport must be capable of handling the current 21 and 12 PWR MPC waste package design.

[4] metric tons of uranium

[5] monitored retrievable storage

Table 4-1. Key Assumptions (continued)

Description	Key Assumption Identifier	Assumption
Horizontal In-Drift Emplacement	011	Waste packages will be emplaced in-drift in a horizontal mode. Rationale: Based on the current 21 and 12 PWR MPC program decision, the borehole emplacement option is impractical. Also, there are benefits in long-term criticality and thermal control associated with this approach.
No Human Entry in Emplacement Drifts Containing Waste Packages	013	No human entry is planned in emplacement drifts while waste packages are present. The waste emplacement/retrieval equipment may use robotics and/or remote control features to perform operations and monitoring within the emplacement drifts. Under off-normal conditions, human entry will be considered if protection to the workers can be provided. Rationale: RDRD (YMP 1994a): Geologic Repository Operations Area (GROA) shall to the extent practicable achieve occupational doses that are As Low As Reasonably Achievable (ALARA). Under off-normal conditions, radiation exposures to workers should be within allowable limits.
Retrievability Period	016	The repository will be designed for a retrievability period of up to 100 years after initiation of emplacement. Rationale: The Engineered Barrier Segment will be designed for a retrievability period of 100 years to be consistent with the repository period of retrievability. This key assumption was developed at a Key Assumption Workshop held in Las Vegas, Nevada, on May 4, 1994 (Letter W. B. Simecka to L. D. Foust, DOE 1994a).
Reasons for Retrieval	017	Retrieval of emplaced waste may be performed for the following reasons: • Failure in site, waste package, or some other system causing an unreasonable risk to public health and safety • The determination that recovery of valuable resources from the SNF is necessary. Rationale: This assumption is consistent with the NWPAA[6] guidance, and Retrievability System Study, September 1994 (CRWMS M&O 1994g).

[6] *Nuclear Waste Policy Amendments Act of 1987*

Table 4-1. Key Assumptions (continued)

Description	Key Assumption Identifier	Assumption
Thermal Load Range	019	Surface, subsurface, and waste package designs will be based on a reference thermal load of 80-100 MTU per acre. The reference thermal load for the MGDS ACD Report is 83 MTU per acre. Rationale: The reference thermal loading was developed at the CDA meeting held in Las Vegas, Nevada, on November 16, 1995 (CRWMS M&O 1995ba). No final decision regarding the design load has been made and flexibility for accommodating higher or lower thermal loads is part of the thermal strategy.
Repository Horizon	022	For the reference thermal loading of 80-100 MTU per acre, the repository horizon will be located mainly in the TSw2[7] geologic unit within the primary area. Rationale: ESFDR[8] states "the ESF Main Test Level shall be constructed at the planned repository horizon, which is currently the TSw2 rock unit." Recent evaluations indicate the TSw1/TSw2 contact is not well defined and some work within the presently defined TSw1 unit is suitable for the emplacement level. Revised assumption provides more flexibility. Primary area is consistent with site characterization activities. Primary area is as defined in *Preliminary Evaluation of the Subsurface Area Available for a Potential Nuclear Waste Repository at Yucca Mountain* (SNL 1984a). The primary area is not rigidly defined. Therefore, rigidly restricting the repository to an arbitrarily defined region is not warranted. Modest crossing of the boundary should be allowed. Assumption is consistent with the thermal strategy reference loading.

[7] Topopah Spring Welded Thermal/Mechanical Unit
[8] *Exploratory Studies Facility Design Requirements (YMP 1995l)*

Table 4-1. Key Assumptions (continued)

Description	Key Assumption Identifier	Assumption
Subsurface Fault Standoff	023	To the extent practical, repository openings will be located to avoid Type 1 faults. For unavoidable Type 1 faults that intersect emplacement drifts, allow a 15-m stand off from the edge of the fault zone to the nearest waste package. Avoidance is assumed to be adequate by using a 60-m offset from the main trace of a fault at the repository level. Exception: 120-m stand off should be used on the west side of the Ghost Dance Fault because the Topopah Spring Main Drift will be excavated before the Ghost Dance Fault characteristics are fully investigated. Rationale: NUREG -1494 (NRC 1994), Staff Technical Position on Consideration of Fault Displacement Hazards in Geologic Repository Design, September 1994. Key Assumption 023, Rev. 01, is a combined version of Key Assumption 023, Rev. 00; Key Assumption 034, Rev. 00; and Key Assumption 035, Rev. 00.

Table 4-1. Key Assumptions (continued)

Description	Key Assumption Identifier	Assumption
Site-Generated Wastes	024	Secondary site-generated waste (low-level, hazardous, mixed, and municipal) will be transported to government-approved off-site facilities for disposal. Temporary accumulations would be accommodated on-site to facilitate treatment of low-level waste, and packaging of all waste types prior to transport to designated facilities. Off-site disposal options are to be assessed. Rationale: Radioactive Waste (RW) policy excludes mixed waste from disposal at MGDS (June 22, 1995, Dreyfus memorandum bounding NEPA[9] analysis to non-RCRA[10] SNF and vitrified HLW) (DOE 1995d). Current planning calls for disposal of all secondary waste forms at off-site facilities. Low-level waste unsuitable for recycling will be collected, treated, and packaged on-site for transport to an off-site government-approved disposal facility. Mixed low-level wastes will be minimized or eliminated through waste minimization programs; if small quantities are generated, they will be collected and packaged on-site for transport to an off-site RCRA-approved treatment, storage, and disposal facility. Hazardous waste will be collected and packaged on-site for transport to an off-site RCRA-approved treatment, storage, and disposal facility. Municipal and construction wastes (non-radioactive, non-hazardous) will be collected in dumpsters for transport to state-permitted landfills.

[9] *National Environmental Policy Act of 1969*

[10] *Resource Conservation and Recovery Act*, 42 USC 6901-6987

Table 4-1. Key Assumptions (continued)

Description	Key Assumption Identifier	Assumption
Mechanical Tunnel Excavation	027	The primary method of tunnel excavation will be mechanical. Rationale: 10 CFR 60.133e(2): Openings shall be designed to reduce deleterious rock movement. 10 CFR 60.133(f): Use excavation methods that limit potential for creating preferential pathways for groundwater. NUREG 1347, Comment 132 (NRC 1989a): Compare the alternatives of drilling and blasting and mechanical excavation methods. Nuclear Waste Technical Review Board's (NWTRB) First Report to Congress (NWTRB 1990): Maximize use of the most modern mechanical excavation techniques in studies of tunnel excavation methods. Results of the ESF Alternative Study (SNL 1991) recommended mechanical excavation.
Tunnel Drill-and-Blast Option	028	Where it is impractical to use mechanical methods, drill-and-blast may be used to a limited degree primarily in non-emplacement areas of the repository. Rationale: 10 CFR 60.133e(2): Openings shall be designed to reduce deleterious rock movement. 10 CFR 60.133(f): Use excavation methods that limit potential for creating preferential pathways for groundwater. NUREG 1347, Comment 132 (NRC 1989a): Compare the alternatives of drilling and blasting and mechanical excavation methods. NWTRB First Report to Congress (NWTRB 1990): Maximize use of the most modern mechanical excavation techniques in studies of tunnel excavation methods. Results of the ESF Alternative Study (SNL 1991) recommended mechanical excavation.
Underground Rail Transport of Personnel and Supplies	030	Rail will be used for transporting underground supplies and personnel to the extent practical. Rationale: Rail system is compatible with handling of the current 21 and 12 PWR MPC waste package. Rail system is well-suited to in-drift emplacement mode. Ideal for supplying tunnel boring machine (TBM) operation and transportation of personnel. Repository subsurface gradient will allow use of rail system. Highly suitable for remote handled or automated operations.

Table 4-1. Key Assumptions (continued)

Description	Key Assumption Identifier	Assumption
Waste Package Shielding	031	A. Waste package containment barriers will provide sufficient shielding for protection of waste package materials from radiation-enhanced corrosion. B. Individual waste packages will not provide any additional shielding for personnel protection. C. Additional shielding for personnel protection will be provided on the subsurface transporter and in surface and subsurface facilities. Rationale: The cost, size, and weight of an individually shielded waste packages may be excessive; therefore, MGDS will meet ALARA requirement with more cost-effective shielding options. Personnel radiation protection from individual waste packages will be provided through the use of: (1) Remote handling equipment in the assembly and emplacement areas (2) A shielded waste package transporter during emplacement operations (3) Shielding and seals at the entrances to the emplacement drifts.
Backfill in Emplacement Drifts	046	Current design assumes no backfill in emplacement drifts. Options for backfill will be considered based on ongoing and future backfill studies. Rationale: No performance credit is currently allocated to backfill (since no backfill is assumed). Waste package will be designed to withstand expected rockfall during the substantially complete containment period. Potentially difficult and expensive to emplace a backfill. Backfill consisting of excavated or new materials will be evaluated to determine possible negative attributes including the potential to add thermal insulation, the potential to cause crevice corrosion, and potential to act as a water wick.

Table 4-1. Key Assumptions (continued)

Description	Key Assumption Identifier	Assumption
Backfill in Emplacement Drifts (continued)	046	Backfill consisting of excavated or new materials will be evaluated to determine the effectiveness of backfill to provide a capillary barrier, to control relative humidity at the waste package surface, to spread the flow of water and provide a drip barrier, to provide a diffusion barrier, to provide a retardation barrier for the transport of radionuclides, to provide structural protection to the waste package, and to provide a chemical barrier (before and/or after water enters/exits the waste package). Backfill requirements will be established once values and characteristics of the backfill are well understood.
Surface Facilities Location	047	The proposed repository waste handling and administrative surface facilities will be located adjacent to the North Portal. Rationale: SCP-CDR[11] proposed the location of the central surface facilities at the entrance to the waste ramp portal. Northern Midway Valley is more likely to contain an area demonstrably free of late Quaternary surface faults. The ESF alternatives study recommended relocation of the waste and tuff ramps portals based on Option 30 findings. The current technical baseline identifies a North and South Portal locations in accordance with the ESF enhanced configuration. The ESF is presently located at the entrance to the north portal. The South Portal will have a steeper ramp grade (2.57%) compared to the North Portal ramp (2.15%). Planned site improvements for the ESF can be used for the proposed repository surface facilities.

[11] *Site Characterization Plan Conceptual Design Report* (SNL 1987)

Table 4-1. Key Assumptions (continued)

Description	Key Assumption Identifier	Assumption
Addition of Filler Material at the Repository	052	Table 4-6 provides a scenario for receipt of first procurement MPCs that may have to be opened each year at the repository for the insertion of reactivity control additives. The table may be used to provide an upper bound for abnormal MPCs requiring remedial operations at the repository. Rationale: Based on programmatic guidance documented in (CRWMS M&O 1995bb), verification assumptions made in that memo and complete execution of the direction, this assumption should provide an upper bound on the number of MPCs needing remedial operations at the repository. The table is based on several considerations: (1) the assumption that five years of MPCs from the first procurement could be deployed and loaded with fuel that may not meet final disposal requirements on MPCs; (2) several criticality control-related activities must occur before disposal requirements on MPCs could be finalized (e.g., completion of the Disposal Criticality Control Topical Report, approval of a Burnup Credit Topical report that would include principal isotopes (including some fission products) and completion of basket material corrosion testing; (3) the analysis in the memo indicated below. Based on these assumptions and this analysis, 113 of the first procurement MPCs will require additional criticality control measures. This number was determined by comparing each of the 544 individual MPC k_{∞} values with an estimated value that reflected the demarcation point between those MPCs that should be opened and those that did not have to be opened. This estimated value, which assumes principal isotope burnup credit and no credit for engineered neutron absorbers, varied depending on whether the MPC being evaluated was large or small, and whether it contained BWR or PWR assemblies. This analysis is described in detail in the memo from M.A. Balady, "Update to Rationale for Selection of First Procurement MPCs to be Opened" (CRWMS M&O 1995bc). The reopening of MPCs will be an off-normal operation. Adding filler additives or other reactivity control additives will also be considered an off-normal operation.

Table 4-1. Key Assumptions (continued)

Description	Key Assumption Identifier	Assumption
Off-Normal Waste Handling Building (WHB) Capability	053	The MGDS shall have the capability to handle any abnormal MPCs and other canistered waste forms that require remedial processing. Such processing may include opening the canister, transferring the waste form, adding filler material, and resealing. Rationale: Since this MGDS requirement excludes other methods of opening an MPC except for cutting it open, it is assumed that this requirement pertains to MPCs intended not to be opened. Also, the referenced 10 CFR 60 and *CRWMS Requirements Document* (DOE 1995a) sections are off-normal headings. Therefore, this requirement applies to an off-normal occurrence. The justification for moving the spent fuel assembly in and out or even resealing an MPC before being sealed into a waste package is not clear. The importance of undamaged waste is also unclear. Surface design will provide for the area necessary to open an MPC, based on the assumption that this analysis either exists or will be provided. Opening an MPC is considered an off-normal occurrence. A separate cell is proposed to prevent special operations from interfering with normal waste handling operations. It is assumed that, until better defined, the probable equipment and systems (such as cutter, welder, and bare fuel handler) in the special operations cell for uncanistered fuel assembly casks and performance confirmation will accommodate the mitigation needs of an off-normal MPC. This special operations cell will need to be adaptable to multiple functional roles for one-time or low-volume events. Probable events and best remedial methodology will need to be investigated before operations and equipment can be defined for this area. Programmatic guidance defines an approach where filler material may be unnecessary (CRWMS M&O 1995bb).

Table 4-1. Key Assumptions (continued)

Description	Key Assumption Identifier	Assumption
Normal WHB Capability (No Filler Material)	054	The design for the WHB MPC standard handling operations is based on no capability to add filler material to MPCs at the repository. The addition of filler material to first procurement MPCs will be performed as an off-normal operation in accordance with Key Assumption 053. Rationale: Programmatic guidance defines an approach where filler material may be unnecessary (CRMWS M&O 1995bb). Since the initial MPC deployment would occur in the years prior to the opening of the repository, those MPCs would be held in some temporary storage yet to be defined. Therefore, it is reasonable to administratively control the shipment of these early MPCs, spreading them evenly over the long duration of repository waste handling operations. They could then be handled as off-normal units that would not interfere with the normal flow of modern MPCs through the WHB operations. A separate cell for accommodating unusual or off-normal operations is presently planned (see Key Assumption 053). Such limited operations could include performance confirmation examinations, bare fuel assembly handling, and opening damaged MPCs. When the modification criteria for these early MPCs are established, this off-normal operation cell design could be modified to correct the MPC as required (filler material, repack, etc.).
Retrieval Demonstration	055	Proof-of-principle demonstrations of waste package retrieval will be conducted following license application. The proof-of-principle demonstration is consistent with the DOE position as stated in Appendix D, "Department of Energy Position of Retrievability for a Geologic Repository," of the Generic Requirements Document for a Mined Geologic Disposal System (OGR/B-2) (DOE 1987c).
Interim Fuel Storage	056	The repository will interface with an interim storage facility located outside the State of Nevada. Rationale: Interim storage is a Congressional program requirement.
Burnup Measurements	057	Burnup measurements of bare uncanistered SNF assemblies, if required at the repository, will be performed non-destructively. Rationale: Burnup measurements of SNF in MPCs will be performed, if required, at purchaser sites. Surface repository will not have the facilities to perform destructive testing. This assumption is based on the future successful development of radiation-based non-destructive measurement equipment.

Table 4-1. Key Assumptions (continued)

Description	Key Assumption Identifier	Assumption
Transportation Mode/Route within Nevada	058	SNF and HLW arriving in Nevada on main line commercial rail lines will be transported to the repository via rail. Rail routes being considered are described in the *Nevada Potential Repository Preliminary Transportation Strategy, Study 2* (CRWMS M&O 1995ax). For costing purposes, four of the routes being considered will be evaluated using a straight average. The four routes to be averaged are (1) Caliente-base route, (2) Carlin-Monitor Valley via Ralston, (3) Valley Modified-via Indian Hills, and (4) Jean-Wilson Pass Option via Stewart Valley. Rationale: These were the least expensive options from the four rail corridors being considered according to the findings of the *Nevada Potential Repository Preliminary Transportation Strategy, Study 2* (CRWMS M&O 1995ax). Using the average of four routes is consistent with the position that the route will be selected once the NEPA process is concluded. It is noted that no decision has been made relative to the transportation mode. The heavy haul transportation mode remains an option. The final decision can be made only in accordance with the NEPA process.

Table 4-1. Key Assumptions (continued)

Description	Key Assumption Identifier	Assumption
MGDS Architecture	059	The configuration item groups (CIGs) of the repository (surface and subsurface) are organized as shown: Surface Repository - Site Preparation Systems - Site Transportation Systems - Site Utilities Systems - Waste Handling Facilities - Operational Support Facilities - General Support Facilities - Surface Closure - Off-site Utilities - Off-site Transportation Subsurface Repository - UG[12] Excavated Openings - UG Support Facilities - UG Utilities Systems - UG Ventilation Systems - UG Shielding Equipment/Systems - UG Waste Package Handling Equipment - UG Operations Support Systems - UG Closure - UG Performance Confirmation Systems - UG Construction Equipment and Temporary Facilities Rationale: The CIGs are based on ACD development and configuration management.

[12] Underground

Table 4-2. Transportation Cask Arrival Scenario

Key 001	Transportation Cask Arrival Scenario								
Cask Contents	MPC					Uncanistered Fuel Assemblies		HLW Canister	Total Casks per Year
Cask Designation	B-LG	P-LG	B-SM	P-SM	B-IN-P	B-LWT	P-LWT	HLW	
Year*	Number of Transportation Casks**								
1	24	12	11	5	0	1	9	0	62
2	20	21	43	26	2	0	25	0	137
3	28	61	80	22	1	1	64	0	257
4	63	116	88	31	2	0	52	0	352
5	120	163	87	34	4	0	72	0	480
6	88	179	111	43	3	1	54	159	638
7	100	190	76	36	3	0	69	161	635
8	106	189	87	34	2	0	54	160	632
9	98	212	62	28	4	0	43	160	607
10	101	196	54	37	1	0	48	159	596
11	98	206	46	46	2	0	29	160	587
12	102	193	72	29	2	0	40	160	598
13	105	211	39	40	2	0	55	160	612
14	113	187	59	37	3	0	29	161	589
15	116	204	62	18	1	0	36	160	597
16	86	210	61	38	0	0	33	160	588
17	111	201	40	29	8	0	57	159	605
18	119	202	63	28	0	0	10	160	582
19	100	206	47	40	0	0	60	160	613
20	98	205	74	33	0	0	37	160	607
21	123	191	56	41	0	0	41	37	489
22	139	185	49	33	0	0	23	87	516
23	115	182	84	34	0	0	57	83	555
24	69	119	54	23	0	0	29	0	294
Total Casks	2,242	4,041	1,505	765	40	3	1,026	2,606	12,228

* Year of MGDS Operation

** Cask quantities are the number of unit casks arriving; they do not necessarily imply that each cask is fully loaded.

Table 4-2. Transportation Cask Arrival Scenario (continued)

<table>
<tr><td colspan="3">Key 001 Legend</td></tr>
<tr><td rowspan="5">MPC</td><td>B-LG</td><td>Transportation cask that holds a large BWR MPC containing a maximum of 40 assemblies</td></tr>
<tr><td>P-LG</td><td>Transportation cask that holds a large PWR MPC containing a maximum of 21 assemblies</td></tr>
<tr><td>B-SM</td><td>Transportation cask that holds a small BWR MPC containing a maximum of 24 assemblies</td></tr>
<tr><td>P-SM</td><td>Transportation cask that holds a small PWR MPC containing a maximum of 12 assemblies</td></tr>
<tr><td>B-IN-P</td><td>Transportation cask that holds a small PWR MPC containing a maximum of 12 Big Rock Point assemblies</td></tr>
<tr><td rowspan="2">Uncanistered Fuel Assemblies</td><td>B-LWT</td><td>GA-9 transportation cask that holds a maximum of 9 BWR assemblies</td></tr>
<tr><td>P-LWT</td><td>GA-4 transportation cask that holds a maximum of 4 PWR assemblies</td></tr>
<tr><td>HLW Canister</td><td>HLW</td><td>Transportation cask that holds a maximum of 5 defense or commercial HLW canisters</td></tr>
<tr><td colspan="3">Base Case Waste Stream, 2010 MGDS, oldest fuel first (OFF) with Deferred Dry Storage, Derated Canisters, 4 Truck Sites</td></tr>
</table>

Table 4-3. Waste Form Arrival Scenario

Key 002	Waste Form Arrival Scenario								
Waste Form (WF)	MPC					Uncanistered Fuel Assemblies		HLW Canister	Total Waste Form Units per Year
WF Designation	B-LG	P-LG	B-SM	P-SM	B-IN-P	B-LWT	P-LWT	HLW	
Max WF Units per Transp. Cask	1	1	1	1	1	9	4	5	
Year*	Number of Waste Form Units								
1	24	12	11	5	0	1	36	0	89
2	20	21	43	26	2	0	100	0	212
3	28	61	80	22	1	4	253	0	449
4	63	116	88	31	2	0	208	0	508
5	120	163	87	34	4	0	288	0	696
6	88	179	111	43	3	2	213	795	1,434
7	100	190	76	36	3	0	276	805	1,486
8	106	189	87	34	2	0	216	800	1,434
9	98	212	62	28	4	0	172	800	1,376
10	101	196	54	37	1	0	192	795	1,376
11	98	206	46	46	2	0	116	800	1,314
12	102	193	72	29	2	0	153	800	1,351
13	105	211	39	40	2	0	191	800	1,388
14	113	187	59	37	3	0	112	805	1,316
15	116	204	62	18	1	0	118	800	1,319
16	86	210	61	38	0	0	111	800	1,306
17	111	201	40	29	8	0	188	795	1,372
18	119	202	63	28	0	0	40	800	1,252
19	100	206	47	40	0	0	185	800	1,378
20	98	205	74	33	0	0	110	800	1,320
21	123	191	56	41	0	0	130	185	726
22	139	185	49	33	0	0	62	435	903
23	115	182	84	34	0	0	188	408	1,011
24	69	119	54	23	0	0	61	0	326
Total Handling Units	2,242	4,041	1,505	765	40	7	3,719	13,023	25,342

* Year of MGDS Operations

Table 4-3. Waste Form Arrival Scenario (Continued)

Key 002 Legend		
MPC	B-LG	Large BWR MPC containing a maximum of 40 assemblies
	P-LG	Large PWR MPC containing a maximum of 21 assemblies
	B-SM	Small BWR MPC containing a maximum of 24 assemblies
	P-SM	Small PWR MPC containing a maximum of 12 assemblies
	B-IN-P	Small PWR MPC containing a maximum of 12 Big Rock Point assemblies
Uncanistered Fuel Assemblies	B-LWT	BWR assembly
	P-LWT	PWR assembly
HLW Canister	HLW	Defense or commercial HLW canister
Base Case Waste Stream, 2010 MGDS, OFF with Deferred Dry Storage, Derated Canisters, 4 Truck Sites		

Table 4-4. Waste Package Emplacement Scenario

Key 003	Waste Package Emplacement Scenario								
WP Content	MPC					Uncanistered Fuel Assemblies		HLW Canister	Total Waste Pkgs per Year
WP Content Designation	B-LG	P-LG	B-SM	P-SM	B-IN-P	B-LWT	P-LWT	HLW	
Max Waste Form Units per WP	1	1	1	1	1	40	21	4	
Year*	Number of Waste Packages**								
1	24	12	11	5	0	1	1	0	54
2	20	21	43	26	2	0	5	0	117
3	28	61	80	22	1	1	12	0	205
4	63	116	88	31	2	0	10	0	310
5	120	163	87	34	4	0	14	0	422
6	88	179	111	43	3	1	10	199	634
7	100	190	76	36	3	0	13	202	620
8	106	189	87	34	2	0	10	200	628
9	98	212	62	28	4	0	8	200	612
10	101	196	54	37	1	0	10	199	598
11	98	206	46	46	2	0	5	200	603
12	102	193	72	29	2	0	7	200	605
13	105	211	39	40	2	0	10	200	607
14	113	187	59	37	3	0	5	202	606
15	116	204	62	18	1	0	6	200	607
16	86	210	61	38	0	0	5	200	600
17	111	201	40	29	8	0	9	199	597
18	119	202	63	28	0	0	2	200	614
19	100	206	47	40	0	0	9	200	602
20	98	205	74	33	0	0	6	200	616
21	123	191	56	41	0	0	7	47	465
22	139	185	49	33	0	0	4	109	519
23	115	182	84	34	0	0	10	102	527
24	69	119	54	23	0	0	4	0	269
Total WPs	2,242	4,041	1,505	765	40	3	182	3,259	12,037

* Year of MGDS operation

** For UCF and HLW packages, numbers are rounded up; WP may not be fully loaded

Table 4-4. Waste Package Emplacement Scenario (Continued)

Key 003 Legend		
MPC	B-LG	Waste package that holds a large BWR MPC containing a maximum of 40 assemblies
	P-LG	Waste package that holds a large PWR MPC containing a maximum of 21 assemblies
	B-SM	Waste package that holds a small BWR MPC containing a maximum of 24 assemblies
	P-SM	Waste package that holds a small PWR MPC containing a maximum of 12 assemblies
	B-IN-P	Waste package that holds a small PWR MPC containing a maximum of 12 Big Rock Point assemblies
Uncanistered Fuel Assemblies	B-LWT	UCF waste package that holds a maximum of 40 BWR assemblies
	P-LWT	UCF waste package that holds a maximum of 21 PWR assemblies
HLW Canister	HLW	Waste package that holds a maximum of 4 defense or commercial HLW canisters
Base Case Waste Stream, 2010 MGDS, OFF with Deferred Dry Storage, Derated Canisters, 4 Truck Sites		

Table 4-5. Repository Total Heat Output

FY95CDAO - OFF, DERATE, DEFERRED DRY STORAGE, 4 TRUCK SITES MGDS TOTAL HEAT OUTPUT [MW]										
Year*	Total REP	Total BWR	Total PWR	B-LWT	P-LWT	B-LG	P-LG	B-SM	P-SM	B-IN-P
0	62.96	20.27	43.68	0.00	1.56	15.29	37.22	4.95	3.90	0.03
10	52.03	16.75	35.28	0.00	1.31	12.56	30.75	4.17	3.22	0.03
20	44.14	14.24	29.90	0.00	1.11	10.65	26.06	3.57	2.72	0.02
30	37.92	12.25	25.67	0.00	0.96	9.15	22.39	3.09	2.33	0.02
40	33.00	10.71	22.29	0.00	0.84	7.98	19.44	2.71	2.02	0.02
50	29.04	9.44	19.60	0.00	0.74	7.02	17.09	2.41	1.77	0.02
60	25.84	8.42	17.42	0.00	0.65	6.26	15.19	2.15	1.57	0.01
70	23.20	7.60	15.61	0.00	0.59	5.63	13.62	1.96	1.40	0.01
80	21.11	6.94	14.17	0.00	0.54	5.13	12.37	1.79	1.27	0.01
90	19.34	6.37	12.96	0.00	0.49	4.71	11.31	1.66	1.16	0.01
100	17.92	5.93	11.99	0.00	0.46	4.37	10.47	1.55	1.07	0.01
200	11.26	3.78	7.48	0.00	0.28	2.76	6.55	1.01	0.65	0.01
300	8.92	3.01	5.91	0.00	0.22	2.19	5.17	0.81	0.51	0.01
400	7.52	2.54	4.99	0.00	0.19	1.84	4.36	0.69	0.43	0.00
500	6.52	2.20	4.33	0.00	0.16	1.60	3.79	0.60	0.38	0.00
600	5.73	1.93	3.80	0.00	0.14	1.40	3.33	0.52	0.33	0.00
700	5.11	1.71	3.40	0.00	0.13	1.24	2.97	0.47	0.30	0.00
800	4.58	1.53	3.05	0.00	0.12	1.11	2.67	0.42	0.27	0.00
900	4.15	1.38	2.77	0.00	0.11	1.00	2.42	0.38	0.24	0.00
1000	3.79	1.26	2.54	0.00	0.10	0.91	2.22	0.34	0.22	0.00
2000	2.03	0.65	1.38	0.00	0.05	0.48	1.20	0.18	0.12	0.00
3000	1.58	0.50	1.08	0.00	0.04	0.36	0.95	0.14	0.10	0.00
4000	1.41	0.44	0.97	0.00	0.04	0.32	0.84	0.12	0.09	0.00
5000	1.32	0.41	0.90	0.00	0.04	0.30	0.79	0.11	0.08	0.00
6000	1.22	0.38	0.83	0.00	0.03	0.28	0.73	0.10	0.07	0.00
7000	1.14	0.36	0.78	0.00	0.03	0.26	0.68	0.10	0.07	0.00
8000	1.07	0.34	0.73	0.00	0.03	0.24	0.64	0.09	0.06	0.00
9000	1.01	0.32	0.69	0.00	0.03	0.23	0.60	0.09	0.06	0.00
10000	0.96	0.30	0.65	0.00	0.03	0.22	0.57	0.08	0.06	0.00

Notes: Total BWR column is the sum of B-LWT + B-LG + B-SM + B-IN-P
Total PWR column is the sum of P-LWT + P-LG + P-SM
Total REP column is the sum of Total BWR + Total PWR

* Time scale is based on the collapse technique (see Rationale). Time 0 is emplacement time; however, time dating is inaccurate for 0-100 year and more accurate for longer term calculations.

Table 4-6. First MPC Procurement Requiring Opening at Repository, No MRS, 2010 MGDS, Off (FY95DAO)

Years*	MPCs					Total
	B-LG	P-LG	B-SM	P-SM	B-in-P	
1	0	0	0	3	0	3
2	0	0	0	3	0	3
3	0	0	0	4	0	4
4	0	1	0	7	0	8
5	0	5	0	1	0	6
6	0	4	0	0	0	4
7	0	6	0	3	0	4
8	0	0	1	0	0	1
9	0	10	0	0	0	10
10	0	6	0	1	0	7
11	0	1	0	7	0	8
12	0	18	0	0	0	18
13	0	6	0	0	0	6
14	0	1	0	0	0	1
15	0	1	0	0	0	1
16	0	9	0	0	0	9
17	0	8	0	0	0	8
18	0	4	0	0	0	4
19	0	4	0	0	0	4
20	0	3	0	0	0	3
21	0	0	0	0	0	0
22	0	0	0	0	0	0
23	0	0	0	0	0	0
24	0	0	0	0	0	0
Total	0	87	1	29	0	117

*Years of MGDS operation
BASIS (CRMWS M&O 1995af)

Program Approach scenario (No MRS).

First procurement MPCs in the five-year period 1998-2002 are loaded with OFF and placed in reactor dry storage.

Pickup from dry storage is deferred until no fuel older than 10 years remains in spent fuel pools.

Pickup from only four trucks (no-rail) purchasing utilities is assumed.

Waste package heat limit for emplacement is 14.2 kW.

Transportation casks are derated as shown.

Cask Derating

Operation	MPC Heat Limits (kW)			
	B-LG	P-LG	B-SM	P-SM
Storage	17.60	23.90*	10.56	13.68
Transportation	12.0	14.20	7.20	8.76
Emplacement	14.20	14.20	14.20	14.20

See Key Assumptions 001 to 003 for legend.

*17.85 kW used at various sites for post-shutdown dry storage.

4.2 REPOSITORY DESIGN REQUIREMENTS DOCUMENT ASSUMPTIONS

The assumptions for requirements in the RDRD (YMP 1994a) identified as TBD (to be determined), TBV (to be verified), and TBR (to be resolved) are provided in Table 4-7. Appropriate requirements assumptions are provided for surface and subsurface repository in the sections that follow.

Table 4-7. Requirements Assumptions

Description	RDRD Assumption Identifier	Assumption
Waste Receiving Schedule	RDRD 3.2.1.2.B	Design of waste handling operations are presently based on tables in Key Assumptions 001, 002, 003, and 052. Rationale: Key Assumptions 001, 002, 003, and 052 contain the latest and most accurate data available; they are being used by Surface Design to proceed with waste handling design. Further updates are expected.
Disposal System Postclosure Performance	RDRD 3.2.1.6.C	The disposal system shall be designed to 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 have a likelihood of less than one chance in 10 of exceeding the quantities calculated according to Table A-1 of Appendix A of 40 CFR 191; and have a likelihood of less than one chance in 1,000 of exceeding 10 times the quantities calculated according to Table A-1 of Appendix A of 40 CFR 191. Rationale: The removal of the "TBR" does not change the basic concept of the MGDS design to be compatible with specific long-term (10,000 years) performance goals. Thus, the MGDS design must complement, or at least not adversely impact, those goals set in 40 CFR 191, Appendix A, and elsewhere, such as 10 CFR 960.4-2-1; 10 CFR 960.4-2-7; and 10 CFR 960.5-2-11.
Physical Barriers	RDRD 3.2.1.6.D	Facilities shall be provided to support active institutional controls at the repository site, including physical barriers to human intrusion. Facilities to maintain the institutional controls and physical barriers shall also be provided. Rationale: Logic says the apparent wording was not what was intended. Physical barriers to maintenance facilities make no sense. Detail beyond the need for such facilities and barriers is not deemed necessary for ACD.

Table 4-7. Requirements Assumptions (continued)

Description	RDRD Assumption Identifier	Assumption
Emplacement Concept	RDRD 3.2.3.2.2.A.7	The Repository Segment shall accommodate the emplacement concept selected during ACD. Rationale: The requirement as stated is valid without the TBD. There is no need for the RDRD to specify what that emplacement method will be. The method will be determined during ACD.
Repository Layout to Limit Waste Package-Water Contact	RDRD 3.2.3.2.2.A.11.a	The repository layout shall be designed so that a combination of characteristics will limit the amount of liquid water allowed to come into contact with the waste packages consistent with the requirement that, at most, 1% of the waste packages will be breached at a 1,000 years and that the mean time to breaching is well in excess of 1,000 years. Rationale: The requirement, as written, supports the concept of substantially complete containment developed as a Key Assumption at a Key Assumption Workshop held in Las Vegas, Nevada, on May 4, 1994 (Letter W.B. Simecka to L.D. Foust, DOE 1994a). (Key Assumptions 037 and 038 of this document.)
Non-Potable Water	RDRD 3.2.3.4.B	The Repository Segment will connect with the existing NTS[13] water supply system. Rationale: Use existing water supply system.
Telephone Communications	RDRD 3.2.3.4.D	The Repository Segment shall connect to the existing NTS telephone system. Rationale: DOE/NTS Standard Operating Procedure Chapter 5301, Telecommunications, defines the responsibilities and interfaces for all aspects of telecommunications at the Nevada Test Site. RDRD requirement 3.2.3.4.D is consistent with current policy. See the following: YMP-FOI-5301, Field Telecommunications NTS-SOP-5301, Telecommunications NTS-SOP-5302, Telecommunications – Radio Utilization Program

[13] Nevada Test Site

Table 4-7. Requirements Assumptions (continued)

Description	RDRD Assumption Identifier	Assumption
Special Sources of Groundwater	RDRD 3.7.1.C	There are no special sources of groundwater at Yucca Mountain as defined in 40 CFR 191.12(0); therefore, the requirements of 40 CFR 191.16 do not impact Yucca Mountain. Rationale: "Special source of groundwater" is defined in 40 CFR 191.12(o) as those Class I groundwaters identified in the EPA's Groundwater Protection Strategy that: (1) are within the repository controlled area or are less than 5 km beyond the controlled area; (2) are supplying drinking water for thousands of persons near Yucca Mountain; and (3) are irreplaceable in that no reasonable alternative of drinking water is available to that population. The conditions that must be met for designation as a Class I source are that the source is irreplaceable in that no reasonable alternative is available to substantial populations or that the source is ecologically vital in that it provides baseflow to a sensitive ecological system. If it is determined that there are no special sources of water at or near Yucca Mountain, the requirements of 40 CFR 191.16 will not impact the project. Based on preliminary investigations at the site, there do not appear to be any special sources of water at the site, below the site, within the boundaries of the controlled area, or within 5 km of the controlled area boundary (see Section 8.3.5.1.5 of the SCP[14] for a discussion of special sources of groundwater, and Page 8.3.5.15-6 for a discussion of preliminary findings). Therefore, based on these findings, it is assumed that the requirements of 40 CFR 191.16 will not impact Yucca Mountain.
General Underground Lighting	RDRD 3.7.3.5.A.1	General lighting for underground shall meet OSHA[15] and MSHA[16] codes. Rationale: Setting numerical limits for underground lighting should not be in the RDRD. Those limits are established in building codes governing underground construction, as well as MSHA and OSHA requirements, and MIL-STD-1472D.[17]

[14] *Site Characterization Plan* (DOE 1988a)

[15] Occupational Safety and Health Administration

[16] Mine Safety and Health Administration

[17] HFE Design Criteria for Military Systems, Equipment, and Facilities

Table 4-7. Requirements Assumptions (continued)

Description	RDRD Assumption Identifier	Assumption
Underground Service Facilities Lighting	RDRD 3.7.3.5.A.2	General lighting for underground service facilities not related to waste handling or security shall meet OSHA and MSHA codes. Rationale: Setting numerical limits for underground lighting should not be in the RDRD. Those limits are established in building codes governing underground construction, as well as MSHA and OSHA requirements and MIL-STD-1472D.
Site-Generated Hazardous Waste	RDRD 3.7.3.9.E	Hazardous waste will be collected and packaged on-site for transport to an off-site RCRA-approved treatment, storage, and disposal facility. Rationale: This assumption is needed to document the requirement to provide compliance with appropriate DOE requirements involving the handling of nonradioactive hazardous wastes. The quantities of this waste will be determined during the course of the ACD. See related Key Assumption 024.
Storage Capacity for Waste Receipts	RDRD 3.7.4.1.A.2	The corresponding RDRD requirement is deleted (based on RDRD - 3.7.4.1.A.3 assumption). Rationale: Requirement for surface facility holding or buffer areas will determine the capacity of waste handling facility or other facility storage requirements. No need for requirement. See Rationale for Assumption RDRD 3.7.4.1.A.3

Table 4-7. Requirements Assumptions (continued)

Description	RDRD Assumption Identifier	Assumption
Waste Handling Holding Areas	RDRD 3.7.4.1.A.3	Waste handling facilities shall have buffer or holding areas at certain steps spread out within these operations. These areas will have sufficient capacity so that in the event of an unplanned stoppage, operations may be completed to a reasonable safety shutdown condition. This includes the receipt of in-transit casks, emptying casks, filling and sealing disposal containers, and decontaminating and emptying cask dispatch. Rationale: The term "storage" has many connotations on this project. Capacity to receive unlimited off-site waste has significant design impact, which cannot be necessarily met at this time. Until other criteria is established to limit this capacity, this assumption defines the limit as that waste that is in-processing or in-transit to reduce the need to reverse an operation as a result of a stoppage anywhere in the MGDS. "Buffer" capacity is needed to provide "surge" in the process activities and to maintain steady process flow in the overall system. Because the NWPA does not permit extensive, long-term, interim storage at the repository, this assumption interprets any reference to storage in surface facilities as a short-term holding area for steady process flow and for safe, unplanned stoppages. Holding area capacities will be determined by design process flow simulations.
Underground Air Supply	RDRD 3.7.5.B.6	Supply air to and exhaust adequate quantities of air to and from underground working areas such that operator safety, health, and productivity requirements are maintained. Rationale: The requirement as stated is valid without the TBD. The air quantity is architecture and operations dependent and does not belong in the RDRD.
Shaft Size	RDRD 3.7.5.N.5	If shafts are used, the shaft size shall be determined by the size of the conveyances needed to move materials, personnel, and equipment underground; the volume of ventilation flow needed; and the space required for utility lines. Rationale: The requirement as stated is valid without the TBD. The requirement gives the criteria for determining the shaft size; it need not also give the shaft size or the areas required for the items used to determine the shaft size. These will be determined during design and are architecture and operations dependent.

4.3 DESIGN CONCEPT ASSUMPTIONS

Design concept assumptions for the surface and subsurface repository are identified in Table 4-8 as DCS and DCSS, respectively. The appropriate design concept assumptions are provided for surface and subsurface repository in the sections that follow.

Table 4-8. Design Concept Assumptions

Description	Design Concept Identifier	Assumption
MGDS Operational Center	DCS 001	A future MGDS operational center will be required to maintain communications with the transportation network, maintain inventories, and support security and safeguards requirements. This center will be located at the repository.
Occupational Exposure Limits	DCS 003	Surface facilities housing radioactive materials or in which work is performed on radioactive materials will be designed to control occupational exposures to ALARA and less than 500 millirem per year.
ALARA Studies	DCS 004	ALARA studies will be conducted as needed to establish the allowable dose rates upon which various radiological safety calculations will be based.
One WHB	DCS 005	WHBs 1 and 2 in the SCP-CDR will be consolidated into a single structure.
Waste Treatment Building (WTB)	DCS 007	A WTB will be incorporated into the GROA to treat solid and liquid low-level radioactive wastes in preparation for transport to a government-approved off-site facility for treatment, storage, and disposal.
Decontamination Equipment and Space	DCS 008	Necessary equipment and space required for decontamination will be provided in each building where contamination will be present.
Hazardous Waste Disposal	DCS 010	Hazardous waste will be accumulated and staged for up to 90 days at the source of generation. These wastes will be periodically transported to an RCRA-approved off-site treatment, storage, and disposal facility. Subsurface hazardous wastes will be collected at a surface staging area outside the radiologically controlled area (RCA).
Underground Waste Generation	DCS 011	Significant quantities of secondary mixed or low-level radioactive wastes will not be generated by underground emplacement operations.
No HLW in Waste Treatment Building	DCS 012	The WTB will not process secondary transuranic or HLW. If such waste materials are generated, they will be packaged at the point of generation and disposed in the underground emplacement area via the WHB.

Table 4-8. Design Concept Assumptions (continued)

Description	Design Concept Identifier	Assumption
Waste Generated by Performance Confirmation Activities	DCS 013	Waste quantities generated by the performance confirmation operations will be: • Negligible during the construction/emplacement phase of the MGDS. • Less during the caretaker phase than the waste quantities generated during the construction/emplacement phase normal and off-normal operations. As a result, wastes generated by the performance confirmation operations will not impact the design of the WTB.
Cask Maintenance Operation	DCS 014	Cask maintenance facilities may be integrated into facilities rather than in a separate, standalone structure.
Transportation Cask Fleet Inventory	DCS 015	The cask fleet inventory is based on a sealed canister system (MPC or dual purpose) and consists of a maximum of 12 truck casks and 72 rail casks.
Transportation Cask Fleet Maintenance Frequency	DCS 016	Maintenance requirements for the transportation fleet (as identified in DCS 015) will be comparable to those for existing casks. • Each truck cask is serviced a maximum of three times per year. During one visit, the cask system certificate of compliance inspection is performed. • Each rail cask is serviced once per year during the certificate of compliance inspection.
Repository Layout-Orientation	DCSS 001	Repository layout - preferred orientation: • Orientation of emplacement drifts will be at least 30 degrees from dominant joint orientations. Using the latest information on joint orientations, the emplacement drift orientation will generally fall between N70W and S75W. • Orientation of maintainable access drifts, mains, ramps, etc., will be as needed to complement emplacement drift orientation, generally forming intersections of 70 to 90 degrees where practicable. Repository layout - contingency orientation: • Contingency layouts not meeting the preferred orientations are required in case substantiation of TDSS-017 indicates the joint orientations assumed are incorrect.

Table 4-8. Design Concept Assumptions (continued)

Description	Design Concept Identifier	Assumption
Drift Excavation Methods	DCSS 005	Drift excavation methods: • Primary: TBM • Secondary: other mechanical methods, and drill-and-blast where mechanical methods are impractical.
Maximum Excavation Extraction Ratio	DCSS 006	Maximum excavation extraction ratio for emplacement drifts: 30%.
Maximum Ramp Grade	DCSS 009	Maximum grade in ramps: $\leq$3% to accommodate rail transport. Maximum grade in mains: minimize, but $\leq$2% in mains used for emplacement drift access. Maximum grade in emplacement drifts: minimize within 0.25 to 0.75% range for drainage.
Repository Material Handling Equipment	DCSS 010	Repository material handling equipment: • Supplies: Rail transport • Excavated rock: Conveyor belt, or conveyor belt variation preferred when practical.
Shaft Excavation Method	DCSS 014	Shaft excavation method: Mechanical where practical.
Ventilated Air Properties	DCSS 015	Properties of ventilation air: standard density: 1.2 kg/m^3 Thermal conductivity: 0.02564 W/mK Heat capacity: 1.2082 kJ/m^3K
Maximum Underground Air Velocity	DCSS 016	Maximum allowable air velocity in: Ramps: 7.6 m/s Ventilation shaft: 20.3 m/s Personnel shaft: 11.7 m/s Emplacement drifts during construction: 3.0 m/s Exhaust mains: 10.2 m/s Service mains: 7.6 m/s Waste Handling Main: 7.6 m/s Ductwork: 30.5 m/s
Minimum Underground Air Velocity	DCSS 017	Minimum required air velocity in: (For Active Excavation),(For Development Maintenance) Ramps: 0.51 m/s, 0.31 m/s Shafts: 0.51 m/s, 0.31 m/s Emplacement drifts: 0.51 m/s, 0.31 m/s Exhaust mains: 0.51 m/s,0.31 m/s Service mains: 0.51 m/s, 0.31 m/s Waste Handling Main: 0.51 m/s, 0.31 m/s Ductwork: 12.7 m/s, 10.2 m/s

Table 4-8. Design Concept Assumptions (continued)

Description	Design Concept Identifier	Assumption
Minimum Underground Air Volume	DCSS 018	Minimum required air volume per: Diesel kW: 0.0791 $(m^3/s)/kW$ Underground worker: 0.0944 (m^3/s)/person
Maximum Underground Air Temperatures-Emplacement Drifts	DCSS 019	Maximum allowable air temperature in emplacement drifts during: Construction: 27°C effective Emplacement: 50°C dry bulb, only in portion requiring access Caretaker: no limit, determined by rock temperature Retrieval: 50°C dry-bulb, only in portion requiring access Backfilling: 50°C dry-bulb
Maximum Underground Air Temperatures-Access Mains	DCSS 020	Maximum allowable air temperature in access (ventilation intake) mains during: Construction: 27°C effective Operations: 27°C effective Caretaker: 27°C effective Retrieval: 27°C effective Backfilling: 50°C dry-bulb
Underground Air Quality	DCSS 021	Underground air quality in drifts occupied by personnel during: Construction: $O_2 \geq 19.5\%$, air cooling power ≥ 260 W/m^2, contaminants <TLV values Operations: $O_2 \geq 19.5\%$, air cooling power ≥ 260 W/m^2, contaminants <TLV values Underground air quality in drifts occupied by personnel during: Caretaker: $O_2 \geq 19.5\%$, air cooling power ≥ 260 W/m^2, contaminants <TLV values Retrieval: $O_2 \geq 19.5\%$, air cooling power ≥ 260 W/m^2, contaminants <TLV values Backfilling: $O_2 \geq 19.5\%$, air cooling power ≥ 260 W/m^2, contaminants <TLV values

Table 4-8. Design Concept Assumptions (continued)

Description	Design Concept Identifier	Assumption
"K" Factor for Ventilation Air Flow	DCSS 022	"K" factor for ventilation air flow in: Shafts: Ventilation shaft 0.0030 kg/m^3 "A" Man-and-material shaft 0.0176 kg/m^3 "B" Ramps: Waste ramp 0.0056 kg/m^3 "C" Tuff ramp 0.0111 kg/m^3 "D" Exhaust mains: 0.0111 kg/m^3 "D" Service mains: 0.0130 kg/m^3 "E" TBM launch mains: 0.0130 kg/m^3 "E" Waste main: 0.0111 kg/m^3 "D" Emplacement drifts Without waste packages: 0.0130 kg/m^3 "E" With waste packages: 0.0158 kg/m^3 "F"
Maximum Preclosure Rock Surface Temperature	DCSS 023	Maximum allowable preclosure rock surface temperature in: Shafts: 35°C- unventilated Ramps: 50°C- unventilated Mains: 50°C Emplacement drifts: 200°C Temporary increases in these temperatures are allowed during initial cooling of emplacement drifts for maintenance, performance confirmation, retrieval, and backfilling.
Maximum CHn[18] Temperature	DCSS 025	Maximum allowable surface temperature within CHn: 115°C
Rock Support Materials-Organic Materials Prohibited	DCSS 027	Organic materials (e.g., epoxy resin, timber) are limited for use as rock support and other postclosure permanent materials in all openings. Organic admixtures used in cementitious materials should be minimized to the extent practical. Concrete and steel are allowable preclosure construction materials in all openings.

[18] Calico Hills Nonwelded Thermal/Mechanical Unit

Table 4-8. Design Concept Assumptions (continued)

Description	Design Concept Identifier	Assumption
Emplacement Drift, Shafts, Ramps Maintenance Plans	DCSS 028	Emplacement drifts will be designed to be stable through the caretaker period, with the goal to minimize or eliminate planned maintenance to sustain the ability to retrieve, sample, or relocate waste packages. Shafts, ramps, and all other drifts will be designed to be stable, but may rely on periodic planned maintenance.
Maximum Underground Air Temperatures-Exhaust Mains	DCSS 029	Maximum allowable air temperature in exhaust mains during: Construction: 27°C effective Operations: 50°C dry-bulb Caretaker: 50°C dry-bulb Retrieval: < emplacement drift rock surface temperature Backfilling: 50°C dry-bulb
Limit Ground Surface Uplift	DCSS 030	Limit surface uplift to less than 0.5 cm/yr and relative motion of the top of TSw1 to less than 1 m with no intact rock failure and no continuous joint slip.
Limit Temperatures in PTn[19]	DCSS 031	Limit temperatures in PTn to less than 115°C
Temporary Surface Facilities for Underground Construction	DCSS 032	Underground construction will not use the North Portal for access once emplacement operations begin.

[19] Paintbrush Tuff Nonwelded Thermal/Mechanical Unit

4.4 TECHNICAL DATA ASSUMPTIONS

Technical data assumptions for the surface and subsurface repository are identified in Table 4-9 as TDS and TDSS. The appropriate technical data assumptions are provided for surface and subsurface repository in the following sections.

Table 4-9. Technical Data Assumptions

Description	Technical Data Assumption Identifier	Assumption
Fault Displacement, Locations, Attitudes	TDS 001	Surface facilities fault displacements, fault locations, and fault attitudes shall be as described in Section 1.23 of the RIB[20].
Topography/ Morphology	TDS 002	Topographical survey data and surface morphology shall be as described in Section 1.11 of the RIB.
Soil Properties	TDS 003	Soil properties are described in Sections 1.1311, 1.1312, and 1.1314 of the RIB. Soil hydrologic properties, soil mechanical properties, soil geochemical properties, and soil physical properties are given.
Meteorology	TDS 004	Site meteorology includes data on normal atmospheric and climatic conditions at the site based on historical data. These conditions are described in Section 1.3 of the RIB.
Design Basis Tornadoes	TDS 006	The Design Basis Tornado will be based on the "parameters of Design-Basis Tornadoes (DBTs) for NTS," which are given in the RIB, Section 1.3b, Table 2. Although tornadoes have never been observed on the NTS or within 150 miles of the NTS, the surface facilities design will be consistent with that used at the NTS.
Winds (Operating Basis and Standard)	TDS 007	The prevailing wind summary given in the RIB, Section 1.3a, Table 4, will be used as the Operating Basis Wind and Standard Wind for surface facilities design considerations.
Floods (Design Basis)	TDS 008	The Design Basis Flood shall be the 100-year and 500-year Probable Maximum Floods described in Section 1.54a of the RIB; Table 3 identifies the estimated ranges for peak flood characteristics.

[20] *Reference Information Base* (YMP 1995a)

Table 4-9. Technical Data Assumptions (continued)

Description	Technical Data Assumption Identifier	Assumption
In Situ Stress	TDSS 001	Rock in situ stress at proposed repository horizon: <u>Parameter</u> Vertical Stress Average Value — Range 7.0 MPa — 5.0 - 10.0 MPa Min Horiz/Vert Stress Average Value — Range 0.5 — 0.3 - 0.8 Max Horiz/Vert Stess Average Value — Range 0.6 — 0.3 - 1.0 Bearing - Min Horiz Stress Average Value — Range 57W — N50W - N65W Bearing - Max Horiz Stress Average Value — Range N32E — N25E - N40E
Ground Surface Temperature, Rock Thermal Gradient	TDSS 002	Rock temperature at ground surface: 18.7°C. Thermal gradient in rock: 0.0196.8°C/m for depth 0 to 150 m 0.018°C/m for depth 150 to 400 m 0.030°C/m for depth 400 to 541 m
TSw2 In Situ Saturation	TDSS 003	In situ degree of saturation (%)-TSw2: 65
TSw2 Rock Densities	TDSS 004	Rock index properties: In Situ Density TSw2: 2297 kg/m^3 Dry Density TSw2: 2219 kg/m^3
TSw2 Thermal Conductivity	TDSS 005	Thermal conductivity of in situ rock mass-TSw2: 2.1W/mK

Table 4-9. Technical Data Assumptions (continued)

Description	Technical Data Assumption Identifier	Assumption
TSw2 Heat Capacitance	TDSS 006	Heat capacitance of in situ rock - TSw2: 2.0324×10^6 J/m³K at 25°C 2.1280×10^6 J/m³K at 50°C 2.2638×10^6 J/m³K at 94°C 10.7683×10^6 J/m³K at 95°C 10.4690×10^6 J/m³K at 105°C 10.1984×10^6 J/m³K at 114°C 2.0065×10^6 J/m³K at 115°C 2.1114×10^6 J/m³K at 155°C 2.1912×10^6 J/m³K at 195°C 2.2692×10^6 J/m³K at 235°C 2.3410×10^6 J/m³K at 275°C
TSw2 Thermal Expansion	TDSS 007	Thermal expansion coefficient of in situ rock during heating - TSw2: <u>For Majority of Rock Mass</u> 9.1×10^{-6}/C at 25 - 50°C 8.2×10^{-6}/C at 50 - 100°C 6.8×10^{-6}/C at 100 - 150°C 9.7×10^{-6}/C at 150 - 200°C <u>For Rock (welded and devitrified tuff only) at or Near a Free Surface (Very Near Field)</u> 5.4×10^{-6}/C at 25 - 50°C 8.0×10^{-6}/C at 50 - 100°C 9.8×10^{-6}/C at 100 - 150°C 17.0×10^{-6}/C at 150 - 200°C
TSw2 Elastic Modulus	TDSS 008	Elastic modulus of intact rock-TSw2: 32.7 GPa (at ambient temperature)
TSw2 Poisson's Ratio	TDSS 009	Poisson's ratio (at ambient temperature): Intact Rock-TSw2: 0.22 Rock Mass-TSw2: 0.22
TSw2 Uniaxial Compressive Strength	TDSS 010	Uniaxial compressive strength of intact rock - TSw2: 155 MPa (at ambient temperature).
TSw2 Mohr-Coulomb Strength Parameters	TDSS 011	Mohr-Coulomb strength parameters of intact rock - TSw2 (at ambient temperature): Cohesion 37.8 MPa Friction Angle 36.5°
TSw2 Porosity	TDSS 012	Porosity of intact rock-TSw2: 0.121

Table 4-9. Technical Data Assumptions (continued)

Description	Technical Data Assumption Identifier	Assumption
Rock Joint Orientation and Frequency	TDSS 017	Rock joint orientation: Major Joint Set Strike / Dip N10 - 12W / 75 - 90 NE/SW Minor Joint Sets Strike / Dip N25E / 10SE N - N45E / 80 - 90 SE/NW Rock joint frequency: TSw2:2.51/m for 70-80 degree joints, 11.28/m for 80-90 degree joints (mean value)
Surface Air Temperature/ Humidity	TDSS 021	Surface air temperature: Maximum: 42.2°C Minimum: -25.6°C Annual Average: 12.7°C Surface Air Humidity: Maximum: 71% Minimum: 13% Annual Average: 54%
Wind Intensity	TDSS 022	Wind intensity: Annual Average: 3.22 m/s Peak: >26.8 m/s

4.5 DESIGN BASIS DRIVERS

Although an assumption is listed in the CDA Document (CRWMS M&O 1995a), it may or may not provide a specific value or concept, but, rather, may provide a range of values from which any selection is allowable. For example, thermal loading assumes an acceptable range of from 80 MTU per acre to 100 MTU per acre. In these instances, a design may be based on any value in this range, but should be sufficiently flexible to adjust to all values in the range. In all cases, a value selected for any given point design is rationalized for use within the specific conditions of that design and must be reasonable, but not necessarily optimal.

The MGDS ACD Report is based upon a number of assumptions applicable to this particular point design and which are considered as design drivers. This section lists design drivers that form the bases of the design currently being presented. These are main issues and assumed values (or concepts) having the greatest impact on the design. The list does not contain design features which implement the design bases, are more detailed, and are part of the engineering discretionary function. Design features do not drive the design, but are a part or result of the design process, and will be presented in the report text.

The following lists are presented in a tabular format and state the design bases in a concise manner. A more detailed description of the rationale for selection and/or how the drivers were implemented can be found in the following sections. Note that this list of drivers is specific to this MGDS ACD Report design. Should conditions cause any number of these drivers to change, the design would require modification to reflect those changes. It should also be noted that this list and associated design represents a feasible design scenario without regard to optimization of design features. As such, this list represents the bases chosen for this particular design.

The information presented in the attached list was based on input from the CDA Document (CRWMS M&O 1995a) and current information developed by the repository design staff. The CDA Document (CRWMS M&O 1995a) provided basic information from key assumptions, requirements assumptions [Engineered Barrier Design Requirements Document (EBDRD) (YMP 1994c) and RDRD (YMP 1994a)] and design concepts for surface, subsurface, and waste package. These items were reviewed to select only those assumptions that are design drivers, to confirm the applicability of the assumption to the design, and to indicate selected values wherever a range might have existed.

The list is intended to provide an easy reference to the main drivers affecting the design as presented in the MGDS ACD Report. Some of the design drivers may be the focus of programmatic controversy and/or policy shifts that may require subsequent design changes. The table is organized into the following sections, which have been reviewed to ensure an integrated list of design bases:

- MGDS ACD Report design bases common to all areas
- Surface-related design bases
- Subsurface-related design bases
- Waste package-related design bases that affect the repository design

It is important to note that this list is not a dynamic product. It functions solely to describe the design basis drivers for this particular design. However, this list can be updated for use in describing design bases of future or current designs that have progressed beyond the conceptual phase.

4.5.1 Design Bases Applicable to All Design

Table 4-10. Common Design Bases for the MGDS ACD Report

Design Component/Attribute	Design Basis Driver	Rationale
1. Waste Package Containment Barrier Shielding	• Waste package containment barriers will provide sufficient shielding to protect materials from radiation-enhanced corrosion. • Waste packages will not be shielded for personnel protection. • Shielding for personnel protection will be provided on the transporter and in surface and subsurface facilities. • Emplacement transport shield is a standard three-layer approach with neutron shielding between gamma shielding. • Shielding materials are 5% boron-polyethylene for neutron, and lead for gamma shielding, encased in 316L stainless steel for structural support.	• Cost, size and weight of individually shielded waste packages would be excessive. • MGDS will meet design requirements and strive to achieve ALARA design with more cost-effective shielding options. • Materials are in common use in the nuclear industry, and their use is proven technology.
2. Average SNF Characteristics	• 26.4 yrs old, 39.64 GWd/MTU burnup, 3.68 wt.% enrichment (PWR) • 26.1 yrs old, 31.21 GWd/MTU burnup, 2.97 wt.% enrichment (BWR)	• Oldest fuel first. • No MRS. • Deferred dry storage. • Derated canisters. • Four truck sites. • In accordance with the NWPA, OCRWM Mission Plan, Proposed Program Approach.
3. Lag storage	• Sized to accommodate minor interruptions only (i.e., not designed for cooling, retrieval, or interim storage) • 40 disposal containers	• Consistent with thermal management approach and retrieval design basis.
4. Waste Form	• Based on receipt of canistered fuel. • Receipt of uncanistered fuel is not precluded. • Defense high-level waste. • Navy fuel is not included in the MGDS ACD Report. • The CDR-type MPC is used for cost and design purposes.	• Based on current requirements. • Designs already performed are bounded by 21 PWR MPC parameters for size, weight, and heat output.

4.5.2 Surface Design Bases

Table 4-11. Surface Design Bases for the MGDS ACD Report

Design Component/Attribute	Design Basis Driver	Rationale
1.* Performance Confirmation	• Open 1 WP every 10 . • Bare fuel facility can support performance category mission. • No additional labs required.	• Long measurement periods are consistent with WP design life. • Similar operations can be performed in under-utilized cell. • Infrequent test samples are cost effectively analyzed off-site.
2. Waste Forms and Receipt Rates	• Mostly MPCs at 638 waste shipments per year (maximum): canistered = 424 uncanistered = 55 HLW = 159 • Cask receipt rate and mix of waste form types vary each year per CDA Key Assumption 001 schedule. • HLW will be received in canisters that are not larger than a CDR-type MPC.	• Consistent with program approach (e.g., CDA). • Cost effective to standardize equipment and operations, and Naval fuel needs to be visually obscured.
3. Filler Material	• Added to first procurement canisters (117). • Shipment rates will be limited to meet single-train capacity.	• Consistent with first procurement assumptions. • Minimizes investment for this temporary mission.
4.* Safeguards and Security	Little or no material tracking and a single fence around the RCA.	• Does not impact basic design concepts. • Will be revisited in future design phases.
5.* International Atomic Energy Agency (IAEA) Inspection	No inspection.	• Does not impact basic design concepts. • Will be revisited in future design phases.
6. Retrieval	Facilities will be designed and constructed when retrieval is needed.	Cost effective because retrieval is unlikely.
7a. Low-Level Secondary Waste Disposition	Solids and non-recyclable liquids will be compacted, grouted, packaged and shipped off-site for disposal.	Off-site disposal avoids on-site license.
7b. Low-Level Mixed Secondary Waste Disposition	• Not generated under normal operations. • If generated, will be packaged, and shipped off-site for treatment and disposal.	• Waste minimization. • Minute quantities make off-site treatment cost effective and off-site disposal avoids on-site license.
8.* Wet vs. Dry Shielding Technology	• WHB will use shield walls and hot cells (e.g., dry). • Cask Maintenance Facility (CMF) will use pools (e.g., wet).	• Promote a dry canister interior. • Accommodates more flexible contact operations.
9. CMF Design	MRS design adapted to repository.	Functions and requirements are similar.

Table 4-11. Surface Design Bases for the MGDS ACD Report (continued)

Design Component/Attribute	Design Basis Driver	Rationale
10.* Integrated Nuclear Operations	Separate facilities will be used for nuclear operations (i.e., WHB, CMF and WTB)	Isolated buildings are feasible and resulting design is conservative.
11. Support Facility Design	Same designs and facilities as described in the SCP-CDR.	Designs are representative for a waste storage plant.
12.* Support Area Location	East of the nuclear facilities.	Prevailing wind is least likely to carry emissions from the nuclear buildings to the non-rad support area.
13.* Seismic Design	• Structures will be assigned performance categories in accordance with DOE-STD-1021-93. • For each performance category design basis hazards are developed according to DOE-STD-1020-94.	Approach is prescribed in Topical Report: *Seismic Design Methodology for a Geologic Repository at Yucca Mountain* (YMP 1995d).

Note: * Denotes a component/attribute not currently controlled in the RDRD (YMP 1994a), RDRD (YMP 1994a), or CDA Document (CRWMS M&O 1995a).

4.5.3 Subsurface Design Bases

Table 4-12. Subsurface Design Bases for the MGDS ACD Report

Design Component/Attribute	Design Basis Driver	Rationale
1. Layout Option	• Central main • Long parallel emplacement drifts • In-drift emplacement • Upper and lower blocks	• Allows for potential backfill. • Facilitates retrieval. • Facilitates performance confirmation. • Access for off-normal situations and maintenance/inspection.
2. Emplacement Support Mechanism	Packages remain on railcar.	• Ease of emplacement. • Accommodates retrieval.
3. Waste Package Transportation Underground	By rail.	• Handles heavy loads. • Proven technology. • Capability of automation.
4. Emplacement Mode	Horizontal in-drift.	• Simple and cost-effective emplacement/retrieval as compared to borehole emplacement.
5.* Emplacement Drift Ventilation	Not ventilated after emplacement.	• Does not exceed thermal limits. • Ventilation will remain available if needed during the preclosure period.
6. Emplacement Drift Ground Support	Support according to rock categories (e.g., steel and lagging for Category IV).	• Efficient application of materials. • Cost.
7.* Invert Material	Concrete/crushed tuff combination.	• Proven technology. • Maintainability.
8. Use of North Ramp for Waste Transport	Yes	• Least slope. • Access to facilities. • Concept of operations.
9. Remote Operation	Yes	• Radiological safety. • Proven technology. • Hostile environments.
10. Backfill in Emplacement Drifts	No	• Backfill is not precluded. • Not currently required in emplacement drifts. • Potential for backfill is considered in selection of other design bases.
11. Thermal Loading	21 kg/m^2 (83 MTU/acre)	• Results in conservative layout size.
12. Emplacement Drift Monitoring	• As scheduled (TBD) • Non-continuous	• Emplacement side exhaust ventilation is continuously monitored. • Instrumentation limitation.
13. Retrieval Option	• Maintained for 100 years.	• Accommodated in layout and all affected designs. • Meets 10 CFR 60 and DOE requirements.

Table 4-12. Subsurface Design Bases for the MGDS ACD Report (continued)

Design Component/Attribute	Design Basis Driver	Rationale
14. Emplacement and Development Ventilation	• Separate networks for development and emplacement.	• Positive pressure from development side to emplacement side. • Systems are physically isolated, but vary in size with operations.
15. Emplacement Drift Entrance Doors	Required.	• Doors needed for access and ventilation control.
16. Emplacement Scenario	• 63000 MTU commercial SNF. • 7000 MTU HLW.	• Supports the NWPA, OCRWM Mission Plan, Proposed Program Approach, and program requirements. • Satisfies Key Assumption 003.
17. Human Entry in Drifts Containing Waste Packages	• No human entry allowed under normal conditions.	• Achieves occupational doses that are ALARA.
18. Reason for Retrieval	• Failure in site, waste package, or some other system causing safety risk. • Recovery of the resource.	• NWPA. • Retrievability study M&O 1994 (CRWMS M&O 1994g).
19. Performance Confirmation Area	• Can be accommodated in layout. • Size and lateral extent is flexible.	• Needed to support specific testing and monitoring functions. • Satisfies need for flexibility in thermal loading/thermal management.
20. Repository Horizon	• Located mainly in the TSw2 unit.	• Modest crossing of the boundary is allowed. • Consistent with site characterization activities. • Satisfies 10 CFR 960 requirement of 200 m distance below the surface.
21. Subsurface Fault Standoff	• Openings are located to avoid Type I faults traversing major portions of the emplacement area. • 60-m offset from main Type I fault traces in the emplacement area. • 120-m offset used on the west side of the Ghost Dance Fault.	• NUREG-1494 Technical Position is satisfied (NRC 1994).
22. Excavation Method	• Primary method is mechanical. • Drill and blast may be used where mechanical methods are impractical.	• Limits potential for preferential pathways. • Proven results in ESF construction.
23. Underground Transport of Personnel and Supplies	• Rail.	• Compatible with rail haulage schemes for emplacement. • Efficiency.
24. Maintainable Preclosure Service Life	• 150 years following first emplacement of waste (rounded up from 144).	• Derived from 100-year retrieval plus 10 years retrieval preparation plus 24 years to perform retrieval plus 10 years closure.

Table 4-12. Subsurface Design Bases for the MGDS ACD Report (continued)

Design Component/Attribute	Design Basis Driver	Rationale
25. Emplacement Drift Wall Temperatures	• <200°C emplacement drift wall temperature.	• EBDRD requirement.
26. TSw3 Temperature Limit	• <115°C.	• SCP-listed thermal goal at the basal vitrophyre.
27. Ground Surface Temperature Limit	• Limit maximum change to a 2°C rise.	• Conservative goal stated by K. Olster to the NWTRB (DOE 1988a).
28. Access Mains Wall Rock Temperature Limit	• Maximum 50°C during preclosure normal operations.	• SCP-listed thermal goal.
29. Code Requirements	• OSHA and MSHA.	• OSHA controlled and MSHA advised. • Mandated by 10 CFR 60.
30. Emplacement Drift Orientation	• 30 degrees from dominant joint orientations. • Generally between N70W and S75W. • Intersections at 70 to 90 degrees where practical.	• Maximize stability. • Based on current site characterization data.
31. Extraction Ratio	• Maximum 30% in emplacement area.	• Conservative estimate for drift stability. • Based on stress analysis.
32. Ramp Grade	• ≤3% for rail haulage. • ≤2% in mains used for emplacement drift access. • 0.25 to 0.75% for drainage in emplacement drifts. • Other design grades are unimportant as design drivers.	• Operational safety.
33. Preclosure Rock Surface Temperature	• Maximum allowable rock surface temperatures - Shafts: 35°C unventilated Ramps: 35°C unventilated Mains: 50°C unventilated Emplacement Drifts: 200°C.	• SCP-stated values. • Mains may exceed the value during cooling for retrieval or backfill.
34. Maximum CHn Temperature	• 115°C.	• SCP Thermal Goals Reevaluation Report (CRWMS M&O 1993c).
35. Organic Rock Support Materials	• Organic materials (e.g., epoxy resin, timber) are limited for rock support and permanent postclosure materials in all openings. • Organic admixtures in cementitious materials are minimized to the extent practical.	• Organic materials aid in the development of soluble and insoluble complexes, which can potentially be transported via hydrologic mechanism.

Table 4-12. Subsurface Design Bases for the MGDS ACD Report (continued)

Design Component/Attribute	Design Basis Driver	Rationale
36. Limit Ground Surface Uplift	• Surface uplift limited to less than 0.5 cm/year. • Relative motion of the top of TSw1 is limited to less than 1 m with no intact rock failure and no continuous slip.	• SCP Thermal Goals Reevaluation Report (CRWMS M&O 1993c).
37. Maximum Temperature in PTn	• 115°C.	• SCP Thermal Goals Reevaluation Report (CRWMS M&O 1993c). • Requires substantiation.
38. North Portal Access	• Underground construction will not use North Portal access once emplacement operations begin.	• Logistics, safety, separation of operation functions. • South Portal or shaft access is designated for development support.
39. Accesses	• Ramp and shaft penetrations will be monitored as required for ventilation and radiation levels. • Two ramps and two shafts are shown in this design. • Main ramps are 7.62 m diameter, shafts are 6.1 m inside diameter.	• Performance assessment monitoring will be required in specified locations throughout the repository. • The number of penetrations are minimized as per requirements, and sized to accommodate ventilation.
40.* Seismic Design	• Structures will be assigned performance categories in accordance with DOE-STD-1021-93. • For each performance category, design basis hazards are developed according to DOE-STD-1020-94.	Approach is prescribed in Topical Report: *Seismic Design Methodology for a Geologic Repository at Yucca Mountain* (YMP 1995d).

Note: * Denotes a component/attribute that is not currently controlled in the RDRD (YMP 1994a), RDRD (YMP 1994a) or CDA Document (CRWMS M&O 1995a)

4.5.4 Waste Package Design Bases Affecting Repository Design

Table 4-13. Engineer Barrier Segment Design Bases for the MGDS ACD Report

Design Component/Attribute	Design Basis Driver	Rationale
1. External Waste Package Dimensions	• Diameter: 1,802 mm for 21 PWR canistered fuel package (MPC); 1,629 mm for 21 PWR UCF (5) waste package tube type. • Length: 5,682 mm for 21 PWR canistered fuel package (MPC); 5,335 mm for 21 PWR UCF (5) waste package tube type. • Nonstandard fuel (South Texas) will be accommodated to the extent possible through special processing which is not addressed as a driver in this design.	• Determined by waste package design analyses and reported in the waste package section of the MGDS ACD Report. • The MGDS EBDRD requirements classify South Texas fuel as nonstandard, and specifies the possibility of the need for special handling processes and equipment.
2. Waste Package Weight	• 65,900 kg for the 21 PWR canistered fuel package (MPC). • An additional maximum 20,327 kg for the internal filler material in the above-mentioned package.	• Based on MPC of 21 PWR/40 BWR. • Weights determined through waste package design analyses.
3. Waste Package Drop Tolerance	• After being sealed, can tolerate a 2-m drop onto a flat unyielding surface.	• Engineering experience in the design of storage and transportation casks. • TBV.
4. Container Loads	• Container has mechanical integrity to sustain static loads of 25 kN during routine handling and transportation.	• Indicated through initial stress calculations on the multi-barrier waste package.
5. Container Weight	• Weight of empty container shall not exceed 32,000 kg.	• Determined through waste package design analysis. • The weight represents the container portion of the waste package weight identified above.
6. Burnup Credit	• Will receive credit for principal isotope burnup.	• Burnup credit committee discussions with NRC staff indicate possibility for credit.
7. Expected Waste Package Life	• Mean lifetime well in excess of 1,000 years. • Less than 1% containment failures in the first 1,000 years.	• Meets 10 CFR 60 requirements. • Conforms to DOE position on substantially complete containment. • Consistent with multi-barrier approach to waste package design.
8. Criticality Control Period	• Indefinite or until trends indicate that risk will continue to decrease out to 1,000,000 years.	• In accordance with 10 CFR 60 and National Academy of Science recommendations.

Table 4-13. Engineer Barrier Segment Design Bases for the MGDS ACD Report (continued)

Design Component/Attribute	Design Basis Driver	Rationale
9. Waste Package Materials	• Inner barrier - UNS N08825 • Outer barrier for SNF packages - UNS G10200. • Outer barrier for HLW packages - UNS C71500.	• UNS N08825 chosen as a reasonable compromise between high corrosion resistance and low cost. • UNS G10200 provides predictable corrosion rates and low cost. • UNS C71500 provides significant corrosion resistance.
10. SNF Weight	• Spent fuel waste form will be the high-level radioactive waste and any encapsulating or stabilizing matrix, such as cladding associated with spent fuel. • Up to 887 kg per PWR assembly and 332 kg per BWR assembly.	• Based on a bounding condition which is the maximum value. • BWR weight comes from DOE/RW-0184-R1 (DOE 1992).
11. Engineering Barrier Segment Reliability	• Probability of failure of an individual waste package during preclosure shall be less than 10^{-6} per year, based on credible hazards.	• Based on statistical analysis of credible hazard event type, size, frequency of occurrence, and location relative to the waste package.
12. Rock Induced Waste Package Loading	• Uniform external pressure of 0.50 MPa and a dynamic load of 50 kN.	• Stress calculations based on the expected load from a rock falling onto the waste package.
13. Limit of Fuel Cladding Temperature	• Less than 350°C.	• SCP thermal goal, reconfirmed in 1993 analysis (CRWMS M&O 1993c).
14. Limit of HLW Glass Temperature	• Less than 500°C.	• SCP thermal goal, reconfirmed in 1993 analysis (CRWMS M&O 1993c).
15. Engineering Barrier Segment Components	• Waste package (canistered, uncanistered, and HLW), invert, filler, shielding, and packing are addressed in the report. • Backfill, waste package support during preclosure, and the emplacement drift opening are not addressed from the engineered barrier performance aspect.	• Waste package is specified in EBDRD 3.7.1. • Invert is needed for emplacement operations. • CDA Key Assumption 046 specifies no backfill.
16. Waste package performance	• Mean lifetime well in excess of 1,000 years. • Control release from Engineered Barrier Segment after containment period. • Control criticality. • Resist mechanical loads. • Limit waste form temperature. • Limit radiation. • Less than 1% containment failure in the first 1,000 years.	• EBDRD 3.7.1.2.B; also see Item 7. • EBDRD 3.7.E, 3.7.1.2.C. • EBDRD 3.7.1.3.A; also see Items 6, and 8. • EBDRD 3.7.F, 3.7.1.1.F, 3.7.1.2.A; also see Items 3, 4, and 12. • CDA DCWP 001, DCWP 002; also see Items 13 and 14. • CDA Key Assumption 031.

Table 4-13. Engineer Barrier Segment Design Bases for the MGDS ACD Report (continued)

Design Component/Attribute	Design Basis Driver	Rationale
17. Invert performance	• No performance allocated to invert as an engineered barrier.	• No invert requirements in EBDRD
18.* Near-field environment	• Water flux Typical: 0 Extreme: 0.1 mm/yr • pH Typical: 7.4 Extreme: 2 to 12 • Water chemistry Typical: J-13 Extreme: Concentrated J-13, acidified or alkalized • Relative humidity range: 10% (max. dryout) to 98% (ambient) • Temperature, drift wall, typical: 25°C at emplacement 109°C at 1 year 152°C at 10 years 165°C at 40 years 159°C at 100 years 134°C at 1,000 years	• Dryness of ESF, (CRWMS M&O 1995bd and CRWMS M&O 1995be). • UCRL-LR-107476, (LLNL 1993) LLNL SIP-CM-01(LLNL 1995). • UCRL-LR-107476, (LLNL 1993) LLNL SIP-CM-01(LLNL 1995). • Calculations by Buscheck (LLNL 1994). • Calculations by Bahney (CRWMS M&O 1994h) for 20.5 kgU/m^2 (83 MTU/acre).

Note: * Denotes a component/attribute that is not currently controlled in the RDRD (YMP 1994a), RDRD (YMP 1994a) or CDA Document (CRWMS M&O 1995a)

5. CONCEPT OF OPERATIONS

5.1 INTRODUCTION

5.1.1 Purpose

This concept of operations provides a high-level operational description of the design described in this volume of the *Mined Geologic Disposal System Advanced Conceptual Design* (MGDS ACD) Report, and includes the Repository Segment consisting of surface and subsurface facilities at the repository and the rail transportation system within Nevada.

5.1.2 Scope

The Repository Segment includes the surface and subsurface facilities necessary to receive, package for emplacement, and emplace the spent nuclear fuel (SNF) and defense and commercial vitrified high-level waste (DHLW); and to support the maintenance and operation of the repository. The rail transportation system within Nevada includes main rail routes, junction points, connecting rail lines and line-haul carriers.

The Repository Segment is part of the MGDS, which includes two other segments: the Engineered Barrier Segment and the Site Segment. The Engineered Barrier Segment includes the emplaced waste package and subsurface features designed for waste isolation. The Site Segment includes surface and subsurface facilities and activities for collecting site characterization data. The concept of operations for the entire MGDS is provided in Volume I, Section 3.

The concept of operations included in this section provides a summary level description of the repository facilities and operations. More detailed descriptions of the repository are provided in Sections 7, 8, 9, and 11 of this volume.

5.1.3 Organization

The remainder of this section is organized as follows:

- Section 5.2 provides a summary of the operational environment including the repository mission; descriptions of the operational phases, repository site, repository facilities, and waste forms; and an overview of the operations and maintenance approach.

- Section 5.3 provides a high-level description of the major repository operations in each operational phase.

5.2 OPERATIONAL ENVIRONMENT

5.2.1 Mission

The mission of the repository is to provide for the receipt and disposal of 63,000 metric tons of initial heavy metal (MTIHM) of civilian owned SNF, and 7,000 MTIHM of DHLW, such that public health and safety and the environment are protected.

5.2.2 Operational Phases

Operational phases associated with the Repository Segment are described below. A schedule showing the phases for two retrieval scenarios is shown in Figure 5.2.2-1. These phases are consistent with the definitions provided in Section 5.3.1.4 of the CDA Document (CRWMS M&O 1995a); however, operations occurring prior to the start of repository segment operations were excluded (i.e., site characterization). Descriptions of the operations performed in each phase are provided in Section 5.3, except for off-normal.

A. *Construction* – This phase includes all surface construction and sufficient (about 10 percent) subsurface excavation to permit a steady rate of waste disposal. The construction phase is expected to last six years, beginning with the receipt of a license to construct the repository and ending when emplacement start-up operations begin.

B. *Development* – This phase includes the bulk of subsurface excavation that occurs after emplacement operations begin. This phase runs concurrent with the first 22 years of emplacement and ends when the subsurface excavation is complete.

C. *Emplacement* – This phase includes the receipt, packaging, and emplacement of SNF and DHLW. This phase is expected to last 24 years, beginning when construction is complete and ending when all the waste has been emplaced.

D. *Caretaker* – This phase is a waiting period of 76 years, during which the option to retrieve emplaced waste is preserved. This phase begins after emplacement is complete.

E. *Retrieval* – This phase includes all activities required to retrieve some or all of the emplaced waste. Waste retrieval could be required to remove public health or safety concerns, or to recover the waste as a valuable resource. This optional phase could occur anytime after the beginning of emplacement and before closure. Retrieval of all waste packages is allowed to take 30 years as described in 10 CFR 60.111(b)(3) (i.e., about 10 years to design and construct and 20 years to remove the waste).

F. *Off-normal* – The repository is designed, and the operations personnel are trained and equipped to handle unexpected accident, natural disaster, and other events, which can occur during any operational phase.

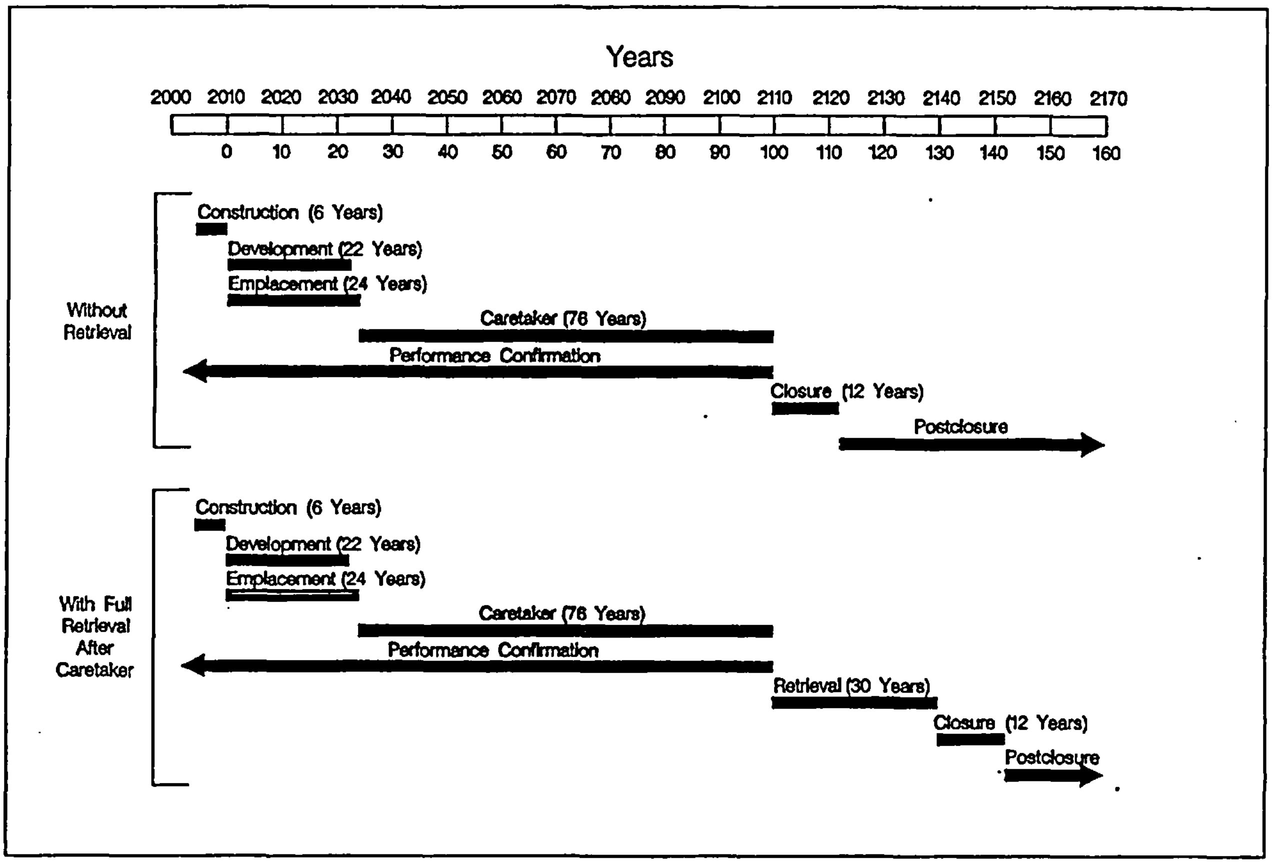

Figure 5.2.2-1. Schedule for Repository Segment Operational Phases

G. *Performance Confirmation* – The performance confirmation phase includes data collection; performance assessment using the collected data to analyze the performance of waste packages, seals, and barriers; and taking corrective action if required. These activities will begin prior to construction during site characterization. The laboratory testing ends at start of closure. In situ monitoring may end at closure or continue in postclosure.

H. *Closure* – This phase includes backfilling and sealing portions of the underground, decontaminating the nuclear surface facilities, dismantling the surface facilities, reclaiming the site, and establishing a system of physical and institutional barriers. This phase is expected to last 12 years, beginning when the U.S. Nuclear Regulatory Commission (NRC) amends the license to authorize permanent closure.

I. *Postclosure* – This phase includes the maintenance and enforcement of the institutional barrier system (markers and land-use records). If a system for postclosure monitoring is established, this phase also includes maintenance of the monitors. This phase begins after closure.

5.2.3 Site

The candidate repository site is Yucca Mountain which is located approximately 100 miles northwest of Las Vegas, Nevada. This desert location is on federal land remote from populated areas.

The site geology includes an underground layer of welded tuff, which is used as the waste emplacement area. The candidate host rock is the Topopah Spring Member, a unit of the Paintbrush Tuff. The Topopah Spring unit is approximately 330 meters (1,100 feet) thick. The unit dips about six degrees to the east. Potentially usable repository areas are outlined by major faults. These areas, which total about 3,700 hectares (9,150 acres), include a primary area and expansion areas. Expansion areas are used if required for a cooler repository design. Location of the repository horizon provides a minimum overburden of 200 meters (650 feet). The regional water table is about 230 to 380 meters (750 to 1,250 feet) below the horizon proposed for the emplacement of the waste packages.

At the start of repository construction, the site will include the surface and subsurface areas of the Exploratory Studies Facility (ESF) that were used for the site characterization activities. The subsurface facilities include the north ramp, main drift, and south ramp. The surface facilities include a change house, electrical and water supply systems, sanitary sewer systems, muck piles, and a number of minor temporary structures. Some or all of these facilities will be used to support repository construction.

Refer to Section 6 for a more detailed description of the repository site.

5.2.4 Facilities

The overall arrangement of the repository surface and subsurface operational areas is shown in Figure 5.2.4-1. Each of the four operational surface areas and the subsurface areas as well as the off-site rail transportation system in Nevada is described below. All structures, systems, and components (SSCs) comply with applicable regulations and standards for safety, health, environmental protection, and operations and maintenance, including 10 CFR 60.

5.2.4.1 North Portal Operations Area

This area covers about 32 hectares (80 acres) and includes 19 structures. It is located adjacent to the North Portal, where disposal containers are loaded and brought underground for emplacement. The operations area includes a radiologically controlled area (RCA), where all nuclear operations are performed, and a balance of plant (BOP) area, where general support facilities are located. Figure 5.2.4-2 is a site map of this area.

Each of the major facilities in the RCA is described below. The Transporter Maintenance Building (TMB), used to conduct maintenance of on-site waste transporters, is described in Section 7.2.6.

A. *Waste Handling Building* (WHB) – The WHB is a five-floor concrete and steel structure that includes several hot cells, operating galleries, and support areas. The facility has a zoned heating, ventilation, and air conditioning (HVAC) confinement system. This building houses systems and components for transferring the waste from transportation casks to disposal containers. The design and operations of the WHB are described in Section 7.2.2.

B. *Cask Maintenance Facility* (CMF) – The CMF is a three-floor concrete and steel structure that includes a pool, operating pits, and support areas. The facility has a zoned HVAC confinement system. This facility houses systems and components for performing maintenance on transportation casks and cask carriers. The design and operations of the CMF are described in Section 7.2.3.

C. *Waste Treatment Building* (WTB) – The WTB is a two-floor metal and concrete block building that includes open operating areas with localized concrete shield walls. The building includes systems and components for processing low-level liquid and solid waste, and accumulation of mixed waste. The design and operations of the WTB are described in Section 7.2.4.

D. *Carrier Staging Shed* (CSS) – The CSS is a single-floor prefabricated metal building with a gable roof. The building is a large open structure that can accommodate up to eight rail or truck cask carriers. The building houses systems and components for preparing cask carriers for cask removal or off-site shipment. The design and operations of the CSS are described in Section 7.2.5.

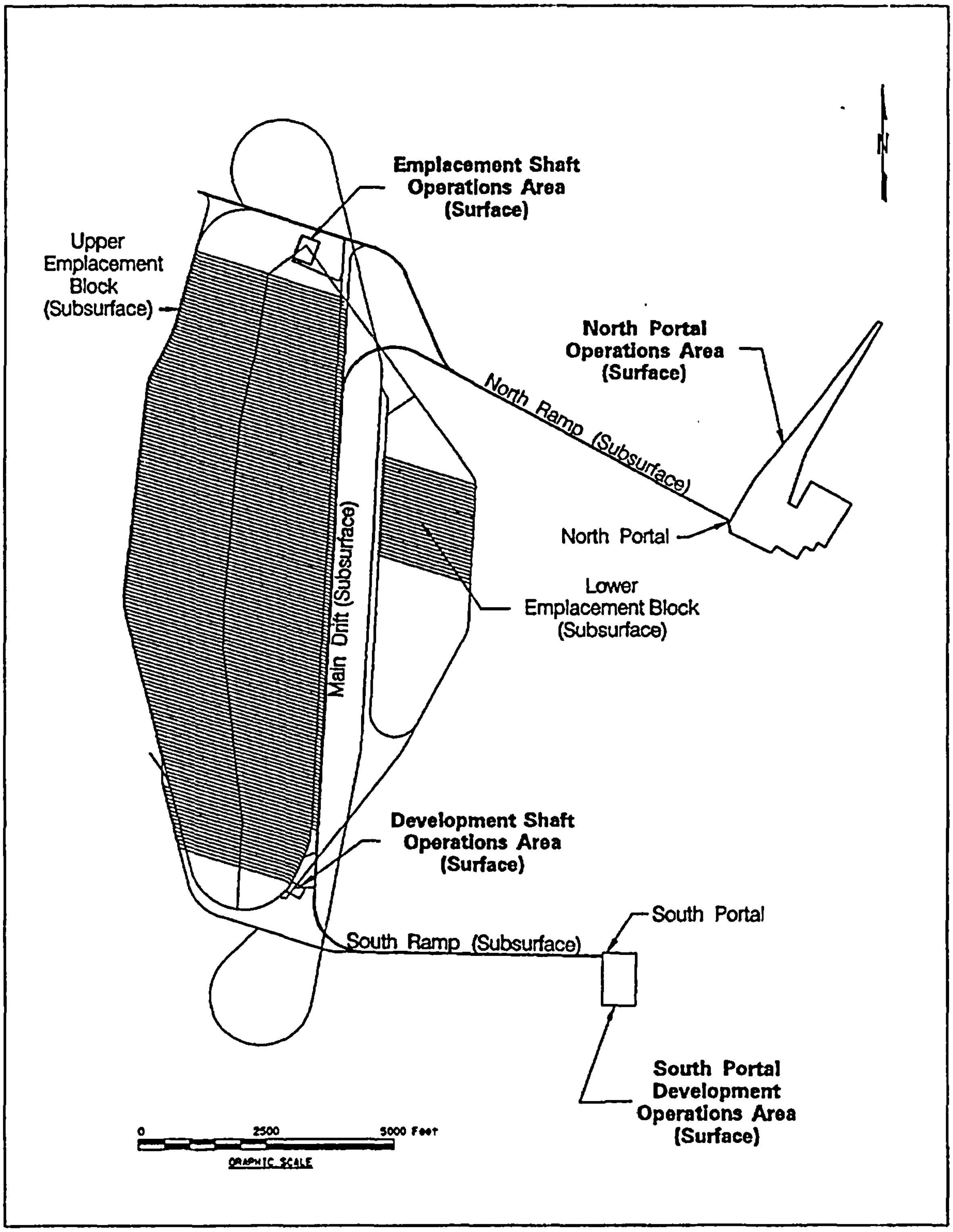

Figure 5.2.4-1. Overall Repository Site Map

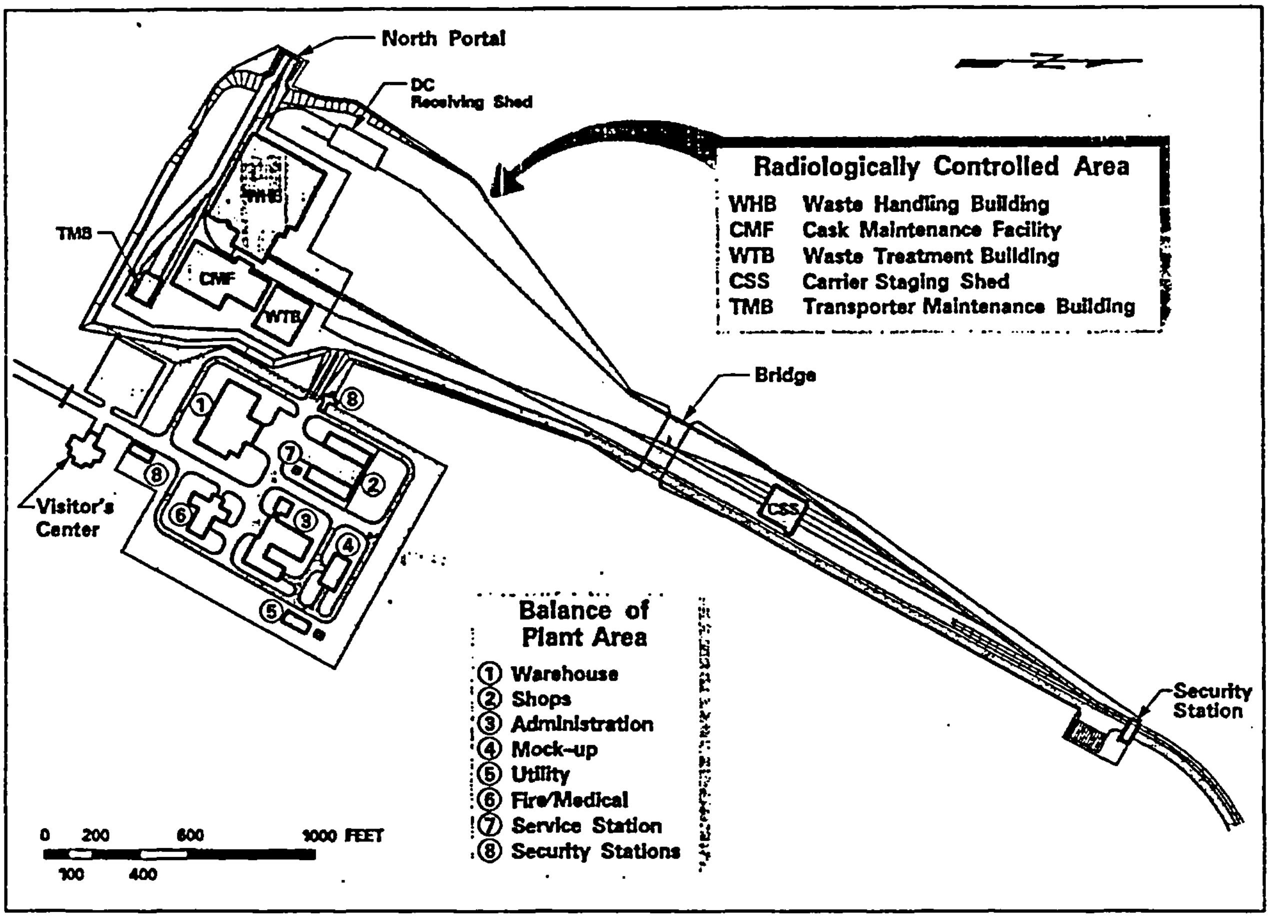

Figure 5.2.4-2. North Portal Operations – Area Site Map

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The BOP area includes structures that support operations in all areas (e.g., general administration, medical center, training center, shops, motor pool, central warehouse, and centralized utilities). These structures are briefly described in Section 7.2.7.

Various systems are provided to support operations at the North Portal and other repository areas (e.g., utility systems; communication systems; monitoring and control systems; and site management systems such as security, administration, transportation, maintenance, and engineering). These systems are briefly described in Section 7.2.8.

5.2.4.2 South Portal Development Operations Area

This area covers about 5 hectares (12 acres) and includes 8 structures. It is located adjacent to the South Portal to support the excavation of the underground and the operation of the development area ventilation supply fans. The area functions independently and includes the basic facilities needed for personnel support, maintenance, warehousing, material staging, security, and transportation. This area is staffed during the development phase and is unmanned after underground excavation is complete. These facilities are briefly described in Section 7.3.

5.2.4.3 Emplacement Shaft Surface Operations Area

This area includes two structures and is located at the opening to the north shaft. The main facility is provided to house the emplacement ventilation system, including exhaust fans and high efficiency particulate air (HEPA) filters, and to support the maintenance of this system. This area is normally unmanned. The facilities in this area are briefly described in Section 7.4.

5.2.4.4 Development Shaft Surface Operations Area

This area includes one structure and is located at the opening to the south shaft. The main facility houses the head frame and shaft conveyance needed for underground emergency personnel egress and inspection access. The area also includes the exhaust for the underground development ventilation system and electrical equipment. This area is normally unmanned. The facilities in this area are briefly described in Section 7.5.

5.2.4.5 Subsurface Facilities

The repository subsurface layout is shown in Figure 5.2.4-3. The subsurface facilities include waste emplacement drifts, two shafts, two ramps, service main drifts, and exhaust ventilation drifts. The total lengths and diameters of the ramps, shafts, and drifts are shown in Table 5.2.4-1.

The emplacement area is located at least 200 meters (650 feet) below the surface in a welded tuff unit that was described in Section 5.2.3. This area is divided into an upper block and a lower block that are separated by the Ghost Dance Fault. The upper block provides about 324 hectares (800 acres) for waste emplacement and is about 70 meters (230 feet) higher than the lower block. The lower block provides about 69 hectares (170 acres) for waste emplacement.

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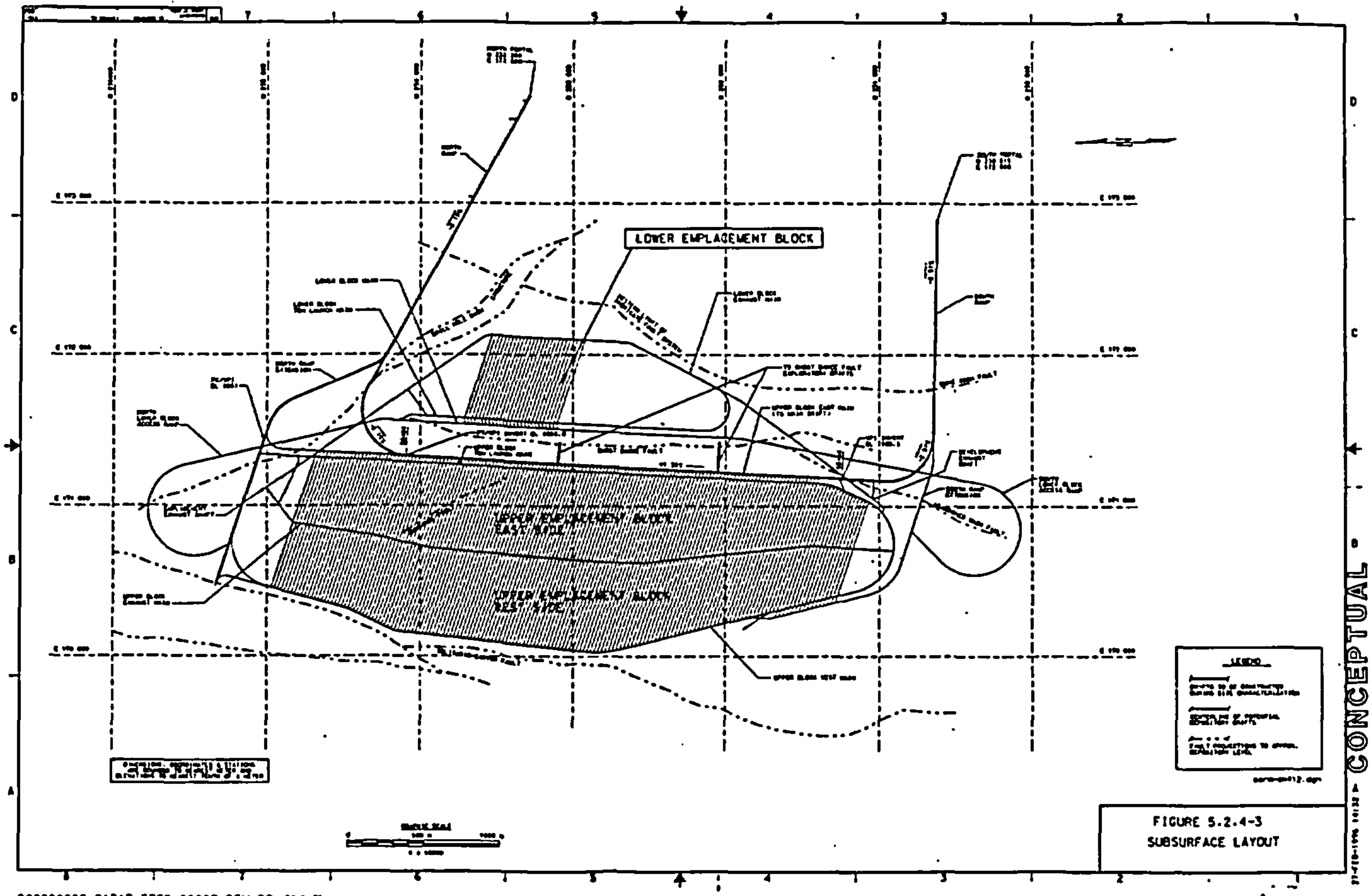

FIGURE 5.2.4-3
SUBSURFACE LAYOUT

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Table 5.2.4-1. Subsurface Excavation Data

Subsurface Feature	Diameter	Total Length or Depth	Construction Method
TBM Launch Mains and Recovery Mains	9.0 meters (30 feet)	11,400 meters (7.1 miles)	TBM
Ramps and Mains	7.62 meters (25 feet)	13,900 meters (8.6 miles)	TBM
Emplacement Drifts	5.0 meters (16 feet)	179,000 meters (111 miles)	TBM (2 machines)
Shafts	6.7 meters (22 feet)	320 meters (1050 feet) and 385 meters (1260 feet)	Mechanical Excavation and Drill and Blast
Upper Block Exhaust Main and Miscellaneous Access Drifts	955,900 cubic meters (1,250,000 cubic yards)		Mechanical Excavator (2 machines)

TBM = tunnel boring machine

The waste emplacement drifts are provided with rail tracks, enabling waste package emplacement in a horizontal position on railcars. The drifts are designed to require minimum maintenance after waste has been emplaced. During the development phase, the emplacement drift excavation continues from the south ramp while emplacement operations occur through the north ramp. Barriers and separate ventilation systems are provided to isolate the development area from the emplacement area.

The service main functions as the primary access for development operations personnel, equipment, and materials haulage; and as a primary ventilation airway in emplacement and development operations. The central exhaust main functions as a primary exhaust ventilation airway.

The north ramp is the primary access for emplacement operations between the North Portal surface operations area and the subsurface emplacement drifts. The ramp is used for the rail transportation of waste packages, materials, personnel, and equipment. It also functions as the main ventilation intake airway for the emplacement side of the repository.

The south ramp is the primary access for development operations between the South Portal surface operations area and the subsurface emplacement area. The ramp is used for the rail transportation of personnel and equipment. It also serves as the main ventilation intake airway for the development side of the repository.

The south shaft supports repository development operations, functioning as the primary ventilation exhaust airway for repository development operations. The north shaft supports emplacement operations, functioning as the principal ventilation exhaust airway on the emplacement side of the repository and an emergency egress route. The ventilation shafts are lined.

The TBM launch and recovery drifts are excavated to support construction. The upper block TBM recovery drift is later used for waste handling.

5.2.4.6 Off-site Rail Transportation Within Nevada

Rail transportation within Nevada includes the main rail routes, connecting rail lines linking the main rail lines to the repository, and junction points (i.e., interchange yards) where the lines meet. The junction point equipment includes trackage, switches, controls, signals, maintenance items, and support facilities. The connecting rail line includes trackage, crossings, bridges, culverts, and signaling as required.

Train service is provided by commercial line-haul carriers (e.g., Southern Pacific and Union Pacific). A train likely consists of two 3,000-horsepower diesel-electric locomotives pulling three SNF transportation cask carriers or five DHLW cask carriers. Options are being considered where trains operating on the main line routes pull commercial freight along with the cask carriers.

The four connecting rail route alternatives being studied are described in Section 11. These routes include: Carlin (north, about 530 km [330 miles] from the Nevada Test Site [NTS]), Jean (south, about 190 km (120 miles) from the NTS), Caliente (east, about 550 km [340 miles] from the NTS), and Dike (southeast, about 160 km [100 miles] from the NTS). The junction points for each candidate route are located in areas suitable as home terminals for the Yucca Mountain transportation crews.

5.2.5 Waste Forms and Receipt/Emplacement Rates

This section briefly describes the waste forms and rates for the SNF and DHLW as this material is received at, and emplaced in, the repository. SNF is in the form of pressurized water reactor (PWR) assemblies and boiling water reactor (BWR) assemblies. DHLW is in canisters that are 80 percent filled with a solid mass of vitrified waste (i.e., glass).

Waste At Receipt

SNF arrives at the repository as uncanistered waste in GA-4 or GA-9 legal weight truck casks or as canistered waste in large or small rail casks. SNF canisters are typically 2.54 centimeters (1 inch) thick. DHLW canisters, which are nominally 9.53 centimeters (3.8 inch) thick, arrive in rail casks. All casks ride on customized carriers installed with impact limiters and personnel barriers. Casks or canisters are provided with baskets and spacers to hold the waste in position. Approximate waste quantities and numbers of shipments are reported for each waste form in Table 5.2.5-1.

Waste At Emplacement

Canistered or uncanistered fuel assemblies or canistered DHLW are packaged in disposal containers for underground emplacement. The disposal containers are welded closed and include two barriers. The total thickness of the disposal container is about 12 centimeters (4.8 inches) for SNF containers and 7 centimeters (2.8 inches) for DHLW containers. The disposal containers are emplaced in a horizontal orientation on an emplacement railcar. Approximately 117 of the SNF canisters may also include filler material as a moderator displacement technique to ensure long-term criticality control. Approximate waste quantities and numbers of shipments are reported for each emplacement waste form in Table 5.2.5-2. Details of the disposal container design are provided in Volume III.

NOTE: After the disposal container is loaded with waste, welded closed, and qualified through non-destructive testing, the configuration meets the 10 CFR 60 definition of a waste package. The waste package as defined in 10 CFR 60 would also include any shielding, packing, or absorbent material immediately surrounding the individual disposal container, but the ACD concept does not include such materials.

Table 5.2.5-1. Transportation Cask Arrival Forms and Quantities

Cask	Transport Mode	Contents	Number of Shipments			Waste Quantity (MTIHM)
			Peak Annual	Avg. Annual	Total	
Large Canister	Rail	40 BWR Assemblies in a Canister	139	93	2,242	16,000
		21 PWR Assemblies in a Canister	212	168	4,041	35,000
Small Canister	Rail	24 BWR Assemblies in a Canister	111	63	1,505	6,500
		12 PWR Assemblies in a Canister	46	32	765	3,800
		12 BWR Assemblies in a Canister	8	2	40	99
GA-9	Legal Weight Truck	1 to 4 BWR Assemblies	1	0	3	1
GA-4		4 PWR Assemblies	72	43	1,026	1,600
DHLW	Rail	5 Canisters of Vitrified Waste	161	109	2,606	7,000
All Casks			*638	510	12,228	70,000

* The peak value of 638 for all casks is less than the sum of the peak values because the number of shipments do not peak in the same year for all cask types.

Table 5.2.5-2. Waste Emplacement Forms and Quantities

Disposal Container	Contents	Number of Emplacements			Waste Quantity (MTIHM)
		Peak Annual	Avg. Annual	Total	
Large Canister	40 BWR Assemblies in a Canister	139	93	2,242	16,000
	21 PWR Assemblies in a Canister	212	168	4,041	35,000
Small Canister	24 BWR Assemblies in a Canister	111	63	1,505	6,500
	12 PWR Assemblies in a Canister	46	32	765	3,800
	12 BWR Assemblies in a Canister	8	2	40	99
Bare Spent Fuel Assembly	1 to 4 BWR Assemblies in Rack	1	0	3	1
	Up to 21 PWR Assemblies in Rack	14	8	182	1,600
DHLW Canister	4 Canisters of Vitrified Waste	202	136	3,259	7,000
All Containers		*634	502	12,037	70,000

* The peak value of 634 for all containers is less than the sum of the peak values because the number of emplacements do not peak in the same year for all container types.

5.2.6 Operations and Maintenance Approach

Operation and maintenance of SSCs used to conduct nuclear operations is conducted in accordance with NRC requirements. Operation and maintenance of general support facilities is conducted in accordance with industry best management practices and the *Project Operations and Maintenance Plan* (YMP 1995h). Industry practices may include but are not limited to Institute of Nuclear Power Plant Operations and DOE regulations.

The operations and maintenance programs address the following issues:

- Maintenance
- Quality assurance
- Visitor control
- Safety and health
- Radiation protection
- Environmental protection
- Training.

Administrative operations include the following activities:

- Procedure development, recording and reporting
- Identification of operational limits
- Preservation of records
- Site markers
- Operation scheduling
- Personnel support.

Maintenance

Maintenance is performed on repository facilities, systems, equipment, instruments, and vehicles. Maintenance operations include the following activities:

- Scheduling and performing maintenance
- Maintaining records of failures and repairs
- Managing spares inventories
- Reporting on failure histories and trends
- Issuing advisories for preventive maintenance procedures.

These operations are managed from the Administration Building in the BOP area.

Maintenance for nuclear operations requires a specialized work force certified in the operation of remote handling and contaminated equipment. A formal maintenance and training program is implemented, and specialized maintenance procedures are developed. Where possible, maintenance is performed in place. Faulty components are removed and replaced. On-site and off-site shop facilities are used to repair and recertify components, where practical.

Organization

The repository includes functional organizations each tasked with specific surface, subsurface, analysis, and support responsibilities. Managers from each organization report to the MGDS Operations Manager. The MGDS Operations Manager reports to the resident DOE Manager. Each functional organization is staffed with the appropriate management, scientific, engineering, medical, technical/specialist, clerical, and craft personnel required to perform their functions.

Personnel Training

Training of repository personnel uses classrooms, audiovisual aids, and mock-up facilities for classroom, field, and on-the-job training. Personnel are certified and re-certified as required, and records are maintained at the Administration Building central computer. The associated training systems are located at various facilities throughout the site including the Administration Building, Training Auditorium, and Mock-up Building. Personnel assigned to waste handling, safety, and quality affecting responsibilities are formally trained and certified to perform their tasks, including specialized operations such as those involved in handling radioactive materials.

Quality Assurance

Site operations and maintenance on components used to conduct nuclear operations are carried out in accordance with a Quality Assurance Program meeting NRC requirements and as defined in the NRC license application.

Work Schedule

The repository operates 250 days per year, normally using the schedule summarized below. Shifts may be added occasionally to increase production rates to recover from unexpected downtime or peak waste receipt rates.

- 3 shifts, 7 days per week – Security and waste receipt operations
- 3 shifts, 5 days per week – Subsurface development operations
- 2 shifts, 5 days per week – WHO operations
- 1 shift, 5 days per week – All other repository operations

Personnel Transportation

Most personnel are expected to live in the cities of Las Vegas, Pahrump, and surrounding areas. Due to the long distance from cities to the repository, most personnel are expected to use buses. Buses are expected to be subcontracted, in which case the repository is not liable for their maintenance. Bus parking is accommodated at the repository.

Some personnel, such as the health physics staff on overnight call, are expected to stay in Mercury or alternative locations outside the repository. Accommodation for such personnel exists in Mercury. Vehicles are expected to be provided to these personnel.

5.3 REPOSITORY OPERATIONS

This section provides a high-level description of the major repository operations occurring in each operational phase described in Section 5.2.2, except off-normal.

5.3.1 Construction

Prior to beginning repository operations, all of the surface facilities, and enough of the subsurface areas, are constructed to permit a steady rate of waste disposal. Construction is scheduled to avoid peaks in construction staffing and resource utilization, to ensure resources are available when needed, and to accommodate the necessary approvals and inspections. The total construction period is six years.

Prior to construction the site is used for site characterization activities. These activities involve both surface and subsurface construction. It is expected that some construction infrastructure (e.g., utility system) will exist when repository construction begins.

Surface Construction

Surface construction begins with site preparation, which includes grading and grubbing and establishing the building pads. This operation likely requires moving the existing muck pile. Following site preparation, structures are built and finished. Routine structures may be prefabricated off site.

The rail route system is constructed on connecting rail route rights-of-way including earthwork, grade crossings, bridges, tunnels, culverts, and trackage.

Subsurface Construction

Subsurface excavation is initially conducted from the North Portal using facilities and equipment that remain from the site characterization activities. When the South Portal support facilities are available, operations are shifted to the South Portal.

Underground excavation is primarily performed with TBMs. The TBMs, road headers, and associated equipment perform the excavation and transferring of excavated rock or muck. Excavated rock is transferred to the surface and placed in a storage pile. The pile is stored with appropriate means to prevent deterioration, as the material may be used for site reclamation and backfill during repository closure.

Where use of a TBM is not feasible, other mechanical methods such as road header-type machines, or drill-and-blast excavation is used. For drill-and-blast excavation, rock must be picked up by loading equipment.

Following excavation, the openings are stabilized using appropriate combinations of rockbolts, welded wire fabric, shotcrete, and steel sets. Consideration is also being given to cast-in-place concrete and segmented precast linings commensurate with postclosure waste isolation requirements.

5.3.2 Development

During development, the emplacement drifts are excavated concurrently with waste package emplacement operations. Excavation techniques are described in Section 5.3.1.

To isolate the development workforce from airborne radionuclides that could be present in the emplacement area, two separate ventilation systems are used. The two systems are physically separated by bulkheads to minimize air leakage between the two areas. Differential pressure is maintained to ensure air leakage between systems is always from the development to the emplacement side. The requirement for separate development and emplacement ventilation areas is in accordance with 10 CFR 60.133(g)(3). Figure 5.3.2-1 shows a simplified illustration of the ventilation flow paths.

Development side ventilation fans are located on the intake and force air into the underground, resulting in the development system air pressure being above atmospheric pressure. The emplacement system ventilation fans pull air through the underground, resulting in the emplacement system being below atmospheric pressure. The flow path for the development system involves intake down the south ramp to the emplacement horizon. Most of the development side air moves to the main drifts and to the active TBM operations.

Development is conducted in phases. As a phase is ready for emplacement, the bulkheads are relocated and the excavation of the next phase begins. At completion of subsurface construction, the development area ventilation system is shutdown; however, this system is maintained until closure, as it may be required to support retrieval operations.

5.3.3 Emplacement

The following emplacement operations are described in this section:

A. *Waste Receipt* – Casks on transportation carriers enter the repository and are staged in a parking area.

B. *Carrier Staging* – Preparations are made to remove the cask from the carrier.

C. *Waste Handling* – Casks are removed from the transportation carrier, waste is transferred from the cask to a disposal container (DC), and the DC is closed and placed in the underground waste package transporter.

D. *Underground Emplacement* – The DC is transported to an underground emplacement position.

E. *Cask Maintenance* – Transportation casks are recertified, reconfigured, or repaired.

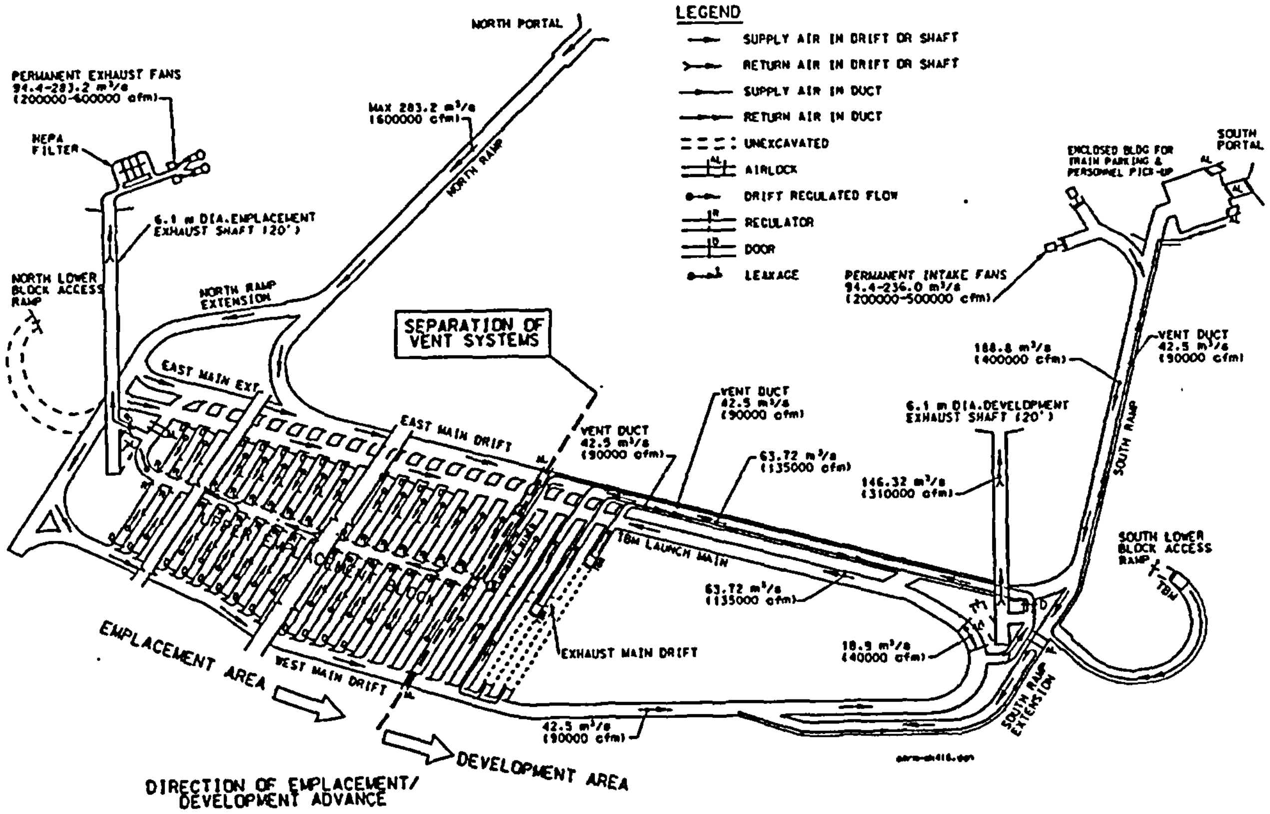

Figure 5.3.2-1. Separate Ventilation Systems for Development and Emplacement

F. *Site Generated Waste Handling* – Site-generated low-level wastes, mixed wastes, hazardous wastes, and sanitary wastes are managed.

G. *Off-site Rail Transportation within Nevada* – Rail transportation casks are moved to the repository.

H. *Support Operations and Services* – Structures and systems are operated to support the operations listed above.

5.3.3.1 Waste Receipt Operations

Transportation casks loaded with SNF are delivered to the MGDS on railcars or legal weight trucks. A loaded transportation cask carrier and its off-site prime mover are externally inspected for contraband and sabotage at the repository security boundary. The cask carrier is then transferred by the off-site prime mover to either the truck or rail parking area within the RCA. The off-site prime mover leaves the transportation cask carrier and exits the RCA. At the parking area, the off-site prime mover may pick up a cask carrier awaiting off-site shipment. Upon receipt at the parking area, the cask and carrier will be inspected for radiological contamination.

5.3.3.2 Carrier Staging Operations

A loaded transportation cask carrier is picked up from the parking area and delivered to the CSS to prepare for cask removal. Here the personnel barrier is retracted or removed, the impact limiters are separated from the cask, and the cask is reinspected for radiological surface contamination. Minor decontamination is performed as required. More substantial decontamination is done in the CMF.

The prepared transportation cask and carrier remain in the CSS until the WHB is available for removal of the cask the carrier. The personnel barriers and impact limiters are later reinstalled on the clean empty cask, returning from the WHB, in preparation for off-site shipment.

5.3.3.3 Waste Handling Operations

The site prime mover transfers the cask carrier to the WHB. In this building the casks are removed from the carrier, waste materials are transferred from the casks to disposal containers, filler material may be added to selected spent fuel assembly (SFA) canisters, and the disposal containers are welded closed and delivered for underground transportation. These operations are described below.

A. *Cask Receiving and Preparation* – A transportation cask is unloaded from a truck or rail carrier and placed on a railcar in a vertical position using a bridge crane.

A loaded cask requiring external decontamination or an empty cask requiring maintenance (i.e., recertification, repair or reconfiguration) is transferred on the cart to the CMF. After decontamination or maintenance, the cask is returned to the WHB. If the returned cask is empty, it is loaded back on a carrier and removed from the WHB by the site prime mover.

Loaded transportation casks are prepared for unloading, which includes operations such as cleaning the top of the cask, checking the pressure of the cask cavity, analyzing the cavity gas for contamination, and introducing a small negative pressure into the cask cavity. Following cask preparation, the loaded transportation cask is unloaded as described below in paragraphs B. and D.

B. *Canistered Waste Transfer* – A loaded rail transportation cask is moved on a cart to a shielded area where the lid is removed. The cask is then positioned under a cell port and the port plug is removed from above with a crane. The canister is lifted from the open cask, through the cask port, and into a hot cell. In the hot cell, the crane places the canister directly into a DC. The port plug is reinstalled. Following removal of the canister, the empty transportation cask is moved to where the lid is reinstalled and the cask is decontaminated, as necessary. The clean, empty cask is then transferred to where cask preparation and shipping operations are performed.

C. *Disposal Container Welding and Transfer* – In a hot cell, a crane moves a DC to an automated welding station, where the DC lids are installed and the welds are inspected. The closed DC (or waste package) is next moved to a device that places the container in a horizontal position. The horizontal DC, moved with a gantry, is decontaminated and placed on a subsurface waste package transporter cart. The cart is pushed into the waste package transporter, which is now ready to be taken underground for emplacement. A lag storage area is provided for in-process staging of DCs before or after welding.

D. *Uncanistered Waste Transfer* – After preparation, a truck transportation cask is moved on a cart to a shielded area where the lid is removed. The cask is then positioned under a cell port, the port plug is removed from above with a crane, and a contamination control barrier is installed. Bare SFAs are lifted, one at a time, from the open truck cask, through the cask port and into a hot cell. In the cell, the crane places each SFA into a staging rack. When the cask is empty, the contamination control barrier is decontaminated and removed, and the port plug is reinstalled. The empty transportation cask is moved to where the lid is reinstalled, and the cask is decontaminated as necessary. The clean empty cask is then transferred to where cask preparation and shipping operations are performed.

When enough SFAs have collected in the SFA staging rack to fill a DC, a DC is positioned under a transfer port. Each SFA is then lowered by crane from the SFA staging rack down through the port and into the DC. The loaded DC is moved to an area where an inner lid is seal welded in place by a laser. The sealed DC is transferred by cart to the DC welding area.

E. *Canister Filler Addition* – The addition of filler material may be required for approximately 117 SFA canisters as a moderator displacement technique to ensure long-term criticality control. This operation is performed by cutting the canister lid off, filling the voids between SFAs with carbon steel shot, and welding the canister lid back on. The operations are conducted remotely in a hot cell, and the cutting and welding are performed with a laser.

F. *Cask Preparation and Shipping* – The empty cask is transferred by cart to a preparation area after the waste has been removed. The cask arrives closed and decontaminated. Cask preparation includes visual inspections, cask closure inspections, health physics inspections, and, if necessary, purging of the cask cavity with an inert gas. These operations are safely conducted by direct contact because the casks do not contain waste materials. If the cask requires maintenance (i.e., recertification, repair, or reconfiguration), it is transferred to the CMF on a cart. Following cask maintenance, the cask is returned to the WHB. The clean empty transportation cask is lifted from the cart and loaded on a truck or rail carrier. The cask and carrier are transferred to the CSS by the site prime mover.

5.3.3.4 Underground Emplacement Operations

The waste package transporter, containing the loaded DC (i.e., waste package) and railcar unit, is pulled to an underground emplacement drift with an electric transport locomotive. This transporter is a specially configured railcar that includes a shielded cask with doors. Here the waste package and emplacement railcar are removed from the transporter and positioned in the emplacement drift with a battery-powered locomotive. These operations are described below.

A. *Waste Package Underground Transfer* – The transport locomotive attaches to the loaded transporter at the WHB loading dock. The locomotive hauls the transporter through the north waste ramp to the Waste Handling Main, into the Waste Handling Main, and to the designated emplacement drift and emplacement entry area. During pre-emplacement operations the emplacement entry area is prepared for emplacement.

The prime mover then positions the transporter in front of the emplacement drift door. The transporter door opens and continuity with the emplacement drift rails is established. A self-contained mechanism pushes the waste package beyond the opening. The transporter is retracted, and the emplacement drift door is closed. The empty transporter is pulled away from the emplacement entry area and transported back to the surface.

B. *Cask Return to Surface* – The transport locomotive parks the transporter at the WHB loading dock in preparation for loading a new waste package.

C. *Waste Package Emplacement* – When the empty transporter clears the emplacement entry area, a battery-powered, remote-operated transport locomotive is brought on a rail carrier, positioned at the emplacement entry area, and inserted into the emplacement drift. The emplacement locomotive advances, attaches to the car, moves the car to its emplacement location in the drift, and retreats back to the emplacement entry area. The emplacement drift door closes, completing the emplacement operation. Post-emplacement operations follow to clear the emplacement entry area or prepare it for the next waste package. The emplacement drift is ventilated until all waste packages of that drift are emplaced.

5.3.3.5 Cask Maintenance Operations

Cask maintenance includes periodically recertifying casks to ensure the cask is safe, clean and properly configured, routinely reconfiguring casks to accommodate different types of fuel assemblies (e.g., replacing the internal spacers and baskets), and repairing casks and cask components as needed to maintain cask certification. The operations required to accomplish recertification and/or reconfiguration are similar and are described below. Some of these operations may be skipped to repair a cask, depending on the nature of the irregularity.

A. *Preparation for Opening* – An incoming cask is received in the WHB and transported, in a vertical orientation on a cart, to the CMF. The cask is placed in a pit using a bridge crane, where a shroud and bottom protector are installed for contamination control. The cask is filled with water, the head is loosened, and the head removal adaptor is installed.

B. *Reconfiguration and Cleaning* – The cask is then transferred to the reconfiguration pool using a bridge crane. The head is removed and transferred to a pit for inspection, repair, and decontamination, as necessary. In the reconfiguration pool, the interior of the cask is inspected and then cleaned with a wet vacuum system. The spacers and baskets are removed from the cask by the pool bridge crane, cleaned, and then placed in an underwater storage rack. The interior of the empty cask is then inspected and cleaned again. Spacers and baskets are placed in the cask. If a cask reconfiguration was required, the design of the spacers and baskets placed in the cask differs from those removed. The cask is then lifted to the pool shelf with a crane, where the interior of the cask and any sealing surfaces are inspected.

C. *Decontamination* – The cask is lifted from the reconfiguration pool, and the shroud and bottom protector are removed as the cask is being placed in a pit. In the pit, the cask exterior is surveyed for contamination and decontaminated as necessary. Decontamination may be conducted with localized scrubbing or high-pressure washing with chemical solutions or tempered water.

D. *Component Repair and Closure* – Following decontamination, the water level in the cask is lowered to allow access to any sealing surfaces. Repairs to seals, fasteners, and any internal components are performed as required. The head is reinstalled, and the water is removed from the cask. The cask is vacuum dried, pressurized with an inert gas, and leak tested.

E. *External Repair* – The cask is removed from the pit to undergo dry tests and repairs to external surfaces. This activity includes welding, grinding, and component replacement. The recertified and/or reconfigured cask is placed on a cart and rolled to the WHB for off-site shipment.

5.3.3.6 Site Generated Waste Handling Operations

Secondary (i.e., site-generated) wastes include low level wastes, mixed wastes, hazardous wastes and sanitary wastes. The repository operations for handling these materials are described below.

A. *Low-Level Waste* – Liquid wastes are collected and routed through a piping system to the WTB. Recyclable liquids are treated with filtration, evaporation, and ion exchange. The treated water is piped to the waste generators for reuse. Non-recyclable liquids are neutralized, solidified, and packaged in drums. Solid wastes are transferred to the WTB in drums. These materials are size-reduced, compacted, or dewatered as necessary, and then packaged in drums with a solidification agent. After treatment, the drums of packaged low-level waste are shipped off site for disposal.

B. *Mixed Wastes* – Although the repository includes provisions to avoid the generation of mixed wastes, small quantities of solid and liquid mixed wastes are assumed to be generated from off-normal repository operations. If generated, this material will be packaged in drums at the point of generation, accumulated, and shipped off-site for treatment and disposal.

C. *Hazardous Waste* – Solid and liquid hazardous wastes are packaged in drums at the point of generation, accumulated, and shipped off site for treatment and disposal.

D. *Sanitary Waste* – Sanitary liquids are routed via sewer lines to an on-site sanitary waste treatment system. Sanitary solid waste is accumulated in dumpsters throughout the site. Garbage trucks periodically collect and transport the garbage to an off-site landfill.

5.3.3.7 Off-Site Rail Transportation Within Nevada

Two options are under consideration for transporting waste to the repository within Nevada. The first option uses a dedicated unit train (e.g., two locomotives and three to five cask carriers). This train, which is operated interstate by a commercial line-haul carrier (e.g., Southern Pacific and Union Pacific), enters Nevada on a main line, stops at a junction point, transfers to a connecting rail line, and continues to the repository. At the junction point, the transport authority is confirmed, crews are changed, and the train is switched to the connecting rail line.

In the second option, the train entering Nevada includes commercial freight cars as well as the cask carriers. The train stops at the junction and switches out the cask carriers. The cask carriers are then configured as a unit train. This unit train transports the waste to the repository via the connecting rail line. In this option, support facilities at the junction points are more extensive to accommodate additional equipment, interchange operations, and crew conveniences.

5.3.3.8 Support Operations and Services

Emplacement operations require a number of support operations and services. These operations are conducted with a variety of support structures, site support systems, and support systems within facilities. The operations are described below.

A. *Administration and Planning* – Administration and planning operations are supported by contractor/government and staff management, automated data processing, video conferencing, payroll, accounting, purchasing, visitor management, and food service. The facilities and equipment are primarily located in the Administration Building

B. *Engineering and Analysis* – Engineering and analysis includes responsibilities associated with health physics, emplacement/transportation planning and simulation, design engineering analysis, environmental analysis, energy conservation, etc. The main engineering workforce is housed in the Administration Building.

C. *Training and Certification* – Training uses classrooms, audiovisual aids, and mock-up facilities for field and on-the-job training. Personnel are certified and re-certified, as required, and the records are maintained on the Administration Building central computer. The facilities and associated training systems are located at various facilities throughout the site including the Administration Building, Training Auditorium, and Mock-up Building.

D. *Emergency Response* – The emergency response capability ensures adequate response to, and mitigation of, the consequences from off-normal events at the repository. Emergency response consists of the required facilities, systems, and trained personnel. The primary site facilities are the Fire Station, emergency response centers, and Medical Facility. The emergency response centers include a variety of special on-site and off-site capabilities to respond to subsurface, radiological, environmental, medical, and security events.

   Emergency response support systems are coordinated through existing site safety systems including communications/public address, fire protection/detection, security, radiological and hazardous monitoring, medical, and weather systems. Automatic and manually entered hazardous alarms are time tagged, identified, and prioritized. Alarm data is automatically routed to the appropriate control room, annunciator station, fire station, medical facility, emergency response center, and law enforcement agency.

E. *Physical Security* – Security maintains safety and the authorized access of people and equipment at the repository site and facilities. The security operation uses trained security and emergency response personnel, fences, barriers, guard houses, control rooms, offices, and equipment. The security equipment includes vehicles, weapons, control, and monitoring systems.

The control and monitoring systems include site/emergency communications, badge/vehicle access and accounting, automated data processing systems, video and electronic detection equipment, central monitor and control, and alarm systems. The system integrates surface facility, subsurface facility, and site security stations on the redundant data network with assigned priority to the emergency response system.

F. *On-Site Transportation* – On-site transportation directs and coordinates the on-site movement and maintenance of the shipping cask transportation vehicles. This operation includes the installed rail and road equipment, transporters and associated instrumentation, communications, safety equipment, and central control facilities. The control stations are in the Administration Building, collocated with the off-site transportation control area.

G. *Site Maintenance* – Site maintenance maintains repository facilities, systems, equipment, instruments, and vehicles. The system schedules and performs the maintenance, maintains records of failures and repairs, manages spares inventories, reports on failure histories and trends, and issues advisories for preventive maintenance procedures. Certain failures are logged automatically. Most equipment failures and the associated repair data is recorded by manual input on in-place or portable workstations. The major maintenance facilities include the TMB, Motor Pool and Facility Service Station, and Central Shops.

H. *Warehousing* – Warehousing maintains the inventory and records for general purpose site equipment and materials. This operation consists of warehouse space, material handling and packaging equipment, and inventory systems. The materials are stored at the Central Warehouse. The Administration Building automated data processing systems maintains the central records for all site inventories. Inventories are also maintained at the Waste Handling and Cask Maintenance Buildings for special equipment associated with maintaining the cask fleet and material handling equipment. The Administration Building staff maintains the central inventory and maintenance records and manages the purchasing activities.

I. *Secondary Waste Management* – The secondary waste management system handles all on-site generated wastes, maintains waste generation records, issues empty containers, coordinates waste minimization and recycling activities, and provides compliance reports. Administrative waste management functions are conducted in the Administration Building and records are maintained on the WTB automated data processing system. Refer to Section 5.3.3.6 for a description of the waste treatment operations.

J. *Utilities* – Utilities include water, electric power, diesel and gasoline fuels, and industrial air. Well water is used to produce potable water, well/fire water, tower cooling water, and chilled water, which is distributed to users throughout the repository. Electric power, provided from off site, is distributed to repository users through a system of transformers and switchgear. Uninterruptible and standby power is provided as required for critical safety and security systems. Liquid fuels are delivered by truck to support vehicle and standby generator operation. Industrial air is generated centrally at two locations and piped to users. Sanitary sewage is collected and treated in a septic system and underground waste water is collected and routed to a waste water pond. Other specialized utility systems are provided within the facilities.

K. *Communications* – Communications include data and voice and video signals throughout the repository, NTS, and off site. This operation uses fiber optic communications networks, a back-up microwave or cellular communication system, and a satellite earth station.

L. *Monitoring and Control* – Monitoring and control includes a number of networked computer systems used to collect, manage, synthesize, and display data from repository operations, and, where appropriate, control operations or notify repository personnel. The following systems are provided:

- Utility monitor and control systems
- Facility monitoring and control systems
- Emergency control, material control, and accountability
- Radiation monitoring
- Site effluent monitoring
- Off-site transportation monitoring and control.

Each system includes the appropriate level of reliability and secure access. Workstations are provided throughout the repository work areas. Central computers and servers are provided in the Administration Building.

M. *Ventilation Systems* – Ventilation systems are provided in all facilities to maintain the proper environmental conditions for the equipment as well as for the health, safety, and comfort of operating personnel. In general, the ventilation systems use electricity for heating and chilled water from central water chillers for cooling.

HVAC systems for nuclear surface facilities confine radioactive and hazardous materials as close to the point of origin as practicable and prevent uncontrolled releases to rooms and areas normally occupied by personnel. This confinement is accomplished through a series of successive confinement zones of varying pressures. Each successive zone is at a lower pressure and has a higher potential for contamination. Exhausts from the lowest pressure zone are routed through HEPA filters and discharged from the facilities at monitored stacks. Non-nuclear surface facilities have commercial-quality HVAC systems.

The subsurface facilities are ventilated by two separate and independent systems during the period when both emplacement and development are ongoing. A description of the emplacement area ventilation system follows. The development area ventilation system is described in Section 5.3.2. Airflow in the subsurface emplacement ventilation system enters the emplacement area through the north ramp and exits through the emplacement exhaust shaft. The air is drawn through a fan at the top of the shaft and is exhausted to the atmosphere. If abnormal levels of radiation are detected in the emplacement area, the exhaust airflow is diverted through a HEPA filtration system to ensure that contaminated particulates do not escape from the facility. Individual emplacement drifts are ventilated until all waste packages are emplaced in that drift. When the last waste package is emplaced in a drift, the doors are closed, and ventilation is cut off in that drift. Ventilation would be re-established only if access to the drift was required.

5.3.4 Caretaker

The caretaker phase is a waiting period of 76 years from the end of the emplacement phase, during which the option to retrieve emplaced waste is preserved. Caretaker operations are primarily limited to the maintenance of repository subsurface facilities. During this period the performance confirmation operations described in Section 5.3.7 also occur.

All surface facilities, except those required to conduct maintenance, are placed in a cold shutdown condition. The accessible portions of the underground (i.e., drifts not containing emplaced waste) are routinely inspected and repairs are made to the ground support as required. Data on the uninhabitable emplacement drifts is provided from the performance confirmation operations. If this program indicates that the emplacement drifts require maintenance, the drifts are cooled, the waste packages are removed to an empty emplacement drift, and repairs are made.

Caretaker operations require some of the same support operations and services described for the emplacement phase in Section 5.3.3.8, although the level of activity and staffing levels are significantly reduced. This activity includes operation of the subsurface utilities (e.g., ventilation system, lighting, electric power distribution, pumping, monitoring systems, and personnel transportation systems). Note that during caretaker operations, the subsurface ventilation system is reconfigured such that only one fan system is used.

Section 9.1 provides additional descriptions of caretaker operations.

5.3.5 Retrieval

The waste emplaced at the repository may be retrieved any time after the start of emplacement and before closure to remove public health and safety concerns or to recover the waste as a valuable resource. All or part of the emplaced waste packages could be retrieved.

When (and if) retrieval is required, a period of mobilization is needed to modify, expand, or upgrade the repository facilities, as required to conduct the retrieval operations. The following changes to the repository may be required:

- Special equipment is added to operate in emplacement areas that have not maintained their integrity.
- Surface facilities are modified to cut open waste packages, repackage the waste for shipment or remediation, or process the waste for recovery of a valuable resource.

- Lag storage facilities are added to stage the retrieved waste.

- Underground equipment, which has a useful life of 10 to 20 years, is replaced.

Waste package retrieval, under normal conditions, is essentially the reverse of the waste package emplacement operations described in Section 5.3.3. Prior to retrieval, the drifts are ventilated, inspected to confirm that no debris is obstructing equipment operation, and monitored until the drift temperature is within prescribed limits. At the surface, the waste may be repackaged and reemplaced, shipped off site, or processed on site for resource recovery.

Subsurface waste package retrieval may be hampered by a failure of the rock support, deterioration of the shotcrete or deterioration of drift inverts, causing track failure. Descriptions of off-normal subsurface retrieval operations dealing with these conditions, as well as a more detailed description of normal subsurface retrieval operations, are provided in Section 9.2.

5.3.6 Performance Confirmation

The performance confirmation phase includes data collection, performance assessment using the collected data to analyze the performance of the repository, and taking corrective action if required. These activities begin during site characterization, prior to construction.. The laboratory testing ends at start of closure. In situ monitoring may end at closure or continue in postclosure. Each activity is described below. Section 9.3 provides additional descriptions.

5.3.6.1 Data Collection

Data is collected with in situ monitoring, laboratory and field testing, and in situ experiments to monitor the geological and radiological environments of the repository. The types of measurements, collection methods, and quantity of measurements are determined as the current assessment operations and the MGDS design progresses.

In Situ Monitoring

The natural and engineered barriers are monitored in the emplacement drifts assigned to performance confirmation. Waste package and rock surface temperature and radiation measurements are taken. In addition, video cameras are used to inspect for corrosion, other abnormal waste package conditions, and drift conditions.

Measurements are taken on all waste package types. Measurements are also taken in several emplacement drifts to confirm that the confirmation drift data adequately represents conditions throughout the repository. Instrumentation packages are attached to an overhead rail system and remotely operated near the waste packages. In situ instrumentation is avoided because of the hostile environment and serviceability constraints in the emplacement drifts.

The natural barrier is monitored by measuring and profiling temperatures of the geologic media, stress and strain in the rock, water density, chemistry, and movement. Measurements are made in drill holes parallel to emplacement drifts or in empty drifts adjacent to emplacement.

Laboratory Tests

Conceptually, one waste package is retrieved every ten years for evaluation and repackaging in the WHB. The waste package is opened, testing and sampling is conducted, the waste is repackaged and returned to the emplacement area. The waste package supports and welds are inspected for cracks and corrosion, deterioration is photographed and logged, and samples are taken for further examination. Waste package surface temperatures and radiation levels are also noted and compared to the measured in situ levels. If leakage is detected, the waste package is repaired or replaced.

When a waste package is to be evaluated during the caretaker phase, crews are trained and the necessary surface facilities are restarted. After conducting these tests, the facilities are decontaminated and closed. The duration for each operating period is as follows: seven years for standby, two years for restart and waste package disassembly, and one year for decontamination.

Note that requirements for retrieval frequency and laboratory testing have not been established. Ultimately, the waste packages may need to be opened only if non-destructive testing suggest that additional data is required.

Field Tests

Repository ventilation exhausts, site groundwater, and perimeter air quality are continually monitored for radiation levels, composition, and particulates. Wells at the periphery of the repository are also monitored for radiation levels and water chemistry. Other measurements at the repository include seismic activity, ambient temperature, barometric pressure, and relative humidity.

In Situ Experiments

Monitoring of the natural barrier and the monitoring described above is conducted to determine the performance of the natural barrier. Temperature, humidity, and water flow profiles are trended from measurements taken at selected locations throughout the repository. Portable or permanent instrumentation packages are used.

5.3.6.2 Performance Assessment

As in situ monitoring, laboratory, and field test data become available, performance assessment models used during repository design are updated. Actual thermal profiles are compared to predicted profiles and geologic parameters modified where necessary to further refine models.

Using the updated performance assessment models, performance of the engineered barrier and natural barrier is estimated together with performance of the total system. Long-term radiological consequences are also estimated. Any deviation from earlier predictions is carefully examined.

Using environmental and performance data, the environmental performance bounds are assessed. The results are compared to the EPA standards developed prior to approval of the repository for waste receipt.

5.3.6.3 Corrective Action

If the performance assessment indicates that the system is not performing properly, appropriate action is taken. The risk of exceeding the limits is assessed and mitigation actions are planned from predetermined alternatives. For example, if the expected rate of waste package corrosion is exceeded, the following actions may be considered:

- Increase frequency of inspections
- Remove waste package for laboratory testing
- Relocate waste packages to other drifts
- Retrieve additional waste packages.

5.3.7 Closure

Permanent closure operation includes closure of the subsurface facilities, decommissioning of the surface facilities, site reclamation, and establishment and maintenance of institutional barriers.

5.3.7.1 Subsurface Closure

Closing subsurface openings involves removing underground equipment, preparing the openings to receive backfill, backfilling the openings, installing repository seals, and implementing postclosure monitoring, if required. Included in the definition of equipment to be removed prior to closure are utilities and support services, as appropriate (size and type would be considerations), and unsuitable materials. Preparing the openings to receive backfill includes installing utilities and equipment specifically for the backfilling operation.

Backfilling involves obtaining material from the surface stockpile or other source, processing it (screening and, if necessary, crushing) to obtain the required grading, placing the processed material into a stockpile for subsequent loading, and transferring it to the underground for emplacement. The function of such backfill is access prevention.

Placement of seals involves preparing the underground openings to receive the seals, obtaining and transferring seal material, and constructing the seals. Currently, it is assumed that seals are to be placed only in shafts, ramps, and boreholes to ensure proper waste isolation and repository performance. Backfill may be placed on both sides of each seal.

Options for using a special type of backfill, to be placed over the waste packages in the emplacement drifts to enhance waste isolation, are currently being studied. Such backfill is not currently included in the baseline design, but will be included if the requirement for it is established.

5.3.7.2 Surface Decommissioning

As part of the closure activities, the surface facilities are decommissioned and removed from service. Decommissioning includes decontamination, removal/salvage of valuable equipment and materials, and dismantlement.

Decontamination ensures that residual contamination, both radioactive and hazardous, is within permissible levels for unrestricted use, or disposal operations. Decontamination activities include the survey, identification, and characterization of contaminated areas and facilities. Decontamination activities also include determination of methods for removal, degree of treatment needed, packaging, in situ immobilization, and transportation either to an on-site or off-site disposal or storage location.

Decontamination activities for hazardous materials and substances are not anticipated but could occur. It is expected that potential radiological contamination could occur anywhere unconfined radioactive materials (i.e., exposed intact spent fuel assemblies) are handled or where contamination is present on incoming containers within the WHB and CMF. In addition, contamination is expected to be generated within the WTB. Hot cells, decontamination stations, HVAC ducts, and HEPA filters potentially require decontamination or packaging for removal.

Facility dismantlement includes the dismemberment, distribution, or removal from the site of facility systems, in whole or in part, for the purpose of salvage, disposal, interim storage, long-term storage, reuse at another location, or safety. All facilities not part of the Institutional Barrier System functions are dismantled and removed from the site area. Almost all of the surface facilities require demolition of reinforced structures after removal of fixtures and equipment. Consideration for salvage, recycle, and reuse of equipment, materials, and fixtures is planned.

Removal of facilities is required to perform final site restoration activities. Facility removal activities include the preparation and transportation of intact facilities and facility sections to off-site locations.

5.3.7.3 Site Reclamation

Site reclamation includes restoring the site to as near to its pre-construction condition as possible in accordance with the *National Environmental Policy Act of 1969.* Reclamation may require the recontouring of all possible disturbed surface areas, surface backfill, soil buildup and reconditioning, site revegetation, site water course configuration, and erosion control implementation.

5.3.7.4 Institutional Barriers

Institutional barrier systems are incorporated, including land records, and passive and active systems designed to inhibit human disturbance and disruption of the repository site. Active controls include site monitors, warning devices, patrols, and an education institution that informs future generations. Passive controls include surface markers and obstacles.

5.3.8 Postclosure

After closure, the system of institutional barriers is managed and monitored. During postclosure the Engineered Barrier Segment may be monitored to ensure waste isolation, and the data collected is periodically analyzed. If this monitoring is required, monitoring devices will be installed prior to closure and maintained in postclosure.

6. SITE DESCRIPTION

This site description is intended to be an overview of the site and its regional setting. Specific design related site information are covered in the individual sections of Volume II. Since the basis for the design presented in this report is a combination of the respective design requirements documents and the *Controlled Design Assumption Document* (CRWMS M&O 1995a), much of the site information presented in this chapter came from these documents. Where appropriate, more recent information is incorporated to add to the site description.

6.1 GENERAL SETTING

This section presents an overall depiction of the Yucca Mountain area by describing in detail its general setting, physiography, meteorology, stratigraphy, structural geology and tectonics, and hydrology.

6.1.1 Previous Work

The Yucca Mountain area has been studied by U.S. Department of Energy (DOE) as a potential geologic repository site for the disposal of high-level nuclear waste for a number of years. The process and schedule for the siting was specified by Congress in the Nuclear Waste Policy Act of 1982. In May 1986, DOE recommended, and the President approved, the Yucca Mountain site as one of three candidate sites for detailed study. In the Nuclear Waste Policy Amendments Act of 1987, Congress identified the Yucca Mountain Site as the only site to be characterized. Since that time, the area has been investigated with numerous bore holes, trenches, geophysical surveys and the ESF development for the purpose of site characterization and gathering data for design. These site characterization activities are located in the Site atlas (EG&G 1995).

6.1.2 Location and Access

Yucca Mountain is located in Nye County, Nevada, about 160 km (by road), northwest of Las Vegas (Figure 6.1.2-1). Access from Las Vegas is via U.S. Highway 95 to the Mercury turnoff, then northwest on the Jackass Flats road from Mercury. An alternate access is via U.S. Highway 95 to Lathrop Wells, then north on the Lathrop Wells road. The Yucca Mountain area Field Operations Center is located at the junction of the Jackass Flats and Lathrop Wells roads. From the Field Operations Center, the Yucca Mountain project site is reached via "H" road. All accesses to the area are controlled by the Nevada Test Site.

6.1.3 Land Control

The Yucca Mountain area is situated on land that lies within the Nevada Test Site, Nellis Air Force Range, and the U.S. Bureau of Land Management (BLM) administered lands (Figure 6.1.2-1). The Nevada Test Site is reserved for use by the DOE. The western portion of Area 25 on the Site has been informally reserved for the Yucca Mountain Project. The Nellis Air Force Range, withdrawn from the public domain for use by the Air Force, is managed by the BLM. The remaining area is public domain land administered by the BLM.

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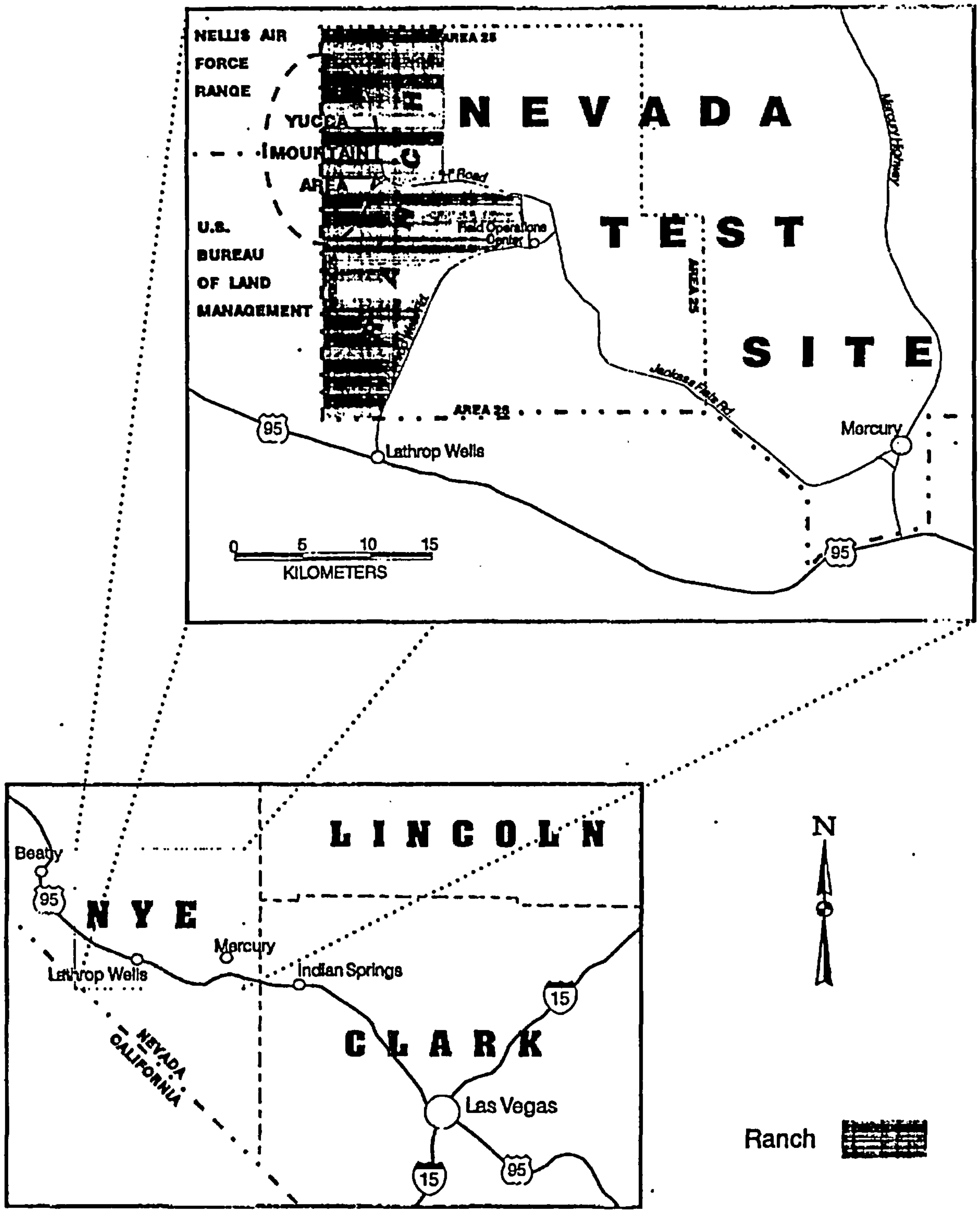

Figure 6.1.2-1. Location and Access Map

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6.1.4 Population

The 1990 U.S. Census population of Nye County was 17,781. Adjacent Lincoln County had a population of 3,775, and Clark County, which contains Las Vegas, had a population of 741,459. Metropolitan Las Vegas is now estimated to contain over 1 million people. In the more immediate area of Yucca Mountain, Beatty, Lathrop Wells, Mercury, and Indian Springs are all minor population centers. Located about 40 km south of Lathrop Wells is the town of Pahrump. In 1990, its population was 7,424, but has more than doubled since then.

6.2 PHYSIOGRAPHY

The physiography of the region around Yucca Mountain is an important indicator of the nature and magnitude of geologic processes that have occurred during the history of the region. A study of these processes, such as tectonics and erosion, results in a better understanding of future changes, and in particular, the changes likely to occur over the life of the repository. The following subsections present a summary of the physiographic setting of the Yucca Mountain area, a description of the geomorphic processes that have shaped the region, and projection of future processes.

6.2.1 Previous Work

A comprehensive discussion of the physiography of the region and Yucca Mountain is presented in the Site Characterization Plan (DOE 1988a).

The general region of Yucca Mountain is surveyed on five U.S. Geological Survey topographic maps. These include Bare Mountain and Big Dune, Nevada, at a 1:62,500 scale with 40- and 80-foot contour intervals respectively, and Busted Butte, Lathrop Wells, and Topopah Spring NW, Nevada, at a 1:24,000 scale with a 20-foot contour interval.

Special topographic map coverage for the Yucca Mountain area includes 1:12,000 scale maps with a 20-foot contour interval, developed from U.S. Geological Survey 1:24,000 scale digital line graph data. Orthophotographic coverage was developed for the Yucca Mountain area from 1:24,000 scale aerial photographs taken in July 1990 (EG&G 1995). The orthophotos were developed at a scale of 1:6,000. Digital elevation contour maps were also developed at a scale of 1:6,000 with 10-foot contour intervals as well as 160-foot spacing digital elevation models. Thirty of the 1:6,000 scale maps were developed for a 1,400 square km area around Yucca Mountain.

Orthophotographs were also developed at a scale of 1:12,000 from 1:40,000 scale color aerial photographs taken in July 1990 (EG&G 1995). Digital elevation contour maps with 20-foot contour intervals and digital elevation models at 250-foot intervals were also developed. Thirty-six 1:12,000 scale maps were developed for a 440 square km area around Yucca Mountain.

Detailed topographic contour maps with 2-foot contour intervals were developed at a scale of 1:1,200 from 1:6,000 scale aerial photographs taken in August 1991 (EG&G 1995). These maps are presented in 90 sheets and cover in area of about 57 square kms.

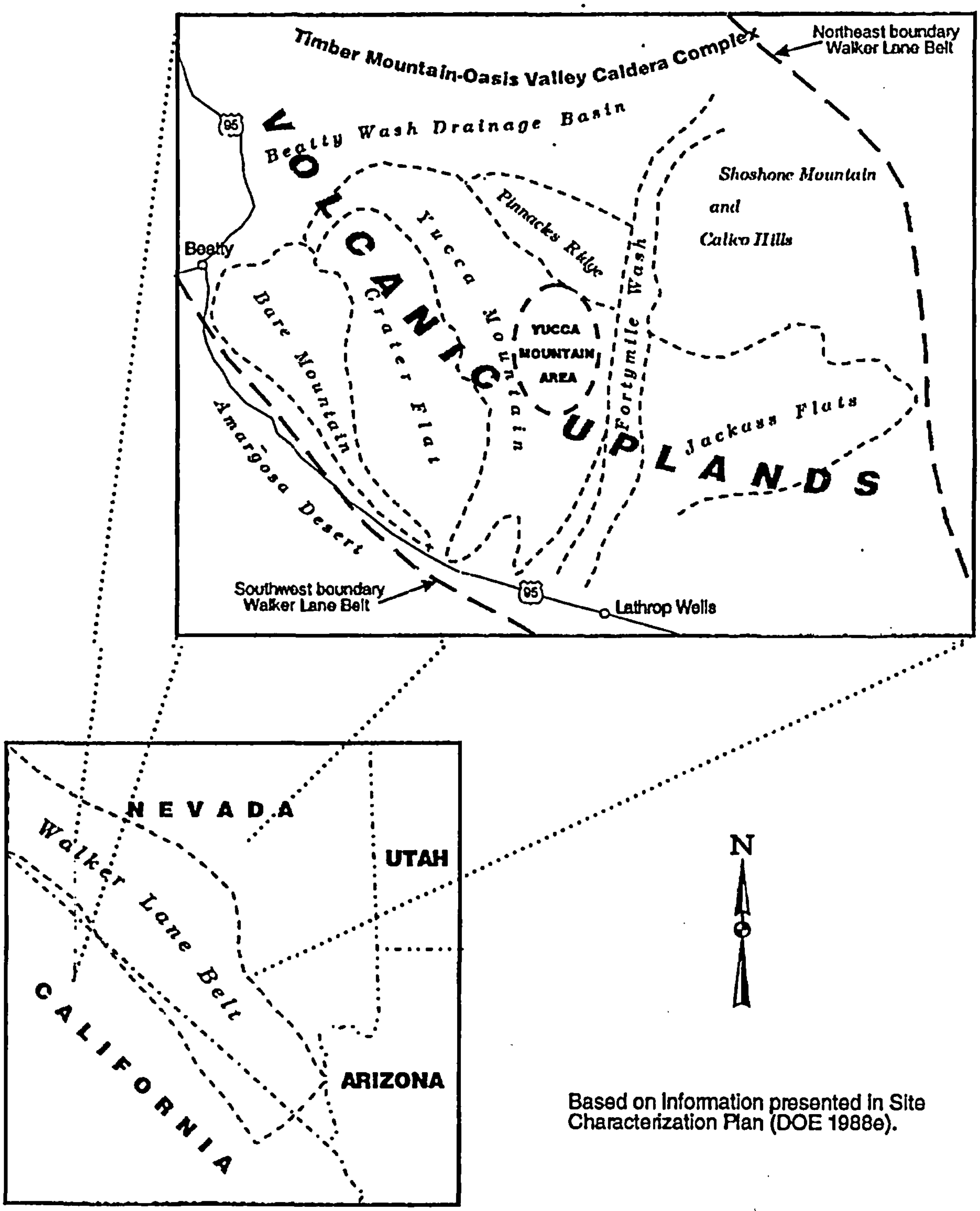
No metric topographic maps have been developed for general use on the project. For repository design, digital metric topographic map data was developed by using the computer-generated topographic surface from the 1:12,000 scale USGS digital maps with 20-foot contour interval, then recontouring the surface to a 20-meter contour interval (CRWMS M&O 1995n). Metric topographic maps have been identified as repository design data need 1.1 (CRWMS M&O 1995o).

6.2.2 Regional Physiography and Geomorphology

The Yucca Mountain area lies in the southern part of the Great Basin subprovince of the Basin and Range physiographic province. The Great Basin is generally characterized by long and narrow, north- to northeast-trending mountain ranges separated by intermontane structural basins. These characteristic basin and range landforms are the result of late Cenozoic high-angle normal faulting. The region around Yucca Mountain shows basin and range features, which are further complicated by local volcanism and the tectonic fabric of the Walker Lane belt (DOE 1988a).

The Walker Lane belt (Figure 6.2.2-1) is a complex zone of northwest-trending strike-slip displacement (DOE 1988a). It subparallels the western margin of the Great Basin subprovince from the area of Pyramid Lake in northwest Nevada to the Mojave Desert in southern Nevada. The Yucca Mountain area is located in an area of volcanic terrain within the Walker Lane belt, which is characterized by shallow-dipping volcanic uplands developed on the southern flank of the associated Timber Mountain-Oasis Valley caldera complex (Figure 6.2.2-1). The volcanics consist of tuffs and flow rocks of the late Tertiary, southwestern Nevada volcanic field (USGS 1995a). Ridge summits are broad and relatively flat with minor topographic relief. In many areas, these surfaces end abruptly at steep, caprock-protected slopes aproned with blocky talus. The flanks of the uplands are deeply dissected with radial and structurally controlled drainage systems (DOE 1988a).

Within the volcanic uplands area (Figure 6.2.2-1), the physiographic characteristics of the land surface are varied. Yucca Mountain itself is an irregularly-shaped volcanic upland 6 to 10 km wide and about 40 km long. It extends from Beatty Wash and Pinnacles Ridge in the north to the Amargosa Desert in the south, and from Crater Flat in the west to Fortymile Wash in the east. It consists of a series of subparallel ridges controlled by high-angle, generally north trending faults. The fault blocks are tilted slightly eastward so that the eastern flanks of the ridges are gentle and dissected, while the western, fault-controlled flanks generally have great topographic relief, steep slopes with talus developed, and are linear in plan view. Collectively, the subparallel ridges form what is referred to as Yucca Mountain. The repository site is located beneath a ridge known as Yucca Crest. The highest point on Yucca Mountain is at about 1,930 m, which is about 650 m above the adjacent lowlands of Crater Flat (DOE 1988a).



Based on Information presented in Site Characterization Plan (DOE 1988e).

Figure 6.2.2-1. Physiographic Setting

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Yucca Mountain is bounded on the north by Pinnacles Ridge (Figure 6.2.2-1), the southern part of which is structurally and lithologically similar to Yucca Mountain. Northward, Pinnacles Ridge changes rapidly to a deeply eroded and irregular highlands formed on the southern flank of the Timber Mountain-Oasis Valley caldera complex. To the east of this area lie the Calico Hills and Shoshone Mountain, which are also highlands formed along the southern flank of this caldera. To the west and east, Yucca Mountain is bound by lowlands of Crater Flat and Jackass Flats. Both these areas drain to the Amargosa Desert in the south. To the west of Crater Flat is Bare Mountain, a large upfaulted block. Along the western margin of Jackass Flats is the Fortymile Wash, which drains a large area within the Timber Mountain-Oasis Valley caldera complex. In its southern reaches, the Fortymile Wash has cut a trench 150 to 600 m wide and up to 25 m deep. To the north of Yucca Mountain and Pinnacles Ridge is one of the largest drainage systems in the area, the Beatty Wash drainage basin. It drains a large area along the southern margin of the Timber Mountain-Oasis Valley caldera complex (DOE 1988a).

6.2.3 Landforms of Yucca Mountain

Yucca Mountain landforms (Figure 6.2.3-1) are very characteristic of eroded and tilted volcanic uplands. Yucca Crest, which overlies the repository site, trends north-south with some irregularity in its trend. The ridge profile is asymmetrical, with a gently rounded top, relatively steeply-sloping west flank and gently-sloping east flank. The western flank of the ridge has well-developed talus slopes that merge into colluvial deposits at the base in Solitario Canyon. Drainage lines developed on this slope are steep, short, and shallow, and join together in the wash of Solitario Canyon. This canyon is wide and asymmetrical with a more gently-sloping, ridged west flank.

The eastern flank of Yucca Crest is more gentle, reflecting the gentle eastward dip of the strata, and is dissected by drainage lines that are linear. In the area closest to Yucca Crest, the washes generally trend to the east, which is parallel to the dip of the strata. As these drainage lines coalesce towards the east to form larger washes, they change their general orientation to east-southeast. Several of the major washes, such as Drill Hole Wash, have developed at this orientation. To the north of Drill Hole Wash, the orientation of the washes rotates to more southeast, reflecting the change in the strike of the strata and reflects the influence of structural control from northwest trending faults through this area.. Washes north of Drill Hole Wash tend to be long, sinuous, and narrow, and generally follow faults.

The developed ridges on the east flank of Yucca Crest are narrow and gently rounded, except where resistant caprock forms cliffs and rugged surfaces. The slopes are steep with a small convex profile developed near the top where the caprock is absent. Mid slopes are often covered with a thin veneer of talus that coalesces at the base. Where the wash bottoms are sufficiently wide, a concave profile may be developed at the base, covering the bedrock. Wash bottoms are sharp and V-shaped near the Yucca Crest, and widen out towards the base of the east flank where thick alluvial deposits have formed.

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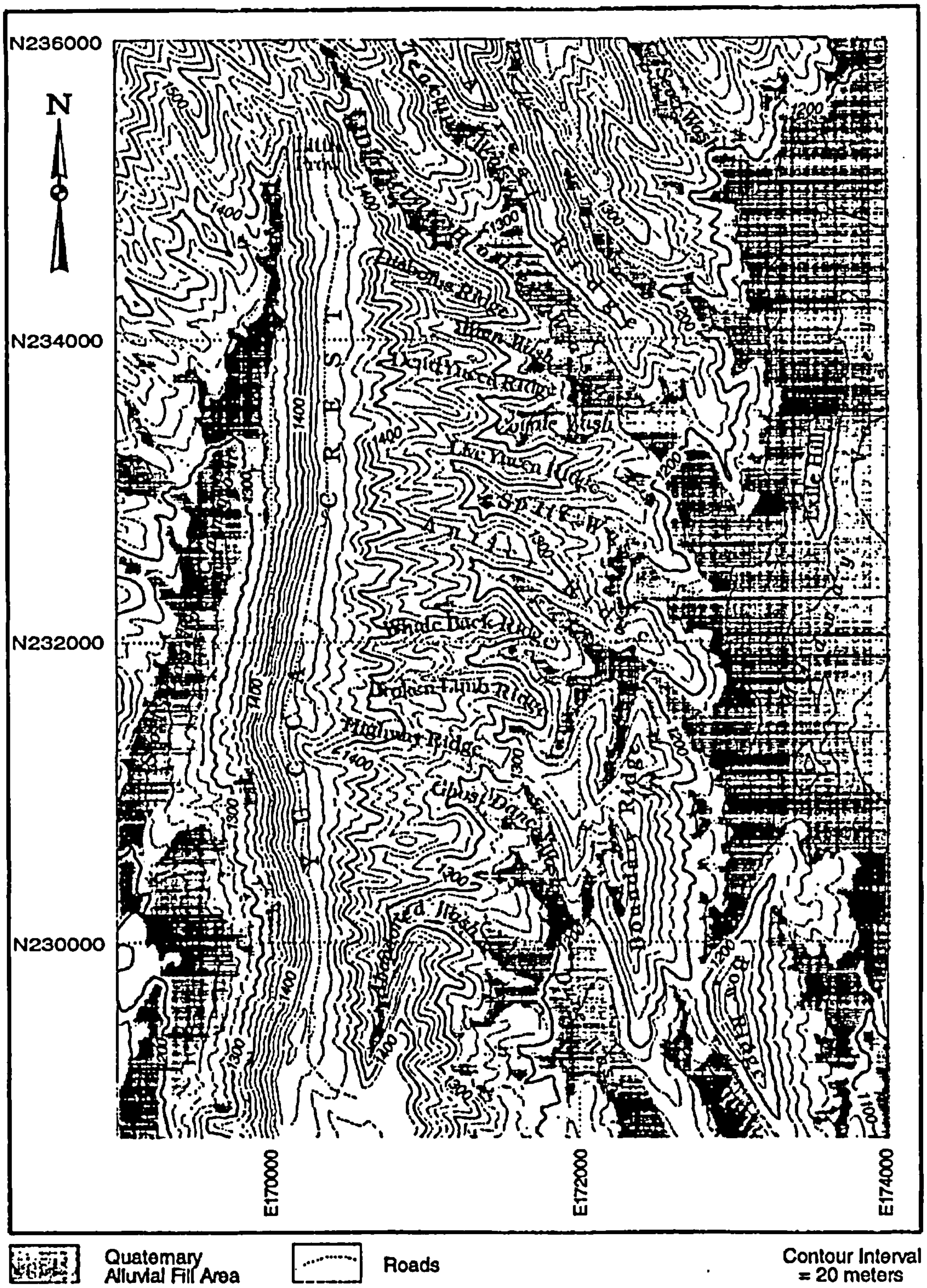

Figure 6.2.3-1. Topographic Map Showing Local Physiographic Features

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The drainages off the east flank of Yucca Crest meet in Midway Valley and join Fortymile Wash just east of the edge of the map in Figure 6.2.3-1. Midway Valley is floored by gentle piedmont slopes with incised washes and low, protruding ridge remnants, such as Exile Hill.

6.2.4 Geomorphic Process

The geomorphic processes that shaped the landscape of Yucca Mountain have been largely controlled by geologic structures, rock type, and climate. These factors have combined to produce a structure-dominated landscape of high relief, with rugged uplands separated by gently sloping lowland basins. Erosional processes are concentrated generally in the uplands and depositional processes are concentrated in the lowlands, with the intervening piedmonts serving as transport surfaces.

The single most important controlling factor in the development of the landscape in the southern Great Basin is the faulting produced by extensional tectonics during the late Cenozoic Era. However, in the area of Yucca Mountain, the Quaternary Period was a relatively quiet time with very little, if any, active extensional tectonics. Vertical tectonic adjustment during the late Tertiary and Quaternary Periods has been estimated (Scott 1990) at 0.1 to 0.5 mm per year between 13 and 11.5 million years ago, decreasing to 0.01 to 0.03 mm per year between 11.5 million years ago and Quaternary (2 million years ago). During the Quaternary, the rate further decreased to 0.006 to 0.0015 mm/per year. Based on this data, it can be concluded that vertical tectonic movement will not adversely affect the type and rates of geomorphic processes at Yucca Mountain during the next 10,000 years.

The volcanic bedrock of Yucca Mountain has also influenced the landforms. The weather resistant nature of the welded vitric beds at the top and bottom of the ashflow units encourages the formation of cliffs and ridge caps. The intervening welded volcanic ashflows are less resistant but still form steep ridge slopes. The nonwelded portions of the geologic section form more rounded slopes and low areas, except where they are partially protected by overlying resistant beds.

The influence of climate on the development of the landscape has been significant in that the arid to semi-arid climate of the past and present have tended to preserve the landscape. Weathering in arid environments is typically slow and is mainly limited to the steeper bedrock slopes of the ridges. The flow of surface water down the canyons and washes is intermittent and generally restricted to flash flood episodes. The valley fill between the uplands and lowlands has developed soil and desert varnish, both indicative of the slowness of erosion and sediment transport.

The subject of extreme erosion was examined in a Yucca Mountain Site Characterization Project Topical Report, which concluded that there is no evidence of extreme erosion at Yucca Mountain (YMP 1993). This conclusion was based on the following evidence:

- Early and middle Quaternary time hillslopes and basin alluvial deposits are common, while late Quaternary deposits are generally confined to the present washes.

- The evolution of Fortymile Wash indicates that the overall process in this drainage system during the Quaternary has been aggregation, not downcutting.

- Temporary episodes of Quaternary Period downcutting in Fortymile Wash have not migrated upstream into its tributaries.

Canyon downcutting at the Yucca Mountain site was estimated to be only 0.8 cm/ka during the past 12 million years. Erosion is estimated to have been very low, measuring 0.19 cm/ka, 40 times less than the average for the United States. Erosion has also been significantly less than the worldwide average for the same period (YMP 1993).

Similar estimates of erosion were presented in a technical basis report (YMP 1995b). Hillslope erosion rates in the Yucca Mountain area ranged from 0.1 to 0.6 cm/ka, averaging 0.19 cm/ka. Present day hillslope erosion at Yucca Mountain occurs primarily as debris flows that are initiated when summer thunderstorms saturate the ground sufficiently to result in a mass movement of the thin mantle covering. Debris flows are localized and infrequent, as evidenced by the presence of middle Pleistocene colluvium and the absence of erosion scars on the hillslopes (YMP 1995b).

Incision rates were calculated for Yucca Mountain alluvial deposits to range from 42 to 222 cm/ka, but the true long-term downcutting rate is believed to be closer to the minimum of 42 cm/ka (YMP 1995b). It is highly unlikely that the wash incised to bedrock during each downcutting episode; headcutting from the main wash did not migrate upstream into tributaries; and the overall behavior of Fortymile Wash during the Quaternary has been aggregation, not degradation. Bedrock channel incision rates were estimated for the small canyons on the east flank of Yucca Crest to be 0.8 cm/ka or less. The drainage system of Fortymile Wash and its tributaries was established in Miocene time and has changed little in basic course since then.

6.3 METEOROLOGY

The climate in southern Nevada is one of the hottest and driest in the United States. Yucca Mountain's climate is classified as mid-latitude desert, characterized by temperature extremes, a large range in annual temperatures, and annual precipitation of less than 150 mm. All evidence suggests that the region has been arid to semiarid during the Quaternary Period, the past 2 million years. It has been inferred that during the full glacial time in the Pleistocene Epoch, the climate was still semi-arid with temperatures only 7 to 10°C cooler than the present (DOE 1988a). Precipitation during this time was estimated to be 30 to 40 percent higher than the present. It is generally agreed that the area became progressively more arid during the Quaternary Period as the Sierra Nevada range was uplifted, producing a rainshadow effect (DOE 1988a).

6.3.1 Previous Work

Historical meteorological data are taken from the 17-year climatological summary of regional data from the Yucca Flat weather station, as summarized in the *Reference Information Base* (YMP 1995a). The Yucca Flat weather station was operated by the National Weather Service from January 1962 to May 1978, and is located approximately 40 km northeast of Yucca Mountain at an elevation of 1,196 m. In the recent past, meteorological data have been collected from the site and presented in several documents, 1986 to 1990 (USGS 1994e) and 1992 and 1993 (USGS 1995d).

6.3.2 Temperature

According to the data from the Yucca Flat weather station, the lowest daily temperatures occur during the months of November through March when the average daily maximum temperature ranges from 11°C in January to 16°C in November. The average daily minimum temperature ranges from -7°C in December to -2°C in March. The lowest recorded temperature during this period was -26°C in December 1967, and the highest was 31°C in March 1966 (YMP 1995a).

The hottest months at Yucca Flat are June, July, and August, when the average daily maximum temperature ranges from 32°C in June to 36°C in July. The average daily minimum temperature ranges from 10°C in June to 14°C in July. The highest temperature recorded at Yucca Flat reached 42°C in July and August 1972, and the lowest was -2°C in June 1971 (YMP 1995a).

Extreme daily temperature ranges are characteristic of the area. The greatest daily range of 22°C is in September and the smallest range of 17°C is in January (YMP 1995a).

6.3.3 Precipitation

Precipitation in the Yucca Mountain area is associated with two distinct atmospheric patterns. In the winter months and early spring (November through April), the Pacific air masses move towards the area from the west. Though Yucca Mountain lies within the rain shadow of the Sierra Nevada mountains, about 50 percent of the precipitation comes from this pattern. Average precipitation during these months ranges from 10 mm in April to 27 mm in February. The greatest monthly record was 102 mm in January 1969. The greatest daily precipitation was 38 mm in February 1976. Some of the precipitation during this period is in the form of snow. Average snowfall during these months ranges from 10 mm in April to 74 mm in January. The greatest monthly snowfall recorded at Yucca Flat was 739 mm, which fell in January 1974. The greatest daily snowfall of 254 mm was also in that month (YMP 1995a).

In late summer (July, August, and September), a low pressure area dominates the southwestern United States and gives birth to intense thunderstorm activities. These storms can bring flash floods to the area when they release significant amounts of precipitation in a relatively short period of time. Because of these thunderstorms and flooding potential they bring, siting of repository surface facilities must avoid areas subject to flooding. One of the most intense storms on record at Yucca Flat occurred on July 21, 1984, when 65 mm of precipitation fell within a 24-hour period (DOE 1988a). Prior to that storm, the greatest daily precipitation was 55 mm, which fell in August 1977. A very intense storm occurred on March 11, 1995 (DOE 1996) when 51 to 152 mm of precipitation fell in the area of Yucca Mountain. This storm resulted in the highest flows in the last 25 years in Fortymile Wash and Amargosa River. Average precipitation during the summer months ranges from 11 mm in August to 16 mm in September. Precipitation in the months between winter and summer (May, June, and October) averages 9 mm per month (YMP 1995a).

6.3.4 Humidity

The same processes that restrict precipitation in the area also provide for low relative humidity throughout the year. On Yucca Flat, the average monthly relative humidity in the summer months

(June through August) ranges from 13 percent during the heat of the day (4:00 pm) in June to 43 percent at night (4:00 am) in August. In the winter months (November through March), the average monthly relative humidity drops to 25 percent during the day (4:00 pm) in March and reaches 71 percent at night (4:00 am) in January (YMP 1995a).

6.3.5 Barometric Pressure

On the average, barometric pressure during the year varies from about 879 to 885 millibars between summer and winter. The lowest recorded pressures between 1962 and 1978 was 858 millibars and the highest recorded pressure was 901 millibars (YMP 1995a).

6.3.6 Wind

Since Yucca Mountain consists of high ridges and linear, narrow canyons that tend to channel air movement, local wind direction and velocities can be considerably different than in neighboring areas. Wind direction in the area is influenced by two types of atmospheric activity. Regionally, large scale pressure systems govern seasonal variations in wind direction. Winds from this activity blow from the north in the fall, winter, and early spring, and shift to predominantly south to southwesterly in late spring and early summer (DOE 1988a). This annual average wind cycle is affected locally by the terrain and the heating and cooling of the ground surface, which produces diurnal wind reversals. Upslope winds from this latter activity occur during daylight hours in almost all months of the year, and at night, downslope winds predominate.

Wind speeds associated with the various flow patterns in the Yucca Mountain area are highest during the mid-afternoon hours and reach minimum speeds shortly after sunset. This air movement pattern reflects the pattern of heating and cooling, with the maximum movement occurring during the heating period. Average wind speeds recorded in Yucca Flat range from 10 km per hour in November and January, to 15 km per hour in April. Wind speeds of over 85 km per hour can occur during any month of the year and reached speeds of over 97 km per hour in most months (DOE 1988a).

Tornados are considered to be rare in Nevada, but have been observed within 250 km of Yucca Mountain. The most intense of these tornados observed in the vicinity was classified as F-0 on the Fujita tornado intensity scale, which is based on extent of damage. A F-0 tornado is very weak, with winds between 65 to 115 km per hour, a path length of less than 1.6 km, and a path width of less than 16 m. Tornados have not been observed on the Nevada Test Site (DOE 1988a).

Dust devils, which are small whirlwinds containing sand and dust, occur frequently around the Yucca Mountain area and can locally disrupt visibility. Dust devils may develop wind speeds in excess of F-0 tornado intensity, but they are short-lived and dissipate rapidly. They typically spiral upward from 30 to 90 m, but may reach as high as 900 m. Dust devils usually occur during the summer months when there is unstable air at ground level (YMP 1995a).

6.3.7 Severe Weather

Thunderstorms, lightning, and flash floods are perhaps the most important of the severe weather conditions that could affect repository development and operations. Precipitation and flooding are discussed in separate subsections in this section.

Lightning is commonly associated with thunderstorms in the area. In Nevada, cloud-to-cloud lightning occurs 10 times more often than cloud-to-ground lightning. Strikes that result in measurable damage average 18 per year statewide (DOE 1988a). Lightning statistics for Yucca Mountain are not known.

Hail storms have occurred infrequently during thunderstorms but could be quite damaging. Between 1955 and 1967, Nevada had seven occurrences of hailstorms with hailstones at least 19 mm in diameter. One hail storm per year is likely in the Yucca Mountain area (DOE 1988a).

Other severe weather characteristics of the area include tornados, extreme winds and temperature, sandstorms, and fog. Most of these conditions are discussed in previous subsections in this section.

Disruptions due to poor visibility from sandstorms or fog could occur, but would be infrequent. Conditions right for sandstorms of the magnitude that would disrupt activities occur very seldom. Conditions conducive to fog development occur about twice a year from November through March (YMP 1995a).

6.4 STRATIGRAPHY

The stratigraphic setting of the Yucca Mountain area has been characterized for the purpose of siting the repository, evaluating the effects of structural and stratigraphic features, and assessing its pre- and postclosure performance. The host rock, within which the repository may be sited, and the surrounding rock have an important bearing on repository design and performance assessment.

At Yucca Mountain, there are three stratigraphic nomenclatures in common use: lithostratigraphic, thermal/mechanical, and hydrogeologic. The lithostratigraphic nomenclature is based on lithologic characteristics. The thermal/mechanical nomenclature is based on thermal and mechanical characteristics that are important to design. The hydrogeologic stratigraphy is based on hydrologic characteristics and is discussed in Subsection 6.6.3, Hydrogeologic Units, under Section 6.6, Hydrology.

6.4.1 Previous Work

Previous geologic mapping in the Yucca Mountain area was performed in the 1970s and 1980s by several U.S. Geological Survey geologists. The earliest work was mostly concentrated on the Timber Mountain-Oasis Valley caldera complex and the surrounding area including Yucca Mountain. During this period, Scott and Bonk (USGS 1984b) prepared their preliminary map of Yucca Mountain in which they defined the local stratigraphy based on petrologic and weathering characteristics of surface exposures. After the Yucca Mountain site was designated in 1987 as the only site for characterization, more concentrated work was performed in the immediate area of

Yucca Mountain. This stratigraphic work incorporated surface exposure observations, and subsurface information from core and the Exploratory Studies Facility underground excavation. This latest work was summarized by Buesch et al. (USGS 1995a), who presented a revised stratigraphic nomenclature for the Paintbrush Group that links together the diverse stratigraphic nomenclatures currently in use. The detailed stratigraphic nomenclature for the project is presented in the *Reference Information Base* (YMP 1995a).

For underground engineering design, the stratigraphic nomenclature of most interest is the thermal/mechanical stratigraphy. This was first proposed by Ortiz et al. (SNL 1985a) to group rocks with similar thermal and mechanical properties. The stratigraphy was based on the observation by Lappin et al. (SNL 1982) that thermal and mechanical properties can be correlated directly to grain density and porosity. The stratigraphy of Ortiz et al. includes 16 thermal/mechanical units identified megascopically in terms of their welding and lithophysal cavity content. The TSw2 unit, or Topopah Spring welded, lithophysae-poor rocks, was identified as the host horizon for the repository.

6.4.2 Stratigraphic Setting

Yucca Mountain is situated within the southwestern Nevada volcanic field and is on the southern flank of the Timber Mountain-Oasis Valley caldera complex (Figure 6.4.2-1). This was a major center of volcanic activity during the upper Miocene and lower Pliocene between 15 and 11.5 million years ago (Scott 1990). During this time, thick deposits of lava-flow, ashflow, and air-fall tuffs were formed. The principal volcanic rocks exposed on the surface comprise the Paintbrush Group (Figure 6.4.2-1). The two principal units within the Paintbrush are the Tiva Canyon Tuff, formed 12.7 million years ago, and the underlying Topopah Spring Tuff, formed 12.8 million years ago (Sawyer et al.1994). Along the southern flank of the Timber Mountain-Oasis Valley caldera complex, lava rocks make up most of the Paintbrush Group, while in more distal areas, it is composed principally of ashflow rocks. These volcanic deposits at Yucca Mountain are estimated to be close to 2,000 m thick. The Paintbrush Group contains most of the rocks encountered in the Exploratory Studies Facility and all of the rock in the repository development.

6.4.3 Lithostratigraphy

Rocks that are important to repository design are contained for the most part within the Paintbrush Group, which is comprised of welded and nonwelded ashflow deposits of Miocene age. The formations within the Paintbrush Group include in descending order, the Tiva Canyon Tuff, Yucca Mountain Tuff, Pah Canyon Tuff, and Topopah Spring Tuff. Overlying this group in local areas near Exile Hill are younger, nonwelded ashflow and air-fall tuffs. Below the rocks of the Paintbrush Group is the Calico Hills Tuff. The general stratigraphy of the area is illustrated in Table 6.4.3-1 and is described in detail in the *Reference Information Base*, a project Q document, (YMP 1995a) and the *Draft Stratigraphic Compendium*, a project non-Q document (CRWMS M&O 1994c). Specific lithostratigraphic descriptions for the Paintbrush Group are contained in Buesch et al. (USGS 1995a).

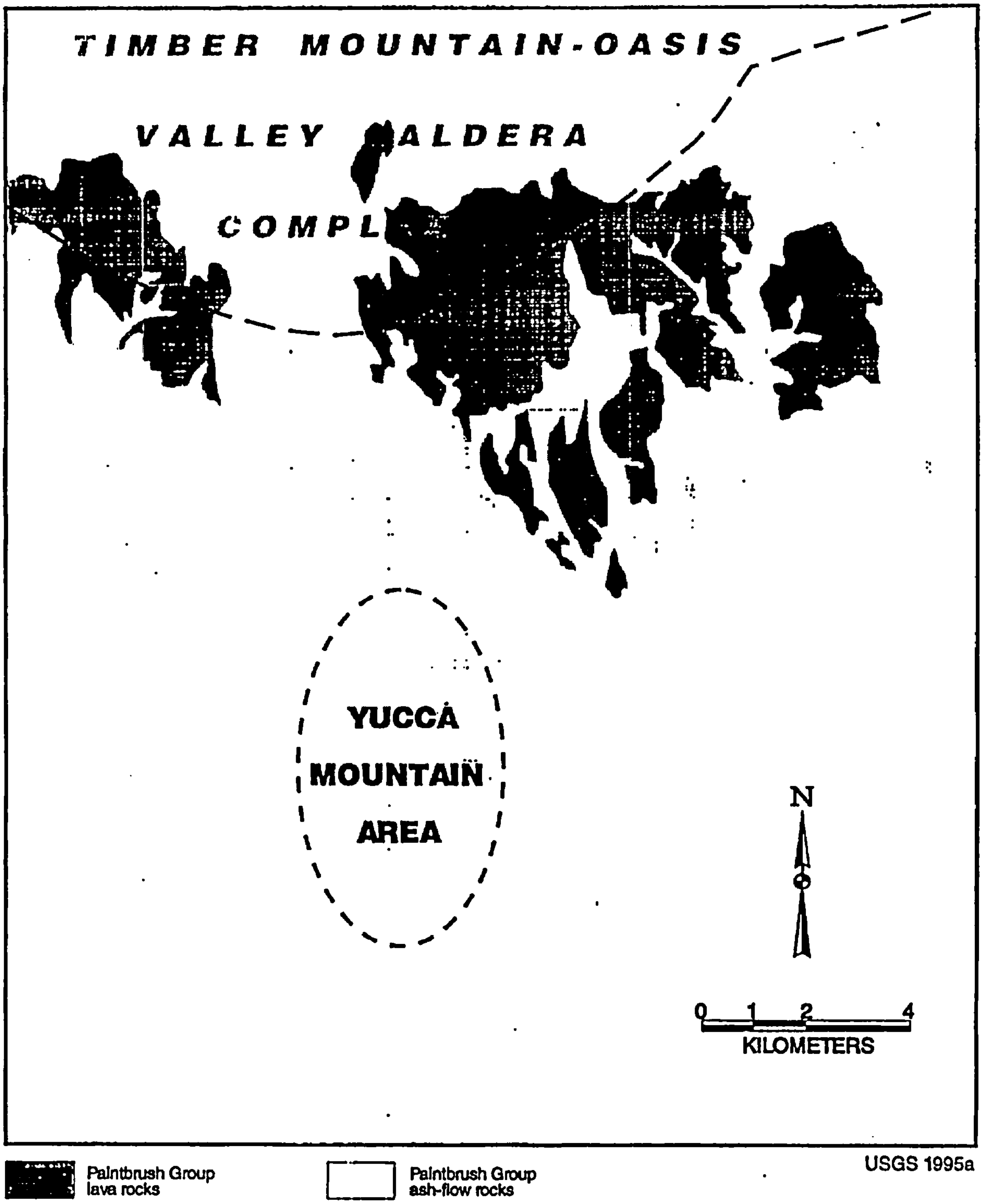

Figure 6.4.2-1. Yucca Mountain Area and the Timber Mountain-Oasis Valley Caldera

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Table 6.4.3-1. Stratigraphic Nomenclature for Yucca Mountain

Lithostratigraphic Units[1]		Thermal/ Mechanical Units[2]	Hydro-Geologic Units[3]
Timber Mountain Tuff (Tm)	Rainier Mesa member (Tmr)	Undifferentiated overburden (UO)	Unconsolidated Surficial Materials (UO)
	pre-Rainier Mesa bedded tuff (Tmrbt1)		
Tuff unit "X" (Tpk)	tuff unit "X" (Tpki)		
	post-Tiva Canyon bedded tuff (Tpbt5)		
PAINTBRUSH GROUP (Tp)			
Tiva Canyon Tuff (Tpc)	crystal-rich member (Tpcr) vitric zone (Tpcrv) - nonwelded subzone (Tpcrv3) - moderately welded subzone (Tpcrv2)		
	- densely welded subzone (Tpcrv1) nonlithophysal zone (Tpcrn) lithophysal zone (Tpcrl)	Tiva Canyon welded (TCw)	Tiva Canyon welded (TCw)
	crystal-poor member (Tpcp) upper lithophysal zone (Tpcpul) middle nonlithophysal zone (Tpcpmn) lower lithophysal zone (Tpcpll) lower nonlithophysal zone (Tpcpln) - hackly subzone (Tpcplnh)		
	- columnar subzone (Tpcplnc) vitric zone (Tpcpv) - densely welded subzone (Tpcpvv) - moderately welded subzone (Tpcpvm) - nonwelded subzone (Tpcpvn)	Paintbrush Tuff nonwelded (PTn)	Paintbrush nonwelded (PTn)
	pre-Tiva Canyon bedded tuff (Tpbt4)		
Yucca Mountain Tuff (Tpy)	Yucca Mountain Tuff (Tpyt)		
	pre-Yucca Mountain bedded tuff (Tpbt3)		
Pah Canyon Tuff (Tpp)	Pah Canyon Tuff (Tppt)		
	pre-Pah Canyon bedded tuff (Tpbt2)		
Topopah Spring Tuff (Tpt)	crystal-rich member (Tptr) vitric zone (Tptrv) - nonwelded subzone (Tptrv3) - moderately welded subzone (Tptrv2)		
	- densely welded subzone (Tptrv1) nonlithophysal zone (Tptrn) lithophysal zone (Tptrl)	Topopah Spring welded, lithophysae-rich (TSw1)	Topopah Spring welded (TSw)
	crystal-poor member (Tptp) upper lithophysal zone (Tptpul) [upper pt]		
REPOSITORY HOST HORIZON	upper lithophysal zone (Tptpul) [lower pt]		
	middle nonlithophysal zone (Tptpmn) lower lithophysal zone (Tptpll) lower nonlithophysal zone (Tptpln)	Topopah Spring welded, lithophysae-poor (TSw2)	
	vitric zone (Tptpv) - densely welded subzone (Tptpv3)	Topopah Spring welded, vitrophyre (TSw3)	Topopah Spring basal vitrophyre (TSbv)
	- moderately welded subzone (Tptpv2) - nonwelded subzone (Tptpv1)	Calico Hills nonwelded (CHn)	Calico Hills nonwelded (CHn)
	pre-Topopah Spring bedded tuff (Tpbt1)		
Calico Hills Tuff (Tac)	Calico Hills Formation (Tac)		
	pre-Calico Hills bedded tuff (Tacbt1)		

1) Based on USGS 1995a
2) Based on SNL 1985a
3) Based on SNL 1995b

6.4.3.1 Zonation of the Paintbrush Group Ashflow Tuffs

The volcanic rocks of the Paintbrush Group are typical, compositionally-zoned, ashflow sheets that emanated from the Claim Canyon segment of the Timber Mountain-Oasis Valley caldera complex (USGS 1976) in the north (Figure 6.4.2-1). These rocks covered a widespread area and were formed during violent, multiple flow, eruptions that were emplaced in rapid succession so that the mass cooled as one unit (USGS 1966). The two thickest formations of the Paintbrush Group, Tiva Canyon Tuff and Topopah Spring Tuff, are very similar in their composition, character, and distribution. These units, as well as other similar volcanic units, display a distinct, vertical systematic chemical, mineralogical, petrologic, and structural zonation. From bottom to top, the ash composition grades from crystal-poor rhyolite to crystal-rich quartz latite (USGS 1995a). Welding varies upward from non-welded to moderately welded tuff at the base, through the densely welded interior, to a capping of moderately-welded to nonwelded tuff. The densely welded interior may have a vitrophyre developed at the base and top of the zone, with the welded rocks between devitrified. The central portion of the welded interior, which contains subzones of lithophysae development, is affected by vapor phase crystallization.

Lithophysae development is prominent within specific zones of the densely-welded sections in the Tiva Canyon Tuff and Topopah Spring Tuff sections. Lithophysae are hollow, bubble-like structures composed of concentric shells of finely crystalline alkali feldspar, quartz and other minerals (USGS 1995a). In section, they are typically comprised of a central cavity with a thin lining of vapor-phase minerals, surrounded by a thicker rim of fine-grained crystals, which is in turn surrounded by a thin border of very fine-grained crystals. Most cavities are only a few centimeters across, but some may be as large as a meter. Lithophysae develop during emplacement of the tuff flow deposit and represent vapor concentrations from trapped gasses released from the cooling mass. Commonly associated with the lithophysae are spots 10 to 50 mm in diameter. They are comprised of fine-grained crystals with a thin very fine-grained border and occasionally a core of crystals or a lithic clast. Their origin may be similar or related to the formation of lithophysae (USGS 1995a).

The lithostratigraphic subdivisions of the Paintbrush Group at Yucca Mountain are identified by macroscopic textural features. The main identifying features include the type and abundance of phenocrysts, welding, crystallization, lithophysae, and fracture characteristics (USGS 1995a). Phenocryst content is the fundamental criteria for subdividing the Tiva Canyon and Topopah Spring Tuff formations into members. The upper member in these two formations is the crystal-rich member, which is characterized by 10 to 15 percent phenocrysts, whereas the lower crystal-poor member has 3 to 10 percent phenocrysts (USGS 1995a).

Within these two members, there are numerous zones and subzones that are subdivided based on welding, crystallization, lithophysae, and fracture characteristics (USGS 1995a). Welding and crystallization in ashflow tuffs typically follow a general pattern that reflects their deposition and cooling history, and the Tiva Canyon and Topopah Spring Tuffs follow these patterns. The lowermost zone of the ashflow deposit is known as the vitric zone. This unit can be subdivided into a nonwelded base, grading upwards through partially and moderately welded to densely welded at the top. The densely welded subzone is often-times present as a densely-welded vitrophyre.

The interior section of the ashflow tuffs is comprised of densely-welded, devitrified tuff with vapor-phase crystallization and lithophysae development. The repository host horizon lies within this interior unit in the Topopah Spring Tuff. Lithophysal zones developed where trapped gasses and vapors concentrated within this interior densely-welded section. Vapor-phase crystallization took place through much of the densely-welded section. Capping the interior section is the crystal-rich vitric zone. It is a mirror image of the crystal-poor vitric zone at the base.

6.4.3.2 Post-Paintbrush Group Rocks

Near Exile Hill where the portal of the Exploratory Studies Facility is located, there are subcrops of the younger nonwelded, ashflow and air-fall tuffs that post-date the Paintbrush Group. These include the Rainier Mesa member of the Timber Mountain Tuff, and the unit known informally as Tuff Unit "X" (SNL 1995a). They were deposited about 11.6 million years ago (Sawyer et al. 1994) after a long period of faulting, uplift and erosion (Scott 1990). These units are underlaid with bedded tuffs and were deposited in topographic lows between major fault blocks. These units were both encountered in the Exploratory Studies Facility north ramp excavation.

6.4.3.3 Paintbrush Group Rocks

The Tiva Canyon Tuff is the youngest formation in the Paintbrush Group. It was formed 12.7 million years ago from an eruption from the Claim Canyon caldera, which is a part of the Timber Mountain-Oasis Valley caldera complex (Sawyer et al. 1994). It is a multiple-flow, compound cooling unit that displays the composition zoning discussed in Section 6.4.3.1. Most of the outcrops on Yucca Mountain consist of units from this formation, which is estimated to have been about 100 m thick (Scott 1990). It forms the ridges on the eastern flank of Yucca Crest and the upper part of the cliff face on the western flank. The unit is mostly composed of welded tuff, except for the top and bottom, which is composed of non-welded to moderately welded tuff. Directly below the Tiva Canyon is the pre-Tiva Canyon bedded tuff, which is an air-fall deposit emplaced prior to the main Tiva Canyon pyrochatic flow units.

Underlying the Tiva Canyon is a series of relatively thin, simple cooling unit ashflow tuffs and associated bedded tuffs. These include the Yucca Mountain Tuff and Pah Canyon Tuff, which are discontinuous across the area (USGS 1995a). These ashflow tuffs are mostly nonwelded, but may be more welded where they locally thicken. These units outcrop on the western cliff face of Yucca Crest and in small local areas in the deep washes on the eastern flank. The Yucca Mountain is up to 30 m thick at the project site and the Pah Canyon is up to 70 m thick, but is absent in the far south.

The Topopah Spring Tuff underlies the Pah Canyon Tuff and was formed 12.8 million years ago (Sawyer et al. 1994). It is about 350 m thick at Yucca Mountain (USGS 1995a). As discussed previously, it is compositionally zoned similar to the younger Tiva Canyon Tuff and has a central welded interior with moderately to nonwelded tuff at the top and bottom. At the base of the welded interior, there is a very thick vitrophyre zone (Tptpv3). The Topopah Spring Tuff contains the host horizon for the repository within part of its central welded interior. The repository host horizon is shown in Table 6.4.3-1 and consists of the lower part of the upper lithophysal zone (Tptpul), middle nonlithophysal zone (Tptpmn), lower lithophysal zone (Tptpll), and lower nonlithophysal zone

(Tptpln). Like the Tiva Canyon, there is a bedded tuff unit at the base of the Topopah Spring Tuff, which consists of air-fall deposits.

6.4.3.4 Pre-Paintbrush Group Rocks

Below the Topopah Spring Tuff is the Calico Hills Tuff, which was formed 12.9 million years ago (Sawyer et al. 1994). This unit consists of relatively massive, homogenous, nonwelded ashflow tuffs separated into five units of ash-fall beds that overlie an interval of bedded tuff and a basal volcaniclastic sandstone (USGS 1994a). The Calico Hills unit contains zeolites, which may be important to waste isolation (CRWMS M&O 1994b). Below the Calico Hills is the Prow Pass Member of the Crater Flat Tuff.

6.4.4 Thermal/Mechanical Stratigraphy

The concept of developing a stratigraphic nomenclature that directly addresses engineering properties of the rock at Yucca Mountain was first introduced by Lappin et al. (SNL 1982). They proposed that the rocks of Yucca Mountain could be subdivided into units with similar thermal and mechanical characteristics, based on correlation to grain density and porosity. This stratigraphy was later refined by Ortiz et al. (SNL 1985a), who identified 16 thermal/mechanical units at the Yucca Mountain site, including the Tram Member of the Crater Flat Group. Their groupings reflected to a large extent the general degree of welding and, in the case of the Topopah Spring rocks, the volume of lithophysal cavities. The thermal/mechanical units correlate generally with groups of lithostratigraphic units, or in one case, parts of a lithostratigraphic unit (Table 6.4.3-1).

The uppermost thermal/mechanical unit identified is the undifferentiated overburden unit. This is a collection of various rock types that overlie the welded, devitrified Tiva Canyon Tuff. The overburden unit contains alluvium, colluvium, nonwelded and vitric portions of the Tiva Canyon Tuff, and other tuff units such as the Rainier Mesa member of the Timber Mountain Tuff, Tuff Unit "X," and their associated bedded tuff units.

Most of the Tiva Canyon Tuff is contained in the Tiva Canyon welded (TCw) thermal/mechanical unit. This unit includes rock between and including the densely welded subzone (vitrophyre) of the vitric zone of the crystal-rich member and the densely welded subzone of the vitric zone of the crystal-poor member (vitrophyre). This unit is exposed on the top of Yucca Crest and the ridges on the eastern flank.

Below the TCw is the Paintbrush Tuff nonwelded (PTn) unit. This unit consists of partially welded to nonwelded, vitric and occasionally devitrified tuffs. Included in this unit are the nonwelded tuffs at the base of the Tiva Canyon Tuff, the Yucca Mountain Tuff, the Pah Canyon Tuff, the nonwelded tuffs at the top of the Topopah Spring Tuff, and the associated bedded tuffs.

The Topopah Spring welded thermal/mechanical unit (TSw) underlies the PTn. This unit is subdivided into three subunits based on their volume of lithophysal cavities. The top subunit, TSw1, is lithophysae-rich and includes the top vitrophyre (crystal-poor member, vitric zone, densely welded subzone), the nonlithophysal zone, and the upper lithophysal zone. This upper subunit ranges from about 49 to 113 meters thick. The middle subunit, TSw2, is lithophysae-poor and consists of the middle nonlithophysal, lower lithophysal, and lower nonlithophysal zones. The TSw2 unit ranges from 175 to 229 meters thick. At the base of the Topopah Spring welded unit is the vitrophyre subunit (TSw3), which is about 7 to 25 meters thick.

Underlying the TSw units is the Calico Hills nonwelded unit (CHn). This unit consists of the lower nonwelded to partially welded portion of the Topopah Spring Tuff, the Calico Hills Tuff, the underlying pre-Calico Hills bedded tuff, and the upper nonwelded portions of the underlying Prow Pass Member of the Crater Flat Tuff.

Ortiz et al. (SNL 1985a) originally defined the TSw2 thermal/mechanical unit as the host horizon for siting the repository. Recent investigations by the M&O (CRWMS M&O 1995n) have identified that in addition to the TSw2 unit, the lower part of the overlying TSw1 unit may also be suitable. This is discussed more fully in Section 8.1, Repository Horizon Description.

6.5 STRUCTURAL GEOLOGY AND TECTONICS

Geologic structures and tectonics are among the important factors that influence repository design and its long-term performance. Study of the existing geologic structures and their analysis is a key to the structural disturbances that might be expected in the future. Seismic investigations that analyze past and current seismic events provide clues as to what can be expected in the future and provide for the development of appropriate seismic design standards.

6.5.1 Previous Work

The geologic structures identifiable on the surface were mapped by Scott and Bonk (USGS 1984b). This mapping has provided the framework for most of the structural investigations at Yucca Mountain. More recent detailed mapping by USGS (USGS 1994b; Spengler et al. 1993) has been carried out on some of the major faults in the area as well as on a more general verification of the structures mapped by Scott and Bonk.

6.5.2 Tectonic Setting

The geologic structures at Yucca Mountain are a result of large-scale plate tectonics as well as regional volcanic-related forces. The site is situated in the Basin and Range structural province, which is in the western deformed half of the North American continental plate. To the west is the Pacific plate, which is joined to the North American plate across a transform fault corresponding to the right-lateral strike-slip San Andreas fault system. Along the western part of the North American plate is the Cordilleran Orogenic belt, which has been subjected to numerous orogenic episodes from the Late Cretaceous Period to the present. Initial orogenic activities produced low-angle, east-directed thrust faults during the late Mesozoic and early Cenozoic Eras. Later in the Cenozoic Era, the crust was subjected to extension block faulting from the Miocene Epoch through the present. With extension comes thinning of the crust, which resulted in increased geothermal gradients and volcanism (DOE 1988a).

The Basin and Range structural province corresponds to the Great Basin subprovince of the Basin and Range physiographic province (Figure 6.5.2-1). The Yucca Mountain project site is situated in an area of the Basin and Range structural province known as the Walker Lane belt (Figure 6.5.2-1), a complex zone of northwest-trending right-lateral strike-slip displacement (DOE 1988a and Scott 1990). Major strike-slip faults near Yucca Mountain include the Las Vegas shear zone with at least 40 km of right-lateral movement, the Death Valley/Furnace Creek fault zones consisting of en echelon right-lateral faults with 10 to 80 km of displacement, and the left-lateral Pahranagat shear zone.

Although the strike-slip faults are the most dramatic and have the greatest displacement, the area is also characterized by the general north- to northwest-trending range-front normal faulting. This faulting has taken place from the Miocene Epoch to the present, and has produced the structural pattern so characteristic of the Basin and Range province. Extensional faulting may have developed as early as the late Eocene Epoch to the middle Miocene Epoch, but the dominant normal faulting occurred during the middle Miocene Epoch to the present (DOE 1988a).

6.5.3 Faults

The Yucca Mountain area lies within a large, east-tilted structural block with north-trending, west-dipping normal faults. Northwest-striking right-lateral and northeast-striking left-lateral strike-slip faults are also present. The surface faults in the Yucca Mountain area are illustrated in Figure 6.5.3-1, as mapped by Scott and Bonk (USGS 1984b). This large scale mapping (1:12,000) was preliminary and is currently being remapped a scale of 1:6,000 by USGS. The Primary Area of Mansure and Ortiz (SNL 1984a), which identifies the general potential repository area, is included in the figure for reference. Identified faults shown include the Bow Ridge, Dune Wash, Abandoned Wash, Ghost Dance, Solitario Canyon, Sundance, Drill Hole Wash, and Sever Wash faults. Between the Ghost Dance and Bow Ridge faults, there is a wide zone of closely-spaced faults known as the Imbricate fault system (Scott 1990). In the central area between the Solitario Canyon and Ghost Dance faults, where the main repository is sited, there are very few faults of significant offset. The only recognized faults in this area include the Sundance fault (USGS 1995c), an unnamed fault in the north between Sundance and Ghost Dance faults, northeast-directed splays of the Solitario Canyon fault, and a fault swarm in the south. These faults within the central area are all minor and are not considered to pose a problem to the repository design.

The easternmost, major normal fault shown in Figure 6.5.3-1 is the Bow Ridge fault. It is a down-to-the-west, steeply-dipping, normal fault that was encountered in the Exploratory Studies Facility North Ramp. Offset on this fault is estimated at about 130 m at the base of the Tiva Canyon Tuff (SNL 1995a). On the surface, the fault has been explored by trenching (USGS 1984c). In preparation for the Exploratory Studies Facility tunneling, the faults, and the geologic units in the hanging wall were also explored with drilling trenching and seismic refraction and reflection lines (SNL 1995a), which identified that the fault decreases in dip with increased depth. As encountered in the Exploratory Studies Facility, the fault is about 2 m thick and consists of brecciated rock (USBR 1995a; 1995b). At the surface in trench 14, the fault is filled with calcium carbonate, opaline silica, and fine-grained sediments that are of pedogenic origin (USGS 1993). The Bow Ridge fault forms the eastern boundary of a major structural block (Scott 1990).

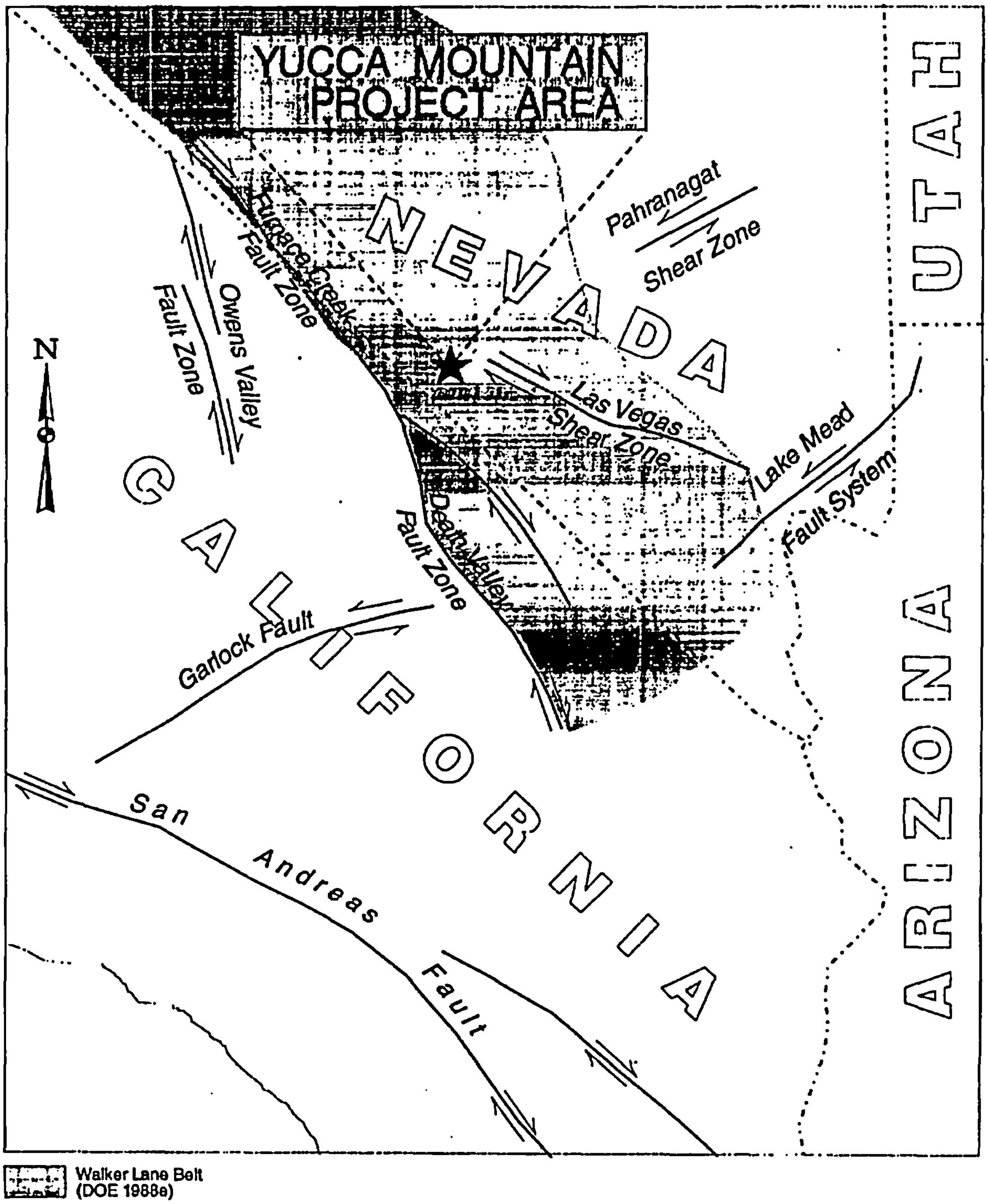

Figure 6.5.2-1. Major Strike Slip Faults in the Region Around the Yucca Mountain Project Site

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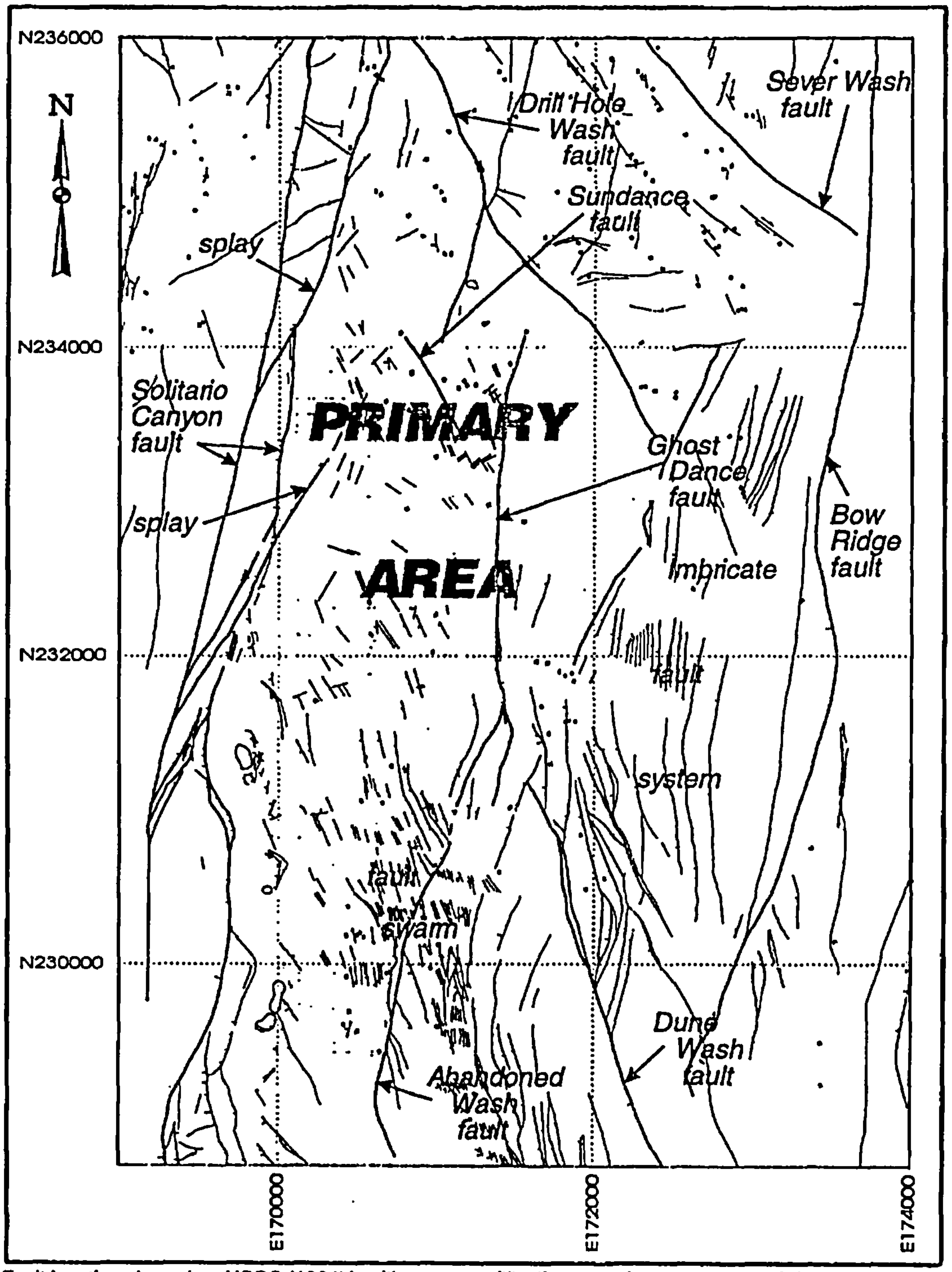

Fault locations based on USGS (1984b), with some modifications to reflect more recent information.
All fault classifications are shown as solid lines.

Figure 6.5.3-1. Surface Faults

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The Solitario Canyon fault (Figure 6.5.3-1) forms the western limit of the major structural block and the repository area. It is a complex, braided, high-angle, down-to-the-west normal fault. Offset on this fault is estimated to be over 400 m (SNL 1995a). The USGS is conducting detailed mapping of the Solitario Canyon fault and associated splays. This work is not yet complete. The westernmost trace of the fault, as mapped by Scott and Bonk (USGS 1984b), consists of a wide brecciated zone. Two small but prominent splays extend off the east side of the fault within the planned repository area. These faults displace rocks of the Topopah Spring Tuff by only a few meters where they join the Solitario Canyon fault, decreasing rapidly to the north where they do not appear to offset the younger Tiva Canyon Tuff (Scott 1990).

The area between the Solitario Canyon and Bow Ridge faults comprises a major structural block that exhibits characteristics typical of internal block deformation associated with extensional tectonics. The structural pattern within these blocks includes a largely unfaulted, uniformly eastward dipping area on the western leading edge of the block, and a complex-faulted, more steeply, eastward dipping area on the eastern trailing edge of the block. These faults along the eastern edge are closely-spaced, steep, west-dipping faults with minor, down-to-the-west offsets of a few meters or less. These faults are referred to as the Imbricate fault system (Scott 1990) and account for about 50 percent of the extension within this block.

The Ghost Dance fault (Figure 6.5.3-1), which is the only major fault that passes through the repository area, has been studied in much detail on the surface (Spengler et al. 1993). Recent pavement mapping and trenching on the Ghost Dance fault indicates that it has not moved in the past 20 to 30 thousand years. The Ghost Dance fault is a north-trending, near-vertical, normal fault with an offset of 30 m in the south, progressively decreasing to zero in the north. Near the northern limit of the fault, it dies out into highly fractured and brecciated rock on Diabolous Ridge (Figure 6.2.3-1). To the south, it bifurcates and may continue south as the Abandoned Wash fault on the west side and the Dune Wash fault on the east side. Detailed mapping along the fault trace where it crosses Antler, Whaleback, and Broken Limb Ridges (Figure 6.2.3-1) have revealed several additional subparallel, braided faults on the east and west side of the main trace (Spengler et al. 1993). These additional faults typically offset strata down to the west by 3 to 6 m and are commonly spaced 15 to 46 m apart for a distance of over 100 m from the main trace of the fault. Cumulative west-side-down displacement along these faults range from 21 to 47 m. To the west of the northern end of the Ghost Dance fault is a small unnamed normal fault that is parallel to the Ghost Dance fault (Figure 6.5.3-1).

The northwest-trending Drill Hole Wash (Figure 6.2.3-1) was identified by Scott and Bonk (USGS 1984b) as the location of a right-lateral strike slip fault (Figure 6.5.3-1). This fault is almost entirely concealed, so was predicted based on exposures on the ridge between Teacup Wash and Drill Hole Wash, geophysical surveys, topographic expression, and projecting unit contacts and thicknesses from drill holes within and across the wash (Buesch et al. 1993). It was predicted that t would have a down-to-the-west dip-slip displacement of less than 10 m (SNL 1995a). In the Exploratory Studies Facility North Ramp, some small faults were found in the tunnel and were identified as the Drill Hole Wash fault.

Detailed mapping of the Ghost Dance fault along the southern flank of Live Yucca Ridge identified a northwest-trending fault system that was subsequently named the Sundance fault system (USGS 1994b). This fault was presented as the southernmost northwest-trending structure and one that extended across the central portion of the planned repository. Later mapping work has minimized the significance of this fault (USGS 1995c). The recent mapping identified the Sundance as a fault zone about 750 m long, 75 m wide at its maximum extent, and with a maximum cumulative northeast side down vertical movement of 11 m. During the excavation of the Exploratory Studies Facility Topopah Spring Main Drift, a small fault was found near the projected location of the Sundance fault. It is thought that this small fault is the Sundance fault.

6.5.4 Fractures

Fractures in the Yucca Mountain area are of two types. The first type is cooling joints that formed during the cooling of the volcanic mass. Fractures that are interpreted to have formed during cooling are common throughout the Yucca Mountain area (Spengler et al. 1993; USGS 1992). The surface of the cooling joints is typically very smooth and planar or gently curving, and exhibit braided tubular structures. These cooling joint fractures occur in two conspicuous orientations around N40°E and N50°W, and appear to increase in abundance from south to north.

The second type of fractures is that associated with the major structures and tectonics. Fractures that are rough and more angular, as compared with cooling joints, are interpreted to be tectonic fractures (USGS 1992). Along the Ghost Dance fault and within the zone of parallel faults, there are northwest-trending fractures that extend out over 100 m from the main fault trace (Spengler et al. 1993).

The *Controlled Design Assumptions Document* (CRWMS M&O 1995a) states the joint orientations and frequency that are currently to be used for design. These were developed by Lin et al. (SNL 1993a) from examination of core and video camera logs from boreholes USW GU-3 and USW G-4. The joint orientations that they recognized in the Tiva Canyon Tuff and the Topopah Spring Tuff from these two boreholes are summarized in Table 6.5.4-1. Also shown are the joint orientations for the Topopah Spring Tuff, as stated in the *Controlled Design Assumptions*. Preliminary stereographic plots of joint orientations by lithostratigraphic units, as developed by the CRWMS M&O from the Exploratory Studies Facility mapping data, show general agreement to the sets as stated in the *Controlled Design Assumptions*.

Also included in the *Controlled Design Assumptions*, are estimates of joint frequency for the TSw2 thermal/mechanical unit, which was also derived from Lin et al. (SNL 1993a). Joint frequency is estimated to be 2.51/m for 70-80° joints and 11.28/m for 80-90° joints.

Table 6.5.4-1. Summary of Fracture Orientations

	Northwest to North-trending Sets with Steep Dips	Northeast-trending Sets with Steep Dips	Sets with Low-angle Dips
TIVA CANYON TUFF[1]			
USW GU-3	N-N30°W, 85°- 90°SW/NE	N50°W, 70°-90°NE/SW	—
	N50°W, 12°NE		—
	N18°W - N36°E, *NM*		—
USW G-4	—	N-N22°E, 65°- 90°NW	—
TOPOPAH SPRING TUFF[1]			
USW GU-3	N10°W, 75°-90°NE/SW	N45°E, 80°-90°SE/NW	N25°E, 10°SE
USW G-4	N12°W, 80°-90°NE/SW	N-N40°E, *NM*	—
CDA, (TDSS-017)[2]	N10°-12°W, 75°-90°NE/SW	N-N45°E, 80°-90°SE/NW	N25°E, 10°S
Cooling Joints[3]	N50°W	N40°E	—

1) From SNL 1993a
2) From *Controlled Design Assumptions*, Assumption TDSS-017 for Topopah Spring Tuff (CRWMS M&O 1995a)
3) From Buesch et al. (1993)
NM Not measured

6.5.5 Strata Dip

In the southern part of the repository area between the Ghost Dance and Solitario Canyon faults, the Tiva Canyon Tuff strata strikes generally north-south and dips about 6° to 9° to the east; however, in the northern part of this block, it rotates eastward to strike northeast and dips about 5° to 6° to the southeast (USGS 1984b). At the repository level within this southern part, the Topopah Spring strata dips about 7° and strikes N10°W, but in the northern part, it shallows to about 6 degrees and the strike rotates eastward to about N25°E near the Drill Hole Wash fault (Figures 8.1.3-2 and 8.1.3-3). To the north of Drill Hole Wash, the strata continues striking to the northeast, thus defining the axis of a gentle syncline centered along Drill Hole Wash.

To the east of Ghost Dance fault, the strata continues with generally the same strike and dip, but upon reaching the complex Imbricate fault system, the strata dip more steeply eastward between 20° and 40° (USGS 1984b).

6.5.6 In Situ Stresses

A summary of the in situ stresses from the *Controlled Design Assumptions*, Assumption TDSS-001 (Technical Data Assumption - Subsurface), is shown in Table 6.5.6-1 (CRWMS M&O 1995a). The principal stress direction is vertical, due to lithostatic load. At the repository level, the vertical stress is estimated to be 7.0 MPa (megapascals) on the average. Horizontal stresses are expected to be lower and range from 3.5 to 4.2 MPa, but they could range as high as 2.1 to 7.0 MPa. These in situ stress values are generally confirmed by a stress profile calculated for the Exploratory Studies Facility test area (YMP 1995a), which showed a vertical stress of 6.0 MPa at a depth of 300 m.

Table 6.5.6-1. Summary of In Situ Stresses at Repository Horizon[1]

Parameter	Average Value	Range of Values
Vertical Stress	7.0 MPa	5.0 - 10.0 MPa
Minimum Horizontal/Vertical Stress Ratio	0.5	0.3 - 0.8
Maximum Horizontal/Vertical Stress Ratio	0.6	0.3 - 1.0
Bearing of Minimum Horizontal Stress	N57°W	N50°W - N65°W
Bearing of Maximum Horizontal Stress	N32°E	N25°E - N40°E

1) From *Controlled Design Assumptions* Assumption TDSS-001 (CRWMS M&O 1995a)

Horizontal stress for the same depth ranged from 2.1 to 4.2 MPa, using a maximum to minimum horizontal stress ratio of 2:1.

In general, horizontal in situ stresses at the repository site are expected to be low; consequently, failure modes around underground openings during construction will be primarily controlled by geologic structures. Minimum and maximum horizontal/vertical stress ratios are close, indicating a weak horizontal stress anisotropy. Consequently, lateral stresses should be approximately the same and the effects similar for all drift orientations. Horizontal stress anisotropy may become significant only during thermal loading as horizontal stress shows a greater increase in a north-south direction along the probable long-axis of the repository (CRWMS M&O 1994d).

6.5.7 Seismicity

Seismicity in the region around the Yucca Mountain site is discussed in the Site Characterization Plan (DOE 1988a) and the Exploratory Studies Facility seismic design (CRWMS M&O 1994d). The pattern of regional seismicity in close proximity to the Yucca Mountain site (within 100 km) consists of the north-south-trending Nevada-California seismic belt and the diffuse east-west seismic belt encompassing the Yucca Mountain site. The Nevada-California belt corresponds in part to the Owens Valley, Furnace Creek, and Death Valley fault zones shown in Figure 6.5.2-1. This seismic belt is the most active in the area. The largest earthquake recorded in the region and the closest to Yucca Mountain was the 1872 Owens Valley shock, centered about 150 km west of Yucca Mountain and located within the Nevada-California seismic belt along the Owens Valley fault zone (DOE 1988a). The magnitude of this shock was estimated at 8.25 M (Richter magnitude) (DOE 1988a). Epicenter density is sparse in the East-West seismic belt except for clusters of aftershocks near weapons testing areas in the Nevada Test Site, induced earthquakes at Lake Mead, and a series of 1966 to 1967 shocks up to 6.1 M located at Clover Mountain near the Nevada-Utah border. Large quiescent areas in the region include the southern part of the Death Valley-Furnace Creek fault zone, the Las Vegas shear zone, and the vicinity of Yucca Mountain (DOE 1988a).

One recent earthquake occurred at Little Skull Mountain on the Nevada Test Site on June 29, 1992. The earthquake's epicenter was at a depth of 9.6 km below Little Skull Mountain, which is about 16 km southeast-ward from the Yucca Mountain repository site. The earthquake's magnitude was 5.6 M (CRWMS M&O 1994d). The type of movement associated with the shock was normal on northeasterly striking planes. Aftershocks of 4.4 and 3.1 M were associated with normal and strike-slip faulting (CRWMS M&O 1994d). At the project Field Operations Center, located about 6 km north of the epicenter, there was some structural damage to the buildings, but none that resulted in loss of use or structural capacity (Voegele 1993). Preliminary estimates of seismic accelerations at the Field Operations Center were approximately 0.10 g to 0.15 g (Voegele 1993). Located about 3 km west of the epicenter is the X-Tunnel, which is an experimental test facility that supported the U.S. Air Force Ballistic Missile Office deep basing studies in the early 1980's. Examination of this underground facility revealed little or no damage, which affirmed that the potential for damage to underground facilities is moderate and attenuated by depth below the ground surface (Voegele 1993). This conclusion was also supported in the seismic analysis for the ESF (CRWMS M&O 1994d), which determined that ground motion would be reduced by a factor of 0.5 to 0.7 for depths of 200 to 400 meters. Based on this observation, seismic hazard is not considered to be significant. The seismic design parameters are considered to be conservative and follow topical report standards.

The Little Skull Mountain earthquake was apparently triggered by the Landers earthquake of June 28, 1992 (Anderson et al. 1994; Gombert and Bodin 1994). The Landers earthquake was a 7.4 M shock that had its epicenter about 280 km south of the Little Skull Mountain epicenter. The Landers earthquake triggered 227 earthquakes throughout southeastern California and southwestern Nevada during the first 83 days following the event (Anderson et al. 1994).

6.6 HYDROLOGY

An understanding of the hydrologic regime of the Yucca Mountain site is important in the design of the surface facilities, repository siting, and for long term performance assessment. One of the primary advantages of the proposed Yucca Mountain repository site is that the intended emplacement is located entirely within the unsaturated zone above the water table (saturated zone). In the proposed repository area, the unsaturated zone is 500 to 700 m thick (YMP 1995b), and the proposed repository is approximately 300 m above the groundwater table.

6.6.1 Previous Work

Much of the information available on the groundwater hydrology of Yucca Mountain has come from regional studies that concentrated on the saturated zone. In 1957 when the U.S. Atomic Energy Commission began underground testing of nuclear devices at the Nevada Test Site, studies on the location and movement of groundwater were carried out to assess the potential for radionuclide contamination. Since about 1978, as a result of the interest in siting the repository above the groundwater table, more emphasis was placed on characterizing the unsaturated zone. Beginning in 1981, hydrologic test holes were drilled into the saturated zone at Yucca Mountain, and beginning in 1983, test holes were drilled specifically to investigate the unsaturated zone. Shallow boreholes, called neutron holes, have been drilled throughout the Yucca Mountain area to obtain water content profiles within the unsaturated zone to investigate meteoric infiltration. The most recent report on the hydrology was developed by the YMP (YMP 1995b).

6.6.2 Surface Hydrology

Although the Yucca Mountain area is in an arid to semiarid climate that is characterized by high evaporation, low precipitation, and infrequent storms, surface runoff does occur. The rugged relief, abundant exposed bedrock, development of caliche in the washes, and sparse vegetation all promote rapid runoff. Some runoff may occur from regional storms in the winter months, but the greatest runoff is associated with the localized thunderstorms in the summer. Dry washes provide channels that concentrate the runoff and may be the principal sources of potential groundwater recharge in the area. There are no springs or seeps within the Yucca Mountain area. There are also no natural lakes or standing bodies of water.

The western flank of Yucca Crest and the repository area is covered by the Drill Hole Wash drainage basin and Busted Butte Wash drainage basin (Figure 6.6.2-1). These areas drain into the Fortymile Wash, which in turn drains to the Amargosa River. On the west side of Yucca Crest is Solitario Canyon, which drains southward to Crater Flat, then the Amargosa River. All these tributaries of the Amargosa River and the river itself are intermittent and carry water only during periods of heavy runoff. Because of the potential for rapid runoff and the nature of the storms in the area, Yucca Mountain is subject to flash floods that are generally confined to the narrow washes. Flash floods commonly occur during the summer months as the result of short-lived, intense thunderstorms. These floods can be destructive over local areas. One especially intense storm occurred on March 11, 1995, which resulted in the highest flows in Fortymile Wash and Amargosa River in the last 25 years (DOE 1996, in prep). This represents the first documented instance during site characterization studies in which Fortymile Wash and Amargosa River have flowed simultaneously throughout their entire Nevada reaches.

The flood potential of the Yucca Mountain site has been investigated as part of the site characterization activities (USGS 1984d; YMP 1995b). The flood potential map (USGS 1984d) for the potential repository area is shown in Figure 6.6.2-1. It was estimated that in the Drill Hole Wash drainage basin, which drains most of the site of the repository, the maximum depths for 100-year and 500-year floods would be 1.2 and 3.4 meters, respectively. These floods would have velocities of 2.4 and 3.4 meters per second. The 100-year flood would stay within the existing stream channel, but the 500-year flood would overflow its banks. The regional maximum flood would inundate all flat alluvial areas in the watershed.

A more recent estimate of flood potential for the Exploratory Studies Facility North Portal and South Portal sites, Drill Hole Wash, and Coyote Wash were presented in a technical basis report (YMP 1995b). This presented estimates of the flood volume of the potential maximum flood for the four sites as follows:

North Portal site (Mid Valley Wash east of portal)	869 - 1897 m^3/s
Drill Hole Wash (upwash from confluence with Coyote Wash)	1189 m^3/s
Coyote Wash (near confluence with Drill Hole Wash)	187 m^3/s
South Portal site (wash east of portal)	98 - 301 m^3/s

The potential maximum flood for the rest of the area has not been determined.

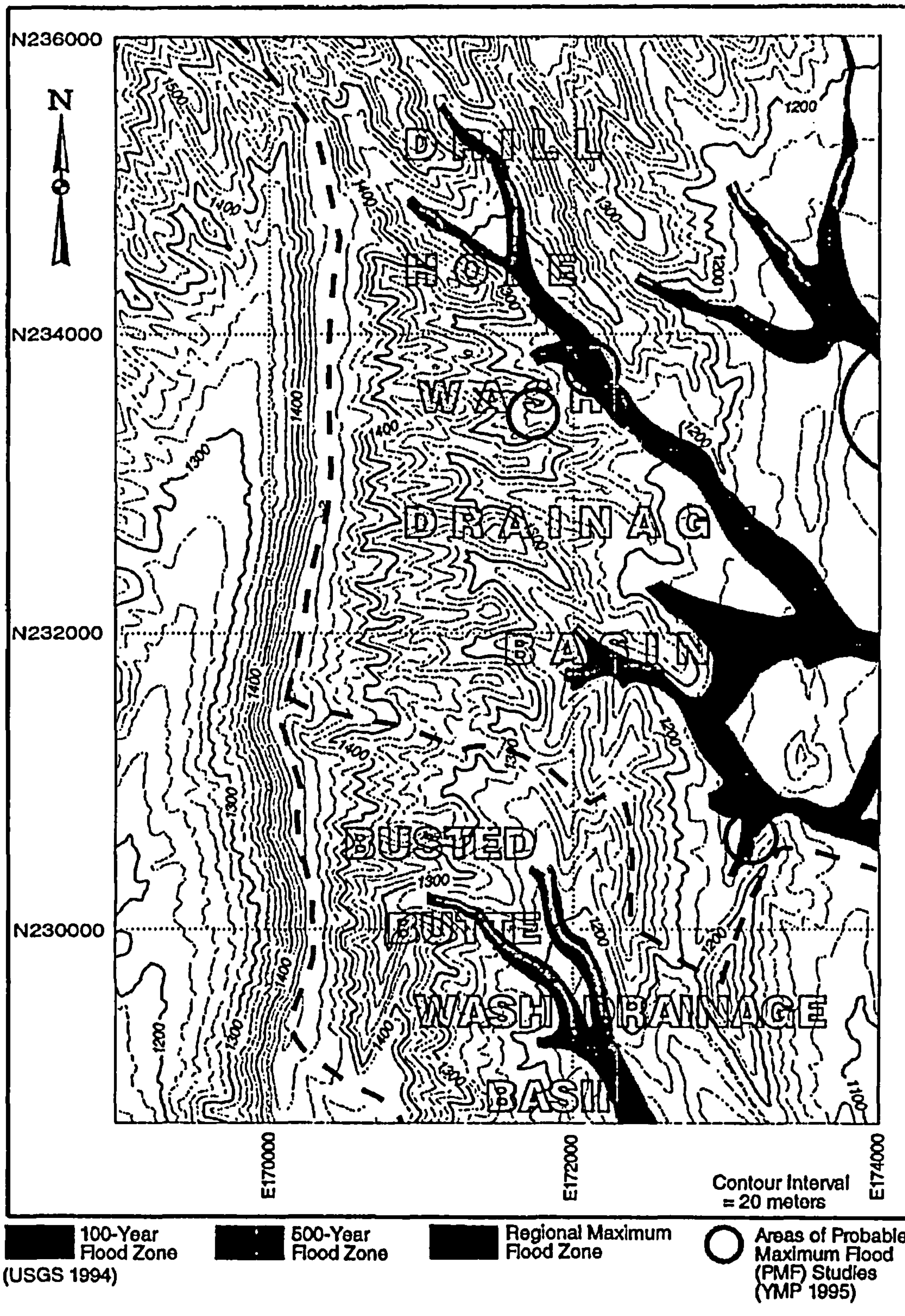

Figure 6.6.2-1. Flood Potential Map for the Drill Hole Wash and Busted Butte Wash Drainage Basins

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6.6.3 Hydrogeologic Units

The rock units of the Yucca Mountain site can be grouped into two gross hydrogeologic units, valley fill aquifer and the welded and bedded tuff aquifer (DOE 1988a). The valley fill aquifer is composed of colluvial, alluvial, and fluvial deposits that are concentrated in the washes and valleys. These deposits are of variable thickness and limited lateral distribution, so their influence on groundwater flow on a regional scale is minimal. The welded and bedded tuff aquifer consists of various nonwelded to welded ashflow tuffs and bedded tuffs. The most important regional aquifer is the paleozoic aquifer, which crops out to the north in Calico Hills and is at a depth of over 1,240 m in borehole p-1 in the eastern part of the area near Boundary Ridge (USGS 1986).

For Yucca Mountain, the welded and bedded tuff aquifer is subdivided into subunits that generally correspond to the thermal/mechanical units described in Section 6.4 and Table 6.4.3-1. These subdivisions are based on hydrologic properties, which group moderately and densely welded tuffs together and the nonwelded and bedded tuffs together (SNL 1995b). The welded tuffs are characterized by relatively low porosities, abundant fractures, and low matrix permeability. Estimates of saturated matrix hydraulic conductivity for the welded tuffs is on the order of 10^{-11} m/s (YMP 1995b). The nonwelded and bedded tuffs, in contrast, are characterized by greater porosities, fewer fractures, and greater matrix conductivities unless clays or zeolites are present. Estimates of saturated matrix hydraulic conductivity for the nonwelded tuffs is on the order of 10^{-7} m/s (YMP 1995b).

The proposed repository is sited within the unsaturated bottom portion of the TSw hydrogeologic unit (Table 6.4.3-1), approximately 300 m above the water table. Water flow to the repository and from the repository to the accessible environment depends mainly upon the hydrogeologic characteristics and flow mechanisms of the unsaturated zone and TSw unit.

6.6.4 Subsurface Unsaturated Zone Hydrology

The subsurface unsaturated zone includes the section of rock from the surface down to the water table, or saturated zone. The unsaturated zone has been investigated by numerous borings, from which the recovered core has been analyzed and in which down-hole testing has been performed.

Perched water has been observed within the unsaturated zone in several boreholes (SNL 1995b). Four of these boreholes are in the Drill Hole Wash proximity and included USW UZ-1, USW UZ-14, USW NRG-7/7A, and USW SD-9. The perched water was encountered about 100 m above the water table. Polymer drilling fluid from G-1 was detected in samples from UZ-1 and UZ-14, and may possibly be present in NRG-7/7A and SD-9. The drilling fluid from G-1 borehole at least contributed to the volume of perched water found at these sites. One borehole, USW SD-7, located further south near the southern end of the repository block, encountered perched water 59 m below the top of the Calico Hills and approximately 150 m above the water table. If perched water were encountered, it is not expected to pose construction problems requiring other than standard engineering measures (YMP 1995b).

Unsaturated groundwater flow occurs in both the matrix and in fractures. At lower degrees of saturation, the flow is primarily within the rock matrix. Significant flow occurs within the fractures only at relatively high degree of saturations.

6.6.5 Subsurface Saturated Zone Hydrology

Groundwater flow in the saturated zone under Yucca Mountain occurs in the lower volcanic rocks and the underlying Paleozoic carbonate strata. Direct observation of the groundwater table was obtained from 28 boreholes, 13 of which are shown in Figure 6.6.5-1. Primarily based on 1988 average water levels, Ervin et al. (USGS 1994c) presented a revised potentiometric-surface map for the region around Yucca Mountain. A rendition of their map is shown in Figure 6.6.5-1, which includes groundwater elevations for boreholes, corrected for hole deviation. General groundwater flow is from the northwest to the southeast. The Primary Area of Mansure and Ortiz (SNL 1984a), which identifies the general area of the potential repository, is included in Figure 6.6.5-1 for reference.

Ervin et al. (USGS 1994c) recognized in the Yucca Mountain area three distinct groundwater areas, which they referred to as the small-gradient area throughout the southeast, moderate-gradient area on the western side, and large-gradient area to the northeast (Figure 6.6.5-1). In the small-gradient area, the groundwater surface elevations range from 740 to 730 m. This area can be explained by flow through high-transmissivity rocks or low ground-water flux through the area. The ground water surface in the moderate-gradient area ranges from 775 to 780 m in elevation and appears to be impeded by the Solitario Canyon fault and a splay of that fault. The groundwater surface in the large-gradient area groundwater levels reach 738 to 1,035 m in elevation and is possibly the result of semi-perched groundwater. The National Academy of Sciences has postulated that the maximum rise of the water table in the event of possible future climatic changes, would be about 100 m, wich is well below the 300 m distance of the repository above the groundwater.

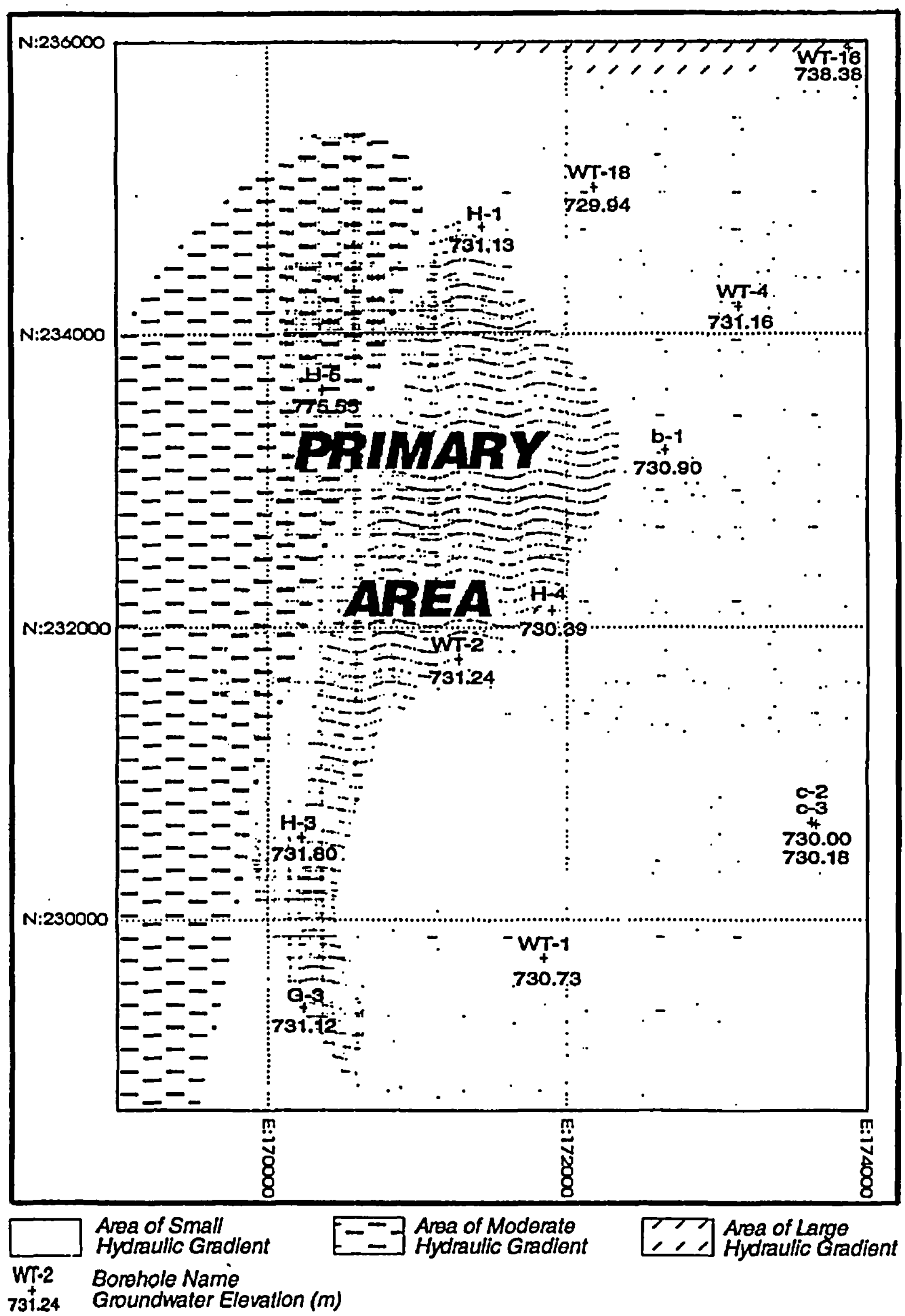

Figure 6.6.5-1. Groundwater Surface Map

7. SURFACE DESIGN DESCRIPTION

7.1 OVERVIEW

Section 7.1 identifies the operational areas at the repository surface, identifies the general design inputs (i.e., design requirements, design assumptions and interface criteria), and describes the organization of Section 7.

7.1.1 Operations Areas

This section describes the selected Advanced Conceptual Design (ACD) concept for all above ground facilities at the repository. The repository surface facilities are located in four discrete operational areas as described below and as shown on the overall repository surface site map in Figure 7.1.1-1. This figure also shows the relationship of these areas to the emplacement (North) and development (South) portals, subsurface ramps and emplacement areas, and emplacement and development shafts.

A. *North Portal Operations Area* – This is the largest and most complex surface facility area, covering about 80 acres and including 19 (17 new and 2 existing Exploratory Studies Facility [ESF]) structures. This area is located adjacent to the North Portal, where the waste is brought underground for emplacement. The operations area includes a Radiologically Controlled Area (RCA) and a balance of plant (BOP) area. The RCA is where the spent nuclear fuel (SNF) and defense high-level waste (DHLW) materials are received from off-site transportation and placed in disposal containers. The balance of plant area includes structures and systems that will support repository operations in all areas (e.g., general administration, medical center, training center, shops, motor pool, central warehouse and centralized utilities). This area will normally be staffed with about 550 employees (full-time equivalents).

B. *South Portal Development Operations Area* – This is the second largest surface facility area, covering about 12 acres and including eight structures. This area is located adjacent to the South Portal to support the excavation of the underground and the operation of the development ventilation intake fans. The area functions independently and includes the basic facilities needed for personnel support, maintenance, warehousing, material staging, security, and transportation. This area will normally be staffed with about 50 employees (full-time equivalents) during the development/emplacement phase and will be unmanned after underground excavation is complete. Most personnel and construction materials will move directly from off site to this area.

C. *Emplacement Shaft Surface Operations Area* – This 3 to 4 acre site includes two structures and is located at the opening of the north shaft. The main facility is provided to house the emplacement ventilation exhaust fans and to support the maintenance of these fans. This area is normally unmanned. Personnel and materials are dispatched as needed from the North Portal Operations Area to conduct inspections and maintenance.

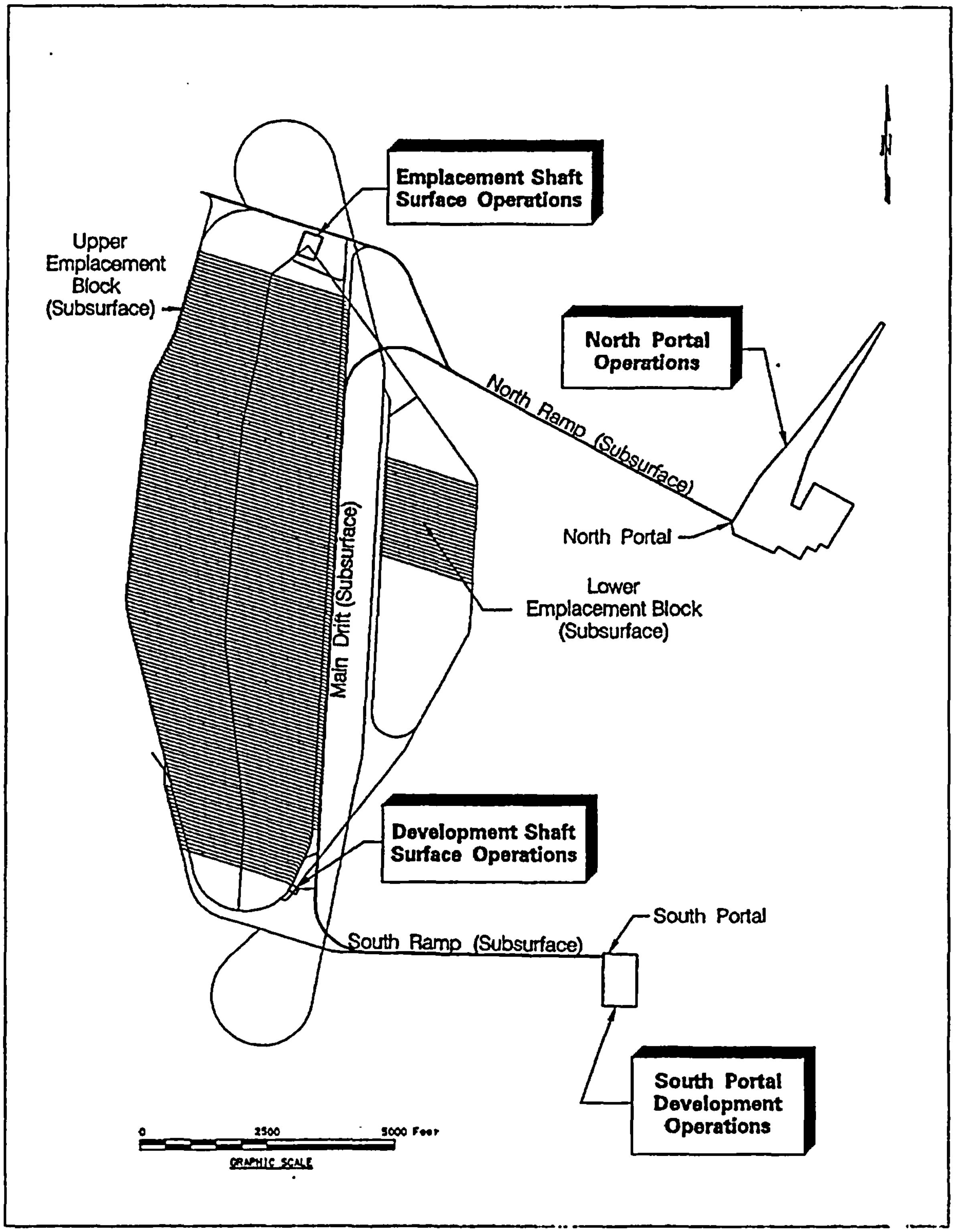

Figure 7.1.1-1. Repository Surface Site Overview

D. *Development Shaft Surface Operations Area* – This small half-acre site includes one structure and is located at the opening to the south shaft. The facility is provided to house the head frame and shaft conveyance needed for underground emergency personnel egress and inspection access. The area also includes the exhaust for the underground ventilation system and electrical equipment. This area is normally unmanned. Personnel and materials are dispatched as needed from other areas to conduct inspections and maintenance.

7.1.2 Design Inputs

This section provides the input on which design analysis decisions are based. These are the general inputs applicable to two or more surface operations and include design requirements, design assumptions, and design data from other groups. Additional design inputs that are specific to individual facilities are provided in the Design Input sections describing those facilities.

Refer to Section 4 for a brief description of the systems engineering approach to developing and evolving design inputs for the repository, and a discussion of the significant requirements and assumptions that form the basis for the design concept selected for this *Mined Geologic Disposal System Advanced Conceptual Design Report* (MGDS ACD Report).

Refer to Section 6 for descriptions of the physical site characteristics that are design inputs to the repository ACD surface design including surface hydrology, meteorology, and a discussion of the facilities that are expected to be existing when repository construction begins.

7.1.2.1 Design Requirements

This section summarizes the design requirements from the *Repository Design Requirements Document* (RDRD) (YMP 1994a) that are expected to impact the design of repository surface facilities. The RDRD (YMP 1994a) includes regulatory requirements from higher level requirements documents as identified in Section 3. Also included are design criteria that were derived and compiled from the higher regulatory requirements, codes, and standards, based on studies; analyses; and agreements.

Design requirements are categorized as either functional requirements or regulatory requirements. Functional requirements are those defining a desired function, operation, system, or facility. Regulatory requirements are those defining bounding limits or constraints on the potential solutions to the functional requirements.

7.1.2.1.1 Functional Requirements

Repository functions were defined in the RDRD (YMP 1994a), Table 7-1 and expanded in the *Controlled Design Assumptions Document* (CDA Document) (CRWMS M&O 1995a). Using the Systems Architecture numbering structure, the repository surface functions are listed below:

1.4.3 Operate MGDS
1.4.3.1 Support MGDS Operations

Support MGDS Operations includes operational, logistical, and administrative services required to support surface and subsurface waste handling operations; support of retrieval operations if required; and support of underground emplacement drift development operations. Principal services include:

1.4.3.1.1	Provide Utilities & Services
1.4.3.1.2	Provide Protective Services
1.4.3.1.3	Administer General Support Services
1.4.3.1.4	Handle Site Generated Waste
1.4.3.1.5	Maintain Operating Facilities
1.4.3.1.6	Administer Quality Assurance

1.4.3.2 Handle Waste

This function encompasses the handling of waste, transporters, casks, waste packages, and temporary storage. Principal subfunctions include:

1.4.3.2.1	Receive & Inspect Loaded Transportation Cask
1.4.3.2.2	Unload Waste from Transportation Cask
1.4.3.2.3	Receive & Prepare New Disposal Container
1.4.3.2.4	Assemble Waste Package
1.4.3.2.5	Prepare Waste Package for Underground Transport
1.4.3.2.6	Emplace Waste Package (This is a Subsurface Function only)
1.4.3.2.7	Retrieve Waste Package
1.4.3.2.8	Perform Post-Retrieval Waste Processing (This is an optional function which could be needed at a future date)
1.4.3.2.9	Prepare Unloaded Transportation Cask for Shipment/Transfer

7.1.2.1.2 Regulatory Requirements

The codes, regulations, standards, and guides applicable to the design of repository surface operations are defined in the RDRD (YMP 1994a). The key performance requirements are summarized in Section 3.2.3.

The general design criteria for surface operations is based on DOE Order 6430.1A, *General Design Criteria*, per RDRD (YMP 1994a) requirement 3.3.1.B. Since a project design criteria manual has not yet been established, this 1989 DOE Order with the accompanying enhancements defined in the RDRD (YMP 1994a) is considered the basic preliminary design criteria for surface repository design.

The following subjects are covered in Divisions 1 through 16 of DOE Order 6430.1A.

Division 1 General Requirements – Unless otherwise enhanced, interpreted, or deleted by the following additional requirements, Division 1 of DOE Order 6430.1A shall apply, as is appropriate, to the scope of the design concept. See RDRD (YMP 1994a) Sections 3.2 through 3.7 for the following:

A. *Additional Repository Performance Requirements* – Topics covered include: Radiological Control Performance Objectives; Emplacement Performance Objectives; Mitigation of Potentially Adverse Conditions; Closure Performance Objectives; Retrievability Performance Objectives; Emergency Response Performance Requirements; Environmental Impact Performance Objective; Classification of Permanent Items

B. *Additional Architectural Design Requirements* – Topics covered include: Federal Aviation Administration Height Restrictions; Flexibility, Expansion, and Integration; Fire Protection Design Requirements; Energy Conservation; Repository Closure Requirements

C. *Additional Structural Design Requirements* – Topics covered include: Vibration Control; Loads; Structural Systems

D. *Additional Environmental Protection Design Requirements* – Topics covered include: Environmental Monitoring; Air Pollution Control; Water Pollution Control; Drinking Water Protection; Toxic Substances Control; Pesticide Control; Solid Waste Control; Noise Control; Work Space Acoustical Noise Control; Endangered Species; Erosion Control

E. *Additional Safety Design Requirements* – Topics covered include: System Safety Design Precedence; Work Place Preventative Safety Measures; Personnel Protective Equipment Facilities; Safety Labels and Placards; Equipment Related Hazards Protection; Elevated Work Areas

F. *Additional Security and Safeguards Design Requirements* – Topics covered include: Physical Protection Requirements; Licensed Material Security and Inventory Control Requirements; Security Access Control

G. *Additional Design Documentation Requirements* – Topics covered include: Specifications; Drawings; Maintenance, Operators, and Technical Manuals; Test Plans and Procedures; Quality Assurance Documentation; Construction Records; Computer Documentation; Records Management

H. *Additional System Quality Factors Design Requirements* – Topics covered include: Reliability; Maintainability and Inspectability; Overall Utilization; Service Life; Availability; Logistics; Human Factors Engineering

Division 2 Site and Civil Engineering – Unless otherwise enhanced, interpreted, or deleted by the following additional requirements, Division 2 of DOE Order 6430.1A shall apply, as is appropriate to the scope of the design concept. See RDRD (YMP 1994a) Sections 3.2 through 3.7 for additional Site and Civil Design Requirements. Topics covered include Sanitary Sewerage System

Requirements, Transportation, Site Surveys, Site Grading, Potable Water System Requirements, and Landscaping.

Division 3 Concrete – No adjustments to the existing criteria in this Division have been identified at this time.

Division 4 Masonry – No adjustments to the existing criteria in this Division have been identified at this time.

Division 5 Metals – No adjustments to the existing criteria in this Division have been identified at this time.

Division 6 Wood and Plastics – No adjustments to the existing criteria in this Division have been identified at this time.

Division 7 Thermal and Moisture Protection – No adjustments to the existing criteria in this Division have been identified at this time.

Division 8 Doors and Windows – No adjustments to the existing criteria in this Division have been identified at this time.

Division 9 Finishes – No adjustments to the existing criteria in this Division have been identified at this time.

Division 10 Specialties – No adjustments to the existing criteria in this Division have been identified at this time.

Division 11 Equipment – No adjustments to the existing criteria in this Division have been identified at this time.

Division 12 Furnishings – No adjustments to the existing criteria in this Division have been identified at this time.

Division 13 Special Facilities – Unless otherwise enhanced, interpreted, or deleted by the following additional requirements, Division 13 of DOE Order 6430.1A shall apply, as is appropriate to the scope of the design concept.

A. See RDRD (YMP 1994a) Sections 3.2 through 3.7 for additional Radiological Protection Design Requirements. Topics covered include Radiation Exposure Control, Radioactive Contamination Control, Criticality Control, Low-level Waste Disposal, and Radiological Monitoring.

B. Section 1300 criteria considered pertinent to surface radiological confinement during engineering analysis:

- Confinement capabilities, including confinement barriers and associated ventilation systems, shall maintain a controlled, continuous airflow pattern from the environment into the confinement building, and then from noncontaminated areas of the building to potentially contaminated areas, and then to normally contaminated areas (DOE Order 6430.1A, Section 1300-7.2.).

- The secondary and tertiary barriers may exist in common, such as a single structural envelope (e.g., walls, roof slab, floor slab), provided the barrier can withstand the effects of man-made events and Design Basis Accidents including design basis earthquakes, and does not contain access ways that allow the routine transfer of personnel, equipment, or materials directly from the exterior of the facility. Access ways into the interior of the single structural envelope are allowed, provided that entrance into the access way is gained from another level of confinement (DOE Order 6430.1A, Section 1300-7.2.).

- The degree of confinement required in a radioactive solid waste facility is both storage specific and process-specific, but in either case shall suit the most restrictive case anticipated (DOE Order 6430.1A, Section 1324-6.1).

Division 14 Conveying Systems – No adjustments to the existing criteria in this Division have been identified at this time.

Division 15 Mechanical – Unless otherwise enhanced, interpreted, or deleted by the following additional requirements, Division 15 of DOE Order 6430.1A shall apply, as is appropriate to the scope of the design concept. See RDRD (YMP 1994a) Sections 3.2 through 3.7 for additional Mechanical Design Requirements. Topics covered include Exhaust Ventilation; Comfort Heating, Ventilation, and Air Conditioning; Plumbing Requirements; Fire Protection Requirements; and Fossil Fuel Storage Areas.

Division 16 Electrical – Unless otherwise enhanced, interpreted, or deleted by the following additional requirements, Division 16 of DOE Order 6430.1A shall apply, as is appropriate to the scope of the design concept. See RDRD (YMP 1994a) Sections 3.2 through 3.7 for additional Electrical Design Requirements. Topics covered include Electrical Safety; Illumination; Emergency Lighting; Lightning Protection; Communications Systems; Electromagnetic Radiation Protection; and Monitoring, Alarms, Recording or Control Systems.

Other Regulations, Codes, And Standards

During engineering analysis other laws and regulations were identified, which are expected to impact the surface repository design. Compliance with these laws and regulations, which are listed below, is expected to be required in future revisions of the RDRD (YMP 1994a).

A. 10 CFR 435 – *Energy Conservation.*

B. ACI 301 – *Specification for Structural Concrete for Buildings*, American Concrete Institute.

7.1.2.2 Design Assumptions

This section presents the general design assumptions that were made to develop the repository surface designs for the ACD, and were necessary to maintain the flexibility in the concepts until analysis and decisions are complete. Assumptions are required because the analyses needed to establish design requirements or qualified design solutions have not been completed. These assumptions are based on engineering judgement with the best available data. When the assumptions are substantiated by analysis the criteria will be incorporated in the RDRD (YMP 1994a).

There are two types of design assumptions: controlled and non-controlled design assumptions (CDAs). CDAs are recorded in the CDA Document (CRWMS M&O 1995a) and non-controlled design assumptions were derived as necessary for the individual engineering analyses.

Controlled Design Assumptions

The CDA Document (CRWMS M&O 1995a) is discussed in Section 4. CDAs that impact the surface repository, in general, are provided in Table 7.1.2-1.

Table 7.1.2-1. CDAs Affecting Surface Design

CDA No.	Title	Assumption	Design Impact
Key 001	Cask Arrival Scenario	The cask arrival scenario at the MGDS is as indicated in Table 4.1-1. Rail shipments total approximately 5000 (spent fuel assembly (SFA) canisters = 4400, DHLW = 600). There is a maximum of three railcars per SNF shipment or five railcars per high-level waste (HLW) shipment, with one transportation cask per railcar. Truck shipments total approximately 1000; all uncanistered SNF. Table 4.1-1 is consistent with MGDS-RD Table 3-3.	Waste handling operations are sized based on this data.
Key 002	Waste Form Arrival Scenario	The waste form scenario at the MGDS is as indicated in Table 4.1-2. The table is consistent with MGDS-RD Table 3-3.	Waste handling operations are sized based on this data.
Key 003	Waste Package Emplacement Scenario	The Waste Package emplacement scenario at the MGDS for the reference thermal load is as indicated in Table 4.1-3. The table is compatible with tables in Key Assumptions 001 and 002 for higher thermal loads. Total commercial SNF - 63000 Metric Tons of Initial Heavy Metal in about 9000 SFA canisters and about 200 uncanistered fuel waste packages. Table 4.1-3 is consistent with MGDS-RD Table 3-3.	Waste emplacement operations are based on this rate.

Table 7.1.2-1 CDAs Affecting Surface Design (Continued)

CDA No.	Title	Assumption	Design Impact
Key 047	Surface Facilities Location	The proposed repository surface facilities will be located adjacent to the North Portal.	If the surface facilities are not at the North Portal, then the assessment objectives involving the utilization of existing Exploratory Studies Facility facilities are not relevant.
RDRD 3.2.1.6.D	Physical Barriers	Facilities shall be provided to support active institutional controls at the repository site, including physical barriers to human intrusion. Facilities to maintain the institutional controls and physical barriers shall also be provided.	This proposed rewording avoids the interpretation in the original wording that physical barriers to maintenance facilities were required.
RDRD 3.2.3.4.B	Non-Potable Water	The Repository Segment will connect with the existing Nevada Test Site water supply system.	Existing water supply is from Well J-13. North Portal water will be supplied from this location. Additional wells or equipment will be added as needed.
DCS 001	MGDS Operational Center	A future MGDS operational center will be required to maintain communications with the transportation network, maintain inventories, and support security and safeguards requirements. This center will be located at the repository.	The center, which manages the off-site transportation network, will be provided within the Administration Building.
DCS 003	As Low As Reasonably Achievable (ALARA)	The Surface Facilities that house radioactive materials or in which work is performed on radioactive materials will be designed to control occupational exposures to ALARA and less than 500 millirem per year.	ALARA analysis will be part of radiological operations design.
DCS 005	One Waste Handling Building (WHB)	WHBs 1 & 2 in the *Site Characterization Plan-Conceptual Design Report* (SCP-CDR[1]) will be consolidated into a single structure.	The current WHB design includes this consolidation.
DCS 006	Cask Maintenance Facility (CMF) Requirement	A Transportation CMF will be required at the MGDS.	Facilities for the CMF functions are included.
DCS 007	Waste Treatment Building (WTB)	A WTB will be incorporated into the Geologic Repository Operations Area to treat solid and liquid low-level radioactive waste (LLW) in preparation for transport to a government-approved off-site facility for treatment, storage, and disposal.	Facilities for the WTB functions are included.
DCS 008	Decontaminated Equipment and Space	Necessary equipment and space for decontamination will be provided in each building where contamination will be present.	The decontamination facility cited in the SCP-CDR will not be included.

[1] *Site Characterization Plan Conceptual Design Report* (SNL 1987)

Table 7.1.2-1 CDAs Affecting Surface Design (Continued)

CDA No.	Title	Assumption	Design Impact
DCS 010	Hazardous Waste (HW) Generated Outside RCA	HW will be accumulated and staged, for up to 90 days, at the source of generation. These wastes will be periodically transported to a *Resource Conservation and Recovery Act* - approved off-site treatment, storage, and disposal facility. Sub-surface HW will be collected at a surface staging area outside the RCA.	HW generators will have their own accumulation and staging areas.
TDS 001	Fault Displacement Locations, Attitudes	The Surface Facilities fault displacements, fault locations and fault attitudes shall be as described in Section 1.23 of the RIB, Revision 3.	Siting of facilities important to radiological safety will consider detailed fault investigations.
TDS 002	Topography/ Morphology	The Topographical Survey Data and Surface Morphology shall be as described in Section 1.11 of the RIB.	Surface facilities will be located to reflect impacts of the site topography.
TDS 003	Soil Properties	The Soil Properties are described in Sections 1.311, 1.1313, and 1.1314 of RIB. The soil hydrological properties, the soil mechanical properties, the soil geotechnical properties, and the soil physical properties are given.	Soil conditions are used to design foundations.
TDS 004	Meteorology	The Site Meteorology includes data on normal and atmospheric and climatic conditions at the site based upon historical data. These conditions are delineated in Section 1.3 of the RIB	See TDS 007 and 008.
TDS 007	Winds (Operating, Basis and Standard)	The prevailing wind summary given in the RIB, Section 1.3a will be used as the Operating Basis Wind and Standard Wind for surface facilities design considerations.	The site layout will consider prevailing wind to locate facilities.
TDS 008	Floods (Design Basis)	The Design Basis Flood shall be the 100-year and 500-yr Probable Maximum Floods described in Table 3 of Section 1.54a of the RIB, which identifies the estimated ranges for peak flood characteristics.	Siting of surface facilities will consider the location of flood zones, nuclear surface facilities will not be located in the Probable Maximum Flood zone.

GROA = Geologic Operations Repository Area; MGDS-RD = Mined Geologic Disposal System Requirements Document; RIB = Reference Information Base

Non-Controlled Design Assumptions

The non-controlled design assumptions applicable to surface facilities design are listed below:

Cask Transportation

A. Shipments are received and brought into the RCA around the clock, but are unloaded during regular working hours.

B. A rail cask shipment arrives at the repository as a unit train. A unit train may consist of one to two locomotives, three to five railcars carrying casks, and buffer railcars between railcars carrying casks. Railcars carry no more than one cask.

C. A truck cask shipment includes a single cask.

D. Rail and truck cask carriers on moved within the RCA with a common site prime mover. This diesel powered vehicle has truck tires and retractable rail wheels, such as the prime movers used by the railroad industry. The site prime mover has a maximum speed of three miles per hour.

Secondary Waste Management

A. HW storage areas must be finished with a containment system to contain leaks, spills, and accumulated precipitation.

B. The HW storage containment system must have capacity sufficient to hold 10 percent of the total volume of all containers or the volume of the largest container, whichever is greater.

C. Waste types will be segregated and handled separately from the point of generation to facilitate on-site or off-site treatment and to minimize the potential for producing mixed wastes (MW).

D. Corrosive vapors, noxious gases and vapors, and flammable or combustible gases are treated prior to receipt by the ventilation exhaust system.

Heating Ventilation and Air Conditioning (HVAC) Design

A. Outdoor Conditions (based on preliminary site characterization data):

Temperature	110°F dry bulb (Summer)/24°F dry bulb (Winter)
Elevation	5000 ft above sea level

To protect against freezing, the HVAC equipment will be selected for operation at -20°F dry bulb entering air temperature.

B. Indoor Conditions - based on American Society of Heating, Refrigerating, and Air Conditioning Engineers standards.

Offices and Change Rooms	72°F dry bulb (Summer/Winter)
Normally occupied process areas	72°F dry bulb (Summer/Winter)
Normally unoccupied areas	85°F dry bulb (Summer)/60°F dry bulb (Winter)
Winter humidification	Not required

A. Maximum horizontal ground surface accelerations are as follows per *Topical Report: Seismic Design Methodology for a Geologic Repository at Yucca Mountain* (YMP 1995d). The WHB, CMF and WTB are designed to performance category 3 criteria, as these facilities are required to continue emplacement operations and are required to have nuclear confinement systems. Other structures are conservatively designed to performance category 2 criteria, as these facilities are not expected to require confinement systems.

Performance Category	Acceleration
PC-1	0.19 g
PC-2	0.27 g
PC-3	0.37 g
PC-4	0.66 g

B. The design tornado missiles are based on page 3-3 of DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*. This missile is either a fifteen-pound two-by-four traveling horizontally through the air at 100 mph; or vertically at 70 mph to a maximum height of 150 feet above the ground; or a five-pound, three-inch diameter steel pipe traveling horizontally through the air at 50 mph; or vertically at 35 mph to a maximum height of 75 feet above ground.

C. The foundation designs for facilities on the North Portal pad are based on a soil bearing pressure of 3,000 pounds per square foot at six feet below grade. The current pad, which was constructed from cut and fill over bore holes and trenches, was not analyzed during the ACD. Future foundation designs will be refined based on a pad analysis using the latest site data.

D. Specified compressive strength of concrete (f'c) is 4,000 pounds per square inch. Specified yield strength of nonprestressed reinforcement (fy) is 60,000 pounds per square inch.

E. The structural steel materials used in this design shall be specified by American Society for Testing and Materials standards.

F. Maximum steel stress (fs) for metal decks is 20,000 pounds per square inch.

G. Minimum design live loads are per the Uniform Building Code, Tables 16a and 16b, Volume 2, 1994.

H. For the natural phenomena hazards, only earthquake and tornado generated missile impact are considered in this preparatory design. Other events are assumed to be not critical.

I. Credible fire and explosion design bases are to be determined.

J. The structural designs do not consider the potential risk from an aircraft crashing into the buildings, nor are the buildings designed to withstand an attack from a man-made missile (e.g., rocket or artillery shell).

Site/Facilities

A. Lag storage for SNF and DHLW is provided to accommodate minor interruptions in waste handling operations. Lag storage is not provided to accommodate surface cooling, retrieval, or interim storage.

B. The security system for the North Portal Operations Area requires a single fence around the RCA to limit unauthorized access. An RCA security perimeter with dual fences and personnel detectors is not required.

C. Facility designs do not include provisions to comply with currently undefined material control and accountability and International Atomic Energy Agency requirements.

D. When (and if) retrieval is required, a period of mobilization is needed to modify, expand, or upgrade the repository surface facilities, as required to conduct the retrieval operations.

E. Separate structures are used for nuclear surface operations (i.e., WHB, CMF and WTB). Future designs are expected to consider consolidating these operations into an integrated facility.

F. Support structures designed during the SCP-CD (e.g., administration building, central warehouse, mock-up building, etc.) are suitable for supporting repository operations.

7.1.2.3 Interface Criteria

Interface requirements impacting the repository design are defined in Section 3.2.3 of the RDRD (YMP 1994a). Additional interface criteria were identified during engineering analysis.

***Transportation System Requirements Document* (TSRD)**

The transportation system includes user functions of transportation service and maintenance support, field operations, and planning and control. This document includes repository interface requirements that are expected to be added to the RDRD (YMP 1994a) in future revisions including maintenance of transportation cask subsystems, transportation support facilities, operations, and utilities. The requirements derived from the TSRD are listed below. The appropriate TSRD sections are shown in parenthesis.

A. The Repository Segment shall provide site improvements, utility services, security facilities, cask handling and site-generated radioactive waste systems, site vehicles, and administrative and warehouse facilities that are appropriate and compatible for use by transportation support facilities (TSRD 3.2.3.2.3.2.1.A).

B. The Repository Segment shall have computer hardware and software that is compatible with that used in the Transportation Segment (TSRD 3.2.3.2.3.2.1.B).

C. The Repository Segment shall have compatible communications with the Transportation Segment, whether located at the Repository Segment or elsewhere, for scheduling casks for maintenance, for providing materials to the Repository Segment for incidental maintenance, and for managing support services (TSRD 3.2.3.2.3.2.1.C).

D. The Repository Segment shall be capable of training MGDS personnel in handling, inspecting, loading, cleaning, decontaminating, and incidental maintenance of transportation cask subsystems provided by field operations (TSRD 3.2.3.2.3.3.1.B).

E. The Repository Segment shall have compatible equipment for long-term planning, real-time scheduling, and control of deliveries of transportation cask subsystems (TSRD 3.2.3.2.3.3.1.B)

F. The Repository Segment shall be compatible with planning and control motive support equipment, in terms of load bearing capability and dimensions, in that area outside of the protected area where motive support equipment will be received, detached from transporters, and dispatched (TSRD 3.2.3.2.3.4.1.C).

Cask Input from Transportation Interface

Transportation interface provides the design criteria for receiving loaded shipping casks, unloading the casks, and preparing the empty casks for dispatch from the repository. For the conceptual design only the external physical characteristics of casks were requested from the transportation interface. The transportation interface has identified the input as to be verified (TBV).

A. *Truck Casks Physical Characteristics* - Input on the *GA-4 Legal Weight Truck From-Reactor Spent Fuel Shipping Cask Final Design Report* (General Atomics 1993a) and *GA-9 Legal Weight Truck From-Reactor Spent Fuel Shipping Cask Final Design Report* (General Atomics 1993b) truck shipping casks obtained from the transportation interface and applicable to the WHB is shown in Table 7.1.2-2. SFA canisters and DHLW are not planned to be shipped to the repository by truck (*Design Input Data for Repository Surface Designs* [CRWMS M&O 1994e]).

B. *Rail Cask Physical Characteristics* – The physical characteristics for rail shipping casks of only large SFA canisters are in Table 7.1.2-3. The large SFA canister rail shipping cask is also assumed for DHLW shipments. Uncanistered SFAs are not planned to be shipped to the repository by rail. The data designated with an "*" was provided by a data transmittal (CRWMS M&O 1994e). The other data was assumed to be the same as for the BR-100 rail shipping cask per *BR-100 100 Ton Rail/Barge Spent Fuel Shipping Cask Final Design Package* (B&W 1991).

7.1.3 Overall Surface Design Organization

The repository surface designs are provided for each of the four operations areas: North Portal Operations Area, South Portal Development Operations Area, Emplacement Shaft Surface Operations Area, and Development Shaft Surface Operations Area. Each area description includes an overview of the layout and operations, a list of facilities, a detailed description of major facilities, and a brief description of other structures and systems.

The repository safety design aspects, including the preliminary Design Basis Events' hazards analysis, and discussions of radiological and industrial safety are provided in Section 10.

Throughout this section design figures such as general arrangements and flow diagrams are referenced to enhance the descriptions. These figures have reference numbers such as WTH-SK-103B or WHB-SK-101B and are provided in Appendix D. Referenced figures with numbers in a format such as Figure 7-1.1-1 are provided in the body of the report following the reference.

Table 7.1.2-2. Truck Casks Physical Characteristics for GA-4 and GA-9

Characteristics	Truck Casks	
	GA-4	GA-9
Cask Body		
Capacity, SFAs	4 PWR	9 BWR
Diameter, inch	42	40
Length (w/out impact limiters), inch	188	199
Loaded weight, pounds	50,242	49,666
Lid weight, pounds	1,510	1,427
Lid diameter, inch	26	26
Lid thickness, inch	11	11
Number of lid closure bolts	12	12
Lid bolts torque, feet-pounds	235 ± 15	235 ± 15
Impact Limiters		
Diameter, inch	90	90
Length, inch	45	45
Weight, pounds	2,000	2,000
Number of bolts	8	8
Torque, feet-pounds	230 ± 15	230 ± 15
Cask Yoke		
Weight, pounds	3,000	3,000
Height (centerline of trunnion to center of crane hook), feet	5½	5½

Table 7.1.2-3. Rail Cask Physical Characteristics for Large SFA & DHLW Canisters

Characteristics	Rail Cask
Cask Body	
SFA canisters carried**	1*
DHLW canisters carried	5*
Diameter, inch	90*
Length (w/out impact limiters), inch	210*
Loaded weight, pounds	210,000
Lid weight, pounds	6,200
Lid diameter, inch	75
Lid thickness, inch	5
Number of lid closure bolts	32
Lid bolts torque, feet-pounds	235±15
Impact Limiters	
Diameter, inch	125
Length, inch	41
Weight, pounds	15,300
Number of bolts	16
Torque, feet-pounds	230±15
Cask Yoke	
Weight, pounds	4,000
Height (centerline of trunnion to center of crane hook), feet	8

* Data provided by a data transmittal (CRWMS M&O 1994e), other data was assumed to be the same as for the BR-100 rail shipping cask (B&W 1991).

** A large SFA canister can hold up to 40 BWR or 21 PWR SFAs.

7.2 NORTH PORTAL OPERATIONS

7.2.1 Area Overview

The North Portal Operations Area covers about 80 acres and incudes five primary RCA buildings, 14 support buildings, and 26 site support systems. Figure 7.2.1-1 presents a conceptual illustration of the North Portal Operations Area including major RCA and BOP buildings. This area is located adjacent to the North Portal, where the packaged disposal containers are brought underground for emplacement. The operations area includes an RCA and a BOP area. The RCA includes all the facilities handling radiological materials (e.g., the WHB, CMF, WTB, Carrier Staging Shed (CSS), and Transporter Maintenance Building [TMB]). The BOP area consists of support facilities that do not involve radiological materials including: general administration, medical center, training center, shops, motor pool, central warehouse and centralized utilities.

The overview of the North Portal Operations Area is presented below in the following order:

- A summary of studies impacting the layout
- A physical description of the site layout
- A description of site operations (i.e., personnel and material movement)
- A list of facilities.

7.2.1.1 Summary of Studies

The general layout of the North Portal Operations Area was analyzed in a single design study titled *Site Facilities Interface Final Report*, issued on March 31, 1995 (CRWMS M&O 1995p). Prior to this study, the site layout was based on the *Site Characterization Plan Conceptual Design Report* (SNL 1987) (SCP-CDR) which was published in 1987. Since 1987, the surface facility designs have continued to develop and a number of changes have occurred that affect the surface facility layout. The North Portal site has also changed with the ongoing construction of ESF surface facilities.

This study addressed the following site layout characteristics:

A. Identifying size requirements for the surface facilities at the North Portal.

B. Arrangement of facilities within the RCA.

C. Arrangement of the RCA and BOP area on the site.

D. Location of major roads, rail lines, utility pipeways, and electrical transmission lines within the site.

E. Utilization of existing and planned ESF surface facilities.

The following approach was used for development and selection of a site layout:

A. Identify the design inputs that could impact the design.

B. Identify and rank the key design objectives that have the greatest impact on the site layout.

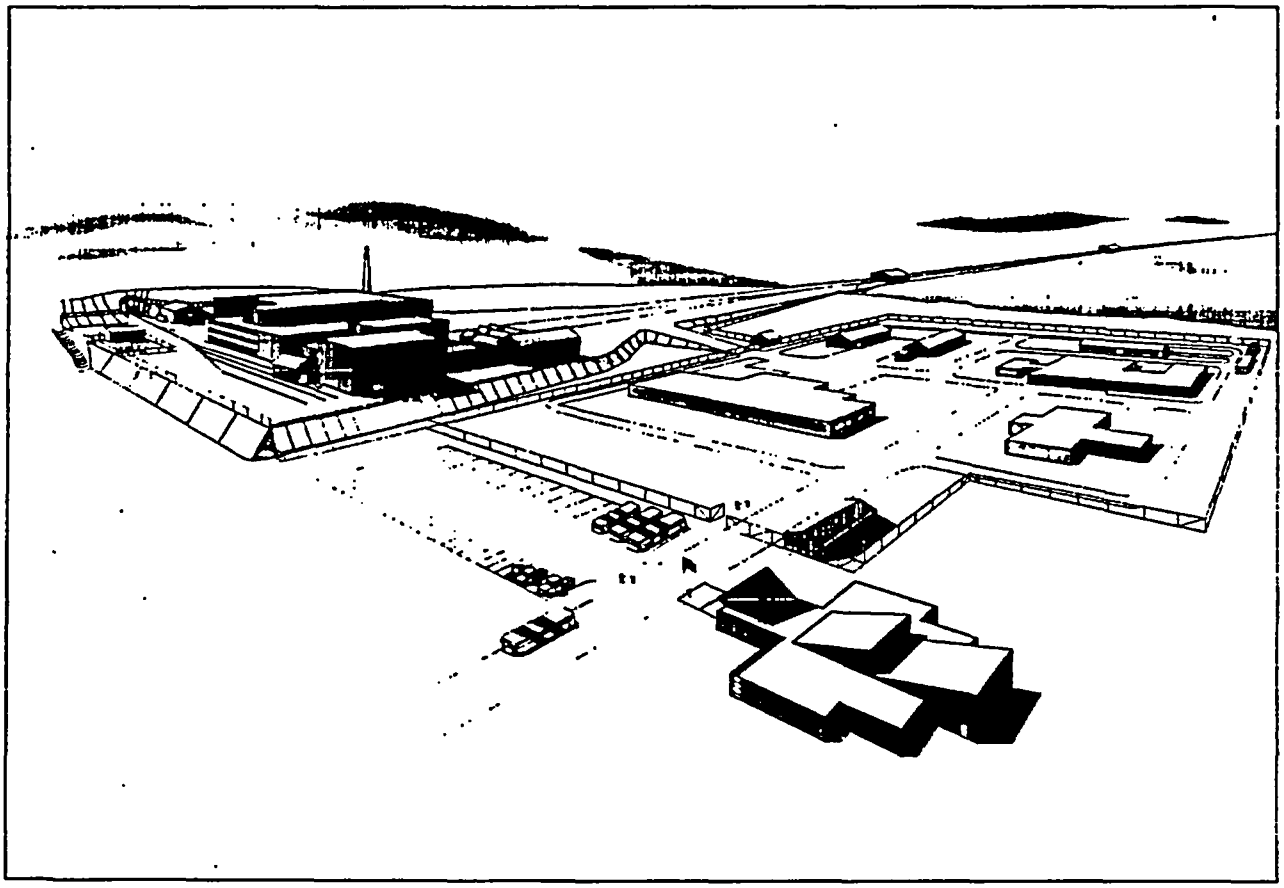

Figure 7.2.1-1 Conceptual Illustration of the North Portal Operations Area

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C. Develop alternate surface facility site arrangements that reflect the design constraints and design objectives.

D. Assess the performance of each alternative against the design objectives and select the best option.

Three main objectives were selected to evaluate the site layout alternatives: maximize preclosure radiological safety, minimize the environmental impact, and minimize repository capital construction and operating cost. Four alternative site layouts for the North Portal repository surface facilities were developed. A decision analysis eliminated one alternative on the basis of the radiological safety objective because in this layout the BOP facilities were located downwind from the radiological facilities, as was done in the SCP-CDR (SNL 1987). Of the remaining three alternatives, a clearly superior site layout could not be selected.

The North Portal surface layout for this volume of the MGDS ACD Report was based on the results of this study. The support facility requirements and interfaces with off-site systems remain essentially unchanged. The size and arrangement of the main nuclear facilities have been revised to reflect the current ACD approach. The current design uses separate structures for the WHB, CMF and WTB, while the interface study was based on using a single integrated structure for these operations. The ACD layout presented in this report reflects these changes.

7.2.1.2 Site Layout

The site plans for the North Portal area are shown in Figures 7.2.1-2 and 7.2.1-3. Figure 7.2.1-2 provides an overview of the site including the relationship of the RCA and BOP area to the off-site utilities, transportation corridors, and natural features such as flood zones and late Quaternary faults. This figure shows the following:

A. The North Portal area is relatively flat (e.g., about 2 percent slope) and is located in Midway Valley between Midway Valley Wash and Exile Hill.

B. Quaternary faults in the North Portal area do not lie under the waste handling facilities. Tertiary faults (not shown on the figure) exist in the area but do not present a seismic hazard.

C. The surface facilities are not currently located in the inundation zone for the probable maximum flood. The flood zone is based on CDA TDS 008 for a regional storm. The *Technical Basis Report for Surface Characteristics, Preclosure Hydrology, and Erosion*, YMP/TBR-0001 (YMP 1995b), which was issued in April 1995, shows a more severe probable maximum flood than indicated by TDS 008, but indicates that the flood would not encroach on the waste handling facilities or the North Portal. Future repository designs will be updated as required to reflect the latest flood information.

D. The North Portal is located in the east side of Exile Hill. This portal is currently used for underground access to the ESF.

E. Rail and truck access to the area will be from the east through Midway valley, south of Alice Hill.

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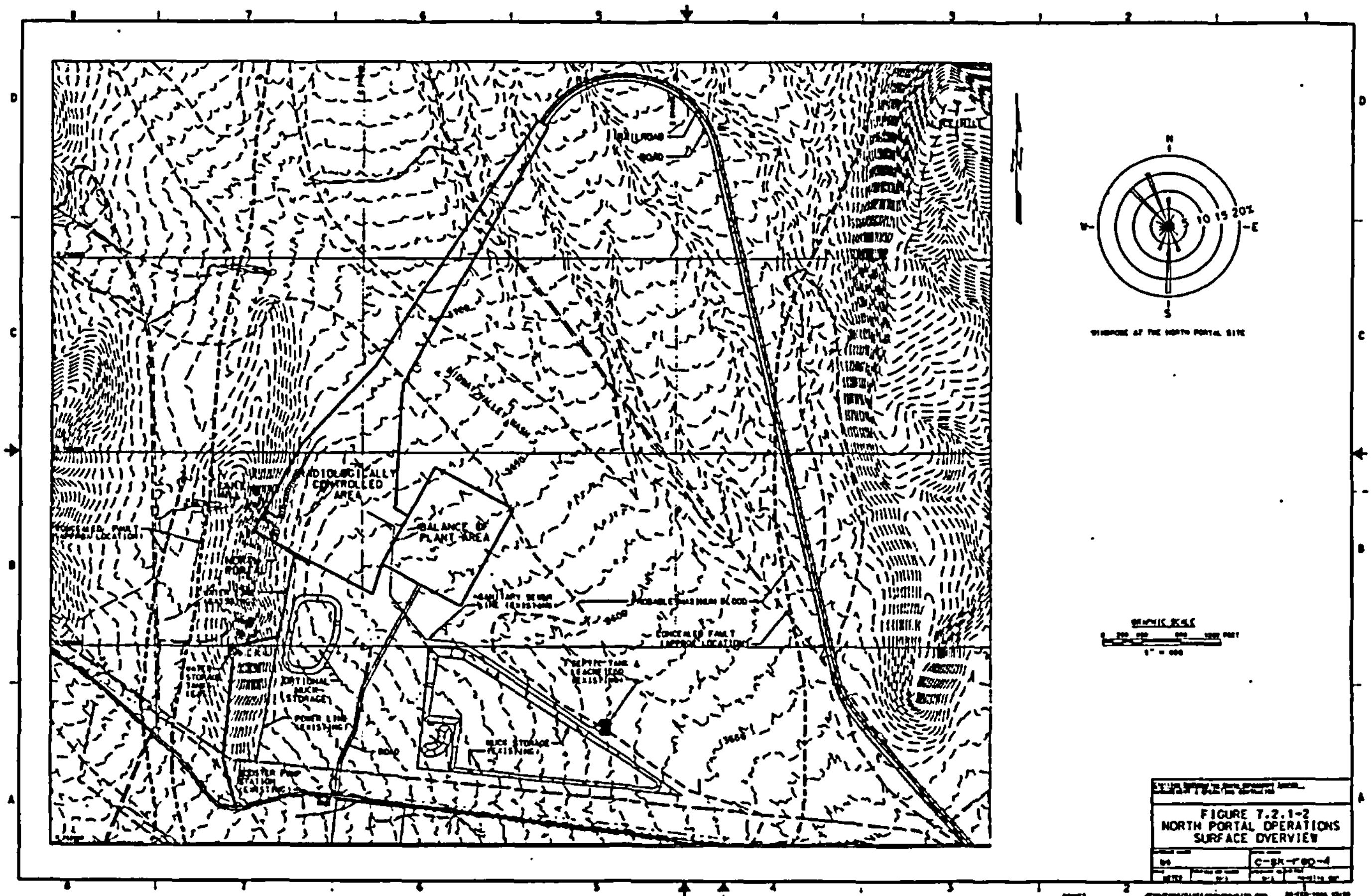

FIGURE 7.2.1-2
NORTH PORTAL OPERATIONS
SURFACE OVERVIEW

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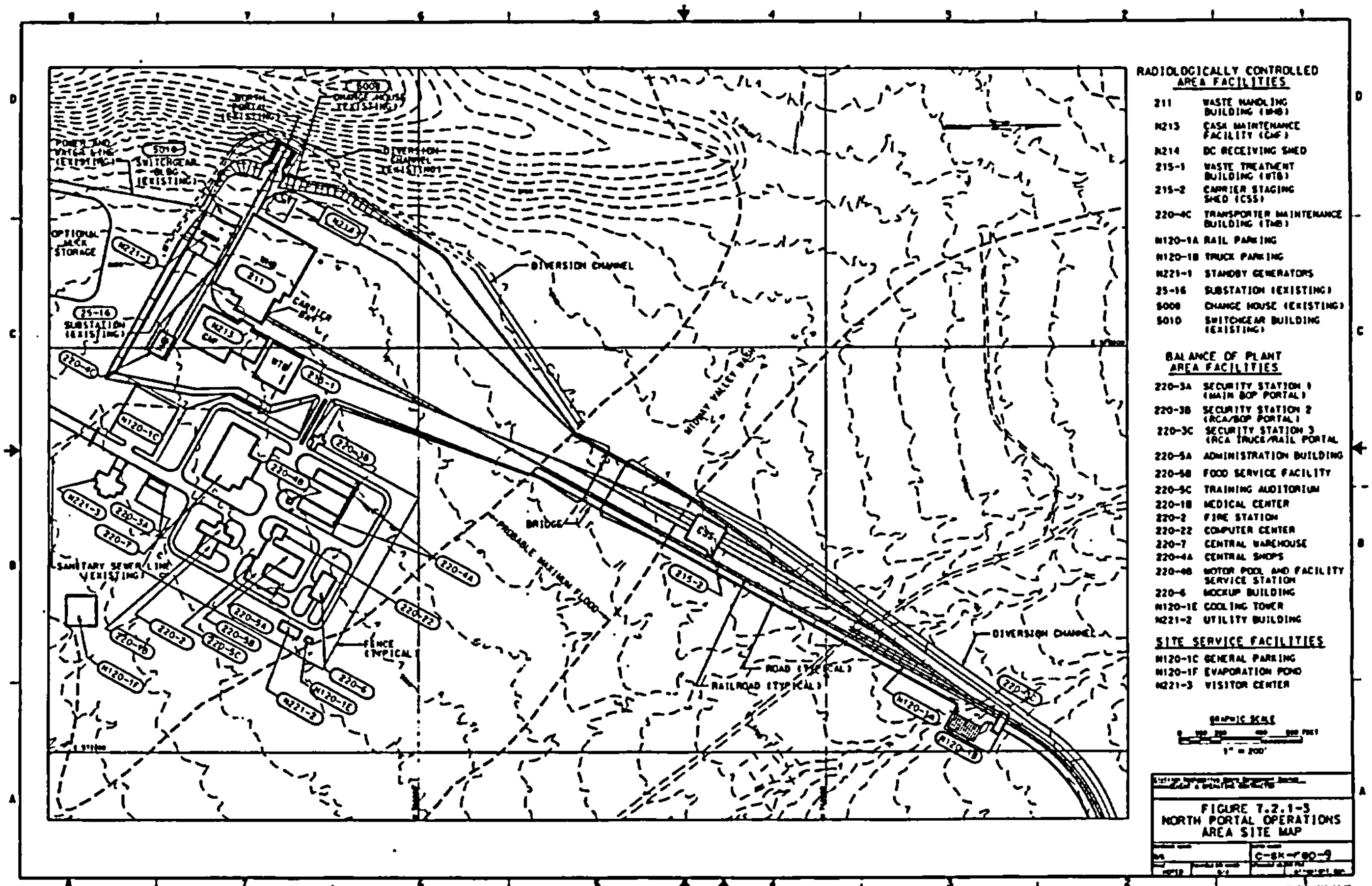

FIGURE 7.2.1-3
NORTH PORTAL OPERATIONS AREA SITE MAP

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F. Power is available to the area from the south via a single existing 69 kV power line with a thermal rating of 20 MVA.

G. Raw well water is supplied to the site via existing NTS Well J-13, which is located about 3.5 miles south east of the North Portal. J-13 is not shown on Figure 7.2.1-2. The water is pumped to a booster pump station a quarter mile south of the portal and then to storage tanks at the top of Exile Hill. The water flows by gravity to North Portal Operations Area potable and non-potable system users.

H. Sanitary liquids are sewered from waste generators at the North Portal Operations Area to a septic tank and leach field treatment system about one-half mile southeast from the BOP area.

Figure 7.2.1-3 identifies the surface facilities by site reference number (e.g., 211 for the WHB). The reference numbers were selected to be consistent with the SCP-CDR (SNL 1987) designations. Where new reference numbers were assigned, an "N" prefix was added. The facilities labeled as existing are expected to be constructed as part of the ESF program and subsequent analyses will demonstrate that the facilities are acceptable for repository use or upgraded as appropriate to repository standards.

The RCA is located adjacent to the North Portal and extends north to enclose Security Station 3 (220-3C). The RCA includes five discrete nuclear facilities: the WHB (211), CMF (N213), WTB (215-1); the TMB (220-4C); and the CSS (215-2). The RCA also includes the parking areas for waste transportation trucks and railcars. The RCA is secured by fencing. The distances between the WHB, CSS, and Security Station 3 are dictated by the spacing required for the rail line branches or "frogs," and the desire to keep the CSS out of the probable maximum flood zone.

The WHB is located just east of the existing Change House, placing the WHB as close as possible to the portal while preserving the Change House. The CMF and WTB were located adjacent to the WHB to facilitate the movement of personnel and materials between these related facilities. The TMB is located to be accessible to the waste transporter rail lines.

The BOP area is located to the east of the RCA. This BOP location was selected to promote radiological safety by considering the prevailing wind directions. The facilities within the BOP house the non-nuclear operations needed to support waste operations and site personnel. The BOP facilities layout is the same as in the SCP-CDR (SNL 1987). The Central Shops (220-4A) and the Central Warehouse (220-7) are located between the RCA area and the other BOP facilities for support of both areas.

Facilities are provided outside the BOP area and RCA for parking, water supply, electrical equipment, sewer systems, access roads and rail lines.

7.2.1.3 Site Operations Descriptions

Major material and personnel movements within the North Portal Operations Area are described below. Movements within the RCA are illustrated on Figure 7.2.1-4. The numbers in parentheses after the facility names are the site map references, which can be identified on Figure 7.2.1-3.

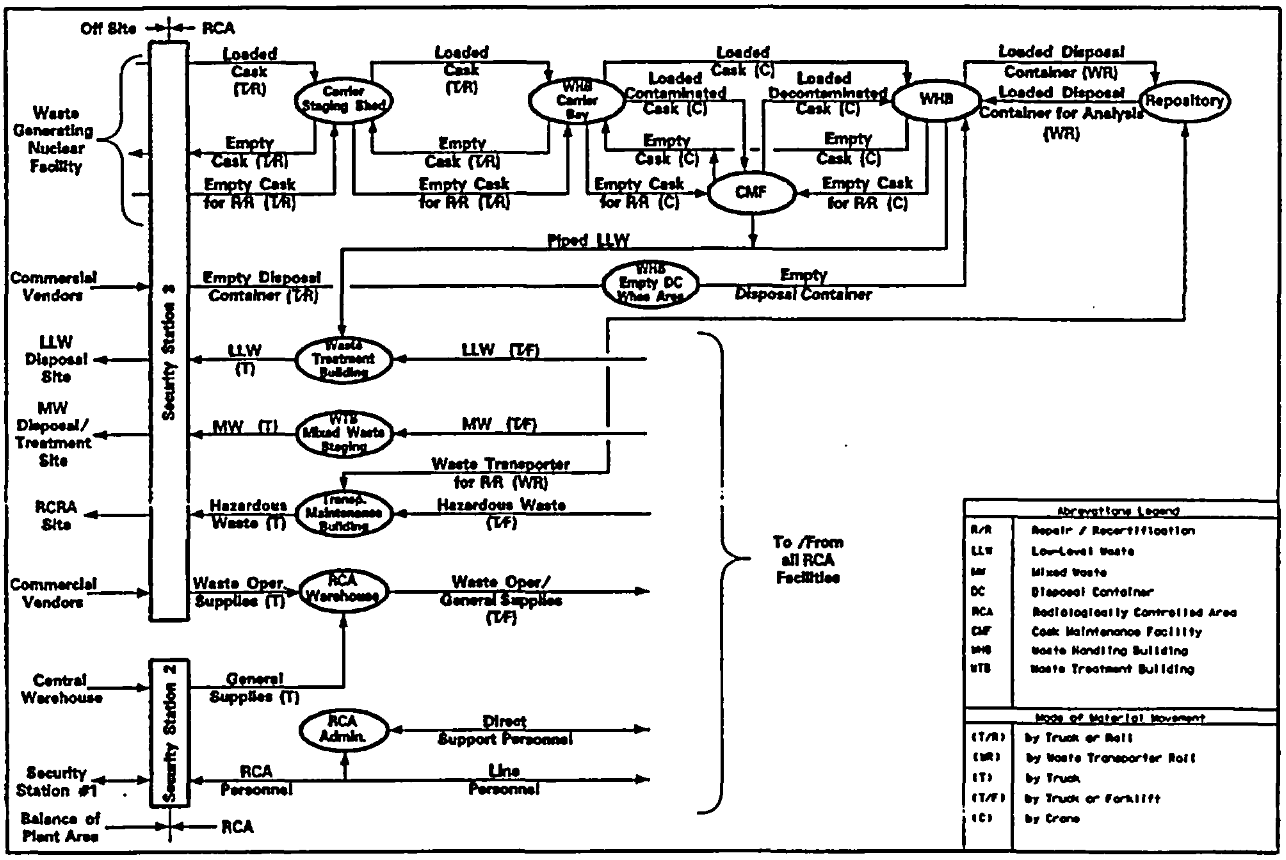

Figure 7.2.1-4 North Portal Operations - RCA Operations Flow

SNF and DHLW Materials and Cask Handling Operations

A waste or cask shipment is delivered by off-site prime mover (i.e., diesel locomotive or truck tractor) through Security Station 3 (220-3C) to one of the parking areas within the RCA (N120-1A or N120-1B). The off-site prime mover then exits as it came in. Materials are inspected for contraband and sabotage as they pass through the security station. Upon receipt at the parking area, the cask and carrier are inspected for radiological surface contamination. A cask carrier is moved from the RCA parking areas, using a site prime mover, to the CSS (215-2), where the personnel barriers and impact limiters are removed, and the casks are reinspected for radiological contamination. The site prime mover then moves the cask carrier into the air lock in the WHB (211), where the casks are dried, as needed, with hot air. The cask carrier is then moved into the carrier bay in the WHB.

The cask may or may not have passed the radiological inspection in the CSS and it may contain waste for emplacement or it may be empty because it was shipped to the repository for cask maintenance (i.e., repair, reconfiguration, or recertification). The cask will be moved by crane to and from the carrier as follows:

A. If the cask passed the radiological inspection and it contains waste, the cask is moved to the WHB cask prep area where it is transferred to the other WHB areas to remove the waste from the cask. After the DHLW or SNF waste is removed from the cask, the cask is inspected for radiological contamination. If the cask is externally contaminated or if it requires maintenance, the cask is moved from the WHB cask prep area to the CMF area. The decontaminated or maintained cask is then loaded on the cask carrier. If the cask does not require CMF operations, it is returned directly to the cask carrier from the WHB cask prep area.

B. If the cask failed the radiological inspection and it contains waste, the cask is moved into the CMF (N213) to be decontaminated before it is moved to the WHB cask prep area. The cask returns from the WHB cask prep area as described above.

C. If the cask is empty it is moved into the CMF for decontamination or maintenance. The recertified cask is loaded back on the cask carrier.

The loaded cask carrier is transported to the CSS with a site prime mover to reinstall the impact limiters and personnel barrier, then to the RCA parking area. An off-site prime mover moves the cask carrier containing an empty cask through Security Station 3 to return the empty cask to an off-site nuclear waste generating facility.

Within the WHB, DHLW or SNF is removed from a shipping cask, packaged for emplacement, and then transferred to the underground via the North Portal. The waste package transporter uses a rail system for underground emplacement operations.

Waste packages will occasionally be removed from the emplacement area for performance confirmation evaluations. This is expected to occur once every 10 years. The performance confirmation operations take place in the WHB. The waste package transfer to the surface facilities will be with the waste transporter. The unloaded waste package transporters will be periodically moved to the TMB (220-4C) for maintenance or the adjacent rail sidings for storage.

Secondary Waste Operations

Secondary (i.e., site generated) wastes handled at the North Portal Operations Area include LLW, low-level mixed wastes (MW), hazardous wastes (HW), and sanitary wastes. LLW and MW materials are only generated within the RCA. MW, which is radiologically contaminated hazardous waste, is only expected to be generated in very small quantities by off-normal operations. Liquid LLW and sanitary wastes are piped to on-site treatment facilities. All other wastes are moved in containers (e.g., drums, boxes and dumpsters).

Solid LLW, MW, HW, or solid industrial waste materials are accumulated in containers at the point of generation and transferred with trucks or forklifts as described below.

A. Drums of solid LLW are transferred to the WTB (215-1) where the material is treated and packaged for disposal. The packaged LLW is then transferred from the RCA through Security Station 3 for off-site disposal.

B. Drums of untreated MW, which are packaged for shipment at the point of generation, are transferred to the WTB for accumulation. The drums are then transferred from the RCA through Security Station 3 for off-site treatment and disposal.

C. Drums of untreated HW, which are packaged for shipment at the point of generation, are transferred to one of two accumulation sheds. One shed is located adjacent to the TMB (220-4C) for HW generated within the RCA. The other shed, which is located near the motor pool (220-4B), accumulates HW generated outside the RCA. Hazardous waste is shipped off-site for treatment, recycling, and disposal.

D. Sanitary solid waste is accumulated in dumpsters throughout the site. Garbage trucks periodically collect and transfer the garbage to an off-site landfill.

Liquid LLW from decontamination operations in the WHB and CMF is piped to waste treatment equipment in the WTB. Treated liquids are piped to the waste generators for reuse. Non-recyclable waste is concentrated, solidified, packaged, and shipped off-site with the other drums of solid LLW.

Sanitary liquids are routed via sewer lines to the sanitary waste treatment system.

Other Material Movements

General supplies are brought by truck into the BOP area through Security Station 1 (220-3A) and stored in the Central Warehouse (220-7). These materials are transferred by truck as needed to other repository facilities or to smaller warehouse areas within the nuclear facilities, through Security Station 2 (220-3B).

Equipment and materials that are only used in the RCA (e.g., new disposal containers or replacement valves for casks) will be delivered by truck directly to equipment storage areas within the nuclear facilities, through Security Station 3.

Empty disposal containers and emplacement railcars are staged at the Disposal Container (DC) Receiving Shed (N214). A specifically configured carrier, hauled by the site prime mover, is used to transfer disposal container/emplacement railcar units from the staging area to the WHB.

Utility Operations

The North Portal operations require the following centralized utility supply systems:

- Potable water and well water
- Cooling tower water
- Chilled water
- Normal and standby electric power
- Diesel fuel
- Industrial air.

The utilities are routed to (and from) users throughout the area in above- and below-ground pipes and cables.

Water is provided from underground wells, storage tanks, and booster pumps to the storage tanks at the top of Exile Hill. The water then flows by gravity to area users.

The cooling water is provided by the Cooling Tower (N120-1E). Chilled water and air are provided from equipment in the Utility Building (N221-2).

Electric power comes to the area from an above-ground power line to the electrical switchgear/standby generators. Users at the North Portal and emplacement shaft operations areas receive 12.5 and 4.2 kV power via underground cable.

Diesel fuel is delivered by truck to a storage tank near the standby generators (N221-1), and diesel fuel and gasoline are delivered by truck to storage tanks near the motor pool (220-4B).

Personnel Movement

Site personnel will arrive at the North Portal Operations Area in buses or personal vehicles, which will be parked outside the BOP area. Personnel will walk to their work place from the parking area through Security Station 1. Personnel working in the RCA will pass through Security Station 2.

7.2.1.4 Facilities

The North Portal surface facilities are listed in Table 7.2.1-1, which includes a site map reference, facility name, and a list of the primary functional areas. These facilities are identified by the site reference on Figure 7.2.1-3. Facilities with a site map reference of "Site" are identified on the overview site map, Figure 7.2.1-2.

Detailed descriptions of the WHB, CMF, WTB, CSS, and TMB are provided in Sections 7.2.2 through 7.2.6 respectively. These structures, which house the primary waste handling operations and transporter maintenance, were redesigned during the ACD effort. The design descriptions typically include the following:

A. An introduction including mission, design background, design methodology, and design status.

B. A description of the design inputs including specific requirements assumptions and design data that were not included in Sections 3, 4 and 7.1.2.

C. A summary of significant studies impacting the facility design.

D. A description of the structure, including key architectural features.

E. A description of the major systems including functions, system scope, and operations description.

F. A list of the major components.

G. Operations data including utility consumption, chemical consumption, waste generation, and staffing.

Brief descriptions of the support structures at the North Portal are provided in Section 7.2.7. These structures are primarily as designed in the SCP-CDR (SNL 1987). Descriptions of the site support systems are provided in Section 7.2.8.

Table 7.2.1-1 North Portal Surface Facilities

Site Map Ref.	Facility Name	Primary Functional Areas
Radiologically Controlled Area		
211	WHB	Carrier bay, airlock, cask preparation area, consolidation cell, cask port room, waste transfer cell, disposal container welding, performance confirmation cell, operating gallery, remote maintenance cell and disposal container staging
N213	CMF	Preparation/decontamination areas; basket storage pool; cask reconfiguration pool; testing, inspection maintenance & repair stations; contaminated shops; laydown area, warehouse and storage areas
N214	Disposal Container Receiving Shed	Staging open for emplacement railcars and empty disposal containers.
215-1	Waste Treatment Building (WTB)	Liquid radioactive waste treatment area, waste solidification area, solid radioactive waste treatment area and loading and unloading area, mixed waste accumulation
215-2	Carrier Staging Shed (CSS)	Staging/cask inspection area (i.e.,impact limiter removal/installation and radiological inspection)
220-4C	Transporter Maintenance Building (TMB)	Transporter storage, parts storage, minor maintenance service bays, wash/decon area, HW staging
N-221-1	Standby Generators	Diesel generators, underground fuel tank
5008	Change House (existing)	Locker rooms, showers, restrooms, first aid, safety/fire control, garage (repository use has not been established)
5010	Switchgear Building with Transformer (existing)	Electrical switchgear, integrated data control systems control room, external transformer
25-16	Substation (existing)	Electrical transformer, switchgear
N120-1A	Rail Parking	Waste transportation railcar parking (12 railcars)
N120-1B	Truck Parking	Waste transportation truck trailer parking (10 trailers)

Table 7.2.1-1 North Portal Surface Facilities (continued)

Site Map Ref.	Facility Name	Primary Functional Areas
Balance of Plant Area		
N120-1E	Cooling Tower	Cooling tower cells, pump basin
220-3A	Security Station 1 (Main BOP portal)	Waiting room, badge distribution, communications center, records storage, security administration
220-3B	Security Station 2 (RCA/BOP portal)	Security check station, health physics offices
220-3C	Security Station 3 (RCA truck/rail portal)	Storage for contamination inspection equipment, security check station, health physics offices, records storage, off-site prime mover communications center.
220-5A	Administration Building	Offices, laboratories, training rooms, off-site transportation control facilities
220-5B	Food Service Facility	Kitchen, lunchroom, serving area, food/supplies storage
220-5C	Training Auditorium	Auditorium, audio/visual control room.
220-1B	Medical Center	Examination rooms, X-ray, medical labs, waiting room, ambulance garage
220-2	Fire Station	Apparatus room, communications room, equipment storage, firemen's quarters, fire truck garage
220-22	Computer Center	Computer room
220-7	Central Warehouse	Storage space, receiving and shipping dock
220-4A	Central Shops	Craft shops (electrical, mechanical, plumbing, welding, automotive, machining), central covered work area (not included in floor area)
220-4B	Motor Pool and Facility Service Station	Dispatch office, carwash, fuel storage, light maintenance, parking (heavy maintenance is off-site)
220-6	Mockup Building	High-bay mockup room, classrooms
N221-2	Utility Building	Water chillers, cooling tower water make-up treatment, plant and instrument air compression

Table 7.2.1-1 North Portal Surface Facilities (continued)

Site Map Ref.	Facility Name	Primary Functional Areas
Site Service Area		
N120-1C	General Parking	Car parking lots, bus loading areas, bus parking lot
N120-1F	Evaporation Pond	Lined pond, collection piping
N221-3	Visitors Center	Theater, meeting/conference rooms, reception/display area, food service, offices, restrooms
Site	Water Supply (2 locations)	(not shown) Booster pump station, water storage tanks, waterlines
Site	Sanitary Waste Water Treating	Septic tank, leach field, sewer line
Site	Muck Storage (2 locations)	Storage pile for rock removed from the North Portal during the underground excavation

7.2.2 Waste Handling Building

7.2.2.1 Introduction

7.2.2.1.1 Mission

The mission of the WHB is to unload SNF or DHLW from truck or rail shipping casks and package the waste for emplacement in welded disposal containers. The primary WHB functions required to accomplish this mission are as follows:

A. Receiving shipping casks, preparing the casks for unloading, unloading the casks, and preparing the casks for dispatch from the repository.

B. Transferring waste forms from the shipping casks to disposal containers.

C. Sealing, cleaning, and transferring loaded disposal containers to the subsurface equipment for emplacement in the MGDS.

D. Opening selected SFA canisters prior to disposal container packaging, and filling the voids with filler material as necessary.

E. Supporting performance confirmation by periodically evaluating disposal containers retrieved from the underground emplacement area, removing samples for laboratory analysis, if appropriate, and taking evaluation measurements.

The primary waste forms to be emplaced in the MGDS and hence handled in the WHB are:

- Bare SFAs
- SFAs packaged in disposable SFA canisters
- Vitrified DHLW packaged in canisters.

7.2.2.1.2 Background

1987 Effort

The first conceptual design of a WHB for a repository at Yucca Mountain was produced in 1987 as part of the SCP-CDR (SNL 1987). This effort suggested two WHBs to be commissioned into service in two stages: the first design was for a small WHB to be commissioned in time to meet the 1998 waste receipt schedule imposed by the *Nuclear Waste Policy Act*. The second design, which was for a much larger WHB than the first, was to be commissioned later to complete emplacement in twenty-five years. WHB-1 was to be started with the handling and packaging of bare SFAs, but two years after the commissioning of WHB-2, WHB-1 was to be relegated to the handling and packaging of canisters of DHLW only while WHB-2 was to take over the handling and packaging of bare SFAs.

Programmatic Changes and Impact

Since the 1987 WHB conceptual design effort, programmatic changes have altered the waste receipt scenarios and also the waste forms. The changes in the waste receipt scenarios and the waste forms has an impact on the design of the WHB. The major changes in the waste scenarios and their impact are described below.

Waste Forms – The waste forms for the 1987 WHBs were conceptualized as bare SFAs and DHLW canisters. Today, however, the waste forms are bare SFAs, disposable SFA canisters, and DHLW canisters. The difference in waste forms handled between 1987 and today is shown in Figure 7.2.2-1. The additional waste form to be handled today, the SFA canister, has an impact on the design of the WHB. Each SFA canister contains a number of bare SFAs; for example, the large SFA canister carries 21 PWR SFAs or 40 BWR SFAs. Transferring 40 bare SFAs from a shipping cask to a disposal container takes a minimum of 40 transfers, transferring 40 SFAs packed in a SFA canister takes only one transfer assuming that in both cases there are no transfers to and from an intervening lag storage. The difference in transfers between 1987 and today is shown in Figure 7.2.2-2.

One transfer takes significantly less time than forty transfers. Other operations supporting the transfer also take less time. For example, the 1987 operations inspected every SFA pulled from a shipping cask. Figure 7.2.2-2 shows that the 1987 WHBs transferred 215,900 SFAs. Even if the optimistic inspection time of five minutes is assumed per SFA, then the 1987 WHBs would have inspected SFAs for a total of 750 days--a little over two years--of the emplacement period, assuming, for simplicity, that the inspections are carried out twenty-four hours a day. Today, as shown in Figure 7.2.2-2, the nuclear fuel waste forms to be handled are 21,616 disposable canisters (SFA and DHLW) plus 3,726 bare SFAs. Every SFA canister does not need inspection, but even if it is assumed that every SFA canister is inspected along with every bare SFA, and that the inspection time is again five minutes per waste form, then the total inspection time today is only 44 days.

The significance of the difference in operational durations is obvious, and the difference has an impact on the size of the WHB: shorter operational durations tend to reduce the size of the WHB. A transfer cell, for example, can now be smaller. Whereas two cell cranes were once necessary for transferring waste forms from shipping casks to disposal containers to keep cask turn around time within reason, now only one cell crane suffices without straining the crane's utilization.

Mode of Transportation – The 1987 WHBs were mainly designed to receive and handle truck shipping casks. Today, however, the waste shipping scenario is mostly comprised of rail shipping casks. The difference in the modes of transportation between 1987 and today is shown in Figure 7.2.2-3. The difference in the mode of transportation has an impact on the size and design of the WHB. Although the 1987 WHBs were to handle a small quantity of rail shipping casks, the rail casks for which the WHBs were sized in 1987 were significantly smaller than the rail shipping casks being conceptualized today. Today, rail shipping casks have a significantly higher capacity than truck shipping casks: for example, a GA-4 truck cask carries 4 PWR SFAs while a large SFA canister shipping cask, which is a rail cask, carries 21 PWR SFAs packed inside the SFA canister. The significantly larger rail shipping casks have an impact on the size of the spaces in the WHB

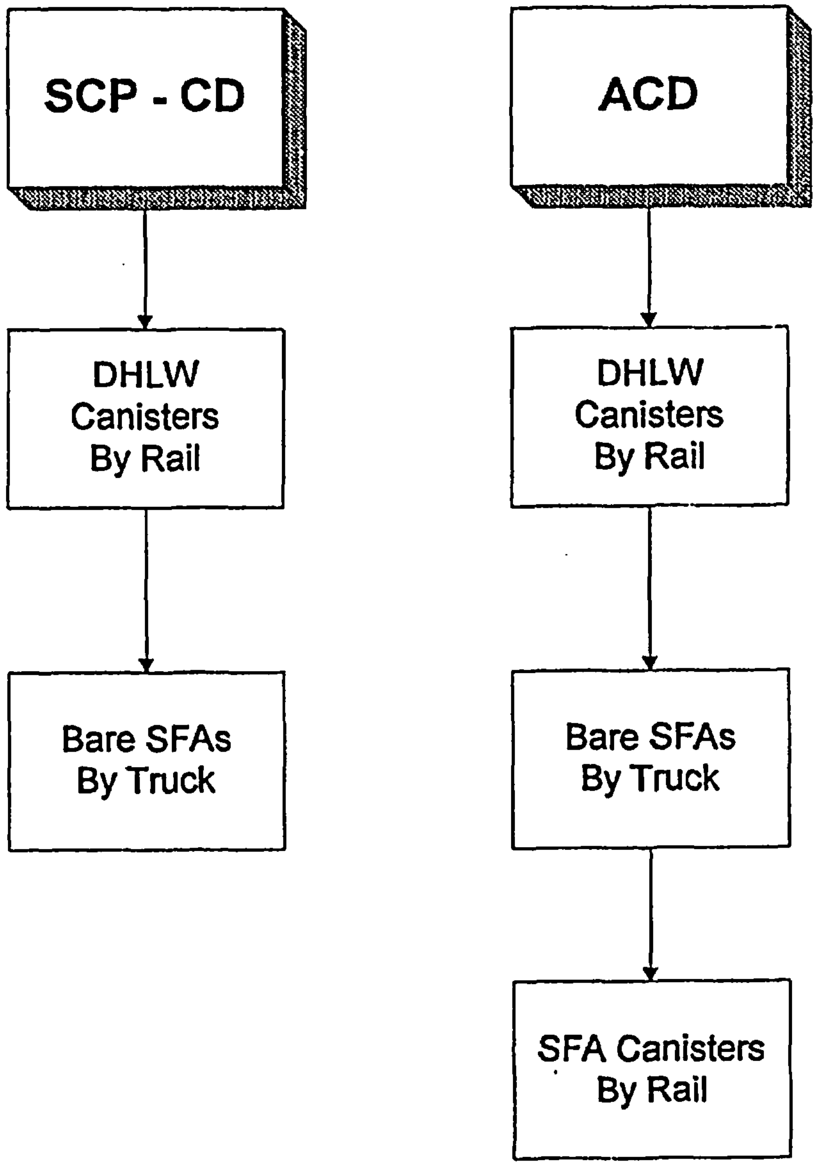

Figure 7.2.2-1 Waste Form Types: SCP-CD and ACD

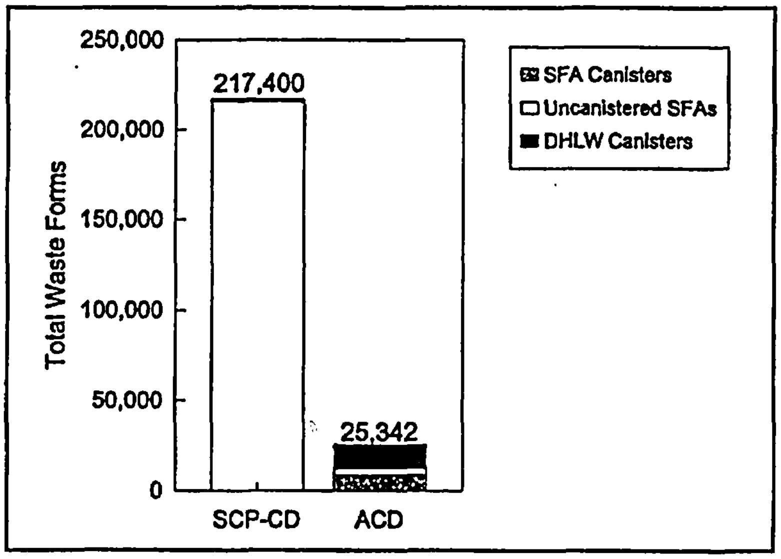

Figure 7.2.2-2 Waste Forms: SCP-CD and ACD

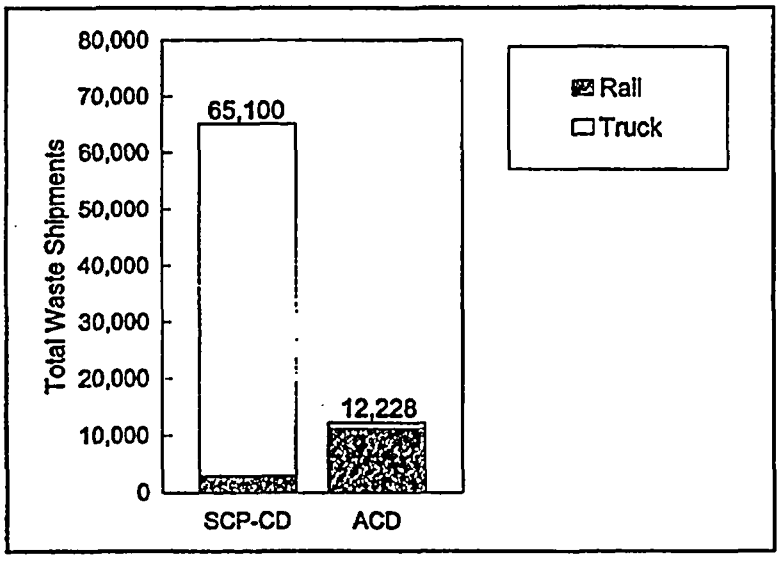

Figure 7.2.2-3 Mode of Transportation: SCP-CD and ACD

where the rail shipping casks are handled. Rail shipping casks are also heavier than truck shipping casks, which has an impact on the capacity of the equipment required to handle shipping casks.

Larger shipping casks also mean fewer shipments because each rail cask brings more waste to the repository per shipment than does a truck cask. The changes in the shipping schedule between 1987 and the present is shown in Figure 7.2.2-4. Fewer shipments tend to reduce the size of the WHB. For example, whereas eight loaded cask preparation stations were once necessary, today four suffice.

Consolidation– The 1987 WHBs were conceptualized to consolidate fuel rods removed from SFAs. The fuel rod consolidation operations were done in a complex consolidation hot cell. WHB-2 of the 1987 conceptual effort provided two consolidation hot cells. The consolidation operations in each cell proceeded as follows:

- Cut the fuel rods from SFAs
- Package the fuel rods in a separate disposal container
- Compact the frame and end fittings of the SFAs
- Package the compacted frame and end fittings in a separate disposal container.

The current program assumption is that there will be no fuel rod consolidation. This direction eliminates the complex consolidation hot cell and the consolidation operations, thus significantly altering the 1987 WHB concept.

Disposal Container – The size, capacity, and weight of the disposal container (i.e., waste package container) has increased significantly since 1987. Table 7.2.2-1 compares between the major changes since the SCP-CDR (SNL 1987) in 1987. The table shows a comparison between the largest disposal containers of the SCP-CDR (SNL 1987), and those of today. The largest container in the SCP-CDR (SNL 1987) was the "3/4 hybrid" container suggested for packaging intact SFAs: that is, SFAs that were not consolidated. The largest disposal container of today is the one designed for the large SFA canister (*QAP-3-12 Design Input Data Transmittal* [CRWMS M&O 1994f]).

Table 7.2.2-1 Disposal Container: 1987 and Present

Parameter	1987	Present
Diameter	2'-4"	6'-11"
Height	15'-7-½"	18'-8"
Wall thickness	⅜"	4.8"
Number of PWR SFAs	3	21 in canister
Number of BWR SFAs	9	40 in canister
Closure welding time	2.75 hours	76 hours
Total loaded weight (PWR)	6,400 (lbs)	145,000 (lbs)

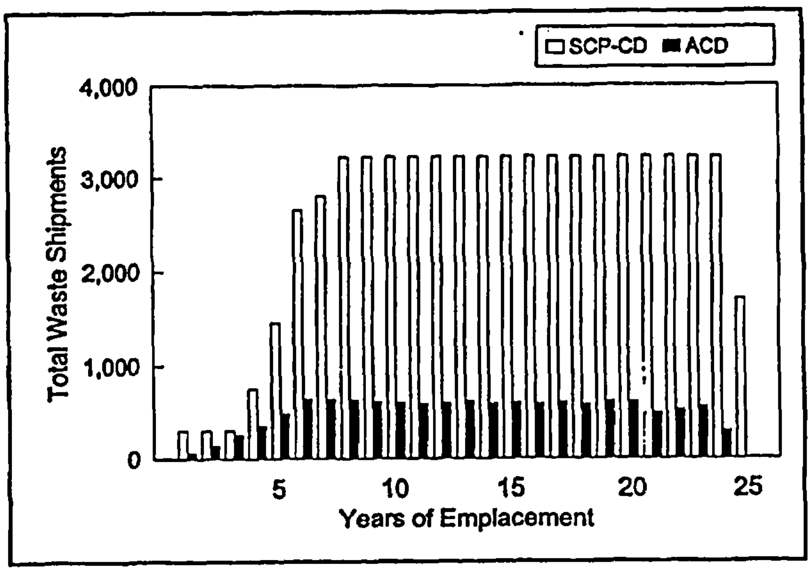

Figure 7.2.2-4 Number of Shipments: SCP-CD and ACD

Table 7.2.2-1 shows that the present disposal container is substantially bigger and heavier and takes significantly longer to prepare for transfer to the subsurface than the 1987 concept. The changes in the design of the disposal container impacts the size and design of the WHB. The areas where the disposal container is handled are now significantly bigger: for example, whereas two welding stations were enough in the 1987 SCP-CDR (SNL 1987), today fifteen welding stations are necessary to maintain the flow of waste forms from receipt of shipping casks to emplacement in the MGDS without accumulating an inventory of casks at the site or waste forms in the WHB. The welding process itself has changed from friction welding to narrow gap gas metal arc welding. The equipment used to handle the disposal container has also suffered an increase in size and capacity: whereas a 10-ton bridge crane sufficed to lift a loaded disposal container in the 1987 SCP-CDR (SNL 1987), today the bridge crane capacity is 125 tons.

Waste Receipt Schedule – The primary reason for suggesting two WHBs in 1987 was to meet the 1998 schedule imposed by the *Nuclear Waste Policy Act* for starting waste receipt. Today, the program's waste shipping schedules start waste shipments in 2010. This change impacts the WHB in that the time gained negates the need for two WHBs. Today, one WHB is proposed.

Conclusion of Impacts – The programmatic changes since 1987 and their impact on the design and operations of the WHB necessitate a reconsideration of the WHB conceptual design. This report describes the conceptual design of the WHB resulting from the impact of the programmatic changes on the mechanical handling and HVAC aspects.

7.2.2.1.3 Design Methodology

The design methodology that has been followed for advanced conceptual design of the WHB is as follows:

A. Identify the design inputs applicable to the WHB design; including requirements, assumptions, and design data from other groups (for example, types of waste forms and shipping casks, and the rate at which they are to be handled).

B. Develop system block flow diagrams that support key functions.

C. Simulate the operation of the WHB to determine the number of operating trains and the capacity of in-process staging areas.

D. Determine the major pieces of equipment, or resources, that are necessary to perform the above operations – this includes developing alternatives and conducting trade studies to select a concept.

E. Develop a preliminary layout of the WHB.

F. Develop the HVAC design including flow diagrams and mechanical equipment room sizes.

G. Revise the WHB design to reflect material throughput simulation results and HVAC design input.

H. Finalize the WHB ACD documentation including:

- Design inputs
- General arrangement sketches
- Waste handling and HVAC system descriptions
- Annotated major component lists
- Estimates of WHB utilities consumption, chemical consumption, waste generation, and staffing.

7.2.2.1.4 Design Status

An advanced conceptual design of the WHB has been developed including the waste handling systems and the HVAC system. The ACD design documentation includes the following:

A. Identification of design inputs including requirements, assumptions, and data.

B. Design analyses for selecting waste handling designs.

C. Description of the facility and major design features.

D. General arrangement sketches for the WHB including plans, sections, and elevations.

E. Descriptions of the waste handling systems including block flow sketches, mechanical flow diagrams, and operations descriptions.

F. Description of the HVAC system including HVAC flow sketches and a narrative description.

G. A major component list including descriptions, capacities, and Construction Specifications Institute specification references.

H. WHB operating data including utilities consumption, resource consumption, waste generation, and staffing.

The above scope of work is limited to the mechanical handling and HVAC considerations for waste emplacement operations on shipping casks, waste forms, and disposal containers. Other conceptual design considerations for the WHB (e.g., electrical, fire protection) are planned future activities and are only briefly described in this report.

Note that this design is based on the design basis assumptions described in Section 7.2.2.2.2. Significant assumptions, or strategies, that could have the greatest impact on the WHB design are discussed in Section 12, Development Tasks and Issues.

7.2.2.2 Design Inputs

7.2.2.2 WHB Design Inputs

This section provides the design input bases for the development of waste handling operations and conceptual designs.

7.2.2.2.1 Design Requirements

Design requirements are categorized as either functional requirements or regulatory requirements and are extensions of the surface inputs defined in sections 3, 4 and 7.1.2.1.

Functional Requirements

The basic functions of Waste Handling, as defined in the RDRD (YMP 1994a), Table 3-1, and expanded in the CDA Document (CRWMS M&O 1995a), Section 4, are as follows:

1.4.3.2 Handle Waste
1.4.3.2.1 Receive & Inspect Loaded Transportation Cask
1.4.3.2.2 Unload Waste from Transportation Cask
1.4.3.2.3 Receive & Prepare New Disposal Container
1.4.3.2.4 Assemble Waste Package
1.4.3.2.5 Prepare Waste Package for Underground Transport
1.4.3.2.6 Emplace Waste Package (Subsurface Function Only)
1.4.3.2.7 Retrieve Waste Package (Optional Function)
1.4.3.2.8 Perform Post-Retrieval Waste Processing (Future Potential Function)
1.4.3.2.9 Prepare Unloaded Transportation Cask for Shipment/Transfer

The RDRD (YMP 1994a) also includes certain Waste Handling functional requirements needing further derivation and more definition:

Waste Handling Operations

RDRD 3.7.4.1:

The waste handling facilities will be properly designed to safely receive, stage, package, emplace, and retrieve HLW and SNF waste materials.

RDRD 3.7.4.1B:

The repository shall be capable of receiving shipments of spent fuel and commercial and HLW delivery by truck or rail.

Surface Waste Storage

RDRD 3.7.4.1.A.1:

Surface facilities in the Geologic Repository Operations Area shall be designed to allow safe handling and lag storage (if needed) of wastes at the Geologic Repository Operations Area, whether these wastes are temporarily on the surface before emplacement or as a result of retrieval from the underground facility.

RDRD 3.7.4.1.A.2:

Waste handling facilities shall provide a temporary storage capacity equivalent to [TBD] waste receipts.

RDRD 3.7.4.1.A.3:

Storage facilities shall have the capability to store the waste as received from off site as well as the prepared waste packages on site.

Operations Reversed for Retrieval

RDRD 3.7.4.1.A.4:

The facilities and equipment used for waste handling operations shall be designed so that waste handling operations can be performed in reverse order to permit retrieval of emplaced waste packages.

Decontamination Requirements

RDRD 3.7.4.1.A.8:

Waste handling facilities shall provide a contamination free waste package exterior surface prior to release to the underground.

Regulatory Requirements

The general regulations, codes, and standards applicable to the design of the WHB and other repository surface facilities are defined in Sections 3.2 through 3.7 of the RDRD (YMP 1994a). These requirements are summarized in Section 7.1.2.1 of this report.

7.2.2.2.2 Assumptions

This section lists the assumptions applicable to the design of the support facilities. Assumptions generally applicable to surface facilities are listed in Section 7.1.2.2. There are two types of design assumptions: CDAs and non-controlled design assumptions.

Controlled Design Assumptions

CDAs specific to the WHB are listed in Table 7.2.2-2.

Table 7.2.2-2. Controlled Design Assumptions

Identifier	Subject	Statement of Assumption
Key 008	No Rod Consolidation	Rod consolidation will not be performed at the MGDS.
Key 052	Addition of Filler Material at the Repository	Table 4-6 provides a scenario for receipt of First Procurement SFA canisters that may have to be opened each year at the repository for the insertion of reactivity control additives. The table may be used to provide an upper bound for abnormal SFA canisters requiring remedial operations at the repository.
Key 053	Off-Normal WHB Capability	The MGDS shall have the capability to handle any abnormal MPCs (SFA canisters) and other canistered waste forms that require remedial processing. Such processing may include opening the canister, transferring the waste form, adding filler material and resealing.
Key 054	Normal WHB Capability	The design for the WHB's SFA canister standard handling operations is based on no capability to add filler material to SFA canisters at the repository. The addition of filler material to first procurement SFA canisters will be performed as an off-normal operation per Key Assumption 053.

Non-Controlled Design Assumptions

This section describes the non-controlled design assumptions used as bases for the engineering analysis of waste handling operations.

Waste Forms Assumptions

A. A failed SFA arrives at the repository overpacked in a canister of the type in use at present at utilities. The canister fits in the same shipping cask and cask basket as standard bare SFAs. Further, the canister has an end fitting welded at the top which is the same as the upper end fitting of the SFA inside the canister, which means that the same grapple as required to lift the SFA may be used to lift the canister. *Rationale:* The use of a canister that fits into existing casks and baskets and has the same end fitting welded on top as that of the SFA inside the canister is a standard practice at most utilities.

B. SFA canisters may arrive at the repository with removable contamination on their exterior. *Rationale:* First, utilities load SFA canisters in fuel storage pools, and fuel storage pools are contaminated. Second, if precautions are taken during loading to prevent the pool water from coming in contact with the canister exterior, then the results of such precautions are not yet known. For example, some utilities are already storing canisters similar to the SFA canister in dry storage, and it is believed that such precautions were taken during canister loading in the fuel storage pool. The longest that a utility has stored canisters in dry storage is approaching five years at Carolina Power and Light, H.B. Robinson plant. The dry storage at Carolina Power and Light, as at other utilities that are storing canisters dry, is not designed for inspection of the canister exterior for contamination. As a result, no data exists at Carolina Power and Light, or at any other utility, on the condition of the exterior of the canisters that the utility has had in dry storage for a long period. Third, the history of cask shipments shows that over repeated shipments, casks accumulate contamination inside them. Cask interiors are cleaned during routine maintenance after a prescribed number of shipments, but history shows that the interior of casks do not get completely cleaned. Some contamination always remains in the cask. Contamination inside the cask is bound to be picked up by a SFA canister riding inside the cask. Therefore, it is prudent to assume at this time that SFA canisters coming to the repository, whether coming straight from a fuel storage pool or out of dry storage at the utilities, may arrive at the repository with removable contamination on their exterior.

C. A SFA canister may or may not be loaded evenly with SFAs, which means that a SFA canister may skew slightly from the vertical when lifted. *Rationale:* This assumption is in anticipation of any constraints, such as those stemming from thermal considerations, that may be imposed on the loading of SFA canisters in the future.

D. SFA canisters and the canisters of DHLW stand upright unassisted and steady when placed on a flat concrete floor. *Rationale:* The canisters are wide enough in cross-section to effect this assumption.

E. Each canister of DHLW has an external pintle for vertical lifting. *Rationale:* Most high level waste canisters are designed with an external pintle on top for vertical lifting. It is assumed that this feature exists on all canisters of DHLW that are destined for the repository.

F. Waste forms are inserted into shipping casks freely under gravity and arrive at the repository in good enough shape to be retrieved freely under gravity from a shipping cask and inserted freely under gravity into disposal containers. *Rationale:* The handling of waste forms forced into the shipping casks at the point of origin or damaged in route to the repository to the point that the waste forms cannot be freely pulled out of the shipping casks under gravity is an off-normal situation, and off-normal situations such as these do not fall within the routine operations that are considered for sizing the WHB. For bare SFAs, an SFA that is damaged or deformed such that it cannot be loaded into the shipping cask basket within the fuel pool environment using only gravity is considered a damaged or failed SFA (*Waste Acceptance Support Deliverable 4A: Draft Waste Acceptance Criteria and DOE Position Recommendation for Failed Fuel* [CRWMS M&O 1992b]).

Assumptions on Waste Package Development Interface

Disposal Container Assumptions

A. Each of the two lids of the disposal container has an internal lifting pintle. *Rationale*: A mechanical device is required to lift non-ferrous lids and pintle is a standard industrial approach.

B. The welder outer shell is assumed to have features for a redundant three-point vertical lift. *Rationale:* The features for a redundant lift are a standard hot cell practice, and considering the large size of the welder shell, the assumption of a three-point lift is reasonable for a stable vertical lift.

C. The welding operation is remote. *Rationale:* The disposal container is not shielded.

D. The welder support equipment, such as power supply, wire spools, controls, etc. is located outside the hot cell where it can be readily accessed for maintenance. *Rationale:* It is standard hot cell practice to locate equipment that needs frequent human attention outside the cell.

E. The WHB uses dry hot cells for conducting shielded waste transfers. *Rational:* Dry transfer was selected over underwater waste transfers because a dry system minimizes the quantity of water remaining in the waste package.

Performance Confirmation

One waste package is retrieved every ten years for performance confirmation evaluation in the WHB. The waste package is opened, testing and sampling are conducted, the waste is repackaged and returned to the emplacement area. The waste package supports and welds are inspected for cracks and corrosion, deterioration is photographed and logged, and samples are taken for further examination. Waste package surface temperatures and radiation levels are also noted and compared to the measured in situ levels. If leakage is detected, the waste package is repaired or replaced. *Rational*: Surface testing is expected to provide data that cannot be collected through in situ testing. Testing frequency will be minimized. The requirements for retrieval frequency and laboratory testing have not been established. Ultimately, the waste packages may need to be opened only if non-destructive testing suggests that additional data is required.

Assumptions on HVAC

A. The carrier bay is a contamination free area. *Rationale:* This allows for the free movement of shipping casks, shipping cask carriers, and site prime movers into and out of the carrier bay.

B. Disposal container welders are provided with ventilation hoods. *Rationale:* The welding fumes from the disposal container welders are directed to a separate bank of high-efficiency particulate air (HEPA) filters, for which reason a collection hood is necessary for each welder.

7.2.2.2.3 Interface Criteria

RDRD Interface Requirements

This section lists the interface requirements for the WHB. This section also identifies the organizations within the CRWMS M&O that the WHB has primary interfaces with and depends on for design inputs. Only those interface requirements are reiterated from the RDRD (YMP 1994a) that are applicable to the WHB scope of work. The section of the RDRD (YMP 1994a) in which each interface requirement appears, is identified. Requirements that are marked TBD in the RDRD (YMP 1994a) are not reiterated.

RDRD 3.2.3.1.2 REPOSITORY SEGMENT - WASTE ACCEPTANCE INTERFACES:

This interface primarily involves reports and schedules communicated between the two entities. Waste acceptance provides schedules of acceptance and shipping and descriptions of the contents of each waste shipment to the MGDS.

A. The Repository Segment shall be capable of receiving and handling standard, failed, and nonstandard SNF described in Paragraphs 1, 2, and 3 below, respectively.

1. Standard SNF meeting the criteria specified in 10 CFR 961.11 Appendix E, Sections B.1 through B.5.

2. Failed SNF meeting the criteria specified in 10 CFR 961.11 Appendix E, Section B.6.

3. Nonstandard SNF [TBD], which is any SNF that does not fall within the standard or failed SNF description in Paragraphs 1 or 2 above.

B. The Repository Segment shall be capable of receiving and handling standard and nonstandard HLW described in Paragraphs 1 and 2 below, respectively.

1. Standard canistered HLW, which is borosilicate glass sealed inside an austenitic stainless steel canister with a concentric neck and lifting flange which meets the following criteria:

a) Total length will be 3.000 meters (+0.005, -0.020 m).

b) Diameter will be 61.0 centimeters (+1.5, -1.0 cm).

c) Weight will not exceed 2500 kilograms.

d) Fill height will be equivalent to at least 80% of the volume of the empty canister.

e) Total heat generation rate will not exceed 1500 watts per canister at the year of shipment.

f) Waste temperature will not have exceeded 400°C during transit to ensure that the glass transition temperature was not exceeded.

2. Nonstandard canistered HLW [TBD], which is any HLW that does not fall within the standard canistered HLW description in Paragraph 1.

C. The Repository Segment shall be capable of handling standard canistered HLW using a grapple provided by the waste producer with the following capabilities.

1. The grapple, when attached to the hoist and engaged with the flange, shall be capable of moving the canistered waste form in the vertical direction.

2. The grapple shall be capable of being remotely engaged with and remotely disengaged from the HLW canister flange.

3. The grapple shall be capable of being engaged or disengaged while remaining within the projected diameter of the waste form canister.

4. The grapple shall include features that prevent inadvertent release of a suspended canistered waste form.

D. The Repository Segment shall be capable of handling standard, failed, and nonstandard SNF, and nonstandard canistered HLW using grapples of its own design.

E. The Repository Segment shall have the capability to inspect and verify the description of waste received. If the SNF or HLW is improperly described, the Repository Segment will notify WA for resolution of the waste description.

RDRD 3.2.3.1.3 REPOSITORY SEGMENT - TRANSPORTATION INTERFACE:

The Repository Segment and Transportation interface when SNF and HLW loaded in transportation casks are received for disposal at the Repository Segment and when unloaded casks are returned to the system. It includes all that is involved in interfacing and transferring the load cask systems from Transportation to the MGDS. It includes all the ancillary equipment and consumables needed for the task and then transferring the unloaded cask system from the MGDS to Transportation. The repository segment and the transportation element interface requirements shall be applicable for retrieval [TBD].

A. Transportation provides the Repository Segment with all information needed to mate on-site equipment with the Cask/Transporter, off-load the cask from the transporter with the correct crane apparatus, prepare the cask for opening and ultimately open and mate the cask with the transfer cell so the waste constrained within can be unloaded. Transportation also relays information about the next waste shipment to be made so that the unloaded cask can be refitted at the CMF with the correct basket and ancillary equipment after being closed, cleaned, decontaminated, maintained, and repaired.

B. The Repository Segment is responsible for inspecting and decontamination the cask using Transportation procedures. The Repository Segment also performs minor cask repairs using materials and instructions provided by Transportation.

C. The Repository Segment shall be equipped with communications equipment to allow units operating in the vicinity of the Repository Segment to provide advance notice of their arrival.

D. Access points for vehicles carrying transportation casks shall have an area for detaching and removing the Transportation prime mover from the site and attaching an on-site vehicle to the transporter.

E. Provision shall be made for inspection of loaded transportation cask systems upon receipt. This inspection includes measurement of radiation levels external to the cask, levels of contamination on the cask surface, and the surface temperatures of the cask.

Interface Design Data

Inputs from Waste Acceptance and Transportation interfaces are listed below. Also, this section describes the inputs provided by two WHB interfaces, Repository Subsurface Design interface and the Waste Package Development interface, for which no specific requirements are listed in the RDRD (YMP 1994a).

Waste Forms Physical Characteristics from Waste Acceptance Interface – Waste Acceptance interface provides the descriptions of waste forms shipped to the repository. Descriptions of only external physical characteristics of waste forms were requested from the Waste Acceptance interface.

A. Bare SFAs Physical Characteristics – The enveloping external physical characteristics of bare SFAs as provided by the Waste Acceptance interface are shown in Table 7.2.2-3 (*SNF Assembly Data* [CRWMS M&O 1994j]). Current disposal container designs can only handle 14 feet 10-inches long SFAs. A design variation will be required to handle the 16 feet 9-inches long SFAs.

B. SFA canisters Physical Characteristics – The enveloping external physical characteristics of SFA canisters are shown in Table 7.2.2-4 (CRWMS M&O 1994j).

C. DHLW Canister Physical Characteristics – The enveloping external physical characteristics of DHLW canisters are shown in Table 7.2.2-5 (*Characteristics of Potential Repository Wastes* [DOE 1992]).

Table 7.2.2-3 Bare SFAs Physical Characteristics

Characteristics	Bare SFA	
	PWR	BWR
Length (post-irradiation), feet-inches (millimeters)		
Maximum	16'-9" (5,110)	14'-10" (4,520)
Minimum	9'-5" (2,870)	7'-1" (2,160)
Cross-section, inches (millimeters)		
Maximum	8.6" (220)	6.6" (170)
Minimum	6.3" (160)	4.3" (110)
Weight (with integral control components and/or channels), pounds (kilograms)		
Maximum	1,920 (871)	699 (317)
Minimum	702 (318)	359 (163)

Table 7.2.2-4 SFA Canister Physical Characteristics

Characteristics	Small	Large
Nominal length , feet-inches (millimeters)	16'-0" (4,880)	16'-2" (4,930)
Nominal diameter, feet-inches (millimeters)	4'-2" (1,270)	5'-6" (1,680)
Nominal loaded weight , pounds (kilograms)	49,350 (22,381)	76,550 (34,724)
Maximum capacity for PWR SFAs	12	21
Maximum capacity for- BWR SFAs	24	40

Table 7.2.2-5 DHLW Physical Characteristics

Characteristics	DHLW Canisters
Length, feet-inches (millimeters)	
Maximum	9'-10" (2997)
Minimum	9'-9" (2972)
Diameter, feet-inches (millimeters)	
Maximum	2'-0" (610)
Minimum	2'-0" (610)
Weight, pounds (kilograms)	
Maximum	5,690 (2,580)
Minimum	4,740 (2,150)

D. Non-standard SFAs – Standard SFAs are not expected to fail during transport to the repository. SFAs suspected of being failed at their origin will be properly overpacked prior to shipment to the repository.

E. Thermal and radionuclide characteristics of the waste forms are found in Section 5 of Volume III. This data is consistent with the data provided in *Characteristics of Potential Repository Wastes*, DOE/RW-0184-R1.

Input from Repository Subsurface Design Interface – The WHB interfaces with the repository subsurface when the WHB delivers a loaded, sealed, and clean waste package to the subsurface's waste package transporter. The waste package transporter shuttles only between the surface, from where it receives a loaded waste package from the WHB, to the subsurface repository for final emplacement. The Repository Subsurface Design interface provides the conceptual details of the waste package transporter in the report titled *Emplacement Equipment/Concept Development Report* (CRWMS M&O 1995q). Salient features of the subsurface waste package transporter obtained from the Repository Subsurface Design interface are as follows:

A. The waste package transporter is shielded for radiation protection.

B. The waste package transporter requires a docking platform approximately 4 feet above the top of the rail to receive a loaded waste package on a railcar.

C. After the railcar is loaded with a waste package, it is then pushed by the waste package car loader up to three feet into the waste package transporter. Thereafter, the transporter push-pull mechanism pulls the railcar into the transporter.

Input from Waste Package Development Interface – This section describes the input obtained from the Waste Package Development interface. The Waste Package Development interface has identified the input as TBV. The disposal container is the container into which waste forms unloaded from shipping casks are transferred in the WHB. The design of the disposal containers and the design of the equipment for performing the closure welding on the disposal containers are the responsibility of Waste Package Development. For conceptual design, only the external physical characteristics of the disposal containers were requested from the Waste Package Development interface.

A. Disposal Containers Physical Characteristics – Several models of the disposal containers have been conceptualized. The physical characteristics of each model provided by the Waste Package Development interface are shown in Table 7.2.2-6. Additional disposal container characteristics are provided in Volume III.

B. Disposal Container Welder – Welder enveloping diameter is 2 meters (16 feet 7 inches) larger than the disposal container outer diameter (*QAP-3-12 Request, Waste Package Closure Envelope Requirements and Cost Estimates* [CRWMS M&O 1995r])

Table 7.2.2-6 Disposal Container Physical Characteristics

Characteristics	Bare SFA		SFA Canister		DHLW Canister
	21 PWR	44 BWR	Small	Large	
Container Dimensions, feet-inches (mm)					
Height	17'-6" (5,335)	17'-6" (5,335)	18'-6" (5,647)	18'-8" (5,682)	12'-6" (3,680)
Diameter	5'-4" (1,629)	5'-4" (1,629)	5'-0" (1,531)	5'-11" (1,802)	5'-7" (1,709)
Container Weights, pounds (kg)					
Container	65,528 (29,723)	66,300 (30,070)	52,706 (23,907)	64,044 (29,050)	26,678 (12,101)
Inner lid	680 (308)	680 (307)	585 (266)	860 (390)	870 (393)
Outer lid	3,000 (1,382)	3,000 (1,376)	2,650 (1,198)	3,800 (1,736)	2,200 (1,000)
Contents, no filler	36,120 (16,384)	32,117 (14,568)	49,341 (22,381)	76,553 (34,724)	19,240 (8,728)
Total, no filler	105,300 (47,797)	102,000 (46,325)	105,000 (47,752)	145,000 (65,900)	49,000 (22,222)
Total with filler	139,000 (62,844)	133,000 (60,183)	137,000 (62,285)	190,000 (86,227)	No filler
Welding duration, hours	73	73	69	76	76

- Welder enveloping height: disposal container height plus 1 meter (3 feet 3 inches) above the top edge of the disposal container plus 1.5 meters below the top edge of the disposal container (CRWMS M&O 1995r)

- Welding durations: as listed in Table 7.2.2-6 (CRWMS M&O 1995r)

- Note that input from the Waste Package Development interface on the heat and gaseous outputs from the welder is not yet known and is thus not considered in the conceptual design of the WHB.

7.2.2.3 Summary of Supporting Studies

This section provides a summary of the studies listed below that directly impacted the WHB design. Each summary addresses the study scope, results, relationship to other studies, and applicability to the selected WHB design concept.

A. *Waste Handling Building Advanced Conceptual Design Study for 1995* (CRWMS M&O 1995x)

B. *Repository Surface Waste Handling Concept of Operations* study (CRWMS M&O 1995s)

C. *Preliminary Dose Assessment for the MGDS Surface Facility Waste Handling Operations* study (CRWMS M&O 1995t)

D. *Waste Handling Building Preliminary Estimation of the Internal Radiation Streaming for the MPC* (CRWMS M&O 1995u)

E. *Waste Handling Building Selection of Optimum Cask-Cell and Disposal Container-Cell Interface Method* study (CRWMS M&O 1995v)

F. *Spent Nuclear Fuel Operations Analysis Report* (CRWMS M&O 1995w)

***Waste Handling Building Advanced Conceptual Design Study for 1995* (CRWMS M&O 1995x)**

The objective of this study was to describe the state of the WHB design as it stood at the end of the fiscal year 1995 reporting period. The scope of work for the WHB conceptual design included: identification of design requirements; description of the facility and major design features; block flow diagrams; mechanical flow diagrams; general arrangements; HVAC diagrams; and major equipment and specification list. The scope of work for this report is limited to the mechanical handling and HVAC concepts for waste emplacement operations on shipping casks, waste forms, and disposal containers.

The report described design inputs including requirements, design criteria, design interfaces and assumptions. The design and interface requirements were extracted from the RDRD (YMP 1994a), the design criteria came from DOE Order 6430.1A, the interface data was provided either through design input data transmittals or through documents published by or for the CRWMS. The assumptions provided for the conceptual design of the WHB fell under three categories: assumptions made where input from the WHB interfaces is not yet known; programmatic assumptions documented in the CDA Document (CRWMS M&O 1995a); and assumptions made to clarify a conflict or the relationship between a requirement and an input.

The report summarized several supporting studies, which were undertaken to analyze various factors that influence the size and layout of the WHB. The studies were: Concept of Operations Study; Dose Assessment Study; MPC Radiation Streaming Analysis; Cask-Cell Interface Method Study; and Spent Fuel Operations Analysis. The WHB design concept reflected the results of these supporting studies.

The report also summarized the results of the waste handling operations computer simulation, which was used to refine the above studies and analyses. The primary purpose for simulating the repository surface waste handling operations was to size the WHB. A by-product of the simulation was the further refinement of operations in areas where the operations originally flow charted were creating bottlenecks or points where the smooth flow of entities such as shipping casks, waste forms, and disposal containers was being impeded.

The report described the WHB design concept. For the present waste form arrival scenarios, one WHB is proposed. The conceptual design of the WHB reported in this study handles bare SFAs, DHLW, and disposable canisters received at the repository by truck and rail. To keep worker exposure within the allowable limits and ALARA, most shipping cask operations are remote; all waste form and disposal container operations are remote. Bare SFAs, which are most likely to spread contamination during handling, are handled in areas separate from the areas that handle canistered waste. The WHB has primarily three hot cells: the disposal container cell, where canistered waste is handled; the bare SFA transfer cell, where bare SFAs are transferred from shipping casks to disposal containers; and the performance confirmation and filler cell, where SFA canisters are filled, and disposal containers pulled from the subsurface are evaluated for performance confirmation activities. Standard hot cell practices for non-reactor nuclear facilities are designed into the WHB. Motive equipment such as motors and gears for items inside the cell are located outside the cell to allow direct contact maintenance with minimum risk of worker exposure to radiation and contamination. Contamination is confined within areas that generate it. All exits from the primary confinement zone lead into decontamination rooms to prevent the spread of contamination beyond the primary confinement zone. Equipment that is routinely exposed to the primary confinement zone is kept within the primary confinement. Provisions are included for maintenance of remote equipment. Provisions are also made for operational recovery if a key piece of equipment such as a crane unexpectedly goes off line.

The report concluded that the WHB design concept is consistent with the design requirements, the design criteria, the interface requirements, the design inputs, and the design assumptions. The conceptual design utilizes proven technology and dry nuclear hot cell experience. Some of the key pieces of equipment are, in fact, versions of those currently working in the industry. To make the WHB conceptual design a complete and definitive package, it was suggested that the scope of work be expanded to include electrical considerations, site safety analysis, design basis accidents and events, and fire protection and security and safeguards considerations. It was also recommended that the conceptual design of the WHB reported in this study be updated regularly to include additional inputs from interfaces as the inputs become available.

Repository Surface Waste Handling Concept of Operations (M&O 1995s) Study

The purpose of this study was to identify the operations that are performed on shipping casks, waste forms, and disposal containers. The study reports the operations in a flow chart format. The flow charts are organized as follows:

- Loaded cask operations
- Unloaded cask operations
- Waste forms operations
- Disposal container operations.

The complete set of the operations flow charts includes over a hundred pages. The operations flow charts start with the receipt of a shipping cask at the gates of the repository and follow the shipping cask step by step through the operations for preparing the shipping cask for unloading, then unloading the shipping cask, then preparing the shipping cask for dispatch from the repository, and on through the site until the unloaded shipping cask exits the repository. The operations flow charts also trace step by step the operations performed on the waste forms from their retrieval from the shipping cask to their insertion into a disposal container. The operations flow charts then trace step by step the operations performed on the disposal container from the introduction of a new, empty disposal container into the WHB to the loading of the disposal container and on through the WHB to the delivery of the loaded, cleaned disposal container to the subsurface waste package transporter.

The operations flow charts show what happens to the entities handled in the WHB, where it happens, for how long it happens, and which crew of operators makes it happen. The operations flow charts show the operations that are performed in parallel and the operations that are performed in series. For each operation, the flow charts show the estimated mean time for performing the operation. The operations flow charts also show the decision points encountered during an operation and what the outcome possibilities are for each decision. In addition, the operations flow charts show the probability of occurrence of each outcome.

All operations and information related to the operations--such as times and probabilities--are based on experience in the nuclear waste industry and data collected by the industry. For example, the operations flow charts show that the probability of a cask arriving at the repository with removable contamination on its exterior is eight percent. This information is based on historical cask shipment statistics compiled by Sandia National Laboratories (*Transportation Cask Contamination Weeping: A Program Leading to Prevention* [SNL 1993b]). Another example of the operations flow charts reflecting the experience of the nuclear industry is that the shipping cask handling operations are derived from the applicable shipping cask handling experience in utilities and also the operations recommended by the manufacturers of the shipping casks that are considered in this study.

***Preliminary Dose Assessment for the MGDS Surface Facility Waste Handling Operations* (M&O 1995t) Study**

The purpose of this study was to determine the dose rates in millirem per hour at contact and out to twenty feet from the small SFA canister, large SFA canister, GA-4 and GA-9 truck shipping casks, and the rail shipping casks. The GA-4 and GA-9 truck shipping casks were modeled as rectangular volumes with side shields to determine the mid-plane and center line dose rates out to twenty feet from the shipping casks. The SFA canisters and SFA canister shipping casks were modeled as cylinders with side shields to determine the mid-plane dose rate out to twenty feet from the side of the canister or the shipping cask. The shipping casks were also modeled as cylinders with end shields to determine the centerline dose rate out to twenty feet from the cab and back end of the casks. The dose rates were then applied to the repository surface waste handling operations to determine the total exposure in millirem for each cask shipment.

***Waste Handling Building Preliminary Estimation of the Internal Radiation Streaming for the MPC* (M&O 1995u)**

The purpose of this analysis was to aid in the selection of a strategy to reduce to within acceptable limits operator exposure to radiation originating from the SFA canister during the shipping cask opening operations in the WHB.

An appreciable gap exists between the SFA canister and the shipping cask cavity. In the case of the large SFA canister shipping cask, the gap could be a maximum of 0.7 inches. For casks and canisters of the size in question, a gap this wide is to be expected.

The lateral wall of the SFA canister is conceptualized as nominally one inch of stainless steel and is neither designed for nor intended to provide radiation attenuation in the radial direction. (This is the primary function of the lateral walls of the shipping casks.) High levels of radiation enter this internal radial gap from the SFA canister and stream upward. Although the gap is, geometrically, relatively small when compared with the overall diameter of the SFA canister, the gap width is quite significant in permitting high levels of radiation to stream past the end closure shielding plug in the SFA canister.

The SFA canister streaming analysis resulted in the further refinement of the repository surface waste handling operations. For example, the conceptual design of the SFA canister has six threaded holes for screwing six lifting lugs into them for a redundant three-point lift. The operation of attaching the lifting lugs was at one time being considered as a manual operation with the workers protected by radiation shielding to attenuate the streaming from the gap between the SFA canister and shipping cask cavity.

Waste Handling Building Selection of Optimum Cask-Cell & Disposal Container-Cell Interface Method (M&O 1995v)

The purpose of this study was to suggest the most suitable method for mating a shipping cask to the cell cask port or a disposal container to the cell disposal container port for the transfer of waste forms likely to spread contamination during transfer. The waste forms most likely to spread contamination during transfer are bare SFAs. Cladding dust from the bare SFAs falls off during transfer operations. The contamination spreads into the cell and could also spread into the shipping cask and disposal container port rooms, where shipping casks and disposal containers mate with their respective cell ports. The interface study investigates the feasible methods by which the shipping casks or disposal containers are mated to their respective cell ports so that the spread of contamination into the port rooms is minimized if not altogether prevented.

The interface study considered 27 different alternatives for mating casks and disposal containers to cell ports. The alternatives were evaluated using the Kepner-Tregoe decision analysis method. The alternative selected as the most suitable is shown in Figure 7.2.2-5. The selected alternative consists of a stainless steel funnel that is placed by the cell crane onto the shipping cask or the disposal container through the cell port. The funnel rests on the shipping cask. The tapered shape of the funnel and the location of the flange on which the funnel rests on the shipping cask ensures that the funnel is centered on the cask and that it also protects the cask's polished seal surfaces. Between the top flange of the funnel and the cell floor is a gap for air flow from the port room into the cell. The funnel works the same way with disposal containers except that there are no seal surfaces to protect on the disposal containers.

The funnel is used only on bare SFA shipping casks, which are only truck casks. The cell is equipped with a funnel sized for each bare SFA shipping cask to be handled in the WHB. The contamination that falls off a bare SFA during transfer is directed by the funnel back into the shipping cask, thus minimizing the spread of contamination into the port room. The continuous air flow between the funnel and the cell floor further ensures that the spread of contamination into the port room is minimized if not altogether prevented.

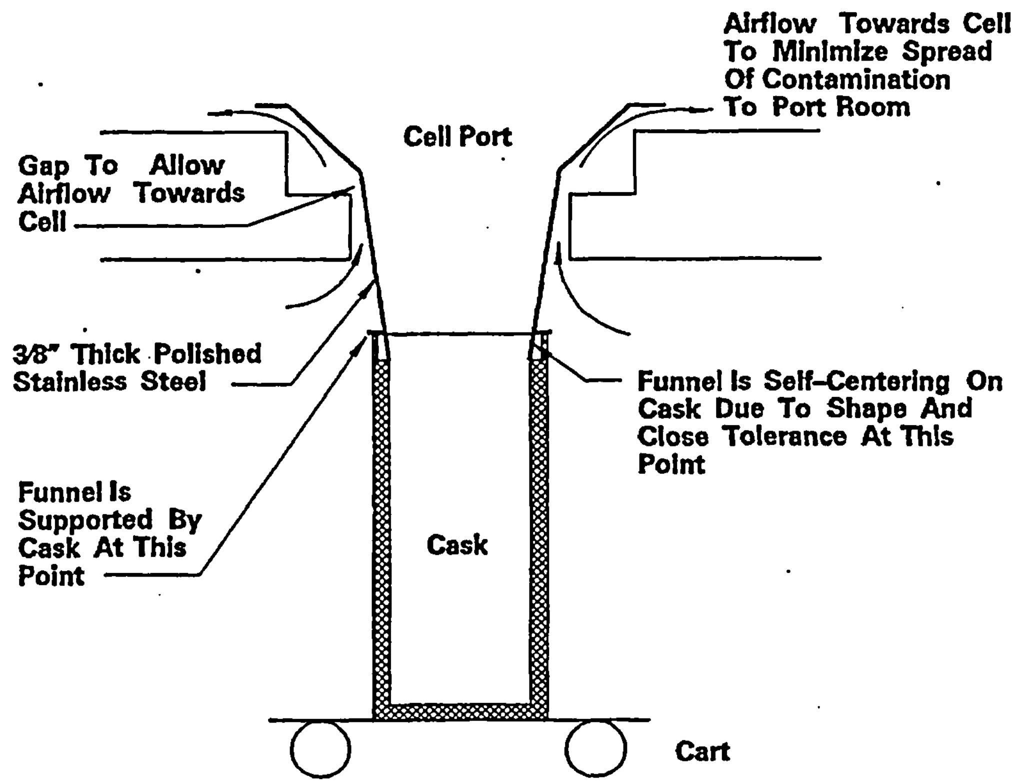

Figure 7.2.2-5 Cask-Cell Disposal Container-Cell Interface Method

The alternative thus selected is a simple device for controlling the spread of contamination. The device has no moving parts. It requires no set up in the shipping cask preparation area. It requires no parts to be installed in the preparation area, which means that after the shipping cask is unloaded, there are no parts that could carry contamination back to the preparation area. The funnel is installed from the cell and pulled back into the cell after it has served its function. The funnel is polished stainless steel with smooth surfaces that have no crud traps, which facilitates decontamination. The funnel is decontaminated prior to lifting it off the shipping cask or the disposal container after waste transfer.

The results of the interface study were used to further refine the repository surface waste handling operations. The funnel also influenced the conceptual design of the WHB cell and the port rooms associated with the transfer of bare SFAs.

Spent Nuclear Fuel Operations Analysis Report (M&O 1995w)

The purpose of this analysis was to determine the repository surface waste handling operations that were common among different surface facilities but could be performed in the WHB. The analysis identified 24 viable alternatives for repository surface facilities. The alternatives were evaluated using the Kepner-Tregoe decision analysis method. The alternative selected as the most suitable suggests the following arrangement for the WHB:

A. Separate the bare SFA handling area from the canistered waste forms handling area in the WHB. This confines the area of high contamination in the WHB to only the bare SFA handling area.

B. Merge the repository's performance confirmation surface operations into the bare SFA handling areas of the WHB, thus eliminating the need for a separate performance confirmation building.

Performance confirmation involves pulling out of the subsurface an emplaced disposal container every few years and examining it. At this time it is anticipated that the examination will include the cutting open of the disposal container to examine the waste forms inside the disposal container. The WHB must be equipped for cutting open SFA canisters. Although the size of a SFA canister is different from the size of a disposal container, the operations for opening both containers are like operations, for which reason the operations for cutting open both containers can be performed in a common area. Further, the opening of both containers carries the strong potential of spreading contamination. The bare SFA handling area of the WHB is already highly contaminated. Therefore, this analysis suggests that the operations for opening both the SFA canister and the disposal container be performed in a common area and that the common area be located in the bare SFA handling area of the WHB.

The above conclusion offers the following advantages:

- The potential for worker exposure is reduced.
- The spread of contamination is confined within areas already contaminated.
- The area requiring decontamination is reduced.

- Functions are shared, thus reducing equipment in remote areas.
- The separate canistered waste handling area offers improved access for maintenance.

The above conclusions of the analysis are reflected in the repository surface waste handling operations and in the conceptual design of the WHB reported in this study.

7.2.2.4 Structure Description

The WHB is a five floor concrete structure with 320,800 square feet of gross floor area. The overall building is approximately 353 feet wide by 454 feet long. The south east corner office area will be constructed of a structural steel frame. Elevated floors and roof will be constructed of composite metal decking with concrete fill. The WHB, which is identified as facility 211, is located about 350 feet east of the North Portal as shown on the site map, Figure 7.2.1-3.

The building layout is shown in the following general arrangements in Appendix D: Plans (WHA-SK-100A through F), Sections (WHA-SK-100G and H), and Elevations (WHA-SK-100I). The floor plans include a location key to identify building subareas. These location numbers are used throughout this description to help identify building areas. Figure 7.2.2-6 shows a schematic presentation of the first floor (El. 100+0).

The structure description section contains a brief overview of WHB operations, followed by a detailed description of each major area, a description of the architectural features and the structural design considerations. The WHB operations are described in detail in the Section 7.2.2.5, Systems Description, and the major components are described in Section 7.2.2.6.

WHB Operations Overview

For the locations of areas called out in this section, see Sketch WHA-SK-100A through WHA-SK-100I. WHB operations begin at the east end of the structure at the carrier bay (location 1). Here shipping casks from truck or rail carriers are unloaded. The casks are moved through airlock 1 (location 2) and then prepared for opening at the loaded cask prep stations (location 3). The casks are then transferred to one of the two cask unloading port rooms (locations 9 and 10), where the cask lids are removed and the cask is positioned under the port for waste transfer. The south port is used to unload SFA canisters from rail casks while the north port is used to remove bare SFAs from truck casks. For both cask types the port cover is retracted, and a crane above the unloading port extends downward to lift the waste through the port.

For canistered waste, the SFA canister is lowered directly into a disposal container located in the disposal container cell (location 21). In this cell, the lid is welded on the disposal container and staged. The disposal container is next placed in a horizontal position and transferred into the underground waste package transporter with a gantry crane. The loaded transporter then leaves the WHB to take the loaded disposal container through the North Portal to the underground emplacement area.

Note: After the disposal container is loaded with waste, welded closed and qualified through non-destructive testing, the configuration meets the 10 CFR 60 definition of a waste package. The waste

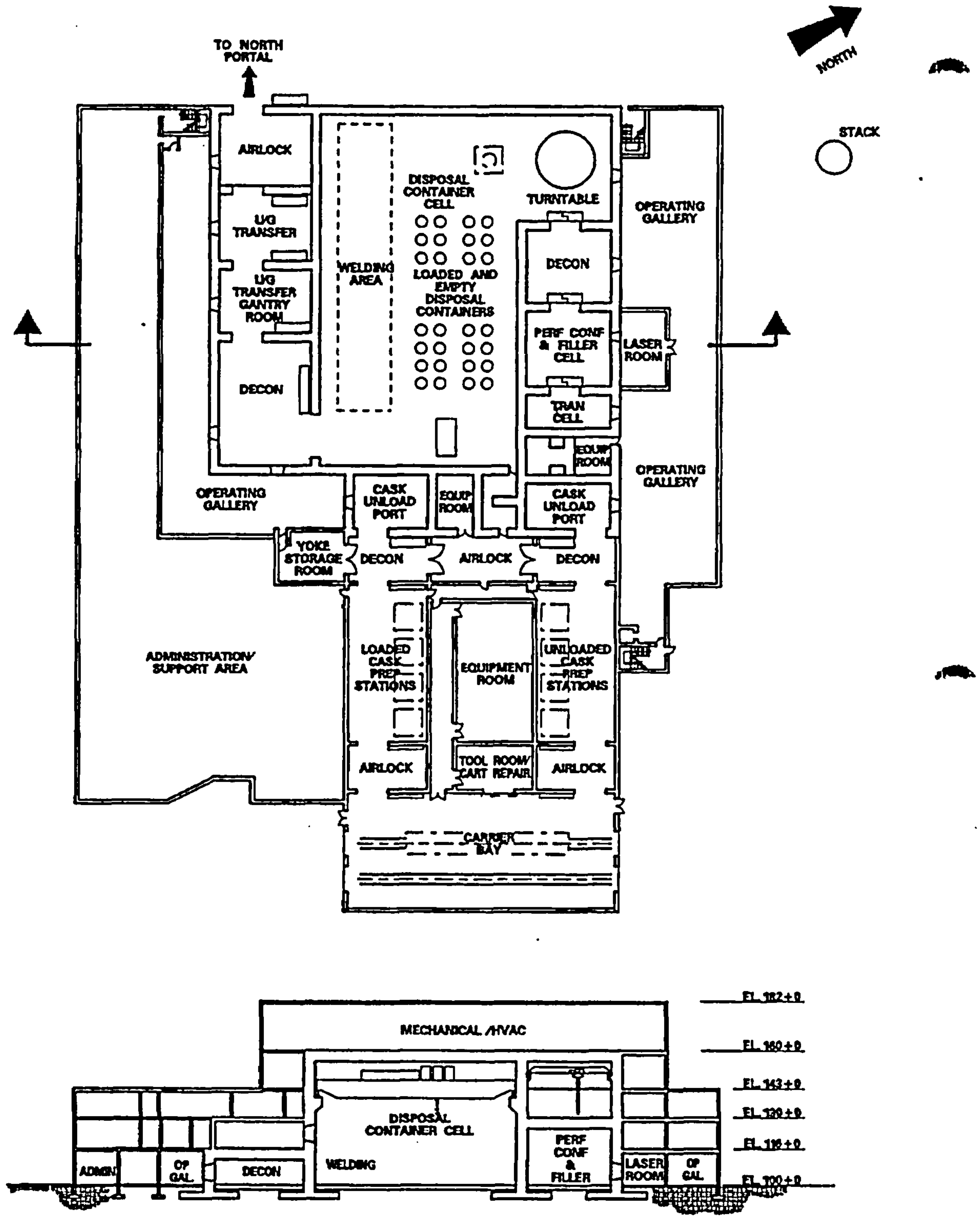

Figure 7.2.2-6 Waste Handling Building

package as defined in 10 CFR 60 would also include any shielding, packing, or absorbent material immediately surrounding the individual disposal container, but the ACD concept does not include such materials.

A relatively small number of the SFA canisters may require the addition of filler material at the WHB prior to emplacement. For these units the loaded disposal containers are transferred from the disposal container cell to the performance confirmation and filler cell (location 19) before the disposal container is closed. In this cell the SFA canister is cut open with a laser, filled with filler material, then welded shut with the same laser.

Uncanistered waste is unloaded from the truck cask through the north cask unloading port (location 10). The SFAs are lifted one at a time from the cask and placed in a staging rack located above the equipment room in the bare SFA transfer cell (location 71). When the rack contains enough waste to fill a disposal container, the SFAs are individually transferred to a disposal container. Next, the disposal container is moved on a cart to the performance confirmation and filler cell to have the inner disposal container lid welded in place with a laser. The sealed disposal container then continues into the disposal container cell where the outer lid is welded in place and the container is staged. The loaded disposal container then leaves the WHB in the same manner described above for containers loaded with canistered waste.

After waste unloading, the empty shipping casks are reclosed and moved by cart to the unloaded cask preparation stations, where the casks are prepared for off-site shipment. The prepared cask is loaded on a carrier in the carrier bay and transferred from the WHB with the on-site prime mover.

All operations described above, except unloaded cask preparation, are performed remotely. This is because neither the waste forms nor the disposal container is shielded, for radiation protection, to levels which allow direct contact. The shipping casks are shielded, but exposure analyses show that due to the high frequency at which they arrive and are handled, the shielding in loaded shipping casks is less than adequate to maintain worker exposures at the repository below the required limits. For this reason cask manufacturers also recommend that loaded shipping casks be handled with remote automation when handled dry.

The disposal container should be dry when sealed. As a result, all operations in the WHB are also performed dry in contrast to water pool operations that are used at most utilities, where spent fuel is stored in water.

The hub of operations support in the WHB are the operating galleries for each transfer area (locations 25 and 28) and a main control room (location 90). All are strategically located to both the bare SFA transfer cell and SFA canister transfer room. The operating galleries are immediately adjacent to each transfer operation with shielded viewing ports to protect the operators.

The WHB includes several other functional areas that serve as operational support including supervisory offices and personnel support areas, such as toilets, lockers, and change rooms; and the environmental, radiation protection, and chemistry laboratory. These cold support areas are located on the south end of the WHB on the first, third and fourth floors. The mechanical equipment areas for the HVAC system is located on the southeast corner of the WHB on the fourth floor. Several other support areas, such as the radwaste treatment and the contaminated machine shop, are shared operations with the CMF and WTB.

Area Descriptions

The design of the major building areas are described below. The presentation order is consistent with the movement of waste from the carrier bay through canistered or uncanistered waste transfer to the underground transfer operation. Support areas are addressed at the end.

Carrier Bay, Location 1 – The waste handling areas of the WHB start with the carrier bay. The carrier bay is where loaded shipping casks enter the WHB and from where unloaded shipping casks leave the WHB. The carrier bay provides access to the WHB for both rail and truck shipping casks. The carrier bay provides two lanes of access to the WHB. Each lane is common to both rail and truck shipping casks. One lane is for the arrival of loaded shipping casks. The other lane is for the exit of unloaded shipping casks. Roll-up doors are provided at the exits of each lane. The carrier bay is sized to accommodate one cask at a time in each lane. The walls of the carrier bay are 30 inches thick. The carrier bay is sized to accommodate the largest shipping cask riding on its carrier.

Airlock 1, Location 2 – The purpose of the air lock is to confine the loaded cask preparation area as a tertiary confinement zone. The air lock accommodates one loaded shipping cask at a time.

Loaded Cask Preparation Area, Location 3 – The loaded shipping cask preparation area is fully enclosed by 18 inch thick concrete walls. The north wall of the preparation area has four shielding viewing windows, one for each preparation station. The preparation area accommodates four loaded cask preparation stations. Each preparation station accommodates one loaded shipping cask, either rail or truck.

Decon 1, Location 7 – Decon 1 is enclosed on the east and west sides by shielding concrete walls and doors. The east shielding door of decon 1 is 18 inch thick concrete. The west shielding door is five foot thick concrete because that side of the room could be exposed to the radiation of the disposal container cell through the canistered waste cask room. On the south side of decon 1 are swing doors that lead to a shipping cask yoke storage room. The room also functions as a maintenance area for the monorail cask lifting device that operates in decon 1.

Canistered Waste Cask Room, Location 9 – The canistered waste cask room is enclosed by five foot thick shielding concrete walls and two five foot thick concrete shielding doors. The south wall has a shielding window. Since all canistered waste comes to the repository in rail casks, only rail casks enter the canistered waste cask room. The canistered waste cask room accommodates one rail cask at a time.

Decon 2, Location 13 – Decon 2, which is similar to Decon 1, is enclosed on the north side by an 18 inch thick shielding concrete wall; on the south side by swing doors that lead into the air lock identified as location 8 in sketch WHA-SK-100; on the west side by a five foot thick concrete shielding wall with an equally thick concrete shielding door; and on the east side by an 18 inch thick concrete shielding wall and an equally thick concrete shielding door opening into the unloaded cask preparation area.

Bare SFA Cask Port Room, Location 10 – The bare SFA cask port room is enclosed by five foot thick shielding concrete walls. The north wall has a shielding viewing window. Entry into the bare SFA cask port room is through a five foot thick concrete shielding door opening into decon 2. The bare SFA cask port room accommodates one truck cask at a time. In the ceiling of the bare SFA cask port room is a port opening into the bare SFA loading cell above.

Bare SFA Transfer Cell, Location 71 – The SFA loading cell is a hot cell enclosed with five foot thick concrete shielding walls and port plugs and shielding viewing windows. The cell has two ports, one at east end and the second at the west end of the cell. The east port is where loaded truck shipping casks are positioned in the SFA cask port room below for unloading into the cell. The west port is where empty bare SFA disposal containers are positioned for loading of bare SFAs into the disposal containers. Between the two ports are the bare SFA staging areas, one for PWR SFAs and the other for BWR SFAs. Concrete shielding plugs are provided for each bare SFA staging area. Each shielding plug, whether for a port or for a bare SFA staging, is moved by motorized equipment that is located in equipment rooms outside the cell with shielding penetrations through the cell walls. A shielding door near the ceiling of the cell, on the east side, provides access to a maintenance bay that serves the cell.

Bare SFA Disposal Container Port Room, Location 12 – The bare SFA disposal container port room is enclosed by five foot thick concrete shielding walls. The room has a port in the ceiling opening into the bare SFA transfer cell above. A five foot thick concrete shielding door at the west end of the port room leads to the performance confirmation and filler cell. The bare SFA disposal container port room accommodates one disposal container at a time riding on the SFA disposal container cart. The bare SFA disposal container port room is sized for all bare SFA disposal containers.

Performance Confirmation & Filler Cell, Location 19 – The performance confirmation and filler cell is enclosed with five foot thick concrete shielding walls. A five foot thick split concrete shielding door is provided on the east side for access to the disposal container port room. Another five foot thick split shielding door is provided on the west side for access to decon 3. This flexible cell includes equipment for adding filler material to SFA canisters, disassembling and evaluating waste packages for performance, welding the inner lid of a disposal container in place after uncanistered SFA loading, and cutting open disposal containers that fail a weld inspection.

Decon 3, Location 20 – Decon 3 is enclosed by five foot thick concrete shielding walls. Decon 3 has shielding viewing windows on the north wall and five foot thick split concrete shielding doors in the west and east walls, the former door opening into the disposal container cell and the latter door leading into the performance confirmation and filler cell. Decon 3 accommodates one SFA canister or disposal container riding on the disposal container cart at a time.

Disposal Container Cell, Location 21- The disposal container cell is enclosed by five foot thick concrete shielding walls. The disposal container cell has shielding viewing windows strategically located through out the cell for maximizing the operator viewing of the cell. A shielding door at the north end of the disposal container cell provides access to decon 3. A maintenance bay is provided along the east wall starting at elevation 130 feet. Access is provided from the disposal container cell to the canistered waste cask port room, decon 4, and air lock 2.

Decon 4, Location 22 – Decon 4 is enclosed by five foot thick concrete shielding walls. Decon 4 has a five foot thick concrete shielding door in the north wall that provides access to the disposal container cell. Access is provided through the west wall to the subsurface transfer gantry room. Decon 4 accommodates one disposal container at a time.

Subsurface Transfer Gantry Room, Location 23 – The subsurface transfer gantry room is enclosed by five foot thick concrete shielding walls. The room has a shielding viewing window on the south wall. The east wall has a five foot thick concrete shielding door that provides access into decon 4. The west wall has a five foot thick concrete shielding door that provides access to the subsurface transfer room, where the subsurface waste package transporter docks with the WHB.

Subsurface Transfer Room, Location 24 – The subsurface transfer room is enclosed by five foot thick concrete shielding walls. The room has a shielding viewing window on the south wall and five foot thick concrete shielding doors in both the east and west walls. The east door provides access to the subsurface transfer gantry room. The west door provides access to air lock 9.

Operating Galleries, Locations 25, 28, 79, 82, 99, 118, 130, 164, 170 – All remote waste handling operations in the WHB are controlled by operators from operating galleries. The WHB has seven operating galleries. The operating galleries are shielded from the primary confinements of the WHB. The operating galleries are equipped with ten through-the-wall mechanical master-slave manipulators. Mechanical master-slave manipulators are commercially available handling tools that are used to perform operations that require separation of the operator from radioactive materials. Each operating gallery is sized to accommodate the dismantling of mechanical master-slave manipulators and transport them on a trolley to either of the mechanical master-slave manipulator repair shops at locations 80 and 128 in sketch WHA-SK-100A through WHA-SK-100I. The operating galleries also include 33 oil-filled shielding windows to provide direct viewing of equipment and operations in remote areas. The overall dimensions of the window unit for a typical five-foot thick concrete shielding wall is approximately two-feet high and three-feet wide on the cold side and three-feet high and four-feet wide on the hot side.

Hot Support Areas – The hot support areas of the WHB are removed from the waste handling areas but support waste handling operations. Examples of hot support areas and their locations are as follows:

- Mechanical master-slave manipulator repair shops, locations 80 and 128
- Calibration lab for warm instruments, location 83
- Dosimetry lab, location 108
- Tool room/Cart repair, location 16
- Equipment decon, location 30
- Laser room, location 31
- Men's and women's change/shower rooms, locations 43 and 44
- Health physics 1 and 2, locations 144 and 177.

Cold Support Areas – The cold support areas of the WHB are areas that do not handle contaminated or potentially contaminated materials. Examples of cold support areas are administrative offices, warehouses, etc.

The central administration and personnel support area is located so that personnel working in or visiting the WHB are routed directly from the protected area badge house. Personnel working in the WHB check in at the administration and personnel support area and then proceed to their appointed work place. If anti-contamination clothing is needed, personnel dress appropriately in the locker room before leaving the administration and personnel area. Administrative or maintenance personnel are directed as necessary from the single point personnel access through the administration and personnel area. Personnel exiting the transfer facility are checked for contamination.

Change rooms, toilets, and office areas are strategically located in operation areas of the WHB to support specific operations and to limit the distance traveled by workers on a routine basis. For example, change rooms located near the exit of each transfer area limit the spread of contamination and provide for worker convenience. Some office space is also provided near each operating area. These local support areas are small and limited in number in keeping with the overall philosophy of a centralized administration and personnel support area.

Architectural Components

Construction materials and finishes for the various areas of the transfer facility will be selected to be durable, functional, and aesthetically pleasing. The operation and support areas are constructed within existing systems, and finishes will be low maintenance and adaptable to decontamination where appropriate. These finishes include painted masonry or concrete walls, sealed or painted concrete floors, or composition tile floors.

Within the primary confinement zones (sketch numbers WHH-SK-103A through WHH-SK-103E), the surface of the floor slab is fully lined with stainless steel plate. The walls are partially lined with stainless steel plate except the decon rooms which have full stainless steel plate finish.

Materials conform to applicable American National Standards Institute and Underwriters' Laboratory standards. The architectural design is in accordance with state and local building codes as well as directives contained in the RDRD (YMP 1994a) for the site selected. Handicapped design requirements apply to the design of the administration and personnel support area.

Structural Design

The structural design of the WHB is based on the assumption that the WHB is performance category 3 as defined in DOE-STD-1020-94. This assumption was selected because the WHB is a nuclear facility that is needed to continue emplacement operations.

Concrete wall, floor and roof slab minimum thickness were determined by selecting the largest among the following requirements:

A. Minimum thickness required by the ACI code.

B. Minimum thickness required by radiation confinement.

C. Recommended tornado missile barriers for Performance Category 3.

The structural design of the WHB complies with the applicable criteria in the RDRD (YMP 1994a). The MGDS ACD Report considered only seismic load and tornado generated missile impact which were judged to be the controlling design conditions. Extreme wind and other loading conditions will have to be considered in the final design. The concrete thickness within the primary confinement zones is on the order of 5 feet. For other areas outside of the primary confinement zone, the concrete thicknesses range from 2.5 feet to 8 inches depending on services and strength requirements.

In the design of reinforced concrete, members were proportioned for adequate strength in accordance with the provisions of the ACI code, using load factors and strength reduction factors specified in the code. Structural steel members and their connections were designed in accordance with American Institute of Steel Construction American Structural Design manual, using the allowable stress design method. Metal decking and composite slab were designed using the manufacture's design manuals and allowable load data.

The floor service loads are dependent on occupancy or use. The minimum live loads specified in Uniform Building Code were used as minimum design live loads. Actual loads will need to be verified in the future. It is anticipated that some equipment weights may exceed the minimum design live loads.

The building is supported on reinforced concrete spread footings. The size of spread footing was determined by the foundation load in proportion to allowable soil bearing capacity.

7.2.2.5 Systems Descriptions

This section describes the systems associated with the WHB. An overview of the waste handling systems are shown on Figure 7.2.2-7. The major systems are listed in Table 7.2.2-7 along with a brief description, applicable flow diagrams, and locations that identify where the system is located within the WHB. These area references are identified on the general arrangement plan drawings WHB-SK-101A through F, which are provided in Appendix D. After the systems summary table, the system functions, system scope and operations are described for each major system. WHB support systems are also discussed. The WHB structure and areas within the WHB are described in Section 7.2.2.4 and the major waste handling components are described in Section 7.2.2.6.

7.2.2.5.1 Cask Receiving and Preparation System

Functions

The Cask Receiving and Preparation System unloads a shipping cask from a truck or rail carrier, prepares the shipping cask for fuel unloading and moves the cask to an unloading point. The system also transfers shipping casks to the CMF for maintenance or from the CMF for fuel unloading preparation. The system supports the delivery of 638 shipments annually. The system is compatible with the following shipping configurations: rail shipping casks containing disposable canistered waste and truck shipping casks containing uncanistered SFAs.

Figure 7.2.2-8 presents a conceptual illustration of this system.

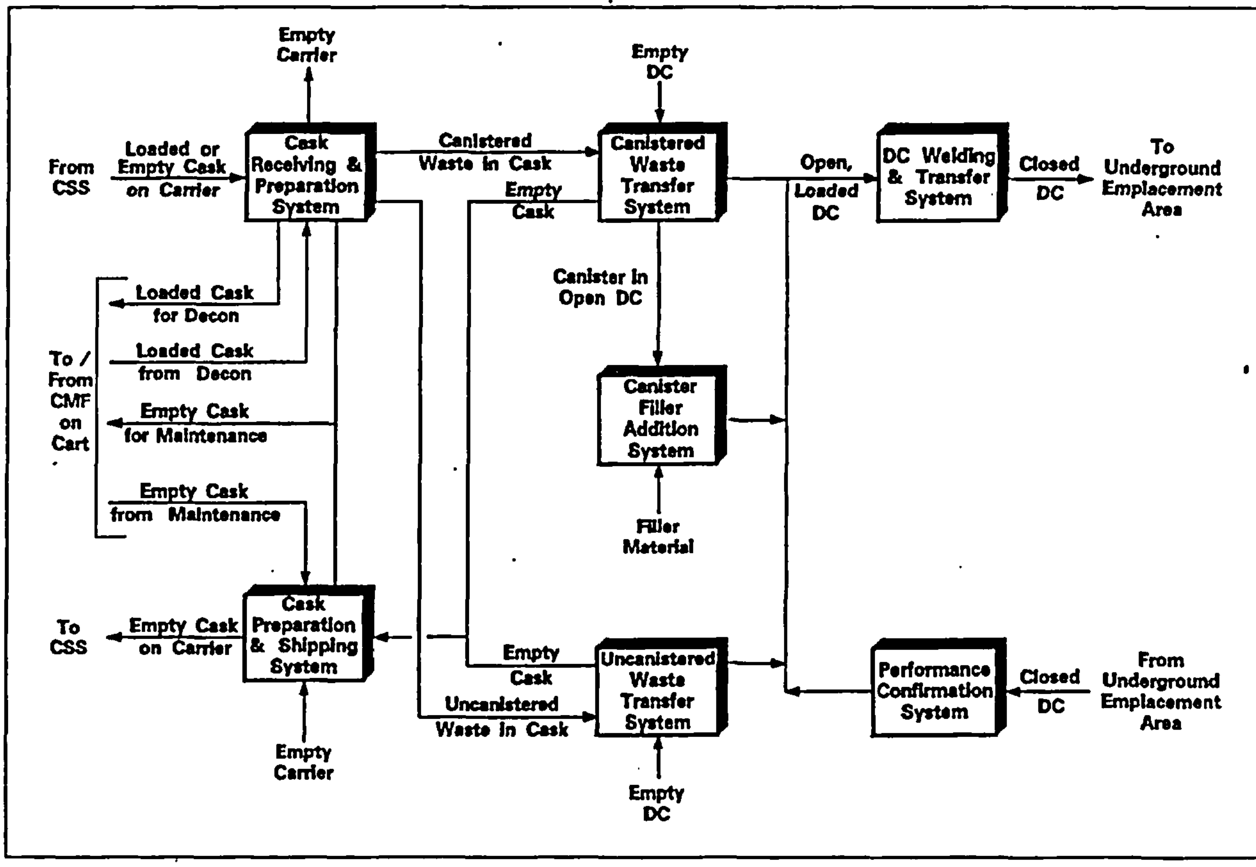

Figure 7.2.2-7. Waste Handling Systems Overview

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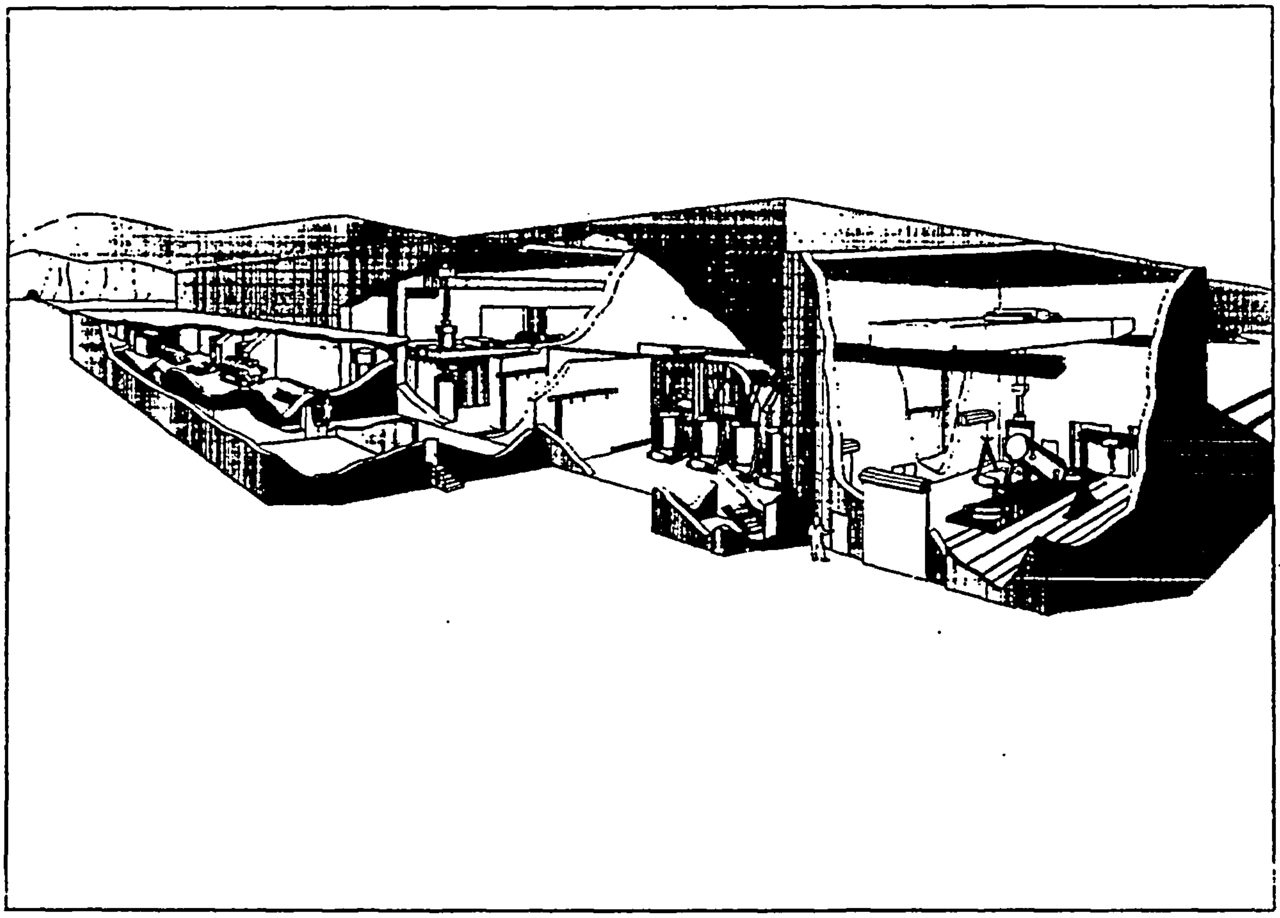

Figure 7.2.2-8. Cask Receipt and Waste Canister Unloading

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Table 7.2.2-7. WHB System Summary

Name	Description	Sizing Parameters	Flow Diagrams	Area Ref.
Cask Receiving & Preparation	Shipping cask is moved into the WHB, unloaded from a carrier, prepared for lid removal and moved to either the canistered or uncanistered waste unloading points	638 casks/yr peak rate, 12,228 casks total	Figure 7.2.2-9 WHB-SK-101B	1, 2, 3
Canistered Waste Transfer	• Shipping cask is moved through an airlock and the waste canister is transferred to DC • Empty shipping cask is decontaminated and removed	623 DCs/yr peak rate 11,849 DCs total	Figure 7.2.2-10 WHB-SK-101C	7, 9, 21
DC Welding & Transfer	• DC cover is welded closed and the DC is positioned horizontally, decontaminated, and loaded into the emplacement railcar • Railcar is loaded into the waste package transporter and moved underground	634 DCs/yr peak rate 12,073 DCs total	Figure 7.2.2-12 WHB-SK-101C&D	21, 22, 23, 24, 67
Uncanistered Waste Transfer	• Shipping cask is decontaminated, bare fuel assemblies are unloaded, accumulated and then loaded into a DC • DC is decontaminated and moved for closing • Empty shipping cask is decontaminated and removed	72 casks/yr peak rate 1,029 casks/total 14 DCs/yr peak rate 185 DCs total	Figures 7.2.2-14&15 WHB-SK-101E	8, 13, 10, 12, 71, 19, 20, 21
Canister Filler Addition	• SFA canister top is cut open, filler material is added, the SFA canister is welded close • SFA canister is decontaminated and loaded into a DC	5 Canisters/yr average 117 Canisters total	Figure 7.2.2-16 WHB-SK-101E	21, 20, 19, 31,
Cask Preparation & Shipping	Empty shipping cask is closed, loaded onto carrier and moved from the WHB	638 casks/yr peak rate, 12,228 casks total	Figure 7.2.2-18 WHB-SK-101F	14, 15, 1
Performance Confirmation	• Emplacement railcar is removed from the underground transfer cask . • DC is unloaded from the railcar and the cover is cut off • If necessary the canister is cut open • Performance confirmation tests are conducted and samples are taken and analyzed in a laboratory • DC is moved foreclosing and transfer to DC welding	1 DC/10 yrs	Figure 7.2.2-19 WHB-SK-101C, D & E	67, 24, 23, 22, 21, 20, 19, 31
HVAC	Heated or cooled air flows through the WHB rooms to control ambient temperatures and differential pressures between confinement zones	3 zones	WHH-SK-100, 101, 102A to K	125, 139, 192, 195

Scope

The Cask Receiving and Preparation System receives loaded and unloaded shipping casks on truck or rail carriers from the on-site transportation system via the CSS or from the CMF on a transfer cart. The system delivers:

A. Loaded shipping casks that are prepared for fuel removal to either the Canistered Waste Transfer System or the Uncanistered Waste Transfer System

B. Loaded or unloaded shipping casks requiring decontamination to the CMF

C. Unloaded shipping casks requiring maintenance to the CMF

D. Empty rail and truck carriers for staging to the on-site transportation system.

The system also requires interfaces with the electric power and industrial air systems to operate the components. The operations take place in the Carrier Bay, Airlock 1 and Loaded Cask Preparation Area of the WHB.

Operations

The Cask Receiving and Preparation System is shown on Figure 7.2.2-9 and the areas used to conduct these operations are shown on the mechanical flow diagram WHB-SK-101A.

A shipping cask is unloaded from a truck or rail carrier and placed on a preparation cart as described below:

A. A shipping cask is brought into the WHB at the carrier bay (location 1) through a roll up door by the on-site prime mover.

B. A preparation cart is brought into the carrier bay. This cart may come from the loaded cask preparation area (location 3) through air lock 1 (location 2); or from the CMF.

C. In the carrier bay, the trunnion block bolter gantry servicing the entry lane is positioned at the cask. The trunnion block bolter remotely unbolts the trunnion blocks on the cask and removes the trunnion blocks. The carrier bay crane, with a yoke applicable to the shipping cask, engages the cask's lifting trunnions and lifts the cask off the carrier until the cask is hanging vertically from the crane. The carrier bay crane lowers the cask onto the waiting cask cart.

The carrier that brought the cask to the WHB is transferred from the carrier bay by the on-site prime mover to the RCA parking area. The carrier is removed so that the loaded shipping cask access lane of the carrier bay is free to receive another loaded shipping cask.

A shipping cask requiring maintenance or decontamination is transferred on a preparation cart to the CMF. After maintenance or decontamination the cask is returned to the carrier bay from the CMF.

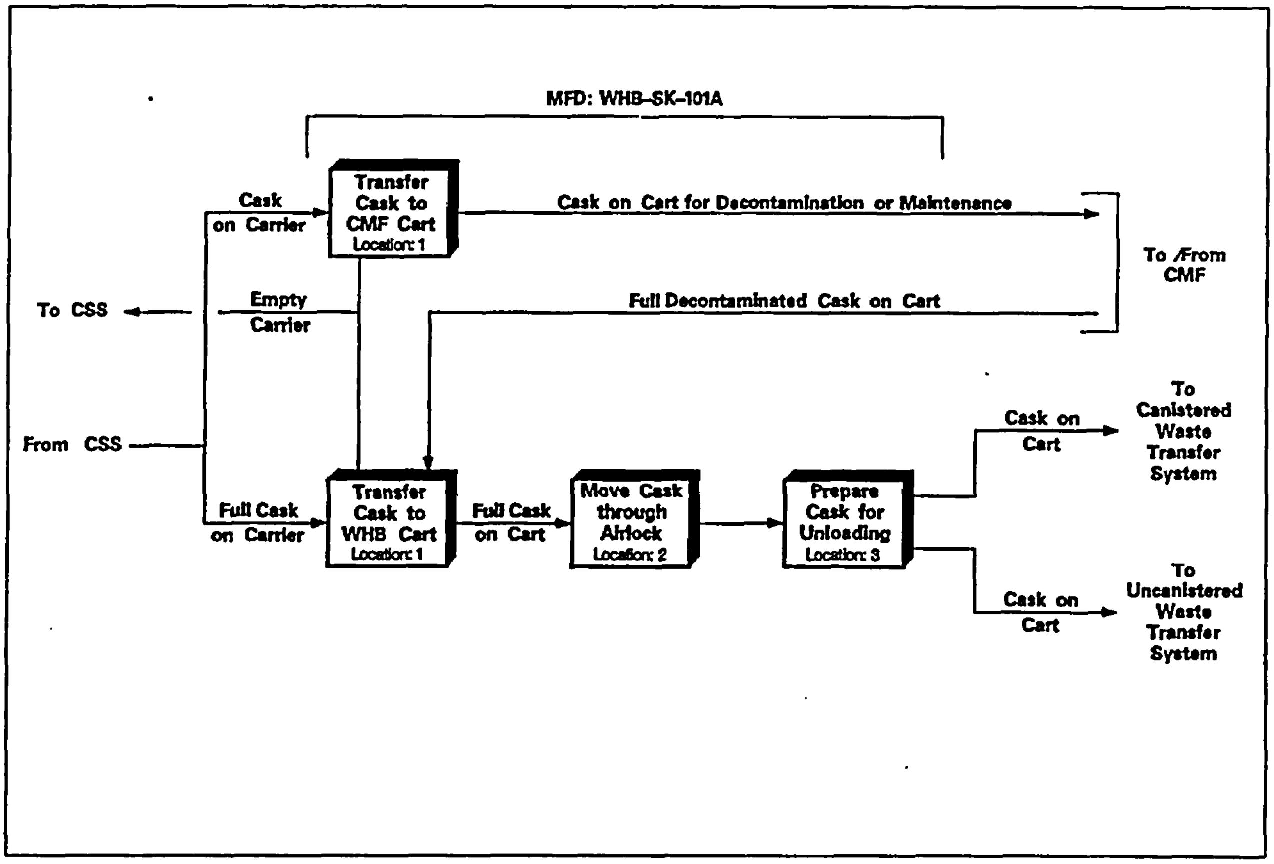

Figure 7.2.2-9. Cask Receiving and Preparation System

If the cask is empty, it is shipped from the carrier bay by the Cask Preparation & Shipping System described in Section 7.2.2.5.6.

Loaded shipping casks are transferred to the loaded cask preparation area as follows:

A. The carrier bay door of the air lock opens.

B. The preparation cart with the loaded shipping cask enters the air lock.

C. The carrier bay door of the air lock closes.

D. The loaded cask preparation area shielding door of the air lock opens.

E. The cart takes the loaded cask into the loaded cask preparation area.

F. The loaded cask preparation area shielding door of the air lock closes.

A loaded shipping cask is prepared for unloading in the loaded cask preparation area. To keep worker exposures to within the applicable requirements, the loaded cask preparation operations are performed remotely. The loaded cask preparation operations for, say, the GA-4 truck cask are described below. Operations for other types of casks are similar.

A. Move the loaded shipping cask to a preparation station in the loaded cask preparation area.

B. Clean the cask top.

C. Remove the cover of the cask's gas sample port.

D. Back out the gas sample port until it hits the stop.

E. Check the cask cavity pressure and gas for contamination by connecting to the gas sample port plug quick disconnect.

F. Introduce a small negative gauge pressure into the cask cavity.

Following cask preparation, the loaded shipping cask is unloaded by the Canistered Waste Transfer System or the Uncanistered Waste Transfer System. Note that two unloading points are serviced by the four preparation stations in the loaded shipping cask preparation area. Thus the ratio of preparation stations to unloading points is 2:1.

7.2.2.5.2 Canistered Waste Transfer System

Functions

The Canistered Waste Transfer System removes a loaded SFA or DHLW canister from a rail shipping cask and places it in a special disposal container for the appropriate type of canistered waste. It is the function of this system to transfer the shipping cask from a preparation cart to a transfer cart; move the shipping cask to the canistered waste cask room; unbolt and remove the canistered waste shipping cask lid; position the cask for unloading through the overhead cell port; remove the SFA canister or DHLW canisters from the shipping cask; place the canistered waste in the appropriate disposal container; service the shipping cask lid; replace the lid on the unloaded shipping cask; decontaminate the shipping cask, if necessary; and return the shipping cask to the preparation cart. This system transfers canistered waste from 623 waste shipments per year (peak rate). Figure 7.2.2-8 presents a conceptual illustration of this system.

Scope

The Canistered Waste Transfer System receives loaded shipping casks from the Cask Receiving and Preparation System and empty disposal containers for either SFA or DHLW canisters from the Disposal Container Welding and Transfer System. This system delivers empty shipping casks to the Cask Preparation and Shipping System, and loaded disposal containers to the Disposal Container Welding and Transfer System and the Canister Filler Addition System.

The Canistered Waste Transfer System also requires interfaces with the electric power, recycled water, and industrial air systems to operate components. The system operations are performed in the following WHB locations: Decon 1, Canistered Waste Cask Room, Disposal Container Cell, and Disposal Container Cell Maintenance Bay.

Operations

The Canistered Waste Transfer System is shown on Figure 7.2.2-10 and the areas used to conduct these operations are shown on the mechanical flow diagram in sketch WHB-SK-101C.

A rail shipping cask on a preparation cart enters decon 1 (location 7) from the loaded cask preparation area (location 3). Decon 1 is an airlock needed to operate the zoned HVAC confinement system described in Section 7.2.2.5.8. Decon 1 is also the first stop for any piece of equipment or cask coming out of the primary confinement zone of the canistered waste cask room. Anything coming out of the primary confinement zone of the canistered waste cask room can be decontaminated if necessary.

In decon 1 the shipping cask is transferred from the preparation cart to a transfer cart and the cask is moved into the port room as described below:

A. The monorail lifting device in decon 1 lifts the cask off the preparation cart.

B. While the cask is suspended, the preparation cart returns to the loaded cask preparation area, where the cart is free to help in the preparation of another loaded shipping cask in parallel to the processing of the cask that the cart has just delivered to decon 1. If necessary, the preparation cart is decontaminated prior to leaving decon 1.

C. In decon 1, the west side shielding door opens.

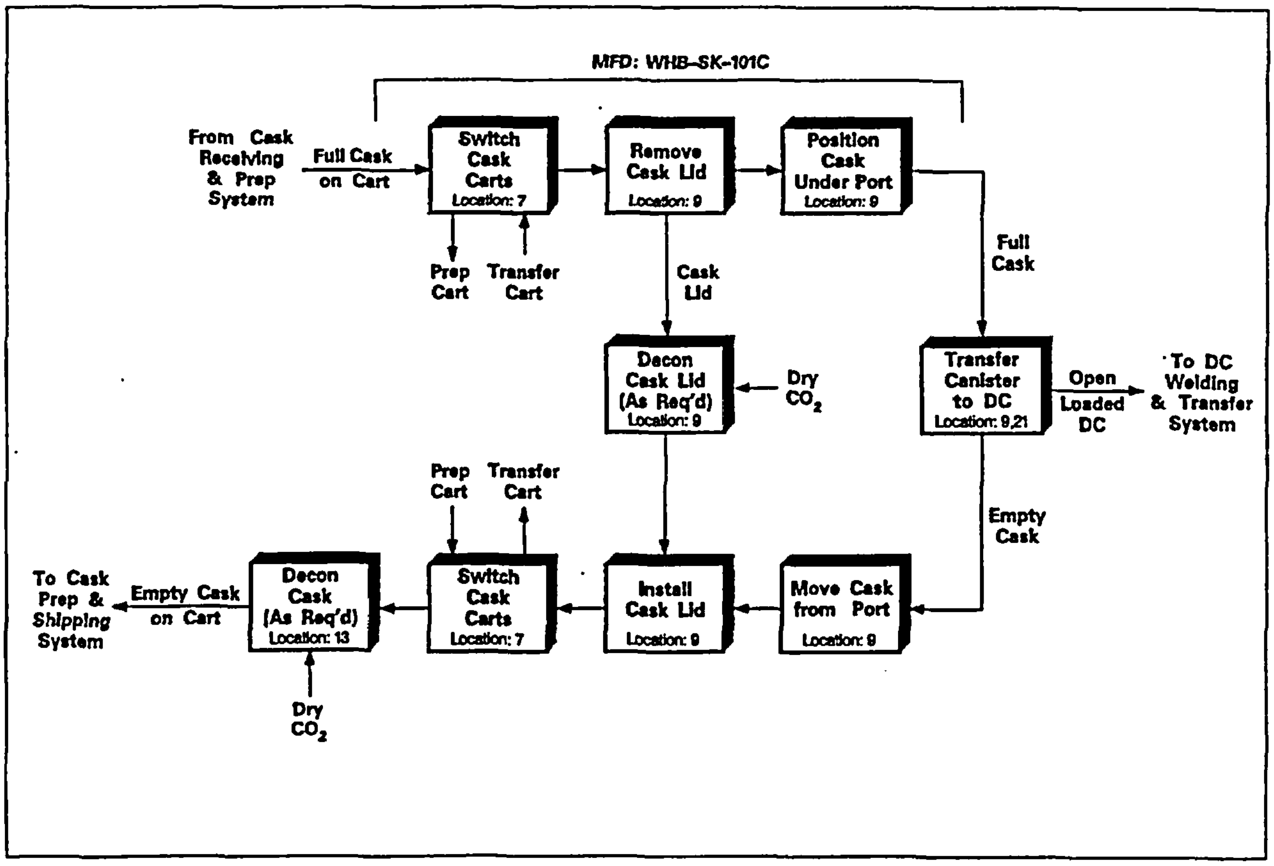

Figure 7.2.2-10. Canister 'Waste Transfer System

D. A transfer cart enters decon 1 and is positioned under the loaded cask suspended from the monorail lifting device.

E. The monorail lifting device lowers the cask onto the transfer cart.

F. The cask is secured to the transfer cart.

G. The transfer cart takes the cask into the canistered waste cask room.

H. The west shielding door of decon 1 closes.

In the canistered waste cask room, the lid of a loaded rail shipping cask is removed from the cask as described below:

A. The cask lid bolter positions itself above the cask.

B. The cask lid bolter un-bolts the cask lid.

C. The cask lid bolter moves out of the way from over the cask by sliding on the channels in the ceiling.

D. The cask lid remover moves into position over the cask.

E. The cask lid remover engages the lifting bolt holes in the cask lid and lifts the lid off the cask.

F. The cask, riding on the transfer cart, is positioned under the transfer port for unloading. The cask lid, while suspended from the lid remover, is decontaminated in the canistered waste cask room using the dry ice method of localized decontamination.

When the cask is positioned under the cell port, the SFA canister is lifted from the open rail cask, through the cask port and into the disposal container cell (location 21). In the disposal container cell, the cell crane places the SFA canister directly into a disposal container. The specific operations are described below:

A. The cask port plug pneumatic seal is deflated.

B. The cask port plug is moved aside to open the port.

C. The crane lifts the SFA canister through the port and into the disposal container cell.

D. The cask port plug is moved back over the cask port.

E. The cask port pneumatic seal is inflated.

Following removal of the SFA canister, the empty shipping cask returns to the canistered waste cask room on the transfer cart where the cask lid is reinstalled. After the lid is installed the empty shipping cask is transferred to the Cask Preparation and Shipping System as described below:

A. After the cask is unloaded, the west shielding door opens again.

B. The transfer cart brings the unloaded cask back into decon 1.

C. The west shielding door closes.

D. If necessary, the transfer cart and the unloaded cask are decontaminated.

E. The monorail lifting device lifts the unloaded cask off the transfer cart.

F. The west shielding door opens again.

G. The transfer cart exits decon 1 back into the canistered waste cask room.

H. The west shielding door closes.

I. The monorail lifting device takes the cask to decon 2 (location 13). An unloaded cask preparation cart awaits the cask in decon 2.

7.2.2.5.3 Disposal Container Welding and Transfer System

Functions

The Disposal Container Welding and Transfer System welds the lid of a loaded disposal container and transfers the sealed disposal container to the subsurface waste package transporter. It is the function of this system to position lids on loaded disposal containers; weld the disposal container lids; test the completed welds for integrity; repair faulty welds, if required; control the emissions from the welding process; store the sealed disposal container until ready for transfer to the subsurface waste package transporter; clean the sealed disposal container; transfer the sealed disposal container to the subsurface waste package transporter; and transfer a fresh, empty disposal container, with lid, into the WHB to replace the loaded container dispatched for emplacement. This system handles 634 loaded disposal containers per year (peak rate). Figure 7.2.2-11 presents a conceptual illustration of this system.

Scope

The Disposal Container Welding and Transfer System receives unsealed, loaded disposal containers from the Uncanistered Waste Transfer System, Canistered Waste Transfer System, Canister Filler Addition System, and new, empty disposal containers from the on-site transportation system. The Disposal Container Welding and Transfer System delivers loaded and sealed disposal containers to the subsurface waste package transporter for underground emplacement.

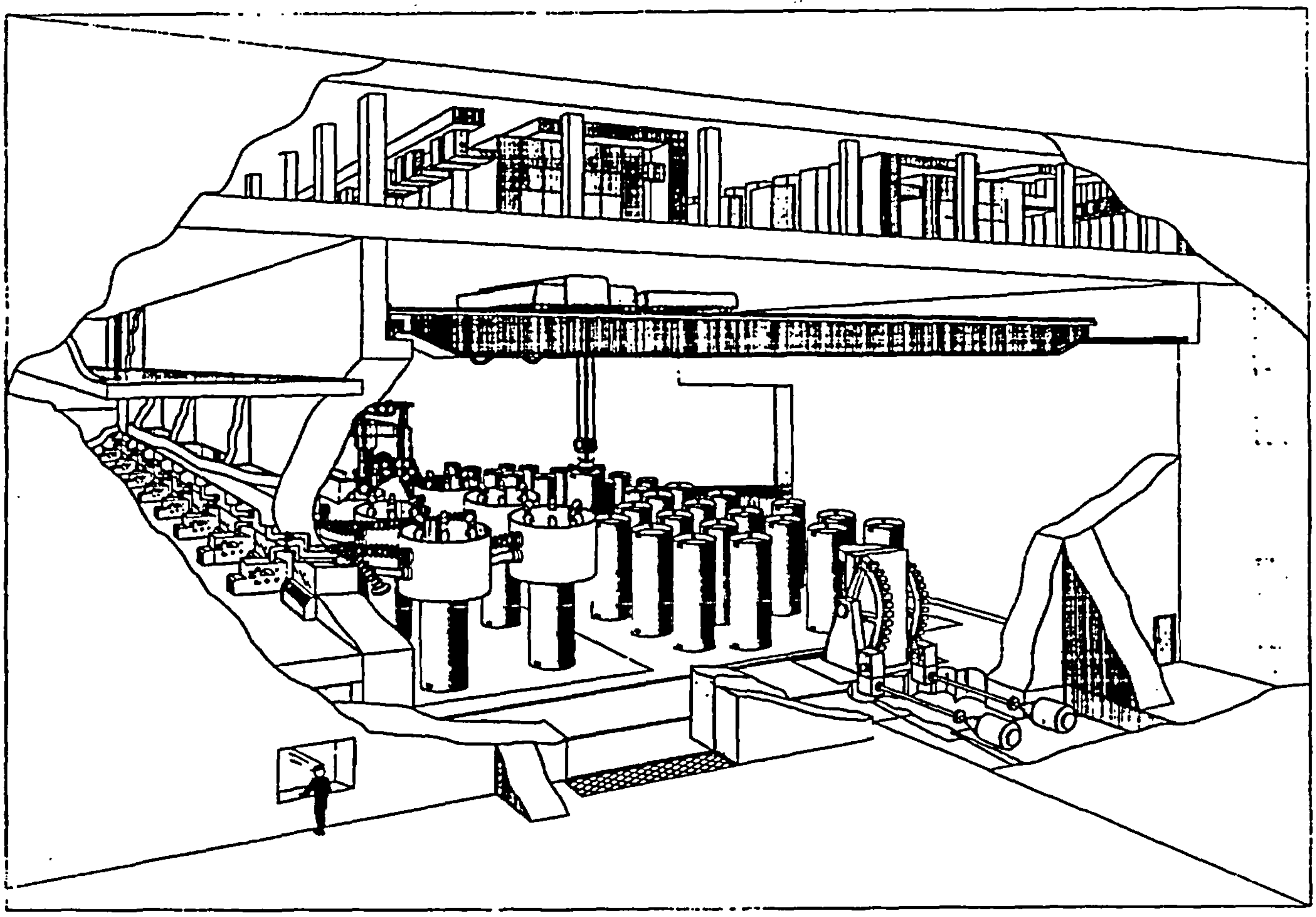

Figure 7.2.2-11. DC Welding and Staging

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Operations

The Disposal Container Welding and Transfer System is shown on Figure 7.2.2-12 and the areas used to conduct these operations are shown on the mechanical flow diagram WHB-SK-101C and D.

An open loaded disposal container is transferred to the disposal container cell (location 21) from one of the following systems:

A. Uncanistered Waste Transfer System, where a disposal container loaded with bare SFA entered from decon 3.

B. Canistered Waste Transfer System, where a disposal container loaded with a SFA canister entered from the canistered waste cask port room.

C. Canister Filler Addition System, where a disposal container loaded with canister containing waste and filler material entered from decon 4.

D. Performance Confirmation System, where an open or closed disposal container is returned after conducting tests and taking samples from decon 4.

In the disposal container cell the, disposal container is closed with a welded lid, positioned horizontally and moved from the disposal cell as follows:

A. If a disposal container welding station is available, the crane takes the disposal container to the welding station. If a welding station is not available, the crane takes the disposal container to a staging area in the cell, and when a welding station becomes available, the crane takes the disposal container to the welding station.

B. The disposal container is welded and qualified through non-destructive testing at the welding station. The loaded disposal container now meets the 10 CFR 60 definition of a waste package.

C. The cell crane takes the disposal container back to the staging area, where the disposal container awaits its transfer to the subsurface waste package transporter.

D. When the subsurface waste package transporter is docked at the WHB in air lock 9 (location 67) the disposal container cell crane puts the disposal container in the horizontalizer.

E. The horizontalizer rotates the disposal container to a horizontal repose.

After leaving the disposal container cell, the loaded disposal container is delivered to the subsurface waste package transporter for underground emplacement in the repository as follows:.

A. The disposal container transfer gantry picks up the disposal container from the horizontalizer and takes the disposal container into decon 4 (location 22).

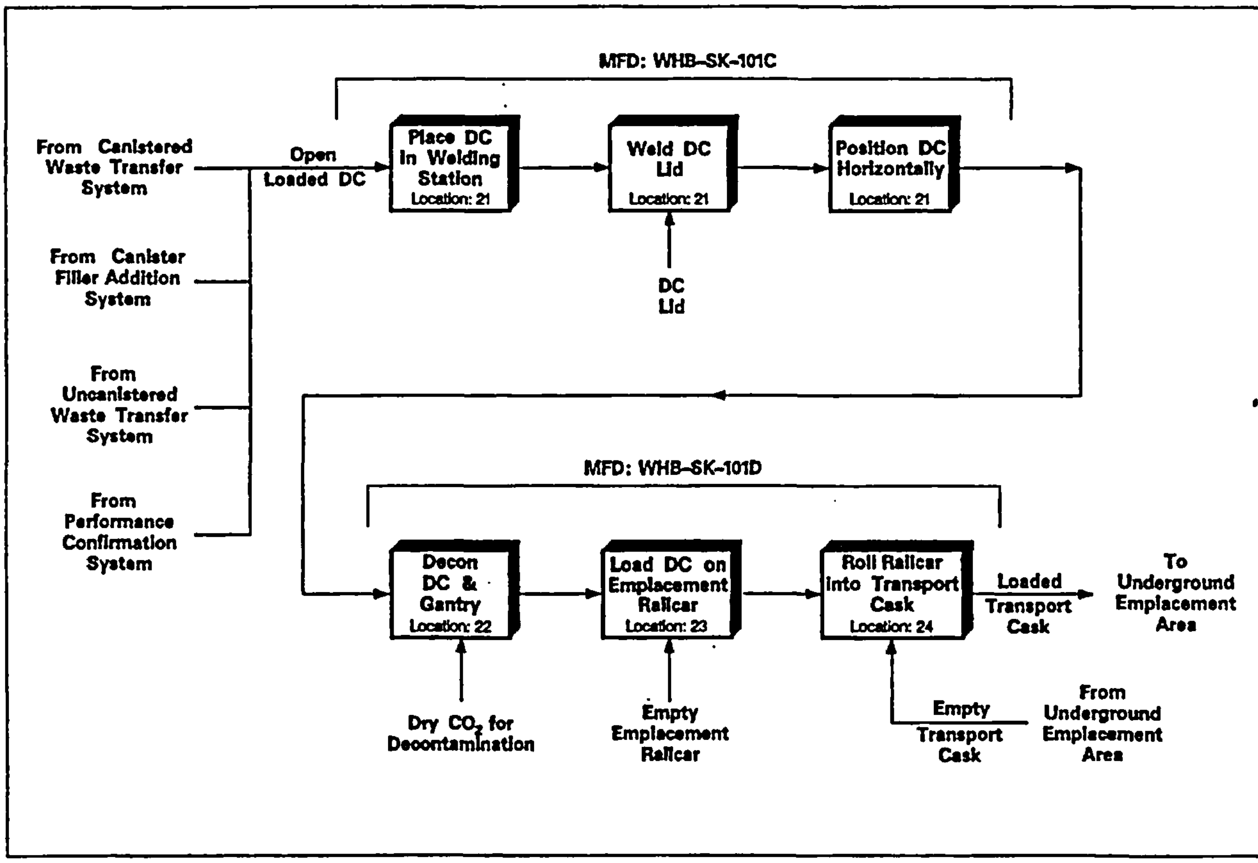

Figure 7.2.2-12. DC Welding and Transfer Systems

B. The gantry puts the disposal container on the saddle in decon 4. The gantry retreats back into the disposal container cell. The shielding door connecting decon 4 to the disposal container cell closes. If necessary, the disposal container is decontaminated. After decontamination, the west shielding door of decon 4 opens, and the disposal container is ready to be put into the subsurface waste package transporter.

C. The subsurface transfer gantry picks up a loaded disposal container from decon 4 and puts it on the emplacement railcar waiting in the subsurface transfer room. The gantry then retreats back into the subsurface transfer gantry room.

D. The shielding door to air lock 9 opens. The railcar loader pushes the railcar, supporting the disposal container, up to three feet into the transporter. Thereafter, the transporter push-pull mechanisms pull the railcar all the way into the transporter. The transporter closes. The disposal container is now ready to be taken underground for emplacement.

7.2.2.5.4 Uncanistered Waste Transfer System

Functions

The Uncanistered Waste Transfer System removes uncanistered SFAs from a truck shipping cask and provides for SFA placement in a special disposal container for the appropriate type (e.g., PWR or BWR) of uncanistered waste. It is the function of this system to transfer the shipping cask from a preparation cart to a transfer cart; move the shipping cask to the bare SFA cask port room; unbolt and remove the truck shipping cask lid; position the cask for unloading through the overhead SFA transfer cell port; remove the SFAs individually from the shipping cask; place the bare SFAs in the appropriate SFA staging rack; requisition an empty disposal container and position it below the disposal container port in the disposal container port room; transfer the SFAs from the staging rack into the empty disposal container; seal the disposal container inner lid; decontaminate the sealed disposal container; service the truck shipping cask lid; replace the lid on the unloaded shipping cask; decontaminate the shipping cask, if necessary; and return the shipping cask to the preparation cart. This system handles bare SFA waste from 72 shipping casks per year (peak rate). Figure 7.2.2-13 presents a conceptual illustration of this system.

Scope

The Uncanistered Waste Transfer System receives loaded shipping casks from the Cask Receiving and Preparation System and empty disposal containers from the Disposal Container Welding and Transfer System. This system returns empty shipping casks to the Cask Preparation and Shipping System, and loaded disposal containers to the Disposal Container Welding and Transfer System.

The Uncanistered Waste Transfer System also requires interfaces with the electric power, recycled water, and industrial air systems to operate components. The system operations are performed in the following WHB locations: Decon 2, Bare SFA Cask Port Room, Bare SFA Disposal Container Port Room, Bare SFA Transfer Cell, and Decon 3.

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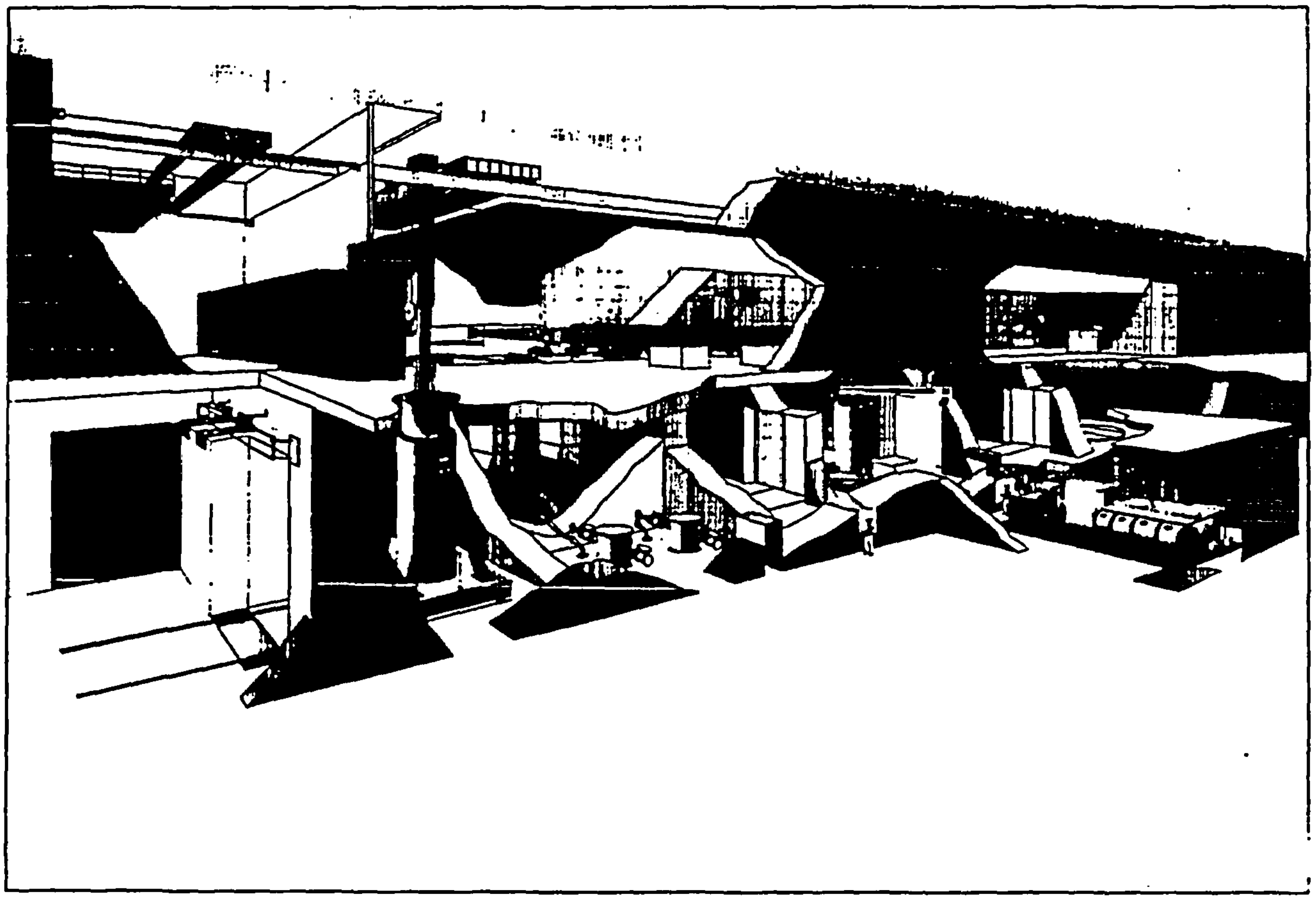

Figure 7.2.2-13. SFA Unloading, Canister Filling and Performance Confirmation

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Operations

The Uncanistered Waste Transfer System is shown on Figures 7.2.2-14 and 15, and the areas used to conduct these operations are shown on the mechanical flow diagram WHB-SK-101E.

A truck shipping cask on a preparation cart enters decon 1 (location 7) from the loaded cask preparation area (location 3). A monorail cask lifting device moves the cask through airlock 3 (location 8) and into decon 2 (location 13). In decon 2, the shipping cask is transferred from the preparation cart to a transfer cart and the cask is moved into the bare SFA cask port room (location 10) in the same manner as casks containing canistered waste are moved from decon 1 to the canistered waste cask port room, as described in Section 7.2.2.5.2.

In the uncanistered waste cask room, the lid of a loaded truck shipping cask is removed and the cask is moved under the cask port in the same manner as the loaded rail shipping cask is handled in the canistered waste cask room, as described in Section 7.2.2.5.2.

Bare SFAs are lifted, one at a time, from the open truck cask, through the cask port and into the bare SFA transfer cell (location 71). In the bare SFA transfer cell, the cell crane places the SFA into one of the two staging racks. The specific operations are described below:

A. The cask port plug pneumatic seal is deflated.

B. The cask port plug is moved aside to open the port.

C. The contamination control barrier is installed on the cask.

D. The fuel transfer crane pulls one SFA out of the cask into the fuel transfer crane mast.

E. The fuel transfer crane places the SFA in an assigned SFA staging rack position in the cell.

F. Operations D and E are repeated until the shipping cask is empty.

G. The inner surfaces of the contamination control barrier are cleaned with the dry ice decontamination method.

H. The contamination control barrier is removed from the port.

I. The cask port plug is moved back over the cask port.

J. The cask port pneumatic seal is inflated.

The empty shipping cask returns to the uncanistered waste cask room on the transfer cart where the cask lid is reinstalled. After the lid is installed the empty shipping cask is transferred to the Cask Preparation and Shipping System in the same manner as the empty rail shipping casks, as described in Section 7.2.2.5.2.

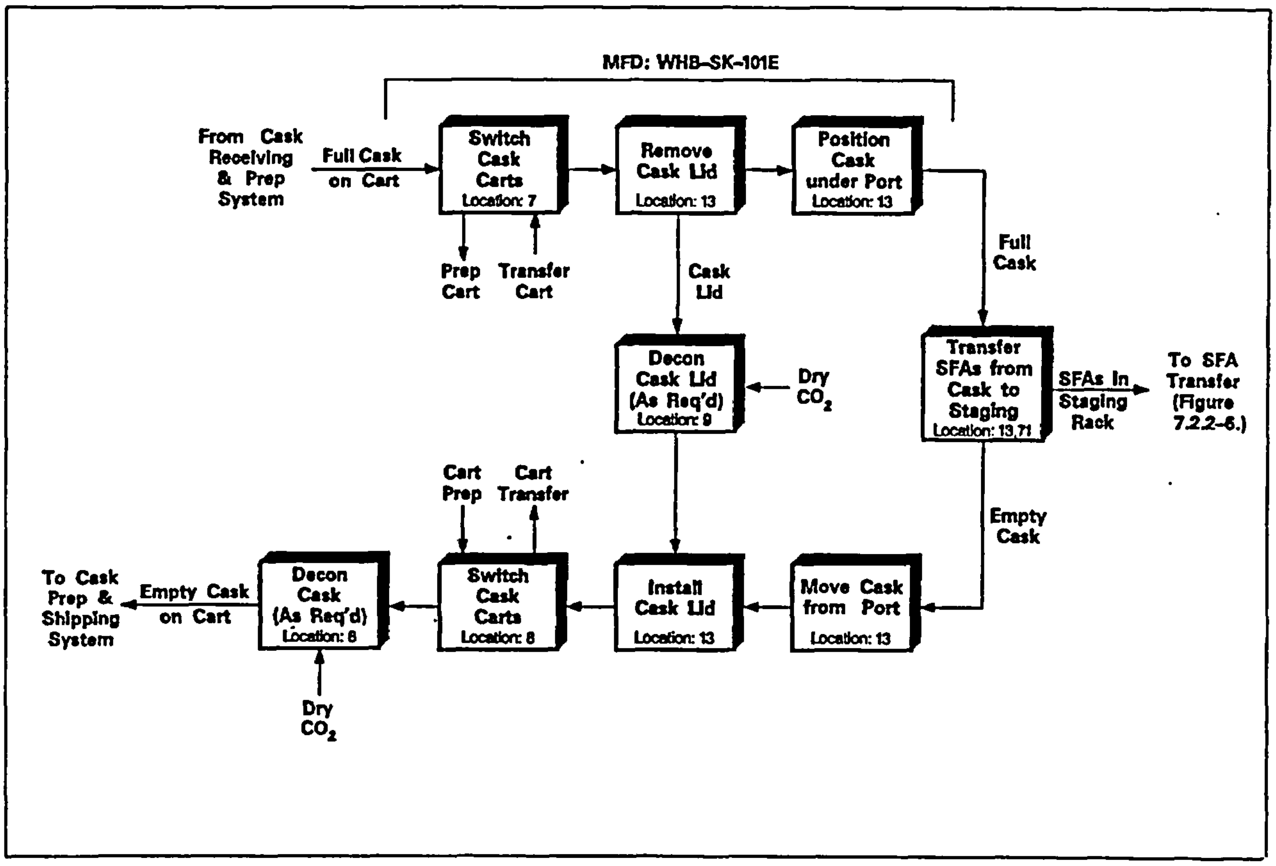

Figure 7.2.2-14. Uncanistered Waste Transfer System (Page 1 of 2)

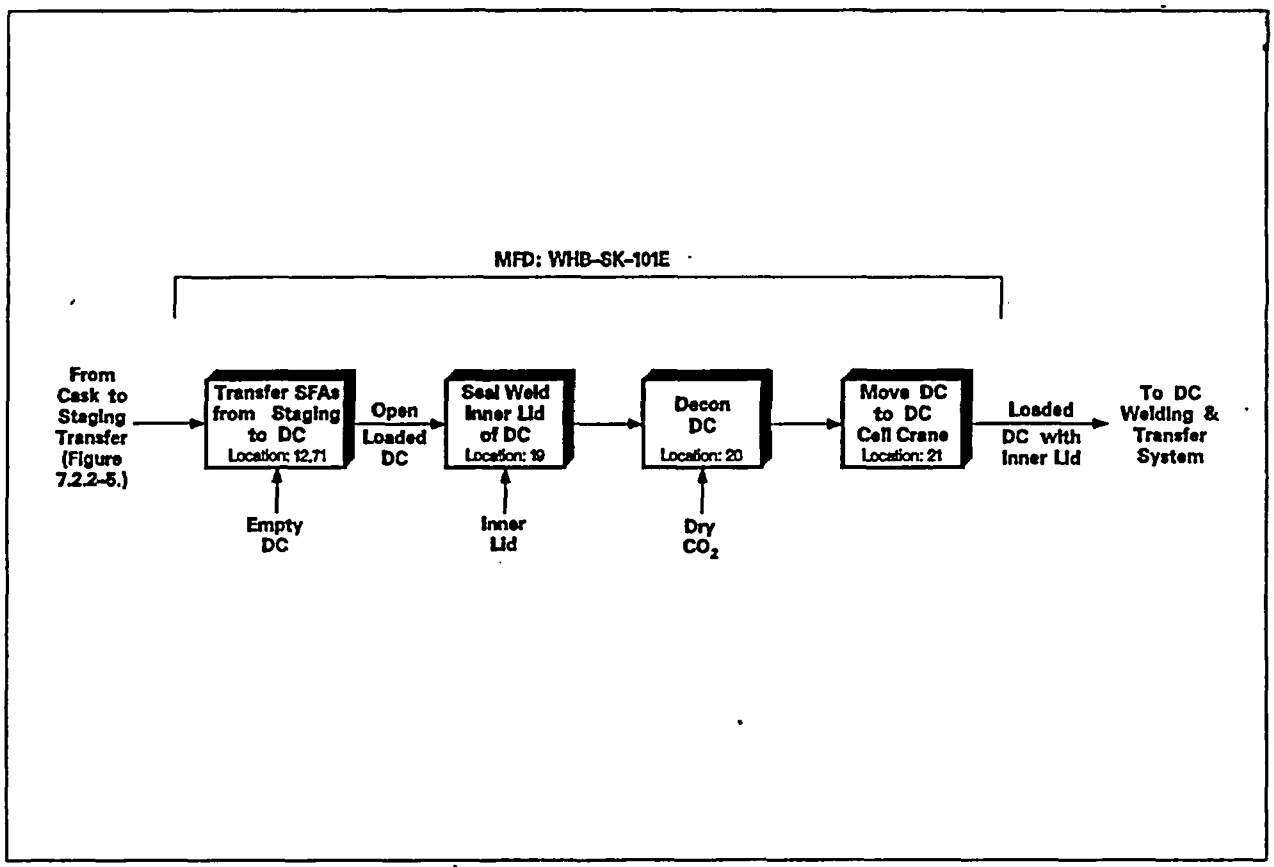

Figure 7.2.2-15. Uncanistered Waste Transfer System (Page 2 of 2)

When a disposal container's worth of SFAs has collected in the SFA staging rack, a disposal container for that type of SFA is requisitioned and positioned under the disposal container port in the disposal container port room (location 12) below the cell. The cell operations for loading a disposal container are as follows:

A. The disposal container port plug pneumatic seal is deflated.

B. The disposal container port plug is moved aside to open the port.

C. The contamination control barrier is installed on the disposal container.

D. The fuel transfer crane pulls one SFA out of a designated staging rack position into the fuel transfer crane mast.

E. The fuel transfer crane the SFA in the disposal container.

F. Operations D and E are repeated until the disposal container is full.

G. The inner surfaces of the contamination control barrier are cleaned with the dry ice decontamination method.

H. The contamination control barrier is removed from the port.

I. The disposal container port plug is moved back over the disposal container port.

J. The disposal container port pneumatic seal is inflated.

Both the cask and the disposal container ports are not opened at the same time. This method of operation accommodates a random bare SFA shipping schedule. By this method of operation, the duration for which a disposal container is attached to the disposal container port is only as long as it takes to continuously fill the disposal container from the bare SFA staging rack in the cell. Further, for reasons of safety, only one cell port, either the cask port or the disposal container port, is open at a time.

After loading, the disposal containers' inner lid is welded on in the performance confirmation and filler cell (location 19), the container is decontaminated in decon 3 (location 20), and the container is moved into the disposal container cell (location 21). The specific operations are described below:

A. The shielding door between the bare SFA disposal container port room and decon 3 is opened. The disposal container cart exits the port room, moves into the performance confirmation and filler cell and the shielding door is closed.

B. In the performance confirmation and filler cell, the disposal container cart aligns the disposal container to the laser port.

C. The performance confirmation and filler cell crane positions the disposal container inner lid for welding. The crane rotates the disposal container inner lid at the same rate at which the turntable on the cart rotates the disposal container. The laser directs a beam through the laser port and welds the disposal container inner lid to the disposal container. This weld is a shallow seal weld, designed to prevent the spread of contamination from inside the disposal container.

D. After welding, the shielding door leading into decon 3 opens. The disposal container cart exits the performance confirmation and filler cell into decon 3 and the shielding door closes.

E. In decon 3, the disposal container is decontaminated. This minimizes the spread of contamination by ensuring the disposal container is clean before it enters the lower contamination area of the disposal container cell.

F. The shielding door between decon 3 and the disposal container cell opens and the cart is moved onto the turntable in the disposal container cell. Here the cart is rotated 90° and moved to where the container can be accessed by the disposal container cell crane.

7.2.2.5.5 Canister Filler Addition System

Functions

The Canister Filler Addition System removes the lid from a sealed SFA canister, adds carbon steel shot to fill the voids between SFAs, and rewelds the lid back on the canister. The addition of filler material may be required for approximately 117 canisters as a criticality control measure. It is the function of this system to receive an SFA canister requiring filler material addition from the Canistered Waste Transfer System; cut and remove the top of the SFA canister; add filler material; replace the removed top; weld the canister top closed; decontaminate the sealed canister; and return the canister to the Disposal Container Welding and Transfer System. This system may fill 5 SFA canisters per year (average). Figure 7.2.2-13 presents a conceptual illustration of this system.

Scope

The Canister Filler Addition System receives loaded and sealed SFA canisters from the Canistered Waste Transfer System and filler material from the Warehousing System. This system returns sealed SFA canisters loaded with filler material to the Disposal Container Welding and Transfer System.

The Uncanistered Waste Transfer System also requires interfaces with the electric power, recycled water, and industrial air systems to operate components. The system operations are performed in the following WHB locations: Performance Confirmation and Filler Cell, Decon 3, Laser Room, and Equipment Room 2.

Operations

The Canister Filler Addition System is shown on Figure 7.2.2-16, and the areas used to conduct these operations are shown on the mechanical flow diagram WHB-SK-101E.

An SFA canister requiring filler is removed from an open disposal container and placed on a cart. The canister is moved from the disposal container cell (location 21), through decon 3 (location 20), and into the performance confirmation and filler cell (location 19). These operations are described below.

A. The disposal container cell crane transfers the SFA canister from an open disposal container to a transfer cart.

B. The transfer cart moves to the turntable and rotates 90°. The two shielding doors between the disposal container cell and the performance confirmation and filler cell are opened.

C. The SFA canister on the cart is moved from the disposal container cell, through decon 3 and into the performance confirmation and filler cell. The two shield doors are closed.

In the performance confirmation and filler cell, the top of the canister is cut and removed. The canister filler device swings into position. (The design of the canister filler device has not been conceptualized yet.) If necessary during filling, the turntable on the cart rotates the canister. After the filling operation, the canister top is replaced and the cart aligns the canister with the laser port. The laser then closes the canister through laser welding.

After filling, the loaded SFA canister is returned to the disposal container cell in the same manner as described in Section 7.2.2.5.4 for disposal containers containing uncanistered SFAs.

7.2.2.5.6 Cask Preparation and Shipping System

Functions

The Cask Preparation and Shipping System prepares empty shipping casks for off-site transfer and loads empty shipping casks on rail or truck carriers for on-site transfer to the CSS. The system also transfers empty shipping casks to the CMF for maintenance after waste unloading. The system supports the shipment of 638 casks per year (peak rate). The system is compatible with both rail and truck shipping casks. Figure 7.2.2-17 presents a conceptual illustration of this system.

Scope

The Cask Preparation and Shipping System receives unloaded shipping casks from the Uncanistered Waste Transfer System and the Canistered Waste Transfer System, maintained shipping casks from the CMF, and empty truck or rail carriers from the CSS. This system delivers empty shipping casks to the CMF for maintenance and returns empty shipping casks loaded on truck or rail carriers to the CSS.

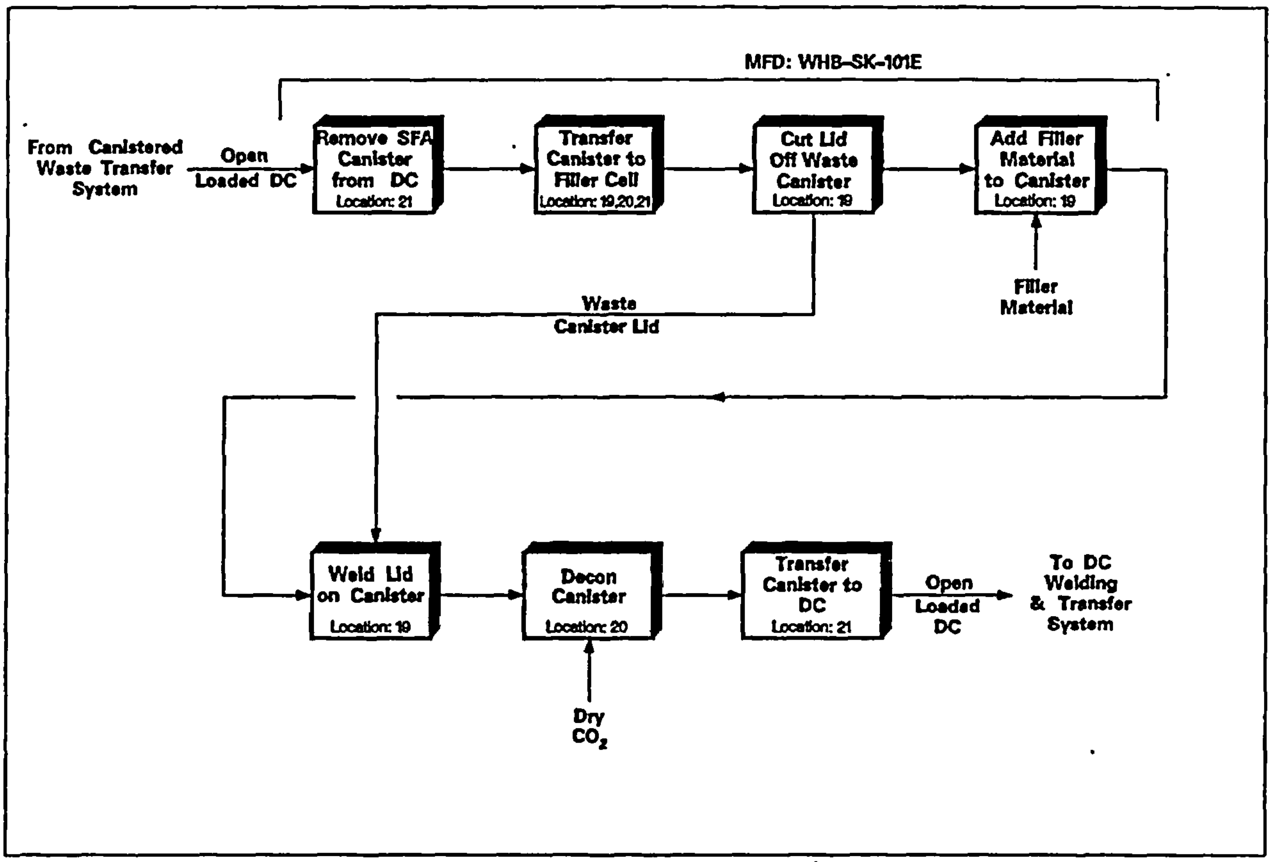

Figure 7.2.2-16. Canister Filler Addition System

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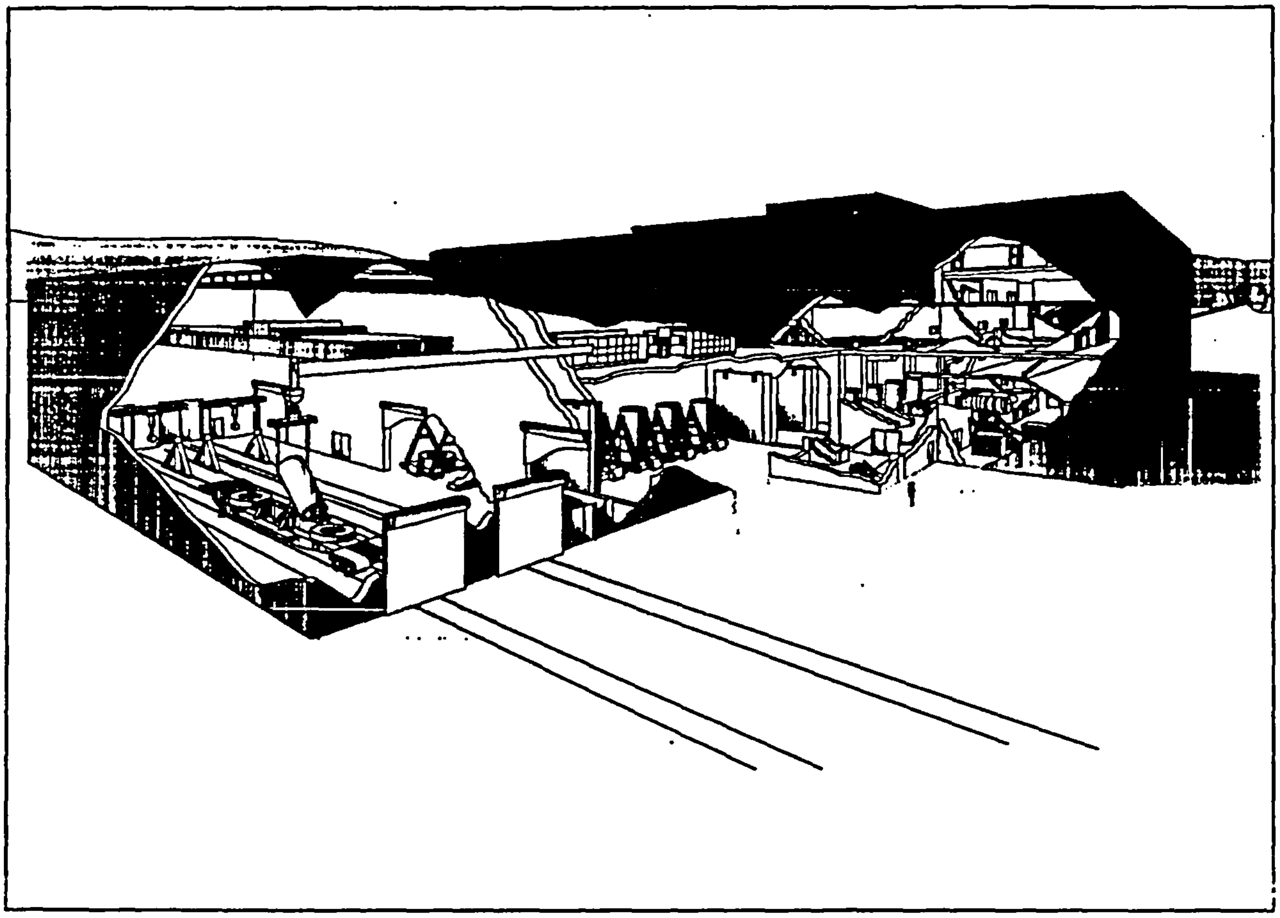

Figure 7.2.2-17. Cask Preparation and Shipping

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The Cask Preparation and Shipping System also requires interfaces with the electric power and industrial air systems to operate components. The system operations are performed in the following WHB locations: Unloaded Cask Prep Area, Airlock 4, and Carrier Bay.

Operations

The Cask Preparation and Shipping System is shown on Figure 7.2.2-18 and the areas used to conduct these operations are shown on the mechanical flow diagram WHB-SK-101F.

The Cask Preparation and Shipping System prepares a shipping cask for off-site transportation following waste unloading. The empty cask is delivered to the unloaded cask preparation area (location 14) by either the Uncanistered Waste Transfer System or the Canistered Waste Transfer System. The cask arrives closed and decontaminated. Cask preparation includes visual inspections, cask closure inspections, health physics inspections, and if necessary, purging of the cask cavity with an inert gas. These operations are safely conducted by direct contact because the casks do not contain waste materials

A cask that has been prepared for shipment is taken by the cart on which it rides into the carrier bay (location 1) through air lock 4 (location 15) as follows: The unloaded cask preparation area shielding door at the air lock 4 opens. The cart takes the unloaded cask into the air lock. The air lock closes. The door between the air lock and the carrier bay opens. The cask enters the carrier bay. The air lock door closes.

If the cask requires maintenance (e.g., recertification, repair or reconfiguration) it is transferred to the CMF on the preparation cart. Casks leaving the CMF are transferred to the WHB carrier bay on preparation carts.

In the carrier bay, an empty shipping cask is lifted from the preparation cart and loaded on a truck or rail carrier as described below:

A. A designated truck or rail carrier is moved to the carrier bay from the RCA parking area by the on-site prime mover.

B. The trunnion block bolter gantry servicing the entry lane is positioned at the cask. The trunnion block bolter remotely unbolts the trunnion blocks on the cask and removes the trunnion blocks. The carrier bay crane, with a yoke applicable to the shipping cask, engages the cask's lifting trunnions and lifts the cask off the preparation cart and onto the carrier until the cask is laying horizontally. The yoke is disengaged and the crane is moved aside.

C. The shipping cask leaves the WHB carrier bay through a roll-up door.

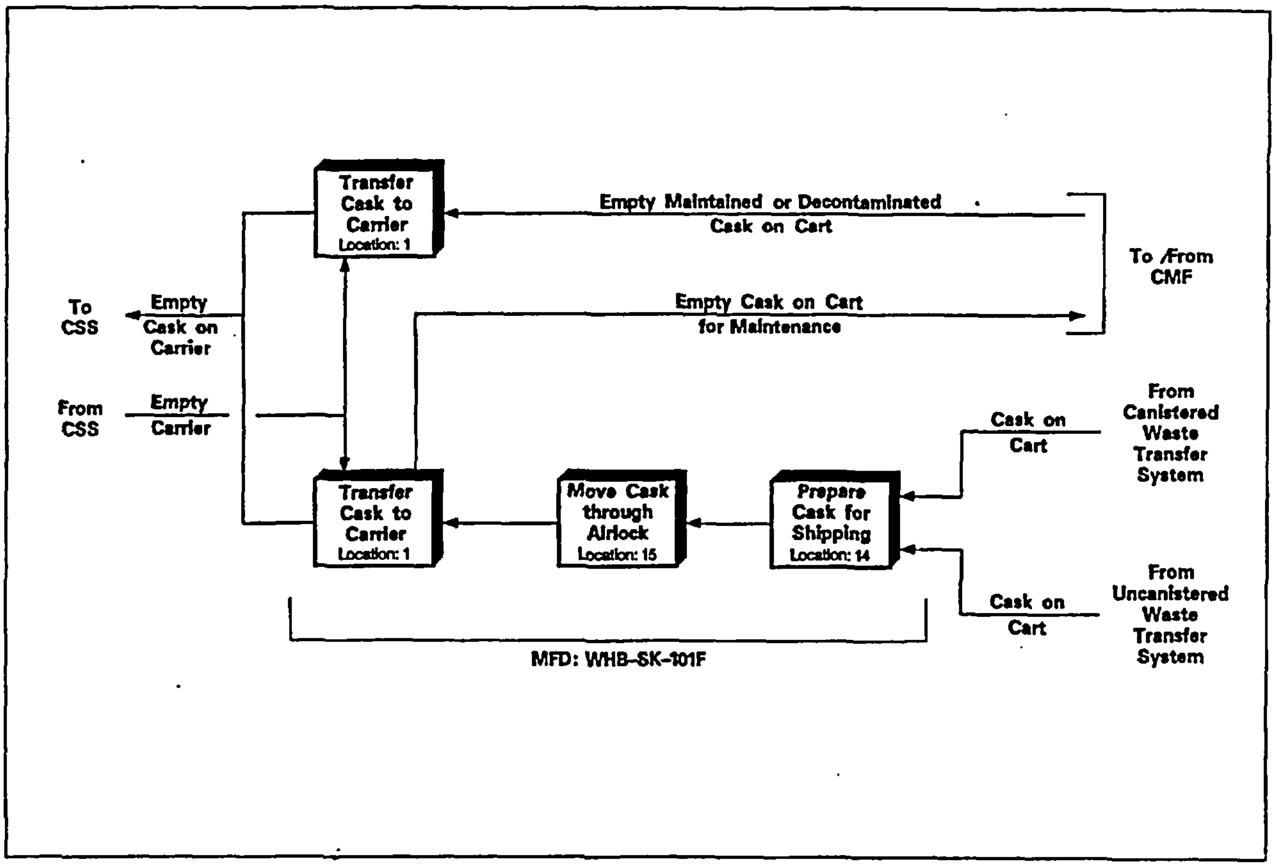


Figure 7.2.2-18. Cask Preparation and Shipping System

7.2.2.5.7 Performance Confirmation System

Functions

The Performance Confirmation System:

- Receives disposal containers retrieved from underground emplacement
- Examines surface corrosion and samples surface films, if required
- Opens the disposal containers and internal waste canister, as required, to remove samples for laboratory analysis (e.g., SFA materials, disposal container materials, and internal gases)
- Performs evaluation measurements
- Repackages the disposal container
- Replaces and seals the internal canister and/or disposal container lids
- Returns the disposal container to the waste package transporter for underground emplacement.

It is assumed that the WHB will be required to process a disposal container for performance confirmation once every ten years. Figure 7.2.2-13 presents a conceptual illustration of this system.

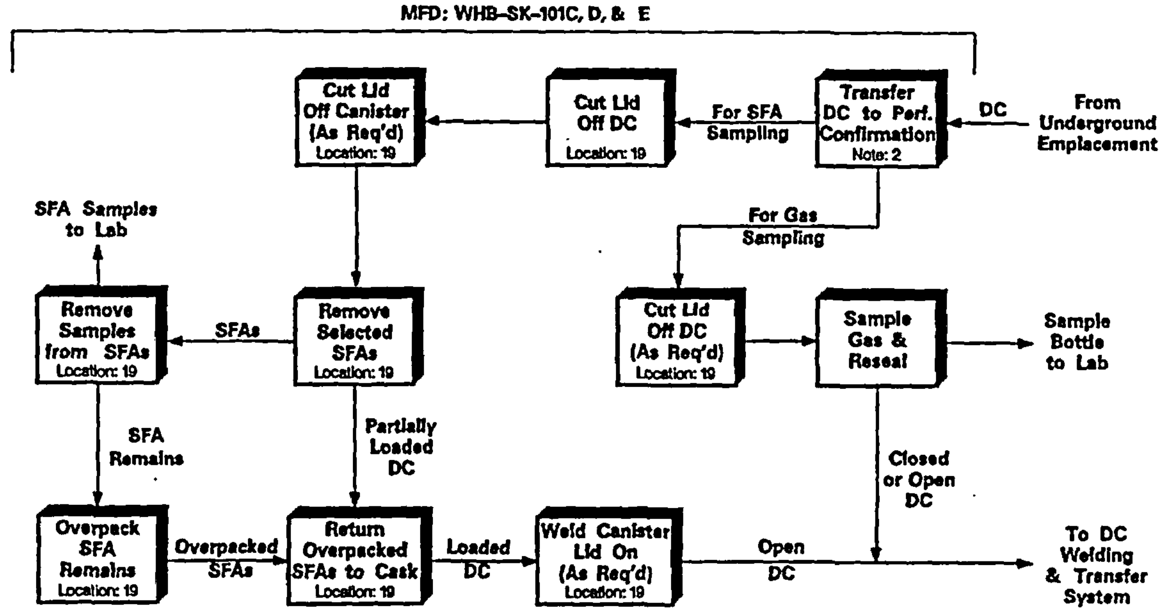
Scope

The Performance Confirmation System receives loaded disposal containers from the underground emplacement area. This system delivers samples to the WHB analytical laboratory and returns loaded disposal containers to the Disposal Container Welding and Transfer System.

The Performance Confirmation System also requires interfaces with the electric power and industrial air systems to operate components. The system operations are performed in the following WHB locations: Disposal Container Cell, Performance Confirmation and Filler Cell, Decon 3, and Laser Room.

Operations

The Performance Confirmation System is shown on Figure 7.2.2-19 and the areas used to conduct these operations are shown on the mechanical flow diagram WHB-SK-101C, D and E.



Notes: 1. Nondestructive evaluation measurements will be taken at various stages of DC disassembly.

2. Transfer from underground emplacement to performance confirmation cell passes through locations: 19,20,21,22,23,24, & 67.

Figure 7.2.2-19. Performance Confirmation System

A closed, loaded disposal container is unloaded from an underground waste package transporter and transferred to the performance confirmation and filler cell (location 19) as described below:

A. The shielding door to air lock 9 (location 67) opens. A waste package transporter enters the air lock. The outside air lock door closes and inside door opens.

B. The transporters own push-pull mechanisms pushes the waste package railcar, carrying the disposal container, partially out of the transporter and into the subsurface transfer room (location 24). The cart loader pulls the railcar completely into the subsurface transfer room. The door between air lock 9 and the subsurface transfer room door closes.

C. The shielding door to the subsurface transfer gantry room opens. The subsurface transfer gantry lifts the disposal container from the waste package railcar and moves the container into the subsurface transfer gantry room (location 23). The shielding door closes.

D. From the subsurface gantry room the disposal container is transferred through the east shielding door into the disposal container cell.

E. After the disposal container enters the disposal container cell and is rotated to a vertical position, the cell crane transfers the disposal container to the cart that takes the disposal container into the performance confirmation and filler cell.

F. The disposal container is next transferred to the performance confirmation and filler cell. The disposal container is put on a cart which takes the disposal container through decon 3 into the performance confirmation and filler cell.

In the performance confirmation and filler cell, operations take place to take evaluation measurements and remove samples for laboratory analysis. The specific testing and sampling requirements have not been determined. It is assumed that in some cases the disposal container and any internal waste canister would need to be opened to sample and test the waste materials (i.e., SFAs). In other cases less evasive testing will be adequate such as cutting a hole through the disposal container and taking an internal gas sample. The operations expected to be performed to conduct each of these options are described below.

For removing SFA samples for laboratory testing the following operations are likely to be performed:

A. The cart is positioned to make the lid of the disposal container accessible to the laser cutter. The laser cuts the lid off the container while the container is rotated by the cart it is riding on.

B. If the disposal container contains a sealed SFA canister, the canister's lid is also cut by the laser.

C. When access to the SFAs has been achieved, an SFA is lifted from the disposal container and samples are cut from the assembly by either the laser or another mechanism capable of making finer cuts. (The latter is not included in the present conceptual design of the

WHB.) The samples are packaged, cleaned, and safely removed from the cell through transfer drawers for subsequent analyses. Note that the samples can also be cut in the bare SFA transfer cell. No matter which cells the samples are cut in, the cut SFA is overpacked in an overpack canister and re-inserted into the disposal container.

D. The remains of the SFA are re-inserted.

E. If the disposal container contains a waste canister, the canister's lid is reinstalled by the laser.

F. The open disposal container is transferred from the performance confirmation cell in the same manner as described in Section 7.2.2.5.4 for disposal containers containing uncanistered SFAs.

For collecting a sample of the internal disposal container gas for laboratory testing the following operations are likely to be performed:

A. If the disposal container contains a sealed SFA canister, the lid of the disposal container is removed as described above.

B. A laser sampling device is positioned on the disposal container or waste canister lid. This device cuts a hole in the container, extracts a gas sample and reseals the hole. The gas sample is captured in a bottle located in an adjacent room.

C. The disposal container is transferred from the performance confirmation cell in the same manner as described in Section 7.2.2.5.4 for disposal containers containing uncanistered SFAs.

Non-destructive evaluation measurements will be taken at various stages of disassembly. These may include dimensional checks and dye penetrant tests.

7.2.2.5.8 HVAC System

Functions

The HVAC system for the WHB provides proper environmental conditions for the equipment used in this facility as well as for the health, safety, and comfort of operating personnel. Details of the WHB HVAC system are presented on HVAC Flow Diagrams WHH-SK-100, 101, 102A through 102L, and HVAC confinement drawings 103A through E in Appendix D.

Confinement Zones

The HVAC system is required to confine radioactive and hazardous materials within the WHB as close to the point of origin as practicable and also prevent uncontrolled releases to rooms and areas normally occupied by personnel. This confinement is accomplished by a series of successive confinement zones of varying pressures. Each successive confinement zone is at a lower pressure and has a higher potential for contamination.

The Primary Confinement Zone is at the lowest pressure. In the WHB this zone includes the enclosures that perform functions of opening or sealing casks, or loading and unloading nuclear material into or from casks, or provide decontamination functions. Examples: cells, decon rooms, port rooms, and the associated HEPA-filtered final exhaust air system.

The Secondary Confinement Zone includes enclosures and rooms that contain potentially contaminated process equipment, or rooms supporting primary confinement functions. Examples of areas that are classified as secondary confinement zones include the mechanical master-slave manipulator shops, warm maintenance enclosure, disposal container welding support enclosure, and associated HEPA-filtered final exhaust air system.

The Tertiary Confinement Zone include enclosures and rooms that do not have contact with the primary confinement but may become contaminated accidentally. Examples of areas that are classified tertiary confinement zones include the operating galleries, corridors, health physics rooms, storage, prep stations, and associated HEPA-filtered final exhaust air system.

The other areas of the facility are normally clean and do not have potential for contamination. These areas are designated Neutral Areas and are required to be maintained at a higher pressure than the adjacent tertiary confinement zone. Provisions are made to prevent these areas from becoming more negative than any adjacent tertiary confinement zone. Examples of neutral areas are the carrier bay, entry air locks, lobby, exit stairwells, vestibules, offices, administration, change rooms, break rooms, and spare parts room.

Scope

The HVAC system for the WHB includes the components necessary for continuous operation during normal or off-normal conditions and is designed to maintain the WHB at the proper environmental conditions for the health, safety, and comfort of operating personnel as well as for the equipment used in the facility. The system is comprised of the components listed on the HVAC flow sketches WHH-SK-100, 101, 102A through 102L, and HVAC confinement drawings 103A through E in Appendix D including: tornado dampers, fans (supply, return and exhaust), air handling units, air curtains, exhaust HEPA filter units, flow measuring elements, isokinetic sampling system, control dampers, ductwork, and an exhaust stack.

The system also requires interfaces with the following support systems:

A. Normal, standby or emergency electric power to operate the components such as instruments, fans, and air heaters during normal and off-normal operation as confirmed by safety analysis

B. Instrument air to operate instruments and pneumatic operators

C. Chilled water to provide air cooling

D. Fire protection fire panels, smoke and temperature detectors to activate the closure of fire dampers in the ductwork or initiate the HEPA protection deluge systems that are integral part of the ventilation system.

E. WHB structure to house system components

Operations

The HVAC System is comprised of three separate, independent subsystems designed to operate continuously. The first is a subsystem that in conjunction with the cells, port rooms, and decon rooms comprises the primary confinement zone of the WHB. The second is a subsystem that serves the secondary and tertiary confinement zones of the WHB. The third is a subsystem that serves the shipping and receiving carrier bay area. The subsystems are shown on HVAC flow sketches contained in Appendix D. These sketches describe the rate and flow path of air through the system components.

Primary Confinement Areas HVAC Subsystem

The WHB Primary Confinement Areas HVAC Subsystem is a separate, independent, once-through, automatic ventilation subsystem designed to: operate continuously, maintain proper design conditions for the equipment; and provide contamination confinement. The subsystem serves the cells, port rooms, and decon rooms in the WHB. The subsystem is shown on HVAC flow sketches WHH-SK-102A, 102C, 102I, and 102K.

The primary confinement zone is maintained at a negative pressure of -0.7" wg with respect to the secondary confinement.

The subsystem consists of dedicated supply air handling units and associated supply air fans, exhaust is discharged to the outside environment by a dedicated final exhaust unit with two testable stages of HEPA filters, associated primary confinement final exhaust fans, and exhaust air stack. The primary confinement negative pressure is maintained by the final exhaust fans which modulate to compensate for variances due to the final HEPA filter loading. Corrosive vapors, noxious gases or vapors, and flammable (or combustible) gases are not anticipated from these exhausts.

Secondary and Tertiary Confinement Areas HVAC Subsystem

The WHB Secondary and Tertiary Confinement Areas HVAC Subsystem is a separate, independent, once-through, automatic ventilation subsystem designed to: operate continuously; maintain proper environmental conditions for the health, safety, and comfort of personnel; maintain proper design conditions for the equipment; and provide contamination confinement. The subsystem consists of dedicated supply air handling units and associated supply air fans, and final exhaust units with two testable stages of HEPA filters, associated final exhaust fans, and exhaust air stack.

The negative pressure in secondary confinement areas is maintained at -0.3" wg and the tertiary confinement areas at -0.15" wg with respect to the outside atmosphere by modulating the supply air flow and providing constant exhaust. The final exhaust fans modulate to compensate for variances due to final HEPA filter loading

The subsystem is shown on HVAC flow sketches WHH-SK-102B, 1O2D through H, 102J, and 102K.

The WHB processing areas are equipped with Continuous Air Monitoring systems.

The components of this subsystem along with the components of the primary confinement subsystem are located in a separate, dedicated equipment room. The components are of nuclear-grade quality comprised of air handling units, fans, pumps, air distribution equipment, and instrumentation. The exhaust is comprised of bag-out housings with two stages of HEPA filters and adequate provisions for testing, inspection, monitoring, maintenance, and repair operations. The HEPA filtration has a minimum start-up efficiency of 99.97 percent as tested in accordance with ANSI-N510. Electric heating is selected as the preheating and reheating media for estimate purposes in the absence of an energy conservation analysis (to be performed later). The ductwork is of welded carbon steel constructed in accordance with Sheet Metal and Air-conditioning Contractors National Association high-pressure standards.

Neutral Areas HVAC Subsystem

The Neutral Areas HVAC Subsystem provides the ventilation for various contamination free functional areas such as:

A. Carrier Bay and equipment room : This functional area is of the recirculation type designed to operate normally with approximately 10 percent outside air ventilation, designed to, maintain space design conditions, and ensure proper indoor air quality. This ventilation concept is shown on HVAC flow sketch WHH-SK-101.

B. The offices and miscellaneous rooms HVAC subsystem is of the recirculation type designed to operate normally with approximately 10 percent outside air except that the change rooms are provided with once-through ventilation with a single stage of HEPA filters. This ventilation concept is shown on HVAC flow sketch WHH-SK-102L.

The components for the neutral areas subsystem are of industrial-grade quality and are comprised of air handling units, fans, pumps, air distribution, and control instrumentation. The filters are 30 and 90 percent efficiency filters. The change rooms HEPA filters have a minimum start-up efficiency of 99.97 percent as tested in accordance with ANSI-N510. Electric heating is selected as the preheating and reheating media for estimate purposes in the absence of an energy conservation analysis (to be performed later). The ductwork is of galvanized steel construction in accordance with Sheet Metal and Air-conditioning Contractors National Association low-pressure standards.

7.2.2.5.9 Other Systems

The operation of the WHB requires a number of additional systems that are listed and briefly described in this section.. The WHB support systems include building utilities, security, monitoring, and control systems required to safely, and effectively maintain waste handling operations. These facility specific support systems are listed below.

A. Power Distribution System including 480/208/120 VAC and the safety bus.

B. Water Distribution System for supplying fire water, potable water, chilled water, and recycled water from the WTB.

C. Sanitary Waste Collection System for the removal of facility sanitary waste.

D. Secondary Waste Collection System for the collection and containment of facility generated LLW and HW.

E. Communications Systems including, telephone/public address, video, data, and secure networks.

F. Facility Monitor and Control System to monitor and control building utilities and material handling

G. Radiological Monitoring System for monitoring facility radiological performance and support to health physics activities

H. Fire Protection and Detection System for manual and automatic initiation of fire suppression, and alarm equipment

I. Security Systems including the following subsystems: physical protection and safeguards, intrusion alarm system, communications, facility security station

J. Office Systems for supporting administrative, planning, and engineering activities

K. Decontamination Systems including water washing and dry carbon dioxide spraying

L. Industrial Air System supporting pneumatic control equipment and industrial air stations.

M. Material Handling System for controlling the electromechanical equipment dedicated to handling and maintaining casks/furnishings, SNF, and waste package/furnishings.

Each of the WHB support systems are briefly described below:

Power Distribution System

The Electrical Power System distributes power throughout the facility to support HVAC, material handling equipment, uninterruptible power supply, battery chargers, instrumentation systems, computer and office equipment, lighting, and general purpose users. Electrical equipment consists of the 480/208/120 volt transformers, facility grounding system, panel boards, cable and conduit, uninterruptible power supply systems, lighting and controls, power meters, termination panels and outlets, and a lightning protection system.

Equipment important to maintaining safety is connected to the facility safety bus including, HVAC, fire detection, security, emergency lighting, communications, and public address equipment. The safety bus is automatically activated following a power failure, including operation of the Standby Generators. Certain material handling equipment may be connected to the bus or provided alternate power for short term recovery operations. Safety bus equipment is installed separately from the general electrical service, and tagged with a unique identifier.

Battery powered uninterruptible power supply is provided for equipment that is adversely impacted by power brown-out, transients or short term interruptions. Security, fire detection, emergency lighting, Facility Monitor and Control System, and communications equipment are powered from the uninterruptible power supply.

Water Distribution System

The Water Distribution System supplies fire, potable, chilled, and recycled water to users throughout the facility. Each water service, which is described below, is independently piped, and tagged with a unique identifier:

A. Fire water is valved and metered at the facility, and services the Fire Protection System, and industrial water user stations.

B: Potable Water is valved and metered at the facility, and distributed throughout the building for servicing drinking, toilet, and sanitary water stations.

C. Chilled Water is valved, and metered at the entry to the facility, and distributed to the facility HVAC systems. Chilled water flow, pressure, and valving are controlled and monitored by the Facility Monitor and Control System.

D. Recycled Water is produced at the WTB by treating recyclable low level liquid waste. The recycled water is stored at the WTB collection and distributed to the WHB and other facilities.

Sanitary Waste Collection System

Sanitary waste is piped from the facility to the Sanitary Waste Collection System distributed throughout the site. The Sanitary Waste Collection System is comprised of a facility network of sanitary waste piping.

Secondary Waste Collection Systems

Recyclable and non-recyclable low-level liquid waste generated within the WHB is accumulated at the facility. The waste collection system includes the pumps and controls required to transfer the waste to the WTB for processing.

Communications Systems

The Communications Systems includes: telephone, video, data, and public address/warning equipment, and networks as described below:

A. Telephone stations are provided and connected to the facility communications network and to the site communications backbone connecting with the site telephone exchange.

B. Video cameras are provided at security stations throughout each building. Video data is included on the Security System network, and can be viewed at the facility security control room, and to other security stations at the site. Video cameras are installed at certain waste handling stations to assist in waste handling, waste packaging, and equipment repair operations. Video display is supported at Facility Monitor and Control System and Material Handling System operator stations as required.

C. Data networks are distributed throughout the facility to support the monitoring and control systems, and office systems. Dedicated, redundant networks are provided for fire detection, security, radiological monitoring, and Facility Monitor and Control System. Security and fire detection system networks are tamper proof, individually routed, and are not routed through other facility systems.

D. The public address/warning equipment provides for automatic and security initiated warning tones, beacons, advisories, and announcements. Facility Speaker and Alarm Panels are installed throughout the operational areas and are bridged to the facility security and communications network. The equipment and network are powered by uninterruptible power supply.

Facility Monitor and Control System

The Facility Monitor and Control System provides central and local monitoring and control of facility support systems including, power, water, HVAC, and miscellaneous mechanical, and support systems. Facility monitor and Control System equipment includes the instrumentation, controls, multiplexers, cable/cable trays, data network, local control stations, annunciators, computers/servers, operator workstations, and printers. The main control room and local control stations associated with this system are described below:

A. The main control room centralizes and integrates the operational activities of the facility. The main control room equipment includes computers, servers, printers, data storage equipment, video displays, and operator workstations. The operator workstations provide supervisory control and monitoring of the Facility Monitor and Control System, material handling system, and radiological monitoring system, software program development, and operator training.

B. Local Control Stations consisting of manual (hardwired) panels or industrial workstations are installed at process equipment stations. These panels support manual process control, emergency, and maintenance activities. Certain local maintenance stations may be supported with portable computers. When local control is selected, the central operator workstation is in a monitor only mode.

Radiological Monitoring System

The radiological monitoring system measures, alarms, trends, displays, and reports radiation levels throughout the facility. The radiological monitoring system also collects radiation data from the Facility Monitor and Control System and material handling systems, HVAC, and other site and plant effluent measurement instruments. Radiological monitoring system equipment includes the radiation instruments, audio/visual alarm panels, communications network, computer/servers, operator workstations, and printers. Radiation instruments include monitors for effluents, HVAC exhausts, areas, portals, hand and foot measurements, process measurements, and continuous air monitors. A vacuum system services the continuous air monitors and HVAC exhaust monitors; however, the vacuum equipment may be integral to the analyzer package.

The radiological monitoring system also encompasses the Health Physics (HP) operations that monitor the facility radiological environment, and coordinate HP activities with the central HP office, security, medical, and other occupational safety offices. HP acquires, displays, and records data from the radiological monitoring system, continuous air monitors, and dosimeters, and maintains that equipment. HP equipment includes the laboratory/calibration instruments, calibration sources, computers, workstations, and printers. The computer is connected to the site network providing access to the HP data base, and meteorological data.

Fire Protection and Detection System

The Fire Protection and Detection system provides automatic and local manual initiation of fire suppression and, alarms. The major subsystems are described below:

A. The fire protection subsystem is a wet pipe sprinkler and fire extinguisher system. The system includes the fire water distribution piping, control valves, sprinkler heads, strategically placed fire hose stations, and fire extinguishers. Fire actuated dampers may be provided near certain radiation areas to automatically close off the air supply when a fire is detected in that area.

B. The fire detection subsystem is a dedicated caution and warning system distributed throughout the facility. The system consists of smoke detectors, thermal detectors, cable/conduit, pull boxes, fire alarm panels, water flow and pressure instruments, and the fire detection system communications network.

C. The emergency response subsystem includes fire and smoke alarms, which are initiated at the local fire panels, fire alarm control center, security stations, and Facility Monitor and Control System stations.

Security System

The Security System prevents unauthorized personnel and vehicle access to the facility, protects from sabotage and theft, and supports safety operations. Security equipment includes the barriers, intrusion alarm system, video surveillance system, security panels, cable/conduit, central control room, communications network, security lighting, and backup power equipment. Security equipment is installed, and routed independent of the other facility equipment. Control room, instruments, signal, and termination equipment are tamper proof. The major subsystems are described below:

A. Physical protection and safeguards subsystem – Physical barriers are installed at the facility to control and divert personnel and vehicles through designated security portals which are designed for effective identification and searches. Primary portals are controlled with electric locks initiated by card access or security personnel. Electric door locks include battery, uninterruptible power supply, or mechanical backup control. Visual searches are performed with the aid of portable detectors or instruments.

B. Intrusion Alarm System – The Intrusion Alarm System provides automatic detection and alarm of unauthorized facility ingress and egress. Access portals are electrically monitored or controlled. Video cameras are located at strategic operating areas throughout the facility. Restricted or unfrequented areas are monitored with intrusion or motion detectors.

C. Communications – Security equipment communicates with the facility and the site on dedicated networks. The network is bridged to the other facility networks for fire and radiological alarms, voice communications, and public address. It is bridged to the site network backbone, supporting data and voice interchange with central security, and to the emergency centers.

D. Facility Security Station – The facility security station provides central monitoring of the intrusion alarm system and serious facility alarms. It is located in a protected room without windows, and is manned twenty four hours a day. The equipment includes, a computer workstation, printer, central alarm display, video displays and controls, public address equipment, and emergency communications.

Office Systems

The Office Systems support the administrative, planning, and engineering activities associated with operations specific to the facility. The systems are connected to the site network and are configured to annex the primary activities performed at the Administrative Building. The office equipment consists of computers, servers, workstations, facsimile, printers, and copiers.

Decontamination Systems

There are a variety of Decontamination Systems under consideration for the WHB. Fire water and recycled water hoses and fittings are available at all decontamination stations to provide water washing capability. A dry carbon dioxide Decontamination System will be installed at various locations in the WHB.

Industrial Air System

The Industrial Air system includes valves and meters at the facility, and a distribution network throughout the building for servicing pneumatic controls and industrial air user stations.

Material Handling System

The WHB material handling system controls the electromechanical equipment dedicated to handling and maintaining casks/furnishings, SNF, and waste package/furnishings. Electromechanical equipment includes the cranes, powered manipulators, tooling, shield door actuators, camera controls, decontamination equipment, welders and inspection instruments dedicated to removing, storing, and packaging the waste, and for remote maintenance. Operator stations are installed at material handling stations throughout the facility, and are customized for the equipment at each location. Operator station equipment includes a main panel/console, workstation, video displays, multiplexers, cable/conduit, data network, and printer.

Main Control Room: The main control room centralizes and integrates the operational activities of the facility. The main control room equipment includes computers, servers, printers, data storage equipment, video displays, and operator workstations. The operator workstations provide supervisory control and monitoring of the Facility Monitor and Control System, material handling system, and radiological monitoring system, software program development, and operator training.

Local Control Stations: Manual (hardwired) panels or industrial workstations are installed at major facility equipment stations. These panels support manual process control, emergency, and maintenance activities. Certain local maintenance stations may be supported with portable computers. When local control is selected, the central operator workstation is in a monitor only mode.

7.2.2.6 Components Data

The list for all major components associated with the WHB are provided in Table 7.2.2-8. This table includes the sketch number of the associated mechanical flow diagram, component location, equipment number, component description/capacity, Construction Specifications Institute specification number, and remarks codes. The remarks codes are defined as follows:

- AD Additional descriptions of the component are provided following the component table.
- CA The component is commercially available.
- MCA The component can be built by modifying commercially available equipment.
- ND The component is not available commercially (i.e., a new design is required)
- WP The component is to be designed by the Waste Package Development group. Mechanical and other interfaces with the WHB will be defined later.

Considerations for component maintenance and recovery from failed component operations are described following the additional descriptions at the end of the component table.

Additional Component Descriptions

Expanded descriptions are provided below for many of the components listed in Table 7.2.2-8. Components with "AD" in the remarks column have such descriptions.

HI-030, Carrier Bay Crane, Quantity 1. This is an overhead 125-ton capacity bridge crane with a 25-ton auxiliary hook. The crane lifts loaded shipping casks off rail and truck carriers and lowers unloaded shipping casks onto rail and truck carriers.

HI-035, Equipment Hoist, Quantity 1. For the maintenance of the carrier bay crane, a maintenance platform is provided in the carrier bay. The equipment hoist serves the function of lifting heavy parts and tools up to the maintenance platform during the maintenance of the carrier bay crane.

HI-040, Trunnion Block Bolter Gantry, Quantity 2. This is a 2-ton gantry that spans across an access lane in the carrier bay. The gantry is wide and high enough to clear the largest shipping cask and its carrier. The purpose of the gantry is to carry the trunnion block bolter, which is described below. Two gantries are provided, one for each of the two access lanes in the WHB.

HI-050, Disposal Container Crane, Quantity 1. The disposal container crane is an overhead bridge crane of 125 tons capacity with an auxiliary hook of 25 tons capacity. The crane spans the entire width of the disposal container cell. The crane serves the following functions: 1) Transfer SFA canisters from rail shipping casks to disposal containers, 2) Transfer canisters of DHLW from rail shipping casks to disposal containers, 3) Move loaded and unloaded disposal containers between various locations in the disposal container cell, 4) Lift cell equipment that needs repair into the maintenance bay serving the disposal container cell.

HI-062, Welding Electromechanical Manipulator, Quantity 1. The purpose of the welding electromechanical manipulator is to assist with the disposal container welding activities in the disposal container cell. The remotely controlled welding electromechanical manipulator is mounted on a track which travels the length of the cell wall against which the welding stations are lined. The electromechanical manipulator can be positioned above any of the welding stations to provide welding support such as coupling and uncoupling hoses, power lines, and if necessary, weld filler metal supply tubes. In addition, the electromechanical manipulator assists the cell crane with the positioning of welders onto disposal containers.

Table 7.2.2-8. WHB Major Component List

Location (Ref.- Desc.)	Equip. No.	Description - Capacity	No. Units	CSI Spec. No.	Remarks
1- Carrier Bay	HI-030	Carrier bay crane - 125 bridge, 25 ton auxiliary	1	14630	AD, CA
	HI-035	Equipment hoist	1	14620	AD, CA
	HI-040	Trunnion block bolter gantry - 2 ton	2	14640	AD, CA
	ME-018	Loaded cask preparation area recovery cart	1	14510	AD, MCA
	ME-019	Winch	1	14610	CA
	ME-020	Roll-up door	4	Not needed	CA
	ME-021	Lifting yoke - large SFA canister cask	1	14600-1	CA
	ME-022	Lifting yoke - small SFA canister cask	1	14600-1	CA
	ME-023	Lifting yoke - truck cask	1	14600-1	CA
	ME-024	Trunnion block bolter	2	11500-1	AD, MCA
	ME-025	Loaded cask preparation cart	4	14510	AD, MCA
	ME-030	Shield door	1	08315	AD, ND
2- Air Lock 1	ME-030	Shield door	1	08315	AD, ND
3- Loaded Cask Preparation Area	ME-030	Shield door	1	08315	AD, ND
	ME-035	Master-slave manipulator	8	14522	ND
	ME-040	Shielding window	4	08570	CA
	ME-045	Preparation area glove box	2	13090	MCA
	ME-046	Vent & purge system	4	15480	MCA
	ME-047	Loaded cask preparation area recovery winch	4	14610	CA
	ME-048	Preparation area Automatic Guided Vehicle	1	14510	MCA
7- Decon 1	ME-050	Decon device	1	15480	AD, MCA
	ME-055	Monorail cask lifting device	1	14620	AD, MCA
	ME-060	Lifting yoke - large SFA canister cask	1	14600-1	CA
	ME-061	Lifting yoke - small SFA canister cask	1	14600-1	CA
	ME-062	Lifting yoke - truck cask	1	14600-1	CA
	ME-065	Shield door	1	08315	ND
9-Canistered Waste Cask Room	ME-070	Transfer cart	1	14510	ND
	ME-075	Cask lid bolter	1	11500-1	AD, ND
	ME-076	Cask lid remover	1	11500-1	AD, ND
	ME-080	Decon device	1	15480	MCA
	ME-107	Shield door	1	08315	ND

Table 7.2.2-8. WHB Major Component List (continued)

Location (Ref.- Desc.)	Equip. No.	Description - Capacity	No. Units	CSI Spec. No.	Remarks
142- Disposal Container Cell & Maintenance Bay	HI-050	Disposal container crane - 125 ton bridge, 25 ton auxiliary hoist	1	14630	AD,CA
	HI-060	Buddy crane - 25 ton bridge	1	14630	MCA
	HI-062	Electromechanical manipulator - welding	1	14640	AD,CA
	ME-085	CO_2 pelletizer	1	15480	ND
	ME-090	Decon device	1	15480	AD, MCA
	ME-095	Disposal container buddy cart	1	14510	MCA
	ME-096	Winch	1	14610	MCA
	ME-100	Shield door - maintenance bay	1	08315	ND
	ME-105	Crane return winch	1	14610	MCA
	ME-110	Shielding window	9	08570	CA
	ME-115	SFA canister ACGLF - universal	1	14600-2	AD, ND
	ME-117	Disposal container ACGLF - universal	1	14600-2	AD, ND
	ME-120	Disposal container lid lifting fixture - universal	1	14600-2	ND
	ME-125	Welder lifting device	1	11500-2	ND
	ME-130	Welder	15	11500-3	AD, ND, WP
	ME-140	Horizontalizer	1	14500	AD, ND
	ME-145	Disposal container transfer gantry	1	14640	AD, ND
	ME-365	Shield door	1	08315	ND
	ME-370	Turntable	1	14700	MCA
5- Equipment Room 3	ME-135	Motor - horizontalizer	2	15170	CA
22- Decon 4	ME-150	Disposal container saddle	1	Not needed	AD, ND
	ME-155	Shield door	1	08315	ND
	ME-160	CO_2 pelletizer	1	15480	CA
	ME-165	Decon device	1	15480	AD, MCA
	ME-167	Shielding window	2	08570	CA
23- Subsurface Transfer Gantry Room	ME-170	Shield door	1	08315	ND
	ME-172	Shielding window	1	08570	CA
	ME-175	Subsurface transfer gantry	1	14640	AD, ND
24- Subsurface Transfer Room	ME-176	Shield door	1	08315	ND
	ME-177	Disposal container railcar loader - pneumatic	1	14610	AD, MCA
	ME-178	Shielding window	1	08570	CA
	ME-180	Shield door	1	08315	ND

Table 7.2.2-8. WHB Major Component List (continued)

Location (Ref.- Desc.)	Equip. No.	Description - Capacity	No. Units	CSI Spec. No.	Remarks
67- Air Lock 9	ME-182	Shielding window	1	08570	CA
	ME-185	Roll-up door	1	Not needed	CA
13 - Decon 2	ME-065	Shield door	1	08315	ND
	ME-200	Decon device	1	15480	AD, MCA
12- Bare SFA Cask Port Room	ME-210	Decon device	1	15480	MCA
	ME-220	Transfer cart	1	14510	ND
	ME-225	Cask lid bolter	1	11500-1	AD, ND
	ME-226	Cask lid remover	1	11500-1	AD, ND
71 - Bare SFA Transfer Cell & 138- Bare SFA Maint. Bay	HI-065	Buddy crane - 10 ton	1	14630	MCA
	HI-070	Fuel transfer crane - 5 ton	1	14630	AD,MCA
	HI-072	Equipment hoist - 10 ton	1	14620	AD,CA
	HI-075	Grapple electromechanical mechanical manipulator	1	14630	MCA
	HI-080	Decon electromechanical mechanical manipulator	1	14630	MCA
	ME-190	Crane return winch	1	14610	MCA
	ME-205	Decon device	1	15480	MCA
	ME-215	Contamination control barrier lifting device	1	14600-3	MCA
	ME-230	Contamination control barrier	2	13090	AD, ND
	ME-235	Port plug - bare SFA cask port room	1	08315	AD, ND
	ME-245	Shield door - maintenance bay	1	08315	ND
	ME-247	Grapple - BWR SFA	1	14600-4	MCA
	ME-248	Grapple - PWR SFA	1	14600-4	MCA
	ME-250	Overhead decon device	1	15480	MCA
	ME-252	Shielding window	3	08570	CA
	ME-255	Bare SFA staging rack shield plug - PWR	1	08315	MCA
	ME-265	PWR SFA staging rack (28 positions)	1	10680	AD, ND
	ME-270	Bare SFA staging rack shield plug - BWR	1	08315	ND
	ME-280	BWR SFA staging rack (48 positions)	1	10680	AD, ND
	ME-290	Contamination control barrier	2	13090	ND
132- Equipment Room 1	ME-295	Port plug (bare SFA disposal container port room)	1	08315	AD, ND
	ME-195	CO_2 pelletizer - maintenance bay	1	15480	CA
	ME-240	Motor - bare SFA cask port plug	1	15170	CA
	ME-260	Motor - bare SFA staging shield plug - PWR	1	15170	CA
	ME-275	Motor - bare SFA staging rack shield plug - BWR	1	15170	CA
	ME-300	Motor - bare SFA disposal container port room shield plug	1	15170	MCA

Table 7.2.2-8. WHB Major Component List (continued)

Location (Ref.- Desc.)	Equip. No.	Description - Capacity	No. Units	CSI Spec. No.	Remarks
	ME-305	CO_2 pelletizer - bare SFA transfer cell	1	15480	CA
12- Bare SFA Disposal Container Port Room	ME-253	Shielding window	2	08570	CA
	ME-285	SFA disposal container cart	1	14510	AD, ND
19- Performance Confirmation (PC)/ Filler Cell & 137- Performance Confirmation Maint. Bay	HI-085	PC & filler cell crane - 10 ton bridge	1	14630	AD,MCA
	HI-090	Electromechanical mechanical manipulator	1	14630	MCA
	HI-095	Buddy crane - 10 ton	1	14630	MCA
	ME-310	Shield door	1	08315	ND
	ME-315	Disposal container lid lifting device - universal	1	14500	ND
	ME-317	SFA canister lid lifting device - universal	1	14500	AD, ND
	ME-321	Laser beam port	1	08570	ND
	ME-325	Filler loading device	1	14570	ND, WP
	ME-330	Shielding window	3	08570	CA
	ME-335	Shield door - maintenance bay	1	08315	ND
	ME-355	Decon device	1	15480	MCA
	ME-360	Crane return winch	1	14610	CA
31- Laser Room	ME-320	Laser welding & cutting machine	1	11500-4	AD, MCA
133- Equipment Room 2	ME-345	CO_2 pelletizer	1	15480	CA
20- Decon 3	HI-100	Electromechanical mechanical manipulator	1	14630	CA
	ME-340	Shield door	1	08315	ND
	ME-342	Shielding window	4	08570	CA
	ME-350	Decon device	1	15480	AD, MCA
14- Unloaded Cask Prep	ME-030	Shield door	1	08315	ND
	ME-380	Work platform	1	14800	CA
	ME-385	Cask cavity pressurization equipment	4	15480	MCA
15- Air Lock 4	ME-030	Shield door	1	08315	ND
	ME-390	Unloaded cask preparation area cart	4	14510	MCA

ACGLF = Automatic Center of Gravity Lift Fixture
CSI = Construction Specifications Institute
CO_2 = Carbon dioxide

HI-070, Fuel Transfer Crane, Quantity 1. The fuel transfer crane is a 5-ton overhead bridge crane mounted with a telescoping mast, the cross section of which is sized to accommodate a bare SFA of the largest cross section. See sketch WHM-SK-101I. The telescoping feature of the mast allows the bottom of the mast to be lowered through the port of the bare SFA cell down to as close as possible to the top of the truck shipping cask positioned in the bare SFA cask port room below the cell. Two closed circuit television cameras are mounted on the fuel transfer crane to aid in the accurate positioning for SFA transfer operations. HVAC equipment mounted on the bridge crane provides a slight negative pressure relative to the cell's ambient pressure inside the mast during SFA transfer so that the spread of the contamination shed by the bare SFA is minimized. To further minimize the spread of contamination during bare SFA transfer, the bottom of the mast has a door that closes after a bare SFA has been pulled into it. The air drawn into the mast is ducted to the SFA cell's HEPA filtration systems. The fuel transfer crane conceptualized for the WHB is the equal of an existing technology called Fuel Master Fuel Handling System developed by PaR Systems, Inc. and operating at the Calvert Cliffs reactor since 1992.

HI-072, Equipment Hoist, Quantity 1. Adjacent to the fuel transfer crane bridge is the 10 ton equipment hoist. The primary function of the hoist is to handle the contamination control barriers in the bare SFA transfer cell. The hoist utilizes a lifting device to mate with the contamination control barriers. When not in use the lifting device rests in a storage rack. A secondary function of the hoist is to lift cell equipment into the cell maintenance bay for maintenance.

HI-085, Performance Confirmation & Filler Cell Crane, Quantity 1. This is a regular 10-ton overhead bridge crane adapted for hot cell applications.

ME-018, Loaded Cask Preparation Area Recovery Cart, Quantity 1. It is possible that a cask cart fails in the loaded cask preparation area. The loaded cask preparation area is a radiation area due to the presence of loaded shipping casks. Human access to this area is not advised when loaded shipping casks are in the area, so a failed cart must be recovered remotely. The recovery cart recovers a failed cask cart remotely from the loaded cask preparation area by pulling the failed cart out of the area. When not in use, the recovery cart is stored in the carrier bay.

ME-024, Trunnion Block Bolter, Quantity 2. The trunnion block bolter is a remotely operated electromechanical manipulator mounted to a rigid telescoping mast for removing or installing shipping cask trunnion blocks, cask hold-down U bolts, or other similar features that hold a shipping cask to its carrier during movement. If needed, the trunnion block bolter can be equipped with instruments that remotely perform radiological surveys of shipping casks in the carrier bay. The electromechanical manipulator is the equal of a PaR Systems, Inc., design that is currently being used in existing facilities for heavy bolting and unbolting operations. The trunnion block bolter is equipped with closed circuit television cameras that assist in performing the trunnion block bolter operations remotely.

ME-025, Loaded Cask Preparation Cart Quantity 4. See sketch WHM-SK-101A and B. The loaded shipping cask preparation cart is a four-wheeled electric cart riding on recessed rails and powered through bus bars on the floor. The cart holds the shipping cask upright on an A-frame from the cask's upper trunnions. The cart has two sets of wheels, one at right angles to the other. By deploying the appropriate set of wheels, the cart can "turn" ninety degrees. Each cart adapts to different shipping casks by changing the cask supports at the top.

ME-030, Shield Door, Quantity 2. The air lock is equipped with two concrete shield doors each two foot thick. The doors are interlocked so that both doors cannot be open simultaneously. The doors are moved by pneumatic cable cylinders mounted on top. At the floor level, each door rides in a trench that prevents radiation from streaming out of the loaded cask preparation area west of the air lock. Each door rides on air bearings. The air bearings are installed for easy replacement. The cable cylinder and air bearings are design features common to all concrete shield doors in the WHB. These design features are the same as used in existing nuclear installations such as the DOE's Waste Isolation Pilot Plant, located in Carlsbad, New Mexico.

ME-050, Decon Device, Quantity 1. Decontamination facilities in decon 1 include a high pressure water jet system and, for more localized decontamination needs, a dry ice decontamination device. The latter includes a dry ice pelletizer. The pelletizer consists of a CO_2 pellet production system and a delivery system. The production system converts refrigerated liquid CO_2 to dry ice snow inside a pressurized chamber. The snow is then compressed into uniform pellets. The dry ice pellets are fed from a hopper to the blasting nozzle, where high-velocity compressed air delivers a high-velocity stream of solid CO_2 or dry ice pellets for blast cleaning. Upon impact, the pellets sublime to CO_2 gas which carries with it the contamination from the surface being cleaned. The contamination is collected by vacuum nozzles and ducted to HEPA filters.

ME-055, Monorail Cask Lifting Device, Quantity 1. The monorail cask lifting device is a monorail crane with redundant hooks and a motorized trolley carrying the shipping cask lifting yoke. The monorail crane is rated at 125 tons. The crane is maintained in a room south of decon 1. The yoke storage room is identified as location 26 in sketch WHA-SK-100A. The crane's monorail extends from the yoke storage room, through decon 1, through an air lock identified as location 8 in sketch WHA-SK-100A, and to decon 2 identified as location 13 in sketch WHA-SK-100A.

ME-075, Cask Lid Bolter, Quantity 1. See sketch WHM-SK-101C. The cask lid bolter is a remotely operated equipment that loosens or installs the lid bolts of a shipping cask. The bolter rides on channels mounted to the ceiling of the canistered waste cask room. The bolter has two pneumatic nut-runners on linear adjusters so that the nut-runners move in and out to adjust for different cask lid bolt locations. Redundant electric motors turn the nut-runners to access the bolts on different cask lid bolt patterns. The bolter can be pre-programmed for different cask lid bolt patterns. The nut-runners are off-the-shelf items sized to provide the torques necessary for installing the lid bolts for the shipping casks handled in the WHB.

ME-076, Cask Lid Remover, Quantity 1. See sketch WHM-SK-101D. The cask lid remover is a remotely operated equipment that lifts a loosened cask lid off a loaded shipping cask or lowers a cask lid onto an unloaded shipping cask. The lid remover is mounted to the same channels as the cask lid bolter described in the previous paragraph. Like the cask lid bolter, the lid remover also uses pneumatic nut-runners that engage the lifting bolt holes on a shipping cask's lid. The lid remover can be pre-programmed for different cask lid bolt patterns. The nut-runners are off-the-shelf items.

ME-090, Decontamination Device, Quantity 1. The decontamination device is an electromechanical manipulator which travels on the disposal container cell crane rails inside the cell's maintenance bay. The primary function of the decontamination device is to decontaminate cell equipment prior to the equipment's maintenance or replacement. The method of decontamination used is dry ice.

ME-115, Universal SFA canister Automatic Center of Gravity Lift Fixture, Quantity 1. See sketch WHM-SK-101F. If an SFA canister is received at the WHB that is not loaded uniformly, then it is expected that the SFA canister will skew from the vertical during a lift. The SFA canister automatic center of gravity lift fixture adjusts the center of gravity of the SFA canister to eliminate the skew. The automatic center of gravity lift fixture has two rotating weights on top that rotate until the skew is eliminated. One automatic center of gravity lift fixture is provided to fit all SFA canisters. The automatic center of gravity lift fixture concept is adapted from the automatic center of gravity lift fixture in use at the Waste Isolation Pilot Plant, located in Carlsbad, New Mexico.

ME-117, Universal Disposal Container Automatic Center of Gravity Lift Fixture, Quantity 1. See sketch WHM-SK-101F. The disposal container automatic center of gravity lift fixture serves the same function and is of the same design as the Universal SFA canister automatic center of gravity lift fixture described above.

ME-130, Welder, Quantity 15. The welder seals the inner and outer lids on the disposal containers. Fifteen welding stations are provided in the disposal container cell for welding disposal containers. Each welding station is sized to accommodate the largest disposal container that is handled in the WHB.

ME-140, Horizontalizer, Quantity 1. See sketch WHM-SK-101G. The horizontalizer lowers loaded disposal containers from the upright position to a horizontal repose in preparation for the transfer of the disposal container to the subsurface waste package transporter. The horizontalizer also raises empty disposal containers brought into the WHB from a horizontal repose to the upright position for subsequent handling in the disposal container cell. For lowering a loaded disposal container to a horizontal repose, the disposal container cell crane places the disposal container on the horizontalizer. Two adjustable locking collars secure the disposal container to the horizontalizer. Two drive motors, located outside the cell for ease of maintenance and repair, drive the rack and pinion rotation mechanisms on the horizontalizer. Drive shafts penetrating the shielding wall of the cell connect the motors to the gear boxes on the horizontalizer. The horizontalizer slowly rotates the disposal container to a horizontal repose. The horizontalizer is recessed into the cell floor to minimize the height the disposal container has to be lifted above the cell floor by the disposal container transfer gantry described below. The horizontalizer is sized to accommodate all the disposal containers that are handled in the WHB.

ME-145, Disposal Container Transfer Gantry, Quantity 1. See sketch WHM-SK-101H. The disposal container transfer gantry a low profile gantry that lifts the disposal container from its two ends with semi-circular hooks. The conceptual design of the gantry is adapted from a concept suggested for the repository subsurface operations. The disposal container transfer gantry is tall enough to clear the horizontalizer and wide enough for stability during motion. The gantry is remotely operated and does not leave the primary confinement of the disposal container cell. The gantry is maintained in decon 4 after it is decontaminated in decon 4. The disposal container transfer gantry is sized to carry all the disposal containers that are handled in the WHB.

ME-150, Disposal Container Saddle, Quantity 1. The disposal container saddle is two benches of thick metal on which the disposal container rests horizontally. The saddle minimizes the disposal container surface contact area so that the saddle does not interfere with the decontamination operations that are performed in decon 4. The saddle is low enough for the subsurface transfer gantry to drive over. The saddle is contoured to conform to the diameter of the largest disposal container.

ME-165, Decon Device, Quantity 1. Decontamination facilities in decon 4 include a high pressure water jet system and, for more localized decontamination needs, a dry ice decontamination device same as provided in decon 3.

ME-175, Subsurface Transfer Gantry, Quantity 1. The subsurface transfer gantry is the same as the disposal container transfer gantry. The subsurface transfer gantry never comes in contact with the primary confinements of the WHB. The gantry is maintained by direct contact in the subsurface transfer gantry room. The subsurface transfer gantry is sized to lift and move all disposal containers handled in the WHB.

ME-177, Disposal Container Railcar Loader, Pneumatic, Quantity 1. The railcar loader consists of a floor mounted pneumatic cable cylinder to which is attached a tow hook. The cable cylinder pushes the emplacement railcar, with a loaded disposal container lying on it, up to three feet into the waste package transporter.

ME-200, Decon Device, Quantity 1. Decontamination facilities in decon 2 include a high pressure water jet system and, for more localized decontamination needs, a dry ice decontamination device same as the decon device for decon 1.

ME-225, Cask Lid Bolter, Quantity 1. Same as the lid bolter described elsewhere in this report but sized for truck shipping casks. The cask lid bolter is conceptualized to work on all truck shipping casks that come to the WHB.

ME-226, Cask Lid Remover, Quantity 1. Same as the lid remover described elsewhere in this report but sized for truck shipping casks. The cask lid remover is conceptualized to work on all truck shipping casks that come to the WHB.

ME-230, Contamination Control Barrier, Quantity 2. The contamination control barrier is a stainless steel funnel used to mate the two types of truck shipping casks to the bare SFA cell cask port in the bare SFA cask port room. The contamination control barrier is also used to mate the two bare SFA disposal containers to the disposal container port. The contamination control barrier rests on the cask or disposal container. The tapered shape of the contamination control barrier and the location of the flange on which the contamination control barrier rests on the cask or disposal container ensures that the funnel is centered on the cask or disposal container. Between the top flange of the funnel and the cell floor is a gap for air flow from the cask port room or the disposal container port room into the cell. The air flow further ensures that contamination does not spread into either the cask port room or the disposal container port room. The contamination control barrier is conceptualized to work on all truck shipping casks that come to the WHB.

ME-235, Port Plug, Quantity 1. See sketch WHM-SK-101K. The two ports (ME-235 and ME-295) in the SFA transfer cell, the cask port and the disposal container port, are provided with a plug when the ports are not in use. The port plugs are identical in design. Each port plug consists of a concrete block mounted on wheels which travel on recessed tracks. Floor mounted mechanical stops are provided at both ends of the plugs travel. Ball screw linear actuators are used to move the plugs. Each linear actuator is driven by a motor and reducing gears located in an equipment room outside the cell so that the equipment can be maintained by direct human contact and minimum risk of worker exposure. A drive shaft, which connects the linear actuator to the motor, penetrates the shielding wall through shielding penetrations. When in position over a port, a plug is mated to the floor with a floor-mounted pneumatic seal. The plug is sized such that when the plug is in place, radiation cannot stream out of the port to the port room below the cell. The cell ports are sized to accommodate all truck shipping casks that come to the WHB. A lift-and-place type of an alternative design of the port plug was considered for the bare SFA transfer cell. The lift-and-place plug required a much larger and expensive cell crane in addition to the fuel transfer crane. The larger crane increased the size of the cell. To minimize cell area and to minimize the number and size of the pieces of equipment in the cell, the port plugs described above were chosen. Another alternative design of the port plug considered was a nested multi-piece plug which could be moved one piece at a time by a smaller cell crane. This alternative still required an additional crane in the cell, and operating time increased due to the handling of more than one port plug piece, for which reasons this alternative was not adopted.

ME-265, PWR SFA Staging, Rack Quantity 1. See sketch WHM-SK-101M and N. SFA staging is an in-cell lag storage for bare SFAs that allows the unloading of shipping casks even if operations downstream of the bare SFA cell are temporarily interrupted. Separate bare SFA staging areas are provided for BWR and PWR SFAs (see ME-280 for BWR SFA Staging). The PWR SFA staging contains a storage rack designed to hold 24 PWR SFAs. The staging rack is sized to accommodate the largest and longest SFAs. The racks are supported by a metal grating which allows cooling air to circulate throughout. Negative pressure is maintained in each staging rack for contamination control. Below each staging rack is an HVAC duct for removing airborne contamination to HEPA filters and for thermal cooling. The grating also prevents liquids from cell decontamination activities from accumulating in the staging rack. Liquids fall to the bottom of the staging rack and are drained through a drain located below the HVAC duct. The SFA staging rack is provided with a shield cover. The SFA staging rack shield cover is similar to the port plugs. The SFA staging shield cover is deployed when and if human entry into the cell becomes necessary and there are bare SFAs in staging. The SFA staging areas are sized for the shortest and tallest bare SFAs and for SFAs with the smallest and widest cross-sections.

ME-280, BWR SFA Staging, Rack Quantity 1. See sketch WHM-SK-101M. SFA staging is an in-cell lag storage for bare SFAs that allows the unloading of shipping casks even if operations downstream of the bare SFA cell are temporarily interrupted. Separate bare SFA staging areas are provided for BWR and PWR SFAs (see ME-265 for PWR SFA Staging). The BWR SFA staging rack contains a storage rack designed to hold 48 BWR SFAs. The staging rack is sized to accommodate the largest and longest SFAs. The racks are supported by a metal grating which allows cooling air to circulate throughout. Negative pressure is maintained in each staging rack for contamination control. Below each staging area is an HVAC duct for removing airborne contamination to HEPA filters and for thermal cooling. The grating also prevents liquids from cell decontamination activities from accumulating in the staging rack. Liquids fall to the bottom of the staging rack and are drained through a drain located below the HVAC duct. The SFA staging rack is provided with a shield cover. The SFA staging rack shield cover is similar to the port plugs. The SFA staging shield cover is deployed when and if human entry into the cell becomes necessary and there are bare SFAs in staging. The SFA staging areas are sized for the shortest and tallest bare SFAs and for SFAs with the smallest and widest cross sections.

ME-285, SFA Disposal Container Cart Quantity 1. See sketch WHM-SK-101J. The SFA disposal container cart is a four-wheeled electric cart riding on recessed rails and powered through bus bars on the floor. The cart holds the bare SFA disposal container upright during the disposal container loading and subsequent operations in the performance confirmation and filler cell. The disposal container is held from the bottom by chucks. The SFA disposal container cart can also carry a SFA canister that needs filling. The chucks on the cart that hold a disposal container are adjustable to also hold a small or large SFA canister. To aid in performance confirmation and filling operations, the SFA disposal container cart is equipped with a turntable. The disposal container or the SFA canister rides on the turntable. The turntable turns the disposal container or the SFA canister to accomplish the performance confirmation or filling operations. For filling operations, for example, the turntable turns the SFA canister while a laser beam enters into the cell through a port hole and cuts open the SFA canister. The turntable also turns the SFA canister during filling, if necessary, and the turntable turns the SFA canister during re-welding. The SFA disposal container cart is sized for all SFA canisters and disposal containers that come to the WHB.

ME-295, Port Plug, Quantity 1. See sketch WHM-SK-101K. Same as ME-235.

ME-317, SFA Canister Lid Lifting Device, Quantity 1. The SFA canister universal lid lifting device lifts a SFA canister lid that is cut off from a SFA canister to be filled. The same device may be used for both the small and large SFA canister lid. The SFA canister lid is engaged using lifting bolts that are turned by pneumatic nut-runners. The lifting device has twelve nut-runners. Six of the nut-runners are located to match the lifting bolt hole pattern of the small SFA canister. The other six nut-runners are located to match the lifting bolt hole pattern of the large SFA canister. The lifting device has the following features built into it.

A. Remote viewing camera mounted on the bottom center of the device, aimed directly down.

B. A rack and pinion arrangement that rotates the lifting device until the lifting points are aligned with the SFA canister lid.

C. Linear electromechanical linear actuators for fine adjustments.

ME-320, Laser Welding & Cutting Machine, Quantity 1. This equipment is located in an equipment room, location 31 in sketch WHA-SK-100A. The laser is a 25 kW CO_2 laser capable of precision cutting and welding of thick metals. The laser system selected for the WHB is the equal of a SM Series Industrial CO_2 laser manufactured by United Technologies Industrial Lasers, South Windsor, Connecticut. The laser is a modular design. A higher power module may be added later to boost the laser's power to 45 kW. For ease of maintenance without putting the workers at risk of exposure, the laser generator is located outside the performance confirmation and filler cell. The laser beam is directed into the performance confirmation and filler cell through a port. The port is designed such that there is no straight path for radiation to stream out of the cell. Gold-plated and water-cooled copper mirrors inside the cell focus the beam to the cutting or welding point. The laser beam remains focused on this welding point while the disposal container or SFA canister is rotated by the turntable on the SFA disposal container cart. The laser equipment is sized for penetrating the wall thicknesses of both SFA canisters and disposal containers.

Several cutting and welding alternatives were considered before selecting the laser option. For example, a large vertical lathe or abrasive cutting machine inside the cell was considered for the disposal container and SFA canister cutting operations. Both options require frequent change of cutting tools and also require coolants and lubricants that produce mixed waste. The laser option does not require cutting tools, and it does not require coolants and lubricants inside the cell. Further, the laser generator can be located outside the cell, which facilitates direct contact maintenance with minimum risk of exposure to radiation and contamination.

Another option considered was plasma arc cutting. The plasma arc system considered was the equal of a system designed by Daytona MIG, Daytona Beach, Florida. The system is designed for a remote cutting application being developed at DOE's Savannah River Site, Aiken, South Carolina. The plasma arc method was found feasible, but the laser was again preferred because of its flexibility of being able to work from outside the cell. Yet another option considered was electron beam welding. It was found that for the metal thicknesses in question, electron beam welding requires a heavy vacuum that may not be possible to generate considering the large cavity volumes of either the disposal container or the SFA canister.

Finally, standard welding processes such as tungsten inert gas welding were considered. The tungsten inert gas welding process was found feasible for remote welding but not for remote cutting. Again, the laser was preferred because it can be used for both cutting and welding from outside the cell.

ME-350, Decon Device, Quantity 1. Decontamination facilities in decon 3 include a high pressure water jet system and, for more localized decontamination needs, a dry ice decontamination device, that is a bridge mounted electromechanical manipulator is used. The decon device travels on overhead crane rails which provide X-Y motion in the room. The Z motion is provided by a telescoping mast which houses a dry ice spray nozzle, dry ice pellet delivery hose, compressed air hose, and a vacuum return hose. A close circuit television camera is attached to the mast above the spray nozzle.

ME-370, Turntable, Quantity 1. The turntable rotates and re-directs the SFA disposal container cart that carries SFA canisters and disposal container into the area of the performance confirmation and filler cell. The turntable is adapted from a design existing at the Waste Isolation Pilot Plant, located in Carlsbad, New Mexico. The turntable lifts its load with an air bearing. The rotation is achieved through electric motors. The air bearings are redundant and are accessible for remote inspection and replacement through access openings in the top deck of the turntable. The turntable is sized to accommodate all the disposal containers that are handled in the WHB, with or without filler, including the weight and size of the SFA transfer cart.

Component Maintenance Considerations

Maintenance of WHB equipment involves two aspects: maintenance associated with radiation hazards, and maintenance not associated with radiation hazards. This section addresses the provisions in the conceptual design of the WHB reported in this study for maintenance associated with radiation hazards. Below are general descriptions of the major provisions for the maintenance of equipment operating in radiation areas.

A. *Decontamination.* Decontamination capability is provided at each point an item or equipment is removed from the primary confinement enclosures as a normal part of WHB operations. Examples are the decontamination rooms for preparation enclosure carts and loaded disposal containers, the latter before the disposal containers are transferred to the subsurface equipment for disposal. Decontamination methods range from high pressure water jets to fixed or portable dry ice decontamination units.

B. *Cell Cranes.* Shielded crane maintenance bays are provided for each hot cell crane so that maintenance, scheduled proof-load testing, and inspection can be performed in a clean enclosure. Maintenance platforms that mate with the cell cranes and buddy crane platforms are provided which include stair access and equipment lift capabilities. Air lock entrances are provided for maintenance bay access.

C. *Carrier Bay Crane.* A maintenance access platform that spans the width of the crane bridge is provided at one end of the crane runway. This is the parking location for the crane when not in use. Stairs and a lifting hoist are provided for worker and equipment access to the platform. This end of the crane runway also has the equipment and provisions for periodic proof-load testing and inspection.

D. *Monorail Cask Lifting Device.* The device is essentially a monorail crane. Maintenance access platforms are provided for it in location 26 in sketch WHA-SK-100A. Location 26 is the cask yoke storage room, which also serves as a parking station for the lifter and for its proof-load testing and periodic inspection. Platform access stairs and an air lock are provided outside the room. Segments of the platform fold out of the way for monorail movement into and out of the room.

E. *Preparation Area Carts.* Cart maintenance is performed in the entry and exit air locks, which are locations 2 and 15 in sketch WHA-SK-100A. High capacity jacks and hoists are available for handling the heavy components of the carts.

F. *Horizontalizer.* The horizontalizer is located inside the disposal container cell. It is accessible during planned cell maintenance. The drive motor, power transmission, speed reducer, and controls for the horizontalizer--that is, items that require more frequent inspections and maintenance--are located outside the cell to facilitate contact maintenance.

The drive system can be remotely disconnected from the horizontalizer so that the whole drive can be removed for repair without cell entry.

G. *Cell Carts.* Cell carts, such as the SFA disposal container cart, are maintained in location 22 in sketch WHA-SK-100A, where the carts may be decontaminated, if necessary, before work. Drive components on the carts, including electrical systems and other items that may need replacement will be specified for modular designs so that they can be replaced quickly and, if necessary, remotely.

H. *Shielding Windows.* Shielding windows in the WHB are oil filled with nitrogen blankets. This type of window seldom needs replacement. If replacement does become necessary, the WHB is designed to allow the installation and removal of shielding cell windows from the cold side of the shielding wall. Heavy lift installation dollies supplied by the window manufacturers are used. The hot side protective glass is remotely replaceable using electromechanical manipulators. Routine maintenance of the shielding windows consists of oil replacement, nitrogen gas bottle inspection, and window cleaning on both sides.

I. *Mechanical Master-slave Manipulators.* For ALARA exposure limits, mechanical master-slave manipulators in the WHB are fully sealed System 50 type. Mechanical master-slave manipulator arms on the hot side are removed remotely by cell cranes and electromechanical manipulators and transferred through the crane maintenance bays to the mechanical master-slave manipulator shops in the WHB. In the shop, the hot arm of the mechanical master-slave manipulator is worked on in a glove box, where it is either cleaned for further work or repaired. The System 50 allows immediate arm replacement so that work can continue while the damaged arm is repaired. The cold side arms are replaced using a dolly fixture supplied by the manufacturer and taken to the manipulator shop. Again, containment is not broken. A new arm is installed so that work in the cell can continue while the damaged arm is repaired. The through-wall section of the mechanical master-slave manipulators seldom needs removal, but if removal becomes necessary, a containment system is installed. The WHB operating corridors are sized to allow for such maintenance operations.

J. *Shielded Doors and Port Plugs.* Shielded doors and port plugs are designed with as many maintenance points outside the cell as possible for contact maintenance. The drive motors and gear reducers for the port plugs are outside the cell. A shielded drive shaft passes through a removable shielded plug in the cell wall. The drive connections to the plugs are remotely removable so that the entire drive assembly can be removed for repair or replacement. Shielded doors are located on the cold or colder side of radiation enclosures for easier access.

Recovery from Major Component Failure

The term "failure" in the section title should not be construed to imply the mechanical or structural failure of an equipment. The term "failure" here implies an equipment that is still structurally sound but has unexpectedly gone off line. Redundant systems in every equipment in remote areas minimize the probability of an equipment going off line unexpectedly, but in case it happens, this section describes the features that have been provided in the conceptual design of the WHB reported in this study to assist in recovering from such an event if it happens with some of the major pieces of equipment located in remote areas.

Cell Crane Failure:

A hot cell crane may fail while handling a load. High radiation in the cell prevents human excursion into the cell. Possible failures include loss of power, loss of control signal response, a mechanical or other failure that prevents lowering the load and returning the crane to the maintenance bay. The use of hydraulics in the cell is minimized, if not completely eliminated, in favor of the design goal of using pneumatics for remote equipment.

The minimization of mechanical crane failures, such as the failure of drive motors and brakes, is accomplished by redundancy and the ability to disengage the failed component and engage the redundant component. For example, a failed motor can be disengaged through the use of clutches and the redundant motor engaged.

To provide for recovery from cell crane failure, a "buddy" crane is provided in the maintenance bay of each cell. A buddy crane is a bridge using separate electrical power and control systems that runs on the same rails as the cell crane. When a cell crane fails, the buddy crane is powered out to the crane. The buddy crane latches itself to the cell crane. Through the latching connections, the buddy crane disengages the cell crane end-truck brakes and engages the cell crane's hoist to lower the load and raise the hook to allow retrieving the crane into the maintenance bay. The buddy crane is already attached to winch cables, the winches for which are in the cell maintenance bay. The winches then pull the buddy crane, which in turn pulls the cell crane, into the maintenance bay. Winches are used because the buddy crane, of light weight, cannot generate enough traction to drag the heavy cell crane. In the maintenance bay, the cell crane is repaired and put back into service.

SFA Disposal Container Cart Failure:

The WHB employs carts to move casks, disposal containers, and SFA canisters. The carts could fail with their loads on them. The concept of recovering from a failed cart is the same as for cell cranes, only for carts "buddy" carts are used, powered by separate electrical power and control systems. Each buddy cart is a mobile winch. Each cart has a retrievable hook with which it engages an opposite hook in the floor of the WHB

The buddy cart for the SFA cell resides in the disposal container cell's maintenance bay. If the SFA disposal container cart fails, say in the disposal container port room, the disposal container crane retrieves the SFA disposal container cart's buddy cart from the bay and puts the cart on the tracks of the SFA disposal container cart. The buddy cart then passes through the decon room and the performance confirmation and filler cell into the disposal container port room. The doors of the rooms it passes do not all open at the same time. To prevent the spread of contamination from the bare SFA handling areas, the doors open one at a time and close after letting the buddy cart through.

The buddy cart latches its winch cable to the SFA disposal container cart. The buddy cart withdraws into the filler cell. Its hook engages the hook in the cell floor. The buddy cart pulls the SFA disposal container cart into the filler cell. If necessary, a lid is installed on the disposal container. The buddy cart repeats its pulling routine to pull the SFA disposal container cart into decon 3. Note that the cell and decon 3 are sized to accommodate the buddy cart and the SFA disposal container cart together. In decon 3, both carts and the load on the SFA disposal container cart are decontaminated if necessary. Then the buddy cart repeats its pulling routine until the SFA disposal container cart is within the hook perimeter of the disposal container cell crane. The crane takes the buddy cart back into the disposal container cell's maintenance bay. The crane takes the load off the SFA disposal container cart. Finally, the crane takes the SFA disposal container cart into the maintenance bay for repair.

Loaded Cask Preparation Cart Failure:

The loaded cask preparation cart could also fail with a loaded cask on it. In this area, contamination is not expected, but radiation may still prevent human entry if there are other loaded casks present in the area.

Winches are attached to the wall opposite the loaded cask preparation stations. If a cart fails at a preparation station, an automatic guided vehicle takes the cable of the winch for that preparation station and latches the cable to the winch. The winch pulls the cart until it is on the track that leads out to the carrier bay.

A buddy cart of the same design as that used for the SFA disposal container cart accesses the preparation cart through the bay air lock. The air lock doors do not both open at once. They open one at a time and close after letting the buddy cart through. The buddy cart latches its winch cable to the preparation cart. The buddy cart withdraws into the air lock. Its hook engages the hook in the floor. The buddy cart pulls the preparation cart into the air lock. Note that the air lock is sized to accommodate the buddy cart and the preparation cart together. The pulling routine is repeated until the preparation cart is in the bay. The bay crane takes the cask off the cart. The cart can now be taken away for repair.

Dropped Items:

An unlikely off-normal event in the hot cells of the WHB is the dropping of items such as tools or the dropping of a waste form during a crane lift. The impact of such an event is a function of the weight of the item dropped and the location of the drop in the cell. The weight of items handled in the cells of the WHB ranges from a few pounds to nearly a 100 tons. Recovery from dropping an item that weighs only a few pounds is less of a problem than if the item weighs 100 tons.

Recovery is undertaken according to the situation at hand. Items of low usage, low weight, and items which are readily replaceable and fall where they do not hinder operations are best left where they fall or are pushed out of the way. They are recovered during cell down time for repair and maintenance.

Dropped waste forms first require a study of the situation. A recovery is then designed based on the situation. An example is, say, a SFA canister that has been dropped and is lying on its side on the cell floor. One recovery from this event is to remotely weld lifting lugs on the sides of the SFA canister. The SFA canister is then taken to the performance confirmation and filler cell. The SFA canister is opened, its contents transferred to a bare SFA disposal container, and the empty SFA canister disposed off as site-generated low level waste.

7.2.2.7 Operating Data

This section describes the operating data available for the WHB. The following aspects are addressed: utility consumption, resource consumption, waste generation and staffing requirements.

Utility Consumption

The WHB and the operations performed in this building will consume chilled water, electric power, and sanitary water as discussed below. Estimates for peak and annual utility consumption are provided in Table 7.2.2-9. The annual data are based on operating during the emplacement phase only.

A. Chilled water is used for HVAC cooling

B. Electric power is used to operate process equipment such as carts, cranes, welders, cutters, HVAC equipment such as fans and heaters, facility lighting, and instruments and controls. The bulk of the use is for HVAC.

C. Sanitary water is used for personnel support such as restrooms, change rooms, and facility maintenance.

Table 7.2.2-9. WHB Utility Consumption

Utility	Peak	Annual
Chilled Water	23,500 gpm	123,000,000 gallons
Electricity	8,600 kW	50,000,000 kWh
Sanitary Water	7,300 gpd	1,900,000 gallons

Resource Consumption

The WHB and the operations performed in this building will consume a variety of materials and chemicals. These include laboratory supplies, dry CO_2 and other chemicals for decontamination, welding supplies and materials for general facility and equipment maintenance. None of these materials are expected to be consumed in large quantities.

Waste Generation

The WHB and the operations performed in this building will generate low level waste, small amounts of HW and sanitary wastes as discussed below. The LLW is processed within the WTB. Rough estimates for the annual generation are provided in Table 7.2.2-10. MW is not included in this table as this material is not expected to be generated from normal operations. If generated from off-normal operations, the quantities of MW would be extremely small.

A. Aqueous and chemical liquid LLW is generated from area and equipment wash down and collected through floor drains. Solid LLW is generated from maintenance activities.

B. Hazardous waste is generated from equipment and vehicle maintenance in the form of waste oils, contaminated rags and packaging materials.

C. Sanitary waste water and solid industrial waste generated by personnel support functions such as restrooms, change rooms, facility maintenance and office work.

Staffing Requirements

The WHB normally operates five days per week, with two eight-hour shifts per day, 250 days per year, except for some utility and security systems which operate continuously. Surge capacity can be accommodated by operating multiple shifts. The number of individuals expected to routinely work in the WHB are estimated to be 185 (full time equivalents). Of these workers, 75 percent are line operators with the balance performing support functions such as supervision, administration and maintenance.

Table 7.2.2-10. WHB Waste Generation Rates

Waste Material	Annual Generation	
	Liquid (gallons)	Solid (cubic feet)
Low-Level	61,400	17,206
Hazardous	486	154
Sanitary/Industrial	1,900,000	2,000

7.2.3 Cask Maintenance Facility

7.2.3.1 Introduction

This introduction to the CMF addresses the mission and the background of the CMF area prior to the conceptual design effort, the design methodology used for the conceptual design and the current status of the design.

7.2.3.1.1 Mission

Casks, ancillary equipment (personnel barriers, impact limiters, etc.) and portions of the transport vehicles must be maintained in proper condition to retain system operational effectiveness and safety. The mission of the CMF function is to meet this requirement by performing the following tasks:

- Testing
- Routine maintenance
- Repair
- Modifications
- Configuration control of all cask system elements
- Preparation of cask system elements for decommissioning and disposal when a cask system element is deemed permanently unfit for use.

Service and maintenance of transport vehicles is limited to those activities required to prevent above normal exposures to the general public.

7.2.3.1.2 Background

The SCP-CDR (SNL 1987) which was published in 1987, did not include a conceptual design for a CMF. However, the *Draft 1988 Mission Plan Amendment* (DOE 1988b) indicated that the Office of Civilian Radioactive Waste Management (OCRWM) shall have a "transport capability" and that a "fleet operational" condition shall occur. Based upon OCRWM plans of late 1989 (*Report to Congress on Reassessment of the Civilian Radioactive Waste Management Program*, DOE 1989), it was assumed that the cask maintenance capability would be available no later than September 2000. Prior to this time, it was assumed that maintenance of cask systems supporting the capabilities to initiate transport/storage system operation and to ship with new casks would be accomplished using limited interim capabilities available through contracts with the Civilian Radioactive Waste Management System Management.

In January of 1991, the *Feasibility Study for a Transportation Operations System Cask Maintenance Facility* (ORNL 1991a) was published by Oak Ridge National Laboratory. This study was based upon the previous work of many organizations and individuals in the existing SNF transportation system. Two particularly important documents served as the foundation for this work. These include operational studies referenced to establish the functions and methods of cask maintenance used in the proposed facility design. They are: *Cask Fleet Operations Study* (NAC 1987), and *A Cask Fleet Operations Study* (ORNL 1988a). In addition, two U.S. Department of Energy (DOE) reports were used to establish many of the system and interface assumptions in this study (ORNL 1991a). These reports are the Generic Requirements for *Mined Geologic Disposal System Rev. 3 dated 3/5/87, DOE/RW-0090, Appendix B-2* (DOE 1987c), and *Analysis of Radiation Doses from Operation of Postulated Commercial Spent Fuel Transportation Systems* (DOE 1987b).

This feasibility study (ORNL 1991a) evaluated the requirements of the *Transportation Operations System Cask Maintenance Facility: System Requirements and Description* (ORNL 1988b) as to their impact on specific facility design areas and a series of "Significant Issue Papers" were written. Each issue paper addressed a single facility configuration question that required resolution prior to fully defining the facility. Conclusions were derived from each issue paper where possible, and a facility concept was synthesized in an iterative manner from the aggregate of all issue papers. This feasibility study documented the definition of areas where further study is needed, and delineated areas where the interfaces with other OCRWM components require resolution.

In February of 1993, a *Monitored Retrievable Storage Facility Cask Maintenance Facility Design Study Report Final Draft* (CRWMS M&O 1993b) was prepared. The CMF collocated with an monitored retrievable storage (MRS) was included in *Multi-Purpose Canister (MPC) Implementation Program Conceptual Design Phase Report, Volume II.C -]MPC MRS Facility Conceptual Design Report: Final Draft* (MRS CDR) (CRWMS M&O 1993i). The description, cost estimate, and schedule provided in the monitored retrievable storage MRS CDR were based on the feasibility study conducted by Oak Ridge National Laboratory, the results of which were published by Oak Ridge National Laboratory in January 1991. The ACD CMF design was based on the transfer facility developed for the MRS CDR reference concept, dry transfer and vertical concrete cask storage. The MRS CDR reference concept involves handling of bare SNF.

In the July 1995 version of the *Mined Geologic Disposal System Requirements Document* Revision 1, DCN01 (DOE 1995b) subparagraph 3.1.5.F required that a CMF be collocated with the MGDS. In the past, the requirement for a CMF had been identified in conjunction with the development of an MRS. As a result, the MRS CMF design was reviewed and became the basis for the proposed conceptual design of an MGDS CMF. This proposed conceptual design varies from the MRS design in that the site waste treatment function has been removed, the HVAC system has been enhanced, and the administration facilities have been incorporated in other administrative areas within the site. In addition, a simulation model was developed to ensure the proper sizing of the facility for the cask receipt rate necessary to support the operations of the MGDS.

7.2.3.1.3 Design Methodology

The design methodology for the conceptual design of a CMF is described below:

A. Identify regulations/requirements relevant to a CMF.

B. Identify available and applicable cask maintenance technologies based on the *Monitored Retrievable Storage Cask Maintenance Facility Design Study Report Final Draft* (CRWMS M&O 1993b).

C. Establish preliminary capacities and capabilities based on MGDS and MRS cask receipt rates.

D. Validate the facility size and configuration of the CMF using a simulation model using the computer codes "allCLEAR" (*allCLEAR Users Guide*, Clear 1993) and "SLAM II" (*SLAM II Quick Reference Manual*, Pritsker, 1992).

E. Prepare the final documentation.

7.2.3.1.4 Design Status

The CMF located at the MGDS is in the early stages of design, therefore, limited information is available. The conceptual design documentation includes the following:

A. Preliminary identification of design inputs including requirements, assumptions and data

B. Draft general arrangement sketches for the CMF including plans, sections and elevations

C. Preliminary description of the HVAC system including HVAC flow sketches and a narrative description

D. A major component list including descriptions, capacities and Construction Specifications Institute specification references

Other conceptual design considerations for the CMF (such as electrical, fire protection, pool cleanup) are planned future activities and are only briefly described in this report. Future design should also address the following issues:

A. The RDRD (YMP 1994a) needs to be expanded further to establish a more relevant basis for design of the CMF.

B. The probable radiological characteristics need to be established for:

- Interior of the cask prior to purging and vacuuming
- Pool water
- Pool purification system.

C. Cleanliness criteria for internal cask surfaces needs to be established.

D. The design of the radiological protection systems (i.e., shielding and dose assessments) need to be developed.

E. The equipment for support systems (e.g., pool system and decontamination) needs to be sized and space allocation for this equipment needs to be verified.

Note that this design is based on the design basis assumptions described in Section 7.2.3.2.2. Significant assumptions, or strategies, that could have the greatest impact on the CMF design are discussed in Section 12, Development Tasks and Issues.

7.2.3.2 Design Inputs

This section provides the design input bases for the development of cask maintenance operations conceptual designs including: design requirements, design assumptions, and design data from other groups.

7.2.3.2.1 Design Requirements

Design requirements are categorized as either functional requirements or regulatory requirements and are extensions of the surface inputs defined in Sections 3, 4, and 7.1.2.1 that are specific to the cask maintenance operations.

Functional Requirements

The following functional requirements for the CMF were identified as part of an engineering analysis in coordination with the Transportation Segment. It is expected that future revisions of the RDRD (YMP 1994a) will include these requirements. The appropriate sections of the TSRD are shown in parenthesis.

Maintain Transportation Fleet

A. Comply with the terms and conditions of the certificates of compliance and the applicable requirements of 10 CFR 71, Subparts A, G, and H (TSRD 3.7.2.2.2.D).

B. Provide adequate on-site facilities and capabilities to ensure that transportation cask subsystems are maintained to meet operational needs and certificate of compliance requirements (TSRD 3.7.2.2.2.A).

C. Handle, maintain, and certify the transportation cask fleet and any supporting equipment. As a minimum, this includes one visit per cask per year for annual certification and major maintenance (TSRD 3.7.2.2.2.N).

Test and Record Status of Transportation Fleet

A. Maintain access to the record system containing all cask subsystem documentation including shop fabrication and as-built drawings, certificates of compliance, safety analysis reports, and fabrication quality assurance records (TSRD 3.7.2.2.2.B).

B. Create and update records of all tests and inspections for each cask subsystem (in accordance with 10 CFR 71, Subparts G and H) including special tools and fixtures, and ancillary equipment; all maintenance performed, including components replacement; all decontamination performed; all cask subsystem usage; and all cask reconfigurations (TSRD 3.7.2.2.2.E).

Decontaminate Transportation Cask Subsystems

A. Maintain the cask internals and components and the cask interiors at the level of internal contamination required by agreements with Purchasers (TSRD 3.7.2.2.2.F).

B. Decontaminate cask subsystem components and cask external surfaces to levels required by regulations and as low as reasonably achievable requirements (TSRD 3.7.2.2.2.G.1).

C. Decontaminate external cask surfaces such that contamination at end of shipment does not exceed ten times the levels specified in 49 CFR 173.443 Table 10 (TSRD 3.7.2.2.2.G.2).

D. Decontaminate transporter external surfaces such that each accessible surface dose rate is 0.5 millirem/hour or less, and those surfaces are free of significant removable contamination as specified in 49 CFR 173.443 paragraph (a) (TSRD 3.7.2.2.2.G.3)

E. Decontaminate ancillary equipment and tools and fixtures external surfaces such that they can be packaged as low specific activity material (TSRD 3.7.2.2.2.G.4)

Handle Casks

Move and lift the cask subsystem or components to the appropriate position in the CMF and onto transporters or other transfer equipment (TSRD 3.7.2.2.2.H).

Test and Inspect Casks

Test and inspection as required by regulation (10 CFR 71.93(b)) or Transportation system requirements for transportation cask subsystems. The tests or inspections may be performed on new or contaminated casks, components of casks, special tools and fixtures, ancillary equipment, and vehicles prior to release for shipping campaigns. The tests and inspections include (TSRD 3.7.2.2.2.I):

A. Radiological inspection for fixed and removable contamination on external and internal surfaces of casks and on cask subsystem components.

B. Visual inspection or other appropriate non-destructive examination for evidence of wear, corrosion, physical damage, or component failure of the:

- Cask body, interior and exterior and all components including seals
- Fuel assembly basket and all related fixtures and fittings
- Impact limiters including bolts, keys, and all fittings

- Closure stud tensioner system including fittings
- Transporter including skid, tie-down system, personnel barrier, deck, placard holders
- Threads of bolts and tapped holes
- Ancillary equipment
- Special tools and fixtures.

C. Compliance tests and inspections pursuant to the requirements of the certificate of compliance, Safety Analysis Report, and the Transportation system requirements, including but not limited to:

- Closure head seals: helium leak test and hydrostatic tests
- Thermal test of casks for heat dissipation capability
- Neutron absorber presence by radiation measurement of loaded casks
- Trunnions: load test and liquid penetration, ultrasonic, and radiographic tests (all welds)
- Lifting lugs: load test, and liquid penetration, ultrasonic, and radiographic tests (all welds)
- Mechanical fit and clearance of all components
- Moisture content of wood-filled impact limiters
- Fusible plug seal integrity.

Repair or Replace Transport System

A. Perform the following component replacements, as a result of the inspections and tests identified in subpart I (TSRD 3.7.2.2.2.J):

- Elastomeric or metal closure seal and retainer clip replacement
- Threaded fasteners such as closure bolts or studs
- Drain and fill and relief or vent valves and fittings
- Valve box or cover plate O-rings
- Fusible plugs
- Threaded inserts
- Trunnion and trunnion bolt replacement.

B. Evaluate damaged or degraded casks or SNF canisters for continued operability, and to prepare the cask or SNF canister for decommissioning and disposal (TSRD 3.7.2.2.2.O).

Reconfigure Casks

A. Remove and install fuel assembly baskets for those casks that have removable baskets (TSRD 3.7.2.2.2.L.1).

B. Remove and install fuel spacers in casks (TSRD 3.7.2.2.2.L.3).

Store Tools and Spare Parts

A. Store contaminated fuel baskets reading in excess of 100 mR at a distance of 30 cm. (high radiation area) in a shielded area (TSRD 3.7.2.2.2.L.2).

B. Store contaminated fuel spacers reading in excess of 100 mR at a distance of 30 cm. (high radiation area) in a shielded area (TSRD 3.7.2.2.2.L.4).

C. Store empty SNF canisters (TSRD 3.7.2.2.2.L.5).

D. Store tools and fixtures and ancillary equipment for transportation casks and SNF canisters that have moderate amounts of removable contamination (TSRD 3.7.2.2.2.M.1).

E. Store spare parts and non-contaminated special tools and fixtures and ancillary equipment for transportation casks and SNF canisters (TSRD 3.7.2.2.2.M.2).

F. Provide quality assurance-approved storage for safety-related spare parts for transportation casks and SNF canisters (TSRD 3.7.2.2.2.M.3):

- Storage areas must control handling, storage, shipping, cleaning, and preservation of materials to be used in packaging to prevent damage or deterioration.

- Storage areas must control handling, storage, shipping, cleaning, and preservation of equipment to be used in packaging to prevent damage or deterioration.

- When necessary, storage areas must provide special protective environments (e.g., inert gas atmosphere, specific moisture content, temperature).

Regulatory Requirements

General Requirements and criteria for Repository Surface facilities, as defined in Sections 3.2 through 3.7 of the RDRD (YMP 1994a), and discussed in section 7.1.2.1 of this report, are applicable to this facility. Additional performance criteria specific to the CMF from 49 CFR 173.443 are provided below. These criteria were identified during engineering analysis and are anticipated to become design requirements.

A. The level of non-fixed (removable) radioactive contamination on the external surface of each package offered for shipment shall be kept as low as practical. Removable external radioactive contamination limits are as shown below.

<u>Source</u>	<u>dpm/cm²</u>	<u>uCi/cm²</u>
Beta-gamma emitting radionuclides	10^{-5}	22
All other alpha emitting radionuclides	10^{-6}	2.2

B. A vehicle shall not be returned to service until the radiation dose rate at each accessible surface is 0.5 millirem or less per hour, and there is no significant removable (non-fixed) radioactive surface contamination.

C. A survey of the interior surfaces of the empty vehicle shows that the radiation dose rate at any point does not exceed 10 millirem per hour at the surface or 2 millirem per hour at 1 m (3.3 feet) from the surface.

7.2.3.2.2 Design Assumptions

This section lists the assumptions applicable to the design of the CMF. Assumptions generally applicable to surface facilities are listed in section 7.1.2.2. There are two types of design assumptions: CDAs and non-controlled design assumptions.

Controlled Design Assumptions

The CDAs specific to the CMF are listed below.

Identifier	Subject	Statement of Assumption
DCS 014	Cask Maintenance Operations	CMFs may be integrated into related facilities rather than in a separate, stand-alone structure.
DCS 015	Transportation Cask Fleet Inventory	The cask fleet inventory is based on a sealed canister system (Multi-Purpose Canister or Dual Purpose) and consists of a maximum of 12 truck casks and 72 rail casks.
DCS 016	Transportation Cask Fleet Maintenance Frequency	Maintenance requirements for the transportation fleet (as identified in DCS 015) will be comparable to those for existing casks. • Each truck cask is serviced a maximum of three times per year. During one visit the cask system Certificate of Compliance inspection is performed. • Each rail cask is serviced once per year during the Certificate of Compliance inspection.

Non-Controlled Design Assumptions

The non-controlled design assumption applicable to the CMF design is as follows:

> Eight percent of the loaded shipping casks received at the repository will require external surface decontamination prior to waste form unloading in the WHB.

7.2.3.2.3 Interface Criteria

This section addresses the data defined by other design areas that are inputs to CMF design. General design data for the repository surface design is presented in Section 7.1.2.2 including:

A. Physical characteristics for GA-4 and GA-9 truck casks.

B. Physical characteristics for rail casks for shipping large spent fuel assembly (SFA) canisters and DHLW canisters.

C. Transportation cask arrival schedule.

7.2.3.3 Summary of Supporting Studies

This section provides a summary of the studies listed below that directly impact the CMF design. Each summary addresses the study scope, results, relationship to other studies, and applicability to the CMF design concept.

- *Review of Designs and Requirements for Cask Operations* (CRWMS M&O 1995y)
- Simulation Model of the MGDS CMF
- *Preliminary Dose Assessment for the MGDS Surface Facility Waste Handling Operations* study (CRWMS M&O 1995t).

***Review of Designs and Requirements for Cask Operations* (CRWMS M&O 1995y)**

The study, issued on September 26, 1995, presents the results of an effort directed at the following:

A. A review of current industry experience and technology in cask maintenance, including past Monitored Retrievable Storage concepts.

B. A compilation of applicable requirements and design criteria.

C. The initiation of a cask throughput simulation model.

This study builds on previous MRS/CMF design efforts, with an emphasis on regulatory requirements and MRS facility experience. The primary contribution to the ACD from this report is in the area of regulatory requirements and a description of MRS facility experience.

Cask Throughput Simulation Results

A computer model was developed for equipment and areas within the CMF that are needed to perform cask maintenance activities. Cask maintenance operations were modeled using a computer program called SLAMSYSTEM, which incorporates the SLAM II (Simulation Language for Alternative Modeling) simulation language (Pitsker 1992).

The simulation model requires definition of the quantities of various pieces of handling equipment, and the numbers of areas and spaces where casks and components will be worked on (known as "resources" in modeling terminology). The activities required to conduct cask maintenance operations are also defined, and a nominal duration is assigned to each activity. For this model, most of the various activities and the durations required for each were determined from (ORNL 1991a; *Estimated Times for Annual Cask Maintenance*, ORNL 1991b; *Cask Maintenance Operations*, ORNL 1992). At various decision points, either a cask attribute is tested (e.g., is it a truck cask or a rail cask?), or a probability that an operation will be needed is assigned (e.g., does a component need repair, is reconfiguration required, or is exterior decontamination needed?).

Cask arrival rates are defined, and as each cask arrives it is released into the maintenance model. As a cask moves through the model, the resources necessary for each operation are seized when needed and released when the operation is finished. If a particular resource is not available when needed, the cask must wait until the resource becomes available. Outgoing casks are given priority over incoming casks for all resources.

The outputs of the simulation include how long each type of cask spent in the CMF (average, minimum and maximum durations), the average time that cask had to wait for each resource, the maximum number of casks that ever waited for the same resource at the same time (the "queue" length), and utilization and availability statistics for each resource. With these outputs, the bottlenecks in the CMF can be identified, and the ability of the CMF to process the required cask throughput in a timely manner can be evaluated.

Equipment and areas modeled within the CMF included these items:

A. One staging area crane, to lift casks from the railcar or truck trailer on which they arrive at the repository and lower them onto the CMF cask carrier.

B. One cask carrier, to transport casks from the staging area to the interior of the CMF.

C. One Test, Inspection, Maintenance and Repair area crane, to lift casks from the carrier, set them down in the test and repair area, and move them between the test and repair area, the preparation and decontamination pits, the pool shelf, and the deep pool space.

D. Two preparation and decontamination pits, where casks are purged, filled with water and later emptied, lids are loosened, and cask exteriors are decontaminated.

E. Two pool shelf spaces, where casks are set to remove closure fasteners and install crane lift adapters.

F. Two deep pool spaces, where cask interiors are inspected and cleaned, and basket reconfiguration is done if required.

G. Ten spacer storage areas, where fuel spacers are stored while casks are reconfigured.

H. One basket cleaning space.

I. Ten basket storage spaces, to hold old and replacement baskets.

J. One pool crane, to remove baskets and spacers from casks and later reinstall them, and to move baskets and spacers between the casks in the deep pool and their respective storage spaces.

Cask arrival rates for the CMF were developed for both a canistered based scenario and an all-bare-fuel scenario. The canistered scenario uses the following inputs:

A. 72 Rail casks per year will be handled in the CMF for decontamination and/or Certificate of Compliance recertification activities.

B. 36 Truck casks per year will be handled (a fleet of 12 casks, each with maintenance performed a maximum of three times per year) for decontamination, reconfiguration and/or Certificate of Compliance recertification activities.

C. 47 Rail casks, in addition to the above scheduled casks, will be handled at the CMF because they arrived at the WHB weeping; i.e., with removable exterior contamination. This amounts to 8 percent of the maximum number of rail cask shipments expected in any one year. These casks will be decontaminated in the CMF before they are processed in the WHB.

D. Five additional truck casks will be handled at the CMF because they arrived at the WHB weeping; i.e., with removable exterior contamination. This amounts to 8 percent of the maximum number of truck cask shipments expected in any one year. These casks will be decontaminated in the CMF before they are processed in the WHB.

The all-bare-fuel scenario uses the following inputs:

A. 150 Rail casks per year will be handled in the CMF (a fleet of 50 casks, each with maintenance performed a maximum of three times per year) for decontamination, reconfiguration and/or Certificate of Compliance recertification activities.

B. 105 Truck casks per year will be handled (a fleet of 35 casks, each with maintenance performed a maximum of three times per year) for decontamination, reconfiguration and/or Certificate of Compliance recertification activities.

C. 41 Rail casks, in addition to the above scheduled casks, will be handled at the CMF because they arrived at the WHB weeping; i.e., with removable exterior contamination.

This amounts to 8 percent of the maximum number of rail cask shipments expected in any one year. These casks will be decontaminated in the CMF before they are processed in the WHB.

D. 27 additional truck casks will be handled at the CMF because they arrived at the WHB weeping; i.e., with removable exterior contamination. This amounts to 8 percent of the maximum number of truck cask shipments expected in any one year. These casks will be decontaminated in the CMF before they are processed in the WHB.

For simulation purposes, casks in each cask type were assumed to arrive on a uniform schedule throughout the year. One-shift and two-shift operations, both five days per week, were simulated to determine the throughput capability of the CMF. An allowance was made for the CMF to be unavailable 20 percent of the year for equipment maintenance.

The simulation results are as follows:

A. For the canister based scenario, two-shift operation, the system easily handles the required throughput of 160 casks per year. The average waiting time for any resource is approximately 20 minutes.

B. For the canister based scenario, single-shift operation, the system still handles the required throughput of 160 casks per year, but the processing times increase as individual casks spend more time waiting for resources. The average waiting time for preparation and decontamination space is 3.5 hours.

C. For the all-bare-fuel scenario, two-shift operation, the system still handles the required throughput of 323 casks per year, which is approximately double that of the canistered case. The average waiting time for preparation and decontamination space is nearly 8 hours.

D. For the all-bare-fuel scenario, single-shift operation, the program was unable to finish the simulation. Casks arrive so frequently that the preparation and decontamination space is overloaded and a bottleneck occurs. If preparation and decontamination space is arbitrarily increased, then the cask carrier becomes the bottleneck. Thus it appears that single-shift operation is not feasible for the all-bare-fuel scenario, unless the design of the CMF is modified.

E. The average processing time for each cask is shown below. This data indicates that an average cask takes about a week to process, bare fuel casks take about 60 percent longer to process than casks for canisters, and adding a second shift shortens the cask turnaround time by about 25 percent.

Cask Type	Average Time Spent in the CMF (hours)			
	Canistered Fuel		Bare Fuel	
	2 Shifts	1 Shift	2 Shifts	1 Shift
Scheduled rail casks	44.2	55.2	60.7	NA
Scheduled truck casks	34.3	47.3	58.5	NA
Weeping rail casks	17.7	27.8	33.0	NA
Weeping truck casks	21.0	27.7	34.3	NA
All casks	33.3	44.5	54.2	NA

Preliminary Dose Assessment for the MGDS Surface Facility Waste Handling Operations (M&O 1995t)

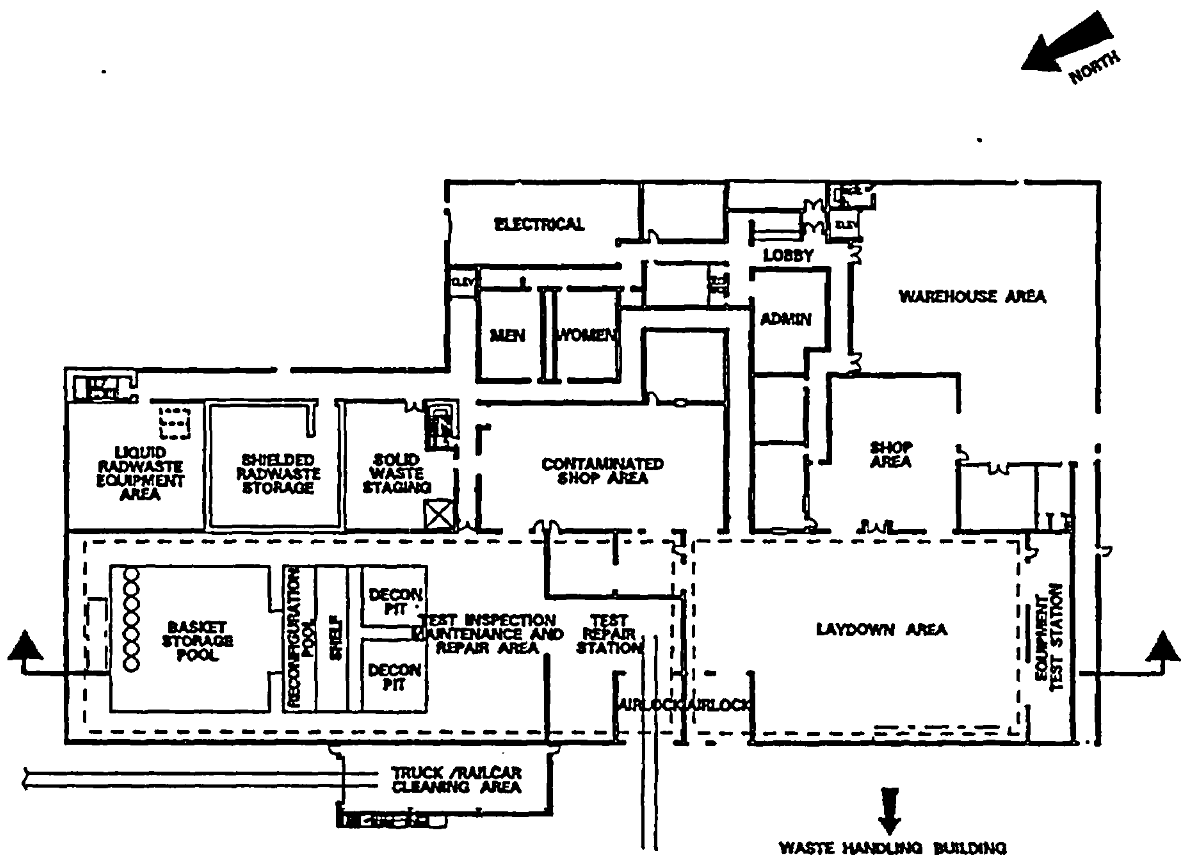
The purpose of this study was to determine the dose rates in millirem per hour at contact and out to twenty feet from the small SFA canister, large SFA canister, GA-4 and GA-9 truck shipping casks, and the rail shipping casks. The GA-4 and GA-9 truck shipping casks were modeled as rectangular volumes with side shields to determine the mid-plane and center line dose rates out to twenty feet from the shipping casks. The SFA canisters and SFA canister shipping casks were modeled as cylinders with side shields to determine the mid-plane dose rate out to twenty feet from the side of the canister or the shipping cask. The shipping casks were also modeled as cylinders with end shields to determine the centerline dose rate out to twenty feet from the cab and back end of the casks. The dose rates were then applied to the repository surface waste handling operations to determine the total exposure in millirem for each cask shipment.

7.2.3.4 Structure Description

The CMF is a three floor concrete and steel structure with approximately 116,000 square feet of gross floor area. The overall building footprint is approximately 360 feet by 226 feet. The CMF, identified as facility N213, is located about 30 feet east of the WHB as shown on the site map in Figure 7.2.1-3.

The CMF layout is shown in the following general arrangements in Appendix D: Plans (CMA-SK-001 through SK-004), Section (CMA-SK-005) and Elevations (CMA-SK-006). The floor plans include a location key to identify building subareas. These location numbers are used throughout this description to help identify building areas. Figure 7.2.3-1 shows a plan view of the first floor (El. 100+0).

This structure description section contains a brief overview of CMF operations, followed by a detailed description of each major area, a description of the architectural features and the structural design considerations. The CMF operations are described in detail in Section 7.2.3.5, Systems Description, and the major components are described in Section 7.2.3.6.



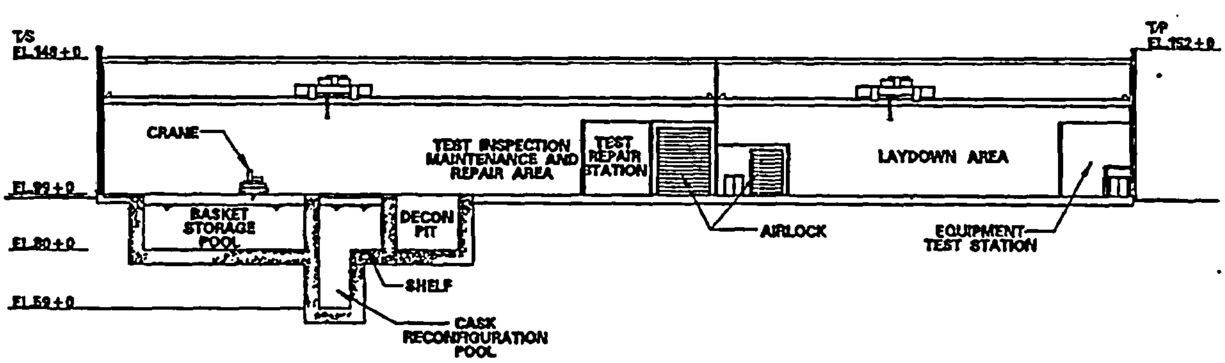


Figure 7.2.3-1 CMF - (Floor Plan and Building Section)

CMF Operations Overview

There are three functions for which a cask may be received into the CMF. These functions are: cask reconfiguration and recertification, external decontamination, and external repairs.

The primary work scope within the CMF is cask reconfiguration and recertification. Any of these steps may be skipped or bypassed as required when a cask is received at the CMF for other activities.

Incoming casks are received in the WHB shipping and receiving bay and transported to the CMF via a cask carrier through an air lock (location 37). Casks are removed from the carrier via the Test, Inspection, Maintenance and Repair 125-ton crane and placed in a preparation and decontamination pit (locations 50 and 52). As the cask is placed in the pit a shroud and bottom protector are installed to reduce exterior contamination when the cask is placed in the reconfiguration pool (location 51). The cask is filled with water and purged of interior gases. The head is loosened and the head removal adaptor is installed. The cask is then lifted into the reconfiguration pool (location 51) and placed on the pool shelf (location 51). The water level is approximately three feet above the top of the cask. The yoke extender is added to the yoke and crane hook in preparation of lowering the cask into the reconfiguration pool (location 51). When the cask is lowered to the bottom of the reconfiguration pool the yoke is disconnected and the yoke, head adaptor and the head are removed. The head is transferred to the decontamination pit (locations 50 & 52) for inspection, repair and decontamination as necessary. The interior of the cask is inspected and wet vacuumed clean. The spacers and baskets are removed by the pool bridge crane as necessary, and the interior of the cask is inspected and vacuumed again. The spacers and baskets are moved to the basket cleaning area (location 53) within the pool and cleaned prior to movement into the storage area (location 53) of the pool.

Spacers and baskets are replaced as required, and the extended yoke is reattached to the cask. The cask is lifted to the pool shelf and the interior of the cask and any sealing surfaces are carefully inspected. The cask is lifted from the pool, and the shroud and bottom protector are removed as the cask is being placed in the preparation and decontamination pits (locations 50 & 52). The cask exterior is surveyed for contamination, and decontaminated as appropriate. The water level in the cask is lowered to allow access to any sealing surfaces. Repairs to seals, fasteners and any internal components are performed as required. The head is retrieved and installed prior to the water being removed from the cask. The cask is vacuum dried and then pressurized with an inert gas.

The cask is then leak tested, if the cask passes the leak test it is transferred into the Test, Inspection, Maintenance, and Repair area (locations 40 and 41). Within the test, inspection, maintenance and repair area, the casks undergo dry test and repairs to external surfaces, mechanical welding, grinding and non-destructive examinations as required. After the casks complete their scheduled activities they are placed on the cask carrier for movement into the shipping and receiving bay in the WHB.

Area Descriptions

This two story CMF w/basement, contains primary operational areas in addition to functional support areas. The major areas within the CMF are described below.

Test, Inspection, Maintenance, and Repair Area (location 41)

The dry test and repair station accommodates tests or repairs to the external surfaces of a cask, or any test or operation to the internal cavity of the cask that can be achieved with the cask containment sealed. The 125-ton overhead crane enables movement of casks and equipment. A jib crane with a lifting capacity of 15 tons is located in the test and repair station. A horizontally and vertically mobile platform allows personnel direct access to the casks' external surfaces and components. The testing and repair station is ventilated by HVAC Zone II. The station may also be equipped with a local HVAC Zone II system capable of capturing and filtering potentially contaminated particulates.

Helium leak tests of the cask cavity, venting or sampling of the cask interior, and purging the interior with inert gas are performed at the test and repair station. In addition, the station is equipped to repair external discontinuities (e.g., gouges and galled or upset metal). Generally these repairs are made using hand or portable tools. Welding equipment is provided to make repairs as necessary. Nondestructive testing of weld repairs, existing welds and machined surfaces is performed as required. Ultrasonic and dye penetrant tests are the most common nondestructive testing methods. Threaded inserts on external surfaces or fasteners are inspected and replaced if necessary.

Preparation and Decontamination Pits (locations 50 & 52)

The preparation and decontamination areas have personnel platforms that are vertically and horizontally mobile. Manual spray apparatus, scrubbing tools, and radioactivity measurement instruments and survey supplies allow for cask external decontamination, wash down, and contamination measurement. Manifolds, controlled drains, equipment, and test apparatus provide for draining, venting, vacuuming, purging, and inert gas leak testing. Inert gas, compressed air tools, and supplies are provided at each preparation and decontamination pit for cask and closure repair handwork, and for repair and replacement of seals, connections, fasteners, valves, vents, drains, and fittings. Cask closure head support and handling stands provided in each pit enable inspection and seal replacement. Hydrostatic testing equipment, fluid measurement equipment, and replacement fluids are provided in the pits for servicing cask cooling and shielding systems, if required. Pit surfaces, work stands, and other fixtures in the preparation and decontamination areas are designed for wet decontamination. The pits are gravity drained into the CMF contaminated floor drains collection tank. Contaminated solutions are transferred via double walled piping to the waste treatment facility.

Reconfiguration and Basket Storage Pool (locations 51 & 53)

Cask reconfiguration and interior cleaning is performed in the reconfiguration pool, located adjacent to the preparation and decontamination area and the basket storage pool. The reconfiguration pool has two floor levels. A shelf level is deep enough for an upright cask. The deep part of the pool accommodates the cask height, plus the height of a cask basket, and additional water depth for basket handling and personnel shielding. The pool is equipped with underwater closed circuit television and lighting; manual remote mechanical tools for bolting, unbolting, and torquing; manual remote submersible cleanup vacuum equipment; and manual remote cleanup equipment. The pool bridge crane travels over the reconfiguration pool. Handling and lifting fixtures manipulate cask closure heads, baskets, and spacers. The pool is stainless steel lined.

Truck and Railcar Cleaning Bay (location 42)

Truck and railcar maintenance occurs in the enclosed truck and railcar cleaning bay. Structural components of either a truck or rail transporter are cleaned, inspected, and repaired as required. Maintenance is performed only on transporter components that are categorized as structural. Nonstructural transporter components such as tires, brakes, wheel bearings, hydraulic system parts, railcar trucks, and other interfacing nonstructural components, are not serviced at the CMF. The truck and railcar cleaning bay is ventilated by a CMF Neutral Zone system. The following operations are performed in the truck and railcar cleaning bay.

A. A radiation survey is performed on the entire surface of the transporter prior to any work being performed.

B. Structural components and related welds are washed to remove road dirt and wiped down as required. Runoff from the wash down operation is routed to the radwaste facility for processing.

C. Beadblasting limited to contained local applications, such as minor paint removal and preparation of welds for inspection, is performed as required. The beadblasting equipment is portable and self-contained. Waste particles created by beadblasting are retrieved by vacuuming and packaged for transfer to the WTB solid radwaste system.

D. Any required weld repairs to the structural components are made in this area. Weld equipment for these operations is shared with other areas in the CMF. Nondestructive testing (e.g., dye penetrant, ultrasonic, and magnetic particle) of the transporter structural components and structural welds is performed.

Clean Shop (location 21)

The clean shop maintains equipment and components from the CMF. The clean shop area is an HVAC neutral zone. The shop is accessible from the CMF warehouse area and the CMF laydown area for movement of transfer facility equipment or components requiring maintenance. Minor machining operations, maintenance, inspection, and repair of special tooling and equipment, such as purging, filling, drying, and vacuuming equipment and apparatus, are performed in the shop area. The shop area equipment includes a milling machine, jib crane and hoist, bench lathe, enclosed parts cleaner, portable steam cleaner, portable welder, drill press, electric fork lift, arbor press, mobile gantry crane, horizontal metal cutter, miscellaneous measuring instruments, mechanics tools, and miscellaneous support tooling for major equipment.

Tool Issue Room (location 26)

The tool issue room provides storage, inventory control, tools, and consumables for the operating areas in the CMF. The tool issue area is an HVAC neutral zone. Tools and consumables include machine tooling, hand tools (e.g., grinders, drill motors, and wrenches), consumable grinding materials, nondestructive testing consumables, and weld consumables. The tool issue area also stores common fasteners and hardware.

Contaminated Shop (location 24)

This shop is dedicated to work on contaminated components from cask systems, the CMF, the WHB and the WTB. The contaminated shop area is an HVAC Zone II. Work in the area is limited to smaller items (e.g., valves, connections, and hand tools) that can be safely lifted by hand, approximately 50 lbs maximum. The shop is equipped with containment glove boxes and hoods to inspect, disassemble, assemble, repair or rebuild small items; an electropolishing tank with enclosure; stainless steel sinks for decontamination; and work benches. Decontamination systems are supplied by the decontamination makeup system. No machining is performed in this area. Contaminated items that require machining are decontaminated and then moved to the clean shop area. Liquid radwaste is collected by the CMF contaminated drains radwaste system and is routed to the liquid radwaste treatment system in the WTB for processing. Solid radwaste is packaged and transferred to the solid radwaste system in the WTB.

Contaminated Tool Crib (location 28)

The contaminated tool crib is a monitored, controlled, and segregated storage area for all tools that are not easily decontaminated. These tools, including tools used in the CMF and the transfer facility, are cleaned and packaged. The contaminated tool crib is an HVAC Zone II.

Laydown Area (location 36)

The laydown area provides storage, queuing, inspection, and repair areas for components such as personnel barriers, impact limiters, tiedowns, transporter structural components (i.e., shipping skids and saddles), intermodal lifting devices, lifting yokes, and ancillary equipment. Maintenance and repair is performed on those components that are not integral to the cask. The laydown area is ventilated by a HVAC Zone III system. Access to the laydown area is through the cask staging area. A 125-ton laydown area overhead bridge crane services the laydown area.

Equipment Testing Station (location 35)

The equipment testing station provides load tests for lifting equipment and components, including trunnions, cask lifting yokes, intermodal lifting devices, slings, and adapters. The equipment testing station is part of an HVAC Zone III system. Humidity checks on impact limiters may be performed in this area. No contaminated items are allowed in the equipment testing station. Valves that are nonintegral to the cask, special tools, and ancillary equipment that require leak or pressure testing are inspected and tested. Weld repairs and handwork are performed in this station. In addition, nondestructive testing is performed on welds.

Equipment Cleaning Area (location 39)

The equipment cleaning area provides the controlled environment and apparatus for cleaning and decontaminating equipment and components, including items returned from purchasers as well as items in use at the CMF, the WHB and the WTB. The equipment cleaning area has two sections, the equipment preparation area and the equipment cleaning area. Both sections are ventilated by a HVAC Zone II system.

Contaminated items initially arrive in sealed packages. After the preparation area door is closed, the items are unpackaged and checked for contamination. If required, contaminated items are moved into the closed equipment cleaning area for decontamination. The decontaminated items are returned to the equipment preparation area. All items below radiological contamination limits are repackaged and the units are moved to operation or storage areas.

Decontamination solutions, tempered water, and spray equipment are supplied from the decontamination supply system. Liquid radwaste generated during the cleaning process is collected by the contaminated drains radwaste system, and is routed to the liquid radwaste treatment system in the WTB for processing. Solid radwaste is packaged and transferred to the solid radwaste system in the WTB for processing.

Warehouse and Parts Storage Area (location 16)

The CMF warehouse acts as the central location for storage and supply of spare parts, components, and campaign shipping boxes used to support operations of the transportation cask systems during shipping campaigns. The warehouse also supports the maintenance and repair of transportation casks at the CMF. Spare parts and equipment that return from a purchaser are considered to be contaminated. These items are cleaned, inventoried, and packaged in the equipment cleaning area before entering the warehouse for storage. The warehouse and parts storage area is ventilated by the HVAC neutral zone systems.

The warehouse contains approximately 8,200 square feet, with 850 square feet for spare parts and office, 6,500 square feet for campaign boxes, and 850 square feet designated as a handling area. The handling area is used primarily for loading and unloading campaign boxes and spare parts. A truck dock is located at the southwest corner of the building. Rail access is provided through the CMF laydown area, where shipments are loaded and unloaded. A fork lift transports items between the warehouse and the rail loading and unloading area. The warehouse also serves as the central storage area for ancillary equipment, special tools, and fixtures when not in use during a shipping campaign.

Calibration Lab (location 23)

All inspection measuring equipment, pressure gauges, and tooling (e.g., torque wrenches, load test measuring instruments) that require scheduled calibration, certification, or repair are monitored and calibrated in this lab. All items must be free of uncontrolled contamination prior to entering this area. The calibration lab ventilation is included in an HVAC neutral zone system. Lab personnel store and issue all inspection measuring devices, such as micrometers, vernier calipers, and dial indicators that are used in daily operations of the CMF. Ultrasonic, magnetic particle, and dye penetrant inspection equipment is also stored in this area.

Additional Support Areas

In addition, the central administration and personnel support area is located so that personnel working in or visiting the CMF are routed directly from the protected area badge house. Personnel working in the CMF check in at the administration and personnel support area and then proceed to their appointed work place. If anti-contamination clothing is needed, personnel dress appropriately in the locker room before leaving the administration and personnel area. Administrative or maintenance personnel are directed as necessary from the single point personnel access through the administration and personnel area. Personnel exiting the facility are checked for contamination.

The remaining support systems such as the cooling tower, plant air, and chilled water systems are located in a separate centralized utility building, servicing all repository surface facilities, including the CMF.

Architectural Components

Construction materials and finishes for the various areas of the CMF are selected to be durable, functional, and aesthetically pleasing. The operation and support areas are constructed within existing systems, and finishes are low maintenance and adaptable to decontamination where appropriate. These finishes include painted masonry or concrete walls, sealed or painted concrete floors, or composition tile floors.

Materials will conform to applicable American National Standards Institute and Underwriter's Laboratory standards. The architectural design will be in accordance with state and local building codes as well as directives contained in the RDRD (YMP 1994a) for the site selected. Handicapped design requirements apply to the design of the administration and personnel support area.

Structural Design

The structural design of the CMF building considered the service loads and the loads associated with natural phenomena hazards such as earthquakes, extreme winds, tornadoes, and flooding. The service live loads are dependent on occupancy or use. The minimum live loads specified in the Uniform Building Code were used as minimum design live loads. Actual loads will need to be verified in the future. It is anticipated that some equipment weights may exceed the minimum design live loads. The structural design of the CMF is based on the assumption that the CMF is performance category 3 as defined in DOE-STD-1020-94. This assumption is based on engineering judgement and will need to be verified by analysis in the future.

The walls and floors of the preparation and decontamination area, cask reconfiguration pool, basket storage pool, pool purification equipment area, and spent resin handling area are constructed of reinforced concrete. Interior surfaces of the preparation and decontamination area, cask reconfiguration pool yoke and adapter storage area, equipment cleaning area, and basket storage pool are lined with approximately 20,000 square feet of 1/4-inch stainless steel plate to help control contamination.

The pool purification equipment area and spent resin handling area consist of a concrete substructure and steel structural frame. Curbs contain the maximum liquid inventory in the event of a spill.

The CMF laydown area consists of spread footings concrete slab on grade, and structural steel superstructure. The laydown area and the test inspection are both serviced by the 125-ton bridge crane supported by structural steel.

The remainder of the facility consists of concrete spread footings, concretes slabs on grade, structural steel superstructure framing, masonry or concrete walls, and lightweight partitions.

In the design of reinforced concrete, structural members were proportioned for adequate strength in accordance with the provisions of the American Concrete Institute Code using load factors and strength reduction factors specified in the code. Structural steel members and their connections were designed in accordance with the American Institute of Steel Construction American Structural Design manual, using the allowable stress design method. Metal decking and composite slab were designed using the manufacturer's design manual and allowable load data.

Final structural design of the CMF will comply with the applicable criteria in the RDRD (YMP 1994a). The MGDS ACD Report considered only service loads, seismic load, and tornado generated missile impact load, which were judged to be the controlling design conditions. Extreme wind and other loading conditions will have to be considered in the final design.

7.2.3.5 System Descriptions

This section describes the major systems associated with the CMF. An overview of the major systems are shown in Figure 7.2.3-2. The CMF systems are also listed in Table 7.2.3-1 along with a brief description, key sizing parameters, and the area within the CMF where the operations take place. The area designations correspond to area descriptions shown on the cask maintenance general arrangement sketches. Following the table, the functional requirements, scope, and operations are described for each major system, and the other CMF support systems are listed.

7.2.3.5.1 Cask Preparation System

Functions

The Cask Preparation System, shown in Figure 7.2.3-3, prepares the transportation cask for opening. Transportation casks are lowered into the Prep/decon pits to accommodate the opening of casks. The shroud and bottom protector are installed, casks are filled with water, and the head is loosened. The casks are transferred into the Reconfiguration and Recertification system.

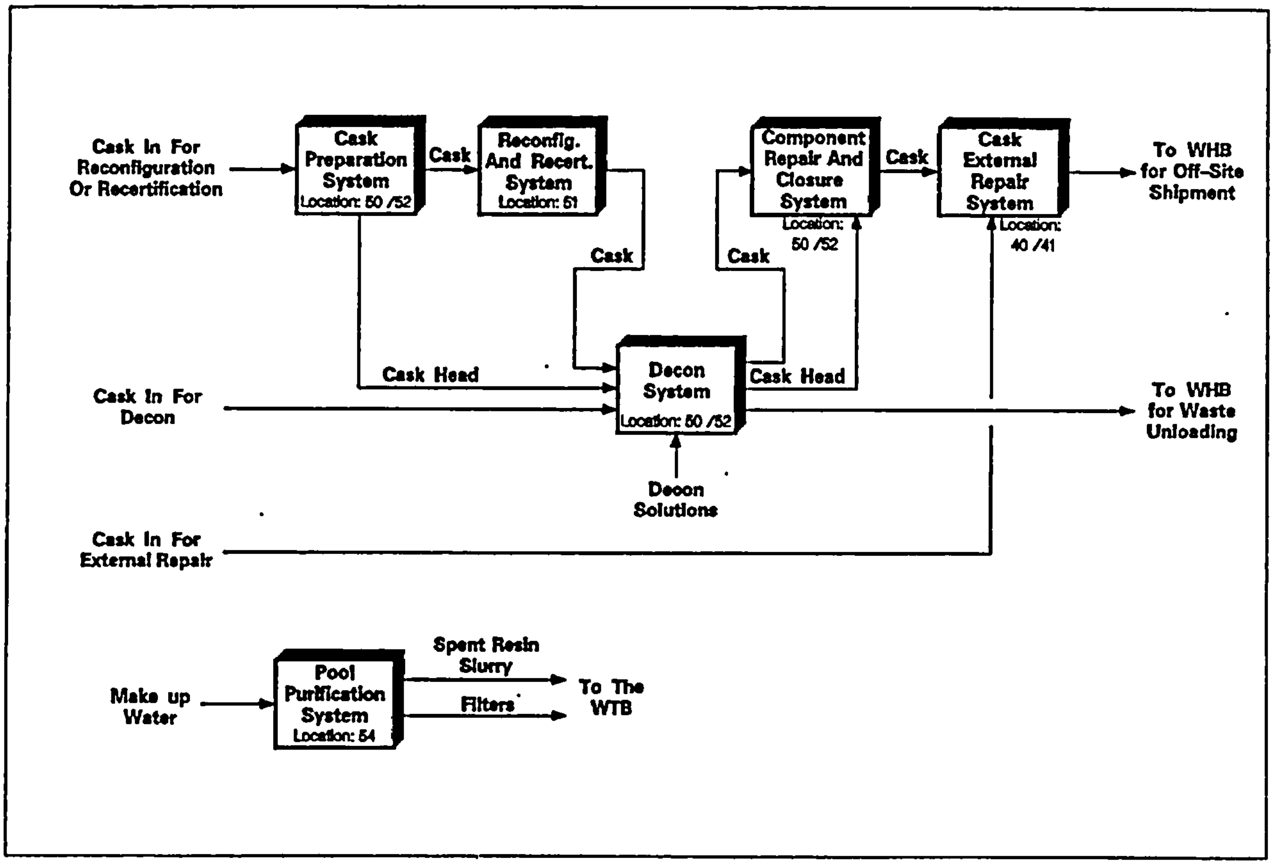


Figure 7.2.3-2. CMF Systems Overview

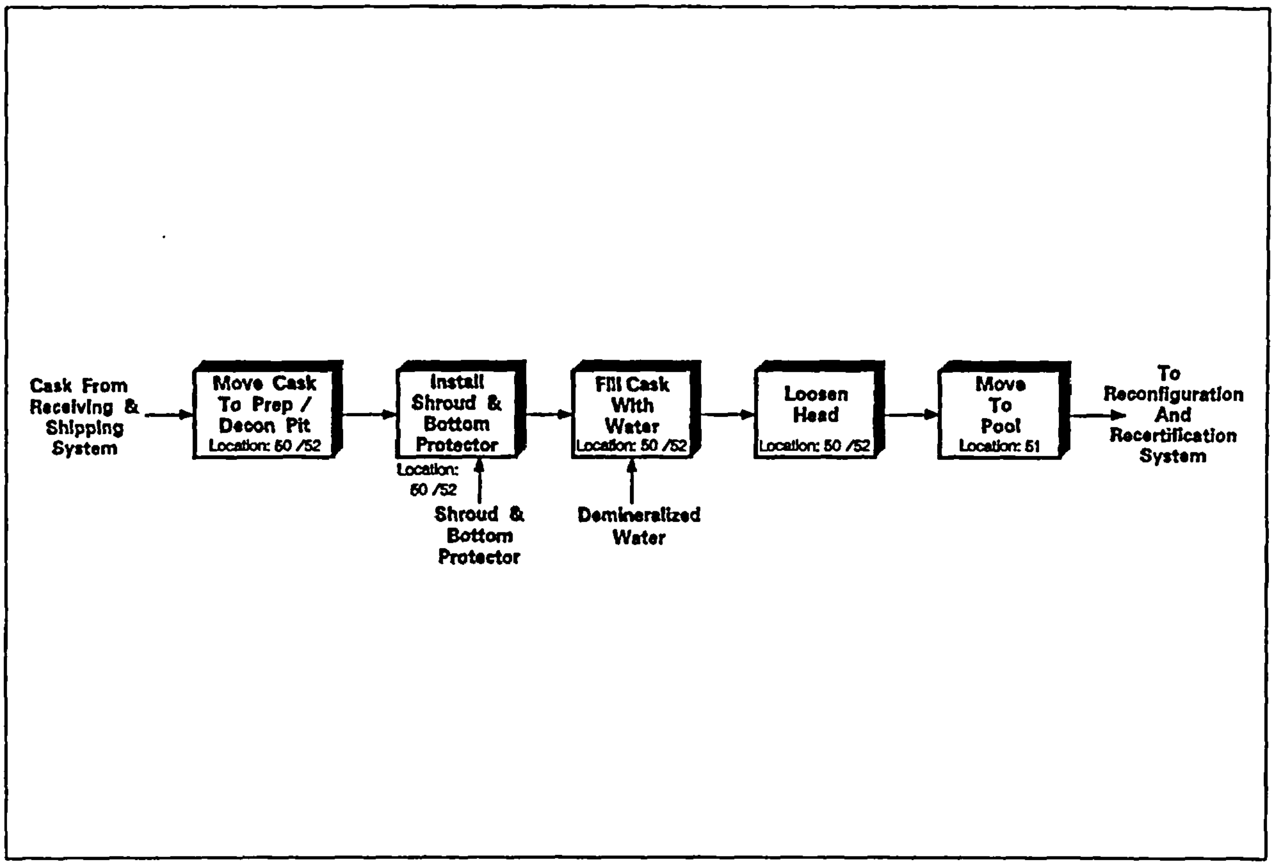


Figure 7.2.3-3 Cask Preparation System

Table 7.2.3-1 CMF Major System Summary

Name	Description	Sizing Parameters	Operational Area
Cask Preparation System (Figure 7.2.3-3)	Transportation casks are lowered into the Prep/decon pits to accommodate the opening of casks. The shroud and bottom protector are installed, casks are filled with water and the head is loosened.	The cask receipt rate for the canister based system is 160 casks per year.	Prep/Decon Areas 1 & 2
Cask Reconfiguration and Recertification System (Figure 7.2.3-4)	Casks are placed in the cask reconfiguration system to facilitate the changeout of baskets, placement of spacers, internal cleaning, maintenance, inspection, test, repair, and replacement of all cask components associated with closing and sealing the cask inner cavity.	The cask receipt rate for the canister based system is 160 casks per year.	The Reconfig. Pool.
Decontamination System (Figure 7.2.3-5)	The shroud and bottom protector are removed if necessary. Radiation surveys are performed and general area decon with water or chemicals are performed as necessary. In addition, localized or spot decons are performed by this system.	The cask receipt rate for the canister based system is 160 casks per year.	Prep/Decon Areas 1 & 2
Cask Component Repair and Closure System (Figure 7.2.3-6)	Inspections, tests, repairs, and replacement of the cask closure and cask body sealing surfaces and components, closure fastening components, drain and fill valves, vent valves, caps, fittings, drain lines, seals, and other components interfacing with the cask cavity are performed. Installation of closure seals and closure testing using air, inert gas, or water are also performed within this system.	The cask receipt rate for the canister based system is 160 casks per year.	Prep/Decon Areas 1 & 2
Cask External Repair System (Figure 7.2.3-7)	Transportation casks are accepted into the CMF area via a cask carrier. Dry test and repair stations accommodate tests or repairs to the external surfaces of a cask or any test or operation to the internal cavity of the cask that can be achieved with the cask containment sealed.	The cask receipt rate for the canister based system is 160 casks per year.	Cask Staging / Receiving Bay, The Laydown area, and the Test Inspection and Repair areas
Pool Purification System (Figure 7.2.3-8)	The pool purification system contains equipment that removes particulate and radioactive materials from the cask reconfiguration and basket storage pools. In addition the system provides high quality makeup water to the pools.	Demineralizers and the pre and post filters have a design flow of 290 gpm. The pool volume is approx. 675,000 gallons.	Pool Purification Equipment area and the Spent Resin Handling area on El.80
HVAC System	The HVAC system conditions air as it flows through the CMF area rooms to control environmental conditions and differential pressures between confinement zones. Process vents are collected, filtered and released from a stack.	3 zones	HVAC Equipment Rooms 1 & 2 on El.126 + 0

Scope

The Cask Preparation system receives a cask from the Cask Receiving and Shipping System and prepares the cask for introduction into the Cask Reconfiguration and Recertification System. The system installs the shroud and bottom protector, samples and purges the internal gases, fills the cask with water, and loosens the head. The cask preparation system interfaces with the following systems:

A. Electric power to operate instruments, platforms, welders, and cranes.

B. Compressed air to operate instruments and pneumatic tools, and provide for testing/purging cask internals.

C. HVAC systems to process cask venting activities.

D. CMF structure to house system components and support the cranes, carriers, and casks.

Operations

To begin preparation operations, the test, inspection, maintenance, and repair crane moves the cask from the cask carrier to one of the preparation and decontamination area pits. As the cask is lowered into the pit, the cask exterior protection shroud and bottom protector are positioned and installed. With the cask in the pit, the work platform is positioned and test connections are made to vent and purge the cask cavity. The cask cavity is filled with water and the cavity space gas is vented through a duct system to the ventilation handling system. The fasteners for the cask head are loosened, however, the closures are not removed. Cask closure adapters or slings, used to remove the closures when the cask is in the reconfiguration pool, are installed. The 125-ton bridge crane and the cask lifting yoke move the cask out of the pit area and onto the shelf in the reconfiguration pool.

7.2.3.5.2 Cask Reconfiguration and Recertification System

Functions

The Cask Reconfiguration and Recertification System, shown in Figure 7.2.3-4, changes the internal components (i.e., baskets and spacers) of a cask as required for the cask to ship the next waste form (pressurized water reactor or boiling water reactor). The Cask Reconfiguration and Recertification system accepts a cask into the reconfiguration pool, cleans the interior of the cask as applicable, and changes the basket or spacer retainers within the cask. The level of cleanliness of the interior of a cask is dependant upon where it is to be transported (i.e., each utility may have different acceptance criteria). This system also contains provisions to service and store cask baskets and spacers. Cask Reconfiguration and Recertification System functions include:

A. Installation and removal of cask lift adapters, basket handling and lifting fixtures, and cask fuel assembly spacers and standoff fittings.

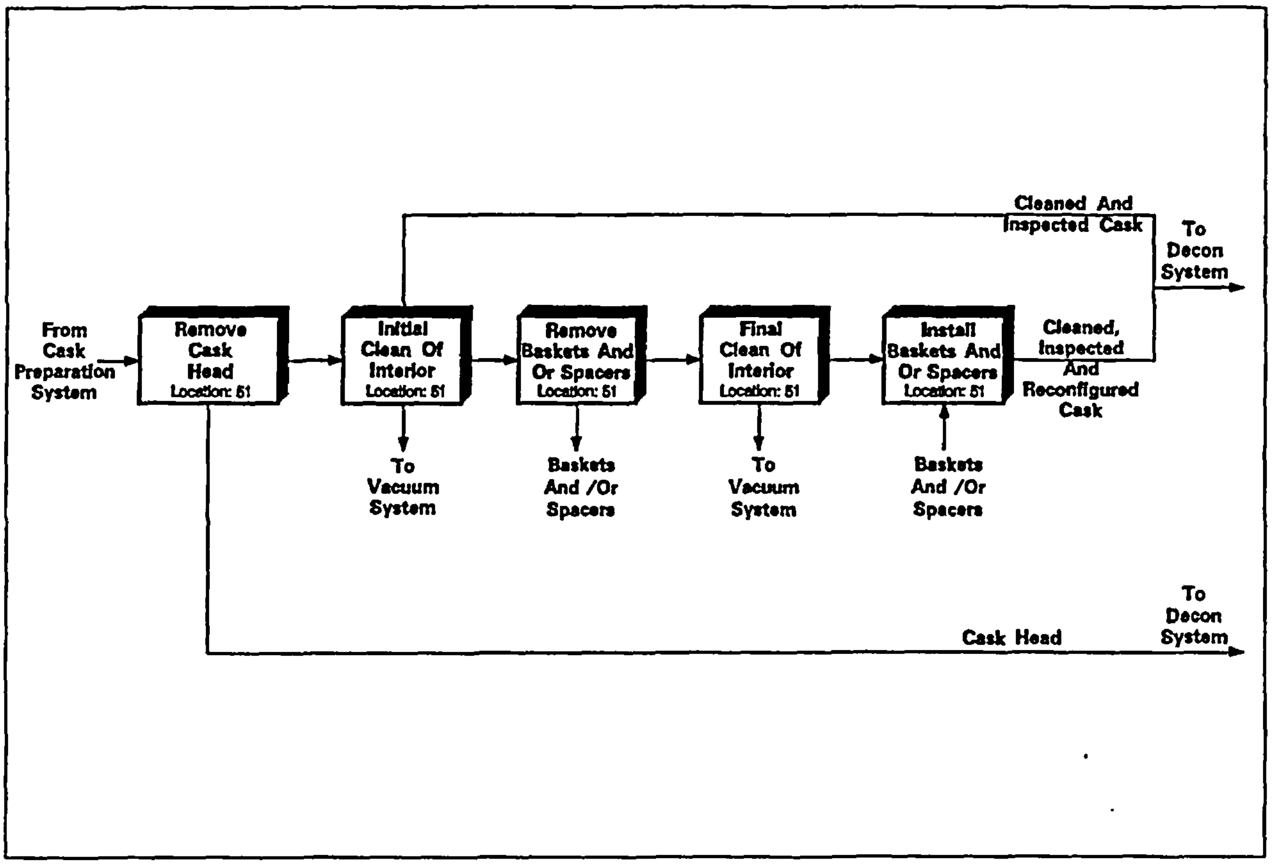


Figure 7.2.3-4 Cask Reconfiguration and Recertification System

B. Cask wet vacuuming, interior cleaning, basket hydro-cleaning, and unidentified deposits (i.e., crud) captured from the cleaning operations.

C. Inspection, release, and installation of basket and spacer retainers within casks

D. Movement of baskets and spacers between the cask reconfiguration pools and the basket storage pool.

Scope

The Cask Reconfiguration and Recertification System receives the cask from the 125-ton crane, typically after it has been prepared by the Cask Preparation system. The casks are opened, spacers and baskets are removed, cleaned, stored and replaced. The cask reconfiguration pool is cleaned by the Pool Purification System. After reconfiguration, the casks are picked up by the crane and placed in the Decontamination System for decontamination and seal inspections. New or replacement spacers, baskets, yokes and other equipment are retrieved or sent to the laydown area for equipment inventory and control. The cask reconfiguration system also interfaces with the following systems:

A. Electric power to operate instruments, cleanup equipment and cranes.

B. Instrument air to operate instruments and pneumatic tools.

C. Underwater closed circuit television system.

D. Pool leak detection system.

E. Demineralized water system to provide flushing, cleaning and makeup capabilities.

F. Pool Purification System.

G. Cask vacuum system.

H. CMF structure to house system components and support the pool, cranes, and casks.

Operations

After completing the operations in the preparation and decontamination pits, the cask is moved onto the shelf in the reconfiguration pool. Cask reconfiguration and interior cleaning are performed in the reconfiguration pool, located adjacent to the preparation and decontamination pits and the basket storage pool. The reconfiguration pool has two floor levels. The shelf level and basket storage area is deep enough for an upright cask/empty basket. The deep part of the pool accommodates the cask height, plus the height of a cask basket or fuel assembly, and additional water depth for component handling and personnel shielding. The pool is equipped with underwater closed circuit television and lighting; manual remote mechanical tools for bolting, unbolting, and torquing; manual remote submersible cleanup vacuum equipment; and manual remote cleanup equipment. The pool bridge crane travels over the reconfiguration pool, the cask shelf and basket storage area. Handling and lifting fixtures manipulate cask closure heads, baskets, and spacers. The pool is stainless steel lined.

The cask lift adapter is installed between the crane hook and the yoke. All remaining closure fasteners are removed. The cask is moved underwater from the pool shelf to the deep pool area. The yoke is remotely disconnected from the cask trunnions. As the yoke is lifted from the pool, the cask closure lifting fixture engages the closure. The yoke, lift adapter, and closure are removed from the reconfiguration pool and transferred to the preparation and decontamination area pit, where the closure is placed on the closure support stand. The yoke can be moved to the yoke and adapter storage rack, located along the side of the basket storage pool.

The interior of the cask is inspected using underwater closed circuit television and lighting. Crud is wet-vacuumed from within the cask. Spacers to be changed are removed with the pool bridge crane, using remote tooling, and are placed in underwater storage racks. Casks requiring basket changeout are prepared for basket removal. Basket lifting fixtures are installed, mechanical retainers removed, and the basket lifted from the cask. The basket is moved underwater to the basket cleaning area of the deep pool. Cleanup of the cask interior is performed using the wet vacuum and submerged filtering unit. Cask interior walls, fuel channels, and other surfaces are cleaned using manual remote cleaning tools.

Baskets moved to the basket cleaning area of the deep pool are placed at the bottom of the pool. Special water circulation aids in underwater capture and removal of crud. Hydro-cleaning wands clean off crud held within the basket structure. When clean, the basket is transferred underwater into the basket storage pool.

For casks requiring basket change out, a reconfigured basket is transferred from the basket storage pool to the cask reconfiguration pool. The basket is placed in the cask and secured. Spacers may be installed at this point. The cask yoke with lift adapter is connected to the cask trunnions. The reconfigured cask is lifted from the deep pool using the 125-ton crane and is placed on the shelf, where the lift adapter is disconnected. Using the crane and yoke, the cask is lifted from the reconfiguration pool and moved back into a preparation and decontamination pit.

The basket service area is a dedicated area of the basket storage pool. Basket service area operations include visual inspection of baskets, repair of surface and top side metal components, and removal and installation of spacers in baskets. Manual remote tools are provided for underwater repair. Underwater closed circuit television and lighting aid repair and inspection. Tools for removing and installing spacers are provided.

The basket storage area in the pool accommodates the height of the baskets, with enough water depth for operations and personnel shielding. The basket storage pool provides storage in racks for baskets, spacers, and spacer handling tools. The basket storage pool is lined with stainless steel. The CMF pool purification system provides water circulation and cleanup. Underwater closed circuit television and lighting are also provided.

Baskets and spacers are stored in racks in the storage pool. The basket handling fixture and pool bridge crane are used to transfer baskets between the reconfiguration area and the basket storage area of the pool.

7.2.3.5.3 Decontamination System

Functions

The Decontamination System, shown in Figure 7.2.3-5, provides cask external decontamination capabilities. In addition, this system provides for decontamination of large components (e.g., the cask head) and radiological inspections. The expected decontamination capabilities include the use of high pressure and temperature water and chemical solutions. The system also provides for localized decontamination as necessary.

Scope

The Decontamination System receives a cask from various systems including the Cask Reconfiguration and Recertification System, and decontaminates the external portion of the cask for introduction into the WHB or transportation to the next waste collection point (utility or DOE facility). The Decontamination System also interfaces with the following systems :

A. Electric power to operate instruments, platforms, welders, and cranes.

B. Compressed air to operate instruments and pneumatic tools.

C. Demineralized water system to provide flushing and cleaning capabilities.

D. Specialized decontamination systems for pressure, temperature or chemical cleaning solutions.

E. Floor drain systems (chemical and aqueous).

F. CMF structure to house system components and support the cranes, carriers, and cask.

Operations

Two stainless steel lined decontamination pits are located adjacent to the reconfiguration pool and the Test Inspection Maintenance and Repair area of the CMF. The decon operations include radiological inspection, water and chemical decontamination and cleanup of external components. Cask and or components are received from various systems. The two primary paths into the Decontamination System are from the Reconfiguration and Recertification system for external decon of an open cask and from the WHB shipping and receiving system for external decon of a sealed cask.

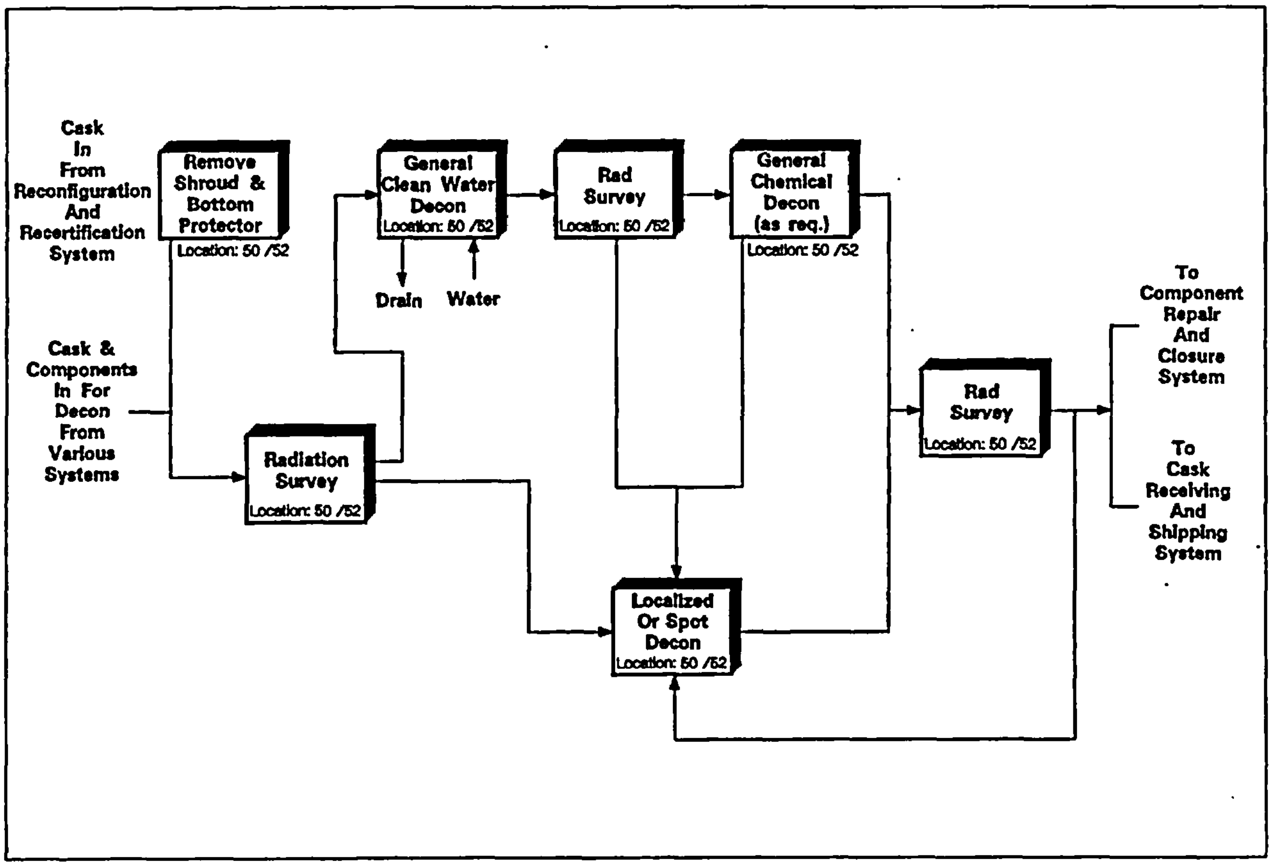


Figure 7.2.3-5 Decontamination System

After cask reconfiguration and cleaning operations are completed in the reconfiguration pool, the 125-ton crane moves the cask into the decontamination pit. The exterior protection shroud and bottom protector are removed from the cask, and the cask exterior surfaces are surveyed for contamination. Decontamination solutions, tempered water, along with equipment and supplies provided in the work station are used to remove surface contamination. Radiation surveys are conducted periodically to ensure adequate decontamination has occurred and the excessive use of decon solutions is avoided.

When the exterior decon is complete, the cask and or component is transferred to the component repair and closure system or to the cask receiving and shipping system.

The preparation and decontamination areas have personnel platforms that are vertically and horizontally mobile. Manual spray apparatus, scrubbing tools, and radioactivity measurement instruments and survey supplies allow for cask external decontamination, wash down, and contamination measurement. Pit surfaces, work stands, and other fixtures in the preparation and decontamination areas are designed for wet decontamination. Decontamination solutions, demineralized water and spray equipment are supplied from the decontamination supply system. The pits are gravity drained into the CMF contaminated floor drain system collection tanks (chemical and aqueous). Contaminated solutions are pumped to the WTB.

7.2.3.5.4 Cask Component Repair and Closure System

Functions

The Cask Component Repair and Closure system, shown in Figure 7.2.3-6, provides for test, inspection, repair, and replacement of cask components, the installation of closure seals and closure testing using air, inert gas, or water.

Scope

The Cask Component Repair and Closure system receives a cask from the Decontamination System, prepares the cask for introduction into the Cask External Repair System for introduction into the WHB or transportation system to the next waste collection point (utility or DOE facility). This system provides for the inspection, testing and replacement of cask components and the installation of seals. The Cask Component Repair and Closure system also interfaces with the following systems:

A. Electric power to operate instruments, platforms, welders, and cranes.

B. Compressed air to operate instruments and pneumatic tools, and provide for testing/purging cask internals.

C. HVAC systems to process cask venting and vacuuming activities (including drying).

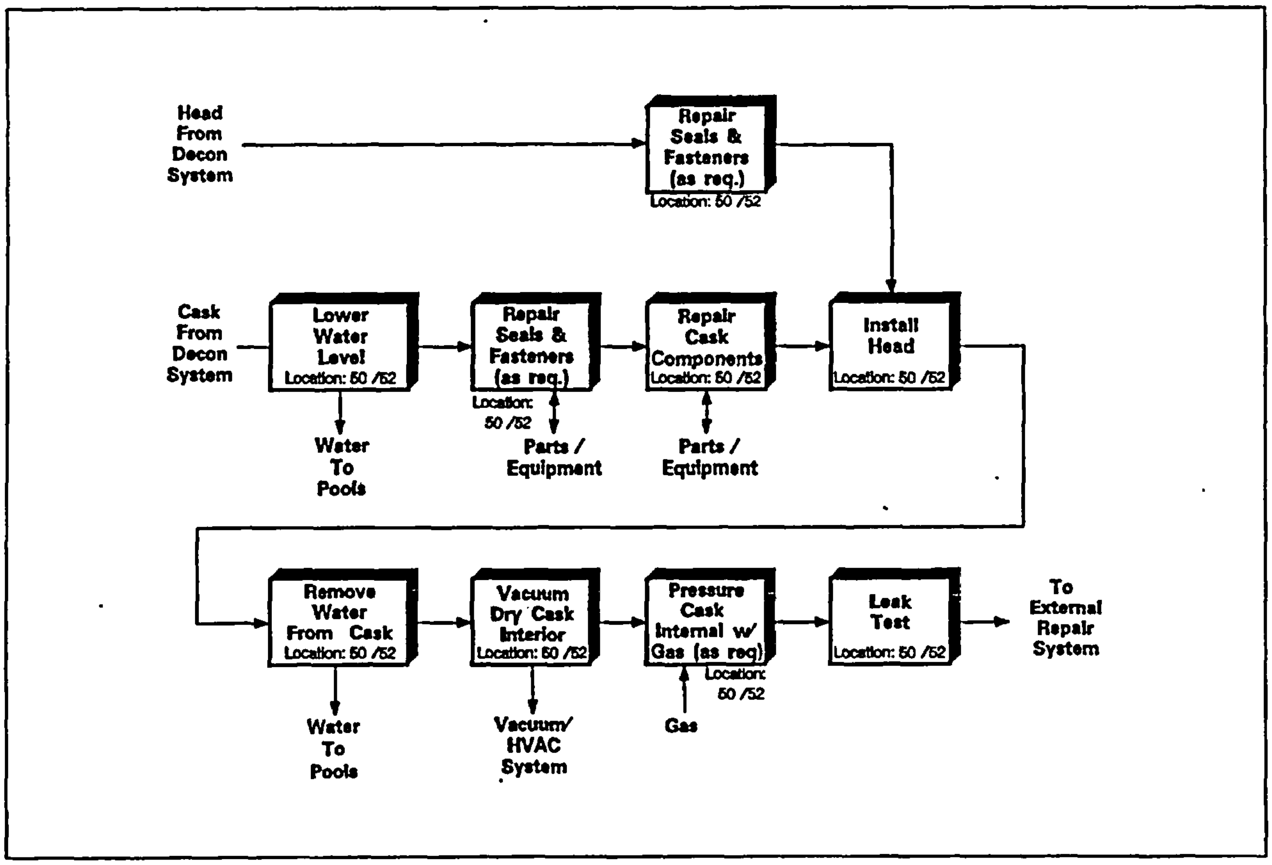


Figure 7.2.3-6. Cask Component Repair and Closure System

D. Inert gas systems for pressure testing and shipment.

E. CMF structure to house system components and support the cranes, carriers, and casks.

Operations

The cask component repair and closure operations include inspection, test, repair, and replacement of the cask closure and cask body sealing surfaces and components, closure fastening components, drain and fill valves, vent valves, caps, fittings, drain lines, seals, and other components interfacing with the cask cavity and the installation of closure seals and closure testing using air, inert gas, or water.

Water within the cask is lowered to the level necessary to perform inspection and repair of the cask closure sealing surfaces and fasteners. A temporary shielding cover placed at the cask top surface provides personnel shielding during inspection and work operations and prevents foreign material from entering the cask during repair operations. Cask closure head and closure surfaces and seals are inspected and repaired as required. All components interfacing with the cask cavity, such as drain and fill connections, vent connections, caps, fittings, and drain lines and seals, are inspected, tested, repaired, or replaced as required. The cask closure heads are installed. Water within the cask is removed and routed to the reconfiguration pool, and the cask cavity is purged and vacuum dried. Cask closure seals, the cask cavity, and all components interfacing with the cavity are tested to meet leak tightness specifications.

When all work is completed, the test, inspection, maintenance, and repair crane moves the cask from the preparation and decontamination area pit to the test and repair station if additional work is to be performed. Otherwise, the cask is placed on the cask carrier. The lifting yoke is disconnected and the yoke and 125-ton crane are moved away.

7.2.3.5.5 Cask External Repair System

Functions

The Cask External Repair System, shown in Figure 7.2.3-7, receives casks, performs external tests and repairs, and tests on the internal cavity of sealed casks.

Scope

The Cask External Repair System receives casks from the CMF cask carrier. In the event that an arriving cask is contaminated beyond acceptable levels for the WHB it will be brought into the CMF and placed in the Decontamination System for decon and then sent to the WHB for unloading. External tests and repairs, and tests on the internal cavity of a sealed cask, are performed by the Cask External Repair System. In addition, helium leak tests of the cask cavity, venting and sampling, and purging of the cask interior are performed at this station. Hand and portable tools and welding equipment are provided to repair external damage as required.

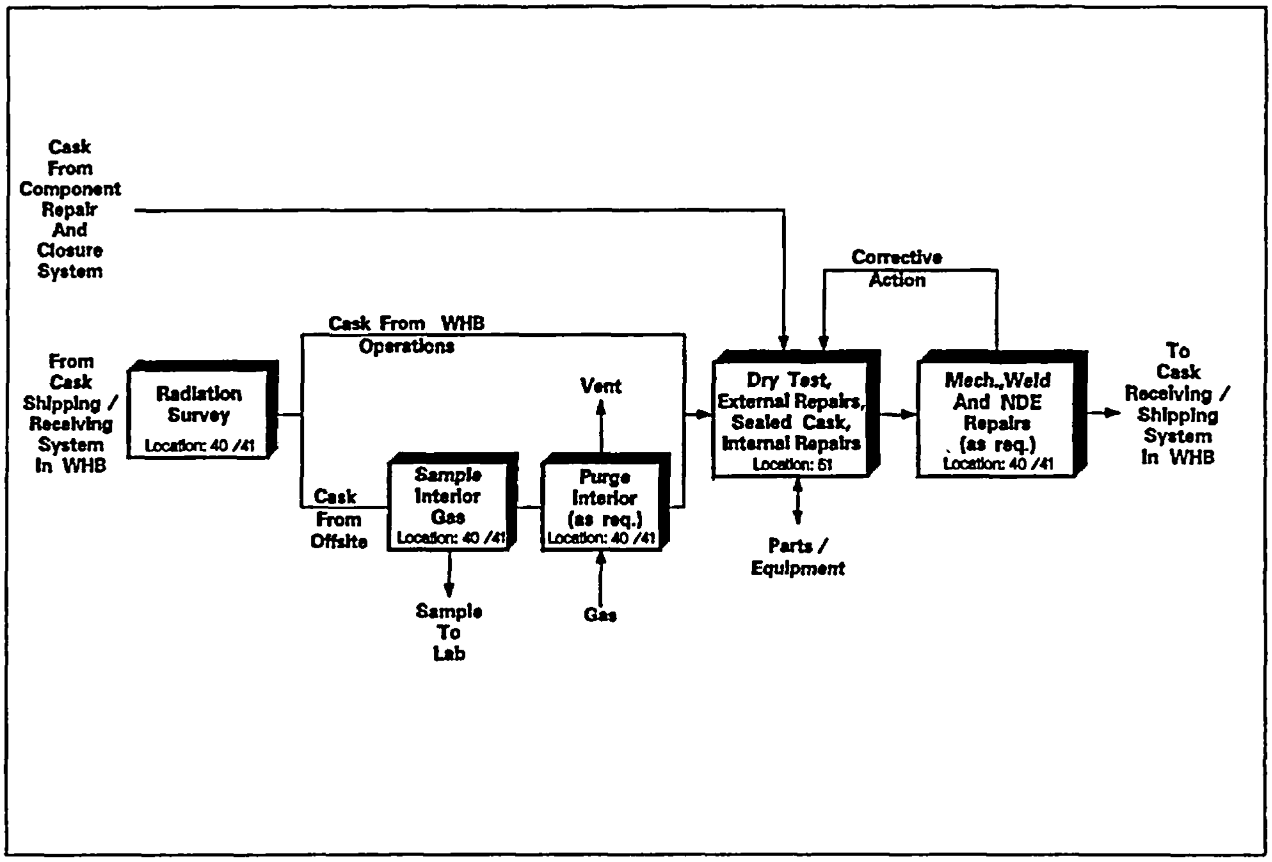


Figure 7.2.3-7 Cask External Repair System

Nondestructive testing, including ultrasonic and dye penetrant tests, of weld repairs, existing welds, and machined surfaces are performed. Threaded inserts on external surfaces and fasteners are inspected and replaced if necessary. The Cask External Repair System also interfaces with the following systems:

A. Electric power to operate the components such as instruments, welding equipment, platforms, and cranes.

B. Compressed air to operate instruments, pneumatic tools and perform pressure test.

C. HVAC system to vent/purge and sampling the interior of the cask, as necessary.

D. CMF structure to house system components and support the cranes, carriers, and casks.

Operations

Casks are received in the shipping and receiving area of the WHB, removed from their transporters, and placed on a carrier. A high-tonnage overhead bridge crane in the staging area is used to move casks between transporters and carriers. If a cask is loaded, it is moved to the WHB for unloading, and then returned to the staging area for transfer to a CMF carrier before it is moved to the interior of the CMF. In the event that a cask is contaminated beyond acceptable levels for the WHB (assumed to be 8 percent of incoming casks), it will be moved from the transporter to the CMF carrier and brought into the CMF for decontamination and then sent to the WHB for unloading.

Typically a cask is brought into the CMF and placed in the testing and repair station. This dry station is where external tests and repairs, and tests on the internal cavity of the sealed cask are performed. A high-tonnage overhead bridge crane (also known as the test, inspection, maintenance and repair crane) and a small-tonnage jib crane are located in the testing and repair area. A mobile platform in the testing and repair area of the CMF allows personnel access to the cask external surfaces and components.

Helium leak tests of the cask cavity, venting and sampling, and purging of the cask interior are performed at this station. In addition, hand and portable tools and welding equipment are provided to repair external damage as required. Nondestructive testing, including ultrasonic and dye penetrant tests, of weld repairs, existing welds and machined surfaces are performed. Threaded inserts on external surfaces and fasteners are inspected and replaced if necessary. Cask certification will be done according to manufacturer and licensing requirements.

7.2.3.5.6 Pool Purification System

Functions

The CMF Pool Purification System, shown in Figure 7.2.3-8, primary function is to remove particulate and radioactive materials from the cask reconfiguration and basket storage pools, and provide high-quality makeup water to the pools.

Scope

The Pool Purification System receives water from the Cask Reconfiguration and Recertification System, filters and demineralizes the water before recycling the water back to the Cask Reconfiguration and Recertification System pools. This system transfers filters and spent resin to the WTB for processing as required. In addition, the Pool Purification System interfaces with the following systems:

A. Electric power to operate instruments and equipment (pumps, valves, etc).

B. Demineralized water system to provide makeup capabilities.

C. Radiation protection and monitoring.

D. WTB radwaste systems.

E. Floor drain system.

F. CMF structure to house system components.

Operations

The Pool Purification System contains equipment that removes particulate and radioactive materials from the cask reconfiguration and basket storage pools. In addition, the system provides high-quality makeup water to the pools.

Cask wet vacuuming equipment, located in the deep section of the reconfiguration pool, consists of a liquid vacuum assembly with cartridge filters to capture radioactive particles. A hose and wand assembly is used to vacuum the internals of submerged casks and to clean the bottom of the pool to minimize the buildup of crud and particulate material. The cartridge filters are changed when differential pressure or contact dose rate readings exceed normal operating ranges. The used cartridges are transferred to the solid radwaste processing area.

The water from the pools is continuously recirculated through a filtration system consisting of cartridge filters and demineralizers (resin beds). These filters remove particulate and radioactivematerials from the water, thereby maintaining the water activity levels ALARA. In addition, the filtration process maintains adequate visual clarity to allow observation of basket changes, maintenance, and identifiers while in their stored position. The resins are also changed out

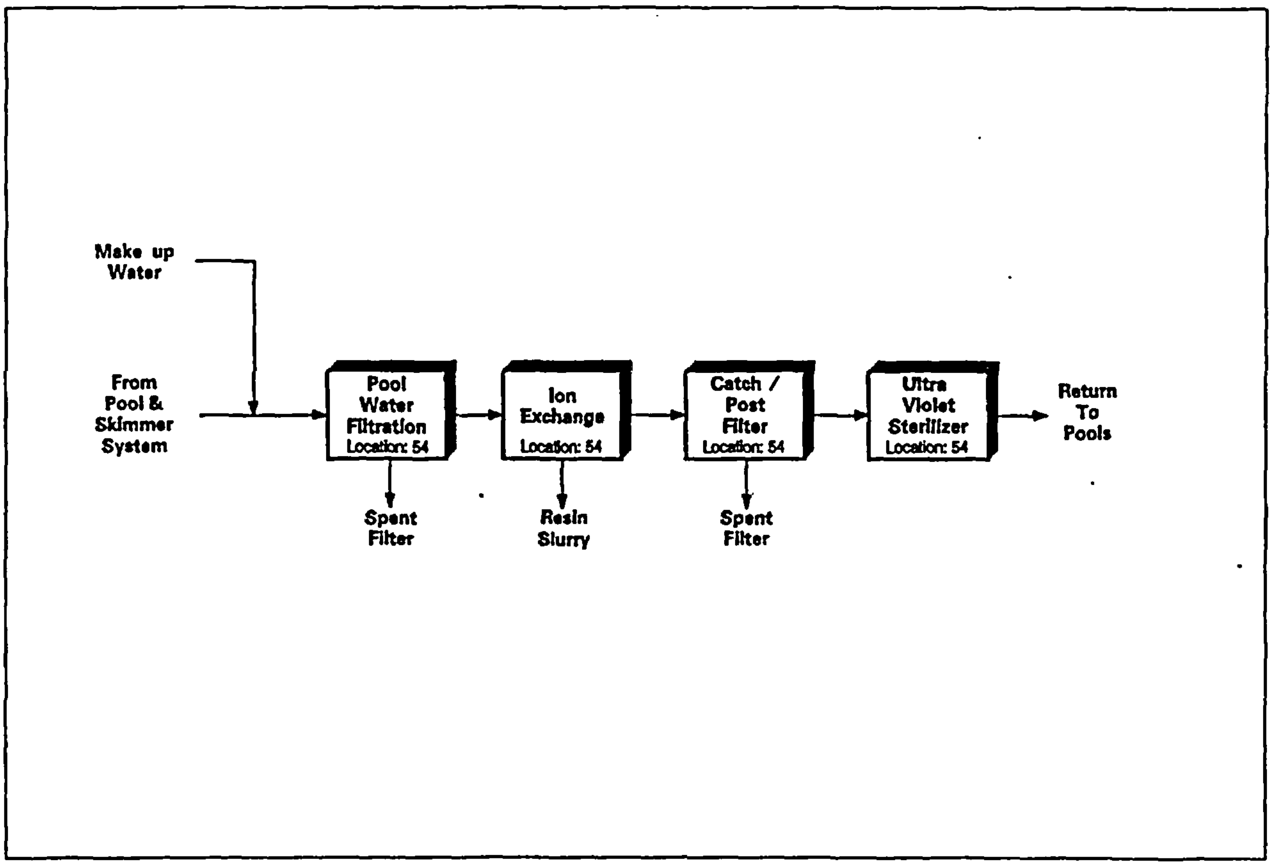


Figure 7.2.3-8 Pool Purification System

when differential pressure or contact dose rate readings are out of their normal operating ranges. Upon changeout, they are transferred to one of two locations, either resin holdup tanks to await batch processing, or directly to high integrity containers for dewatering and packaging.

7.2.3.5.7 HVAC System

Functions

The HVAC system for the CMF provides proper environmental conditions for the equipment used in this facility as well as for the health, safety, and comfort of operating personnel. Details of the CMF HVAC system are presented on HVAC Flow Diagrams CMH-SK-101, 102A, 102B, 103A through E, and HVAC confinement drawings 104A through C in Appendix D.

Confinement Zones

The HVAC system confines radioactive and hazardous materials within the CMF as close to the point of origin as practicable and also prevents uncontrolled releases to rooms and areas normally occupied by personnel. This confinement is accomplished by a series of successive confinement zones of varying pressures. Each successive confinement zone is at a lower pressure and has a higher potential for contamination.

The primary confinement zone is at the lowest pressure. In the CMF this zone includes the process enclosures (e.g., glove boxes, fume hoods), and the associated high efficiency particulate air (HEPA)-filtered final exhaust air system.

The secondary confinement zone includes enclosures and rooms that contain potentially contaminated process equipment, or rooms supporting primary confinement functions. Examples of areas that are classified as secondary confinement zones include the contaminated equipment shops, liquid radwaste equipment area, solid waste handling and staging, cask reconfiguration pool area, prep/decon area pits, test and repair stations, spent resin handling area, pool purification equipment area, and associated HEPA-filtered final exhaust air system.

The tertiary confinement zone include enclosures and rooms that do not have contact with the primary confinement but may become contaminated accidentally. Examples of areas that are classified tertiary confinement zones include the equipment laydown area, equipment testing station, yoke storage area, and corridors adjoining secondary confinement areas.

The other areas of the facility are normally clean and do not have potential for contamination. These areas are designated neutral areas and are required to be maintained at a higher pressure than the adjacent tertiary confinement zone. Provisions are made to prevent these areas from becoming more negative than any adjacent tertiary confinement zone. Examples of neutral areas are entry air locks, lobby, exit stairwells, vestibules, offices, electrical rooms, warehouse, administration, change rooms, break rooms, and spare parts room.

Scope

The HVAC system for the CMF includes the components necessary for continuous operation during normal or off-normal conditions and is designed to maintain the CMF at the proper environmental conditions for the health, safety, and comfort of operating personnel as well as for the equipment used in the facility. The system also provides the final exhaust HEPA filtration for the gloveboxes and fume hoods. The system is comprised of the components listed on the HVAC Flow Diagrams CMH-SK-101, 102A, 102B, 103A through E, and the HVAC confinement drawings 104A through C in Appendix D including: tornado dampers, fans (supply, return and exhaust), air handling units, air curtains, exhaust HEPA filter units, flow measuring elements, isokinetic sampling system, control dampers, ductwork, and an exhaust stack.

The system also requires interfaces with the following support systems:

A. Normal, standby or emergency electric power to operate the components such as instruments, fans, and air heaters during normal and off-normal operation as confirmed by safety analysis.

B. Instrument air to operate instruments and pneumatic operators.

C. Chilled water to provide air cooling.

D. Fire protection fire panels, smoke and temperature detectors to activate the closure of fire dampers in the ductwork or initiate the HEPA protection deluge systems that are integral part of the ventilation system.

E. CMF structure to house system components.

Operations

The HVAC System is comprised of three separate, independent subsystems designed to operate continuously. The first is a HEPA filtered exhaust subsystem that in conjunction with the gloveboxes and fume hoods comprises primary confinement zone of the CMF. The second HVAC subsystem serves the secondary and tertiary confinement areas of the CMF. The third HVAC subsystem serves the shipping and receiving area and the neutral areas (offices, equipment room no.1, and other miscellaneous rooms). The systems are shown on HVAC flow sketches contained in Appendix D. These sketches describe the rate and flow path of air through the system components.

Primary Confinement Areas HVAC Subsystem

The CMF Primary Confinement Areas HVAC Subsystem is a separate, independent, automatic ventilation subsystem designed to: operate continuously; maintain proper environmental conditions for the health, and safety of personnel; maintain design conditions for the equipment; and provide contamination confinement. The subsystem serves the gloveboxes and fume hoods in the CMF as well as providing the final HEPA filtered exhaust. The subsystem is shown on HVAC flow sketches CMH-SK-103B and D.

The primary confinement zone is maintained at a negative pressure of -0.7 inches wg with respect to the secondary confinement.

The exhaust is discharged to the outside environment by a dedicated final exhaust unit with two testable stages of HEPA filters, associated primary confinement final exhaust fans, and exhaust air stack. The primary confinement negative pressure is maintained by the final exhaust fans which modulate to compensate for variances due to the final HEPA filter loading. Corrosive vapors, noxious gases or vapors, and flammable (or combustible) gases are not anticipated from these vents.

Secondary and Tertiary Confinement Areas HVAC Subsystem

The CMF Secondary and Tertiary Confinement Areas HVAC Subsystem is a once-through concept consisting of dedicated supply air handling units and associated supply air fans, and final exhaust units with two testable stages of HEPA filters, associated final exhaust fans, and exhaust air stack. The negative pressure in these rooms/areas is maintained by modulating the supply air flow and providing constant exhaust. The final exhaust fans modulate to compensate for variances due to final HEPA filter loading

The subsystem is shown on HVAC flow sketches CMH-SK-103A through E.

The secondary confinement ventilation zone is maintained at a negative pressure of -0.3 inches wg and the tertiary at -0.15" wg with respect to the outside atmosphere. The CMF processing areas will be equipped with Continuous Air Monitoring systems.

The components of this subsystem along with the components of the primary confinement subsystem are located in a separate, dedicated equipment room. The components are of nuclear-grade quality comprised of air handling units, fans, pumps, air distribution equipment, and instrumentation. The exhaust is comprised of bag-out housings with two stages of HEPA filters and adequate provisions for testing, inspection, monitoring, maintenance, and repair operations. The HEPA filtration has a minimum start-up efficiency of 99.97 percent as tested in accordance with ANSI-N510. Electric heating is selected as the preheating and reheating media for estimate purposes in the absence of an energy conservation analysis (to be performed later). The ductwork is of welded carbon steel constructed in accordance with Sheet Metal and Air-conditioning Contractors National Association high-pressure standards.

Neutral Areas HVAC Subsystem

The Neutral Areas HVAC Subsystem provides the ventilation for various contamination free functional areas such as:

A. Truck and Railcar Cleaning Area: This area is provided with once-through ventilation designed to maintain space design conditions, and ensure proper indoor air quality. This ventilation concept has the capability to switch-over to a standby, single stage HEPA filtered exhaust upon detection of radiological contamination. This ventilation concept is shown on HVAC flow sketch CMH-SK-101.

B. The offices and miscellaneous rooms HVAC subsystem is of the recirculation type designed to operate normally with approximately 10 percent outside air, except that the change rooms are provided with once-through ventilation with a single stage of HEPA filters. The subsystem is shown on HVAC flow sketch CMH-SK-102. The offices and other miscellaneous rooms HVAC Subsystem and associated/independent HVAC equipment room are not classified as confinement zones. This ventilation concept is shown on HVAC flow sketch CMH-SK-102A and B.

The components for the neutral areas subsystem are of industrial-grade quality and are comprised of air handling units, fans, pumps, air distribution, and control instrumentation. The filters are 30 and 90 percent efficiency filters. The change rooms HEPA filters have a minimum start-up efficiency of 99.97 percent as tested in accordance with ANSI-N510. Electric heating is selected as the preheating and reheating media for estimate purposes in the absence of an energy conservation analysis (to be performed later). The ductwork is of galvanized steel construction in accordance with Sheet Metal and Air-conditioning Contractors National Association low-pressure standards.

7.2.3.5.8 Other Systems

The operation of the CMF requires a number of other systems that are not described above. These systems include: building utilities, security, and monitoring and control systems required to safely and effectively maintain casks and certification operations. These facility specific support systems are listed below:

A. Power Distribution System including 480/208/120 VAC and the safety bus.

B. Water Distribution System for supplying fire water, potable water, chilled water, and recycled water.

C. Sanitary Waste Collection System for the removal of facility sanitary waste.

D. Secondary Waste Collection System for the collection and containment of facility generated LLW and HW.

E. Communications Systems including: telephone/public address, video and data networks.

F. Facility Monitor and Control System to monitor and control, building utilities and material handling.

G. Radiological Monitoring System to monitor radiological performance and support health physics activities.

H. Fire Protection and Detection System for manual and automatic initiation of fire suppression and alarm equipment.

I. Security Systems including the following subsystems: physical protection and safeguards, intrusion alarm system, communications, and facility security station.

J. Office Systems for supporting administrative, planning and engineering activities.

K. Industrial Air System supporting pneumatic control equipment, and industrial air stations.

L. Material handling system for controlling the electromechanical equipment dedicated to cask handling operations.

M. Helium Supply System for leak testing shipping casks.

N. Nitrogen Supply System for purging shipping casks.

O. Cask Vacuum System for removing debris from the inside of the shipping casks, when the cask is in the reconfiguration pool.

P. Cask Decontamination Support Systems for supplying steam, high pressure water and high pressure chemical solutions for cask decontamination.

Q. Decontamination Systems for personnel and equipment decontamination.

Systems listed in A through K above are the same as described for the WHB in Section 7.2.2.5.9. Other CMF support systems are described as follows:

Material Handling System

The CMF Material Handling System controls the electromechanical equipment dedicated to handling and maintaining the casks, cask carriers and associated furnishings. The electromechanical equipment controlled by this system includes: cranes, tooling, camera controls, cleaning controls, and inspection instruments dedicated to fitting, repairing, storing the casks, and for remote maintenance purposes. Local material handling system operator stations are installed at specific material handling stations throughout the CMF. Each station includes: controls, indicators, and annunciators customized for the equipment at that location. Typical local panel equipment includes: a main control panel, workstation, video display, multiplexer, cable/conduit, data network, and printer. The main control room and local control stations are as described in Section 7.2.2.5.9 for the WHB Material Handling System.

Helium Supply System

A Helium Supply System is provided at the CMF for cask leak testing. The system consists of helium bottles and an instrumented supply manifold.

Nitrogen Supply System

A Nitrogen Supply System is provided at the CMF for cask purging. The system consists of the nitrogen tank, instruments and valves, facility distribution lines, and process fittings. The Facility Monitor and Control System monitors the status of the supply tank; local panels control nitrogen injection, and monitor the pressure and leakage.

Cask Vacuum System

The Cask Vacuum System is provided to remove debris from the inside of a shipping cask when the cask is in the reconfiguration pool. The system consists of the pumps, flexible tubing, piping, filters, local controls, instruments and valving. The system is manually operated with a reach tool connected to a suction head. The debris is sucked through the filters which are located in the pool and changed on high differential pressure or high radiation. The filtered water is returned to the pool via the pool Purification System. Local process control panels control the vacuum system.

Decontamination Support Systems

The Cask Decontamination Support Systems supplies steam, high pressure water and high pressure chemical solutions to the cask Decontamination System described in Section 7.2.3.5.3. The solutions are used to decontaminate the outside of shipping casks. The subsystems required to provide the decontamination solutions are described below:

A. The steam supply subsystem consists of the boiler, steam vessel, instruments and valves, distribution lines, line insulation, and process fittings. The Facility Monitor and Control System monitors the status of the steam supply equipment; local panels control steam injection, and monitor the temperature, and pressure.

B. The high pressure water subsystem consists of pumps, supply tank, instruments and piping. Recycled water from the WTB will generally provide the source of water. The Facility Monitor and Control System monitors the status of the equipment; local panels control the pumps.

C. The high pressure chemical solution subsystem consists of pumps, supply tank, mix tanks, instruments and piping. Cleaning solutions are mixed from various chemical concentrates and recycled water from the WTB. The Facility Monitor and Control System monitors the status of the equipment; local panels control the pumps.

Decontamination Systems

The Decontamination Systems for personnel and equipment decontamination are as described for the WHB in Section 7.2.2.5.9, except a dry carbon dioxide system is not provided.

7.2.3.6 Component Data

The list for all major components associated with the cask maintenance systems in the CMF are provided in Table 7.2.3-2. This table includes the component tag number, component description, component capacity, and the Construction Specifications Institute specification number. Where Construction Specifications Institute specification numbers do not exist for a component, a number is assigned and designated with "*".

Pumps in radioactive service are provided with installed, 100 percent capacity spares. Whenever possible, failed equipment will be decontaminated, repaired, and returned to service. Items that cannot be repaired must be disassembled before disposal as LLW.

The components associated with the HVAC System are not included in the table and are instead identified on HVAC flow sketches CMH-SK-101, 102A & B, and 103 A through E in Appendix D.

7.2.3.7 Operating Data

This section describes the operating data available for the CMF. The following aspects are addressed: utility consumption, resource consumption, waste generation and staffing requirements.

Utility Consumption

The CMF and the operations performed in this building will consume chilled water, electric power, and sanitary water as discussed below. Rough estimates for peak and annual utility consumption are provided in Table 7.2.3-3. The annual data is based on operating during the emplacement phase only.

A. Chilled water is used for HVAC cooling.

B. Electric power is used to operate process equipment such as cranes, pumps, HVAC equipment such as fans and heaters, compressors for the air systems, facility lighting, and instruments and controls.

C. Sanitary water is used for personnel support such as restrooms, change rooms and facility maintenance.

Resource Consumption

The CMF and the operations performed in this building will consume a variety of materials and chemicals. These include chemicals for decontamination, helium, welding supplies and materials for general facility and equipment maintenance. None of these materials are expected to be consumed in large quantities.

Table 7.2.3-2 CMF Systems Major Component List

Tag No.	Component Description	Capacity	CSI Spec. No.
Cask Staging, Testing and Repair Area			
CCR-101	Cask Carrier	125 Tons	14510
MIS-101 A&B	Personnel Platform	6 people	14400
CRN-101	Jib Crane	10 Tons	14650
CRN-102	Bridge Crane	125 Tons	14630
MIS-102	Lifting Yokes for cask fleet	40 Tons – 125 Tons	14600
Cask Preparation and Decontamination Area			
MIS-103 A&B	Personnel Platform	6 people	14400
MIS-104 A&B	Cask Shroud(s)	Small Truck to Large SFA Canister	05580
MIS-105 A&B	Cask Bottom Protector (s)	Small Truck to Large SFA Canister	05580
Cask Reconfiguration Area			
MIS-106 A&B	Basket Storage Rack	20 Baskets	05500
MIS-107 A&B	Spacer Storage Rack	Spacers for 20 Baskets	05500
P-101	Submersible cleanup vacuum	500 gpm	15480
Pool Purification System			
P-102 A&B	Pool Purification Pump	290 gpm	15160
FLT-101 A&B	Pool Purification Pre Filter	290 gpm	11361*
FLT-102 A&B	Pool Purification Post Filter	290 gpm	11361*
DMZ-101 A&B	Pool Purification Demineralizer	290 gpm	11250
TNK-101	Pool Surge Tank	1,000 gallons	13205
P-103 A&B	Resin Transfer Pump	5 HP	15160
MIS-107 A&B	Resin Fill Hopper	100 CF	13095*
Miscellaneous			
MIS-108 A&B	Underwater Closed Circuit TV	20 to 1 Zoom	16780
TNK-102	Contaminated Floor Drains Holdup Tank	10,000 gallons	13205
P-104	Floor Drain Tank Transfer Pump	500 gpm	15160
MIS-109 A, B &C	Area Radiation Monitors	0.1mR/Hr to 10 R/Hr	15980
MIS-110 A, B &C	Liquid Process Radiation Monitors	$1x10^{-7}$ µCi/cc	15980
TNK-103 A&B	Pressurized Gas Storage Tanks	1000 CF	13205
TNK-104	Pool Makeup Tank	1000 gallons	13205

CSI = Construction Specifications Institute

Table 7.2.3-3. CMF Utility Consumption

Utility	Peak	Annual
Chilled Water	1,000 gpm	5,300,000 gallons
Electricity	3,200 kW	20,000,000 kWh
Sanitary Water	1,300 gpd	340,000 gallons

Waste Generation

The CMF and the operations performed in this building will generate LLW, a small amount of HW and sanitary wastes as discussed below. The LLW waste is processed within the WTB. Rough estimates for the annual generation are provided in Table 7.2.3-4. Mixed waste is not included in this table as this material is not expected to be generated from normal operations. If generated from off-normal operations the quantities of mixed waste would be extremely small.

A. Aqueous and chemical liquid LLW is generated from area, equipment and cask wash down and collected through floor drains. Solid LLW is generated from maintenance activities, filtration activities, and by the ion exchange systems in the form of spent resin slurry.

B. Sanitary waste water and solid industrial waste generated by personnel support functions such as restrooms, change rooms, facility maintenance and office work.

Staffing Requirements

The CMF normally operates five days per week, with one eight-hour shift per day, 250 days per year, except for some utility and security systems which operate continuously. Surge capacity can be accommodated by operating multiple shifts. The number of individuals expected to routinely work in the CMF are estimated to be 69. Of these workers, 73 percent are line operators with the balance performing support functions such as supervision, administration and maintenance.

Table 7.2.3-4 CMF Waste Generation Rates

Waste Material	Annual Generation	
	Liquid (gallons)	Solid (cubic feet)
Low-Level	70,500	17,413
Hazardous	1.6	0.5
Sanitary/Industrial	340,000	1000

7.2.4 Waste Treatment Building

7.2.4.1 Introduction

This introduction addresses the WTB mission, the background of the WTB design prior to the ACD effort, the design methodology used for the ACD and the current status of the design. A conceptual illustration of the WTB operations is presented in Figure 7.2.4-1.

7.2.4.1.1 Mission

The mission of the WTB is to process and/or package secondary wastes generated by normal and off-normal repository operations. Secondary wastes include solid and liquid LLW, HW, and MW. Wastes from both surface and subsurface operations are considered.

The WTB primary functions are:

A. Receive liquid LLW through a piped collection system and solid LLW in drums or boxes, treat the recyclable liquid LLW for reuse by the waste generators, and package and ship the remaining LLW for off-site disposal

B. Receive and accumulate drums containing small quantities of solid and liquid MW generated from off-normal repository operations. Ship the untreated MW off-site for treatment and disposal.

The selected ACD concept does not include the treatment of HW, as the small amount of HW generated at the repository is more cost effectively treated and disposed by off-site commercial facilities. As a result, treatment of HW is not a function of the WTB. The repository HW transferring system is described in this section because it is a waste operation.

Sanitary liquid waste generated by the repository is processed by the Sanitary Waste Water System described in Section 7.2.8.2.

7.2.4.1.2 Background

The SCP-CDR (SNL 1987), published in 1987, included a conceptual design for a waste treatment facility. The design report provided general arrangement drawings, simplified process flow sketches and a brief facility description. The design of this facility appeared to be reasonable but could not be substantiated during ACD based on the report or the applicable references.

The waste rates provided in the SCP-CDR (SNL 1987) could not be used for the ACD as the design of the waste generators has changed significantly. Waste rates calculated for the selected repository ACD concept are substantially lower than those estimated in the SCP-CDR (SNL 1987).

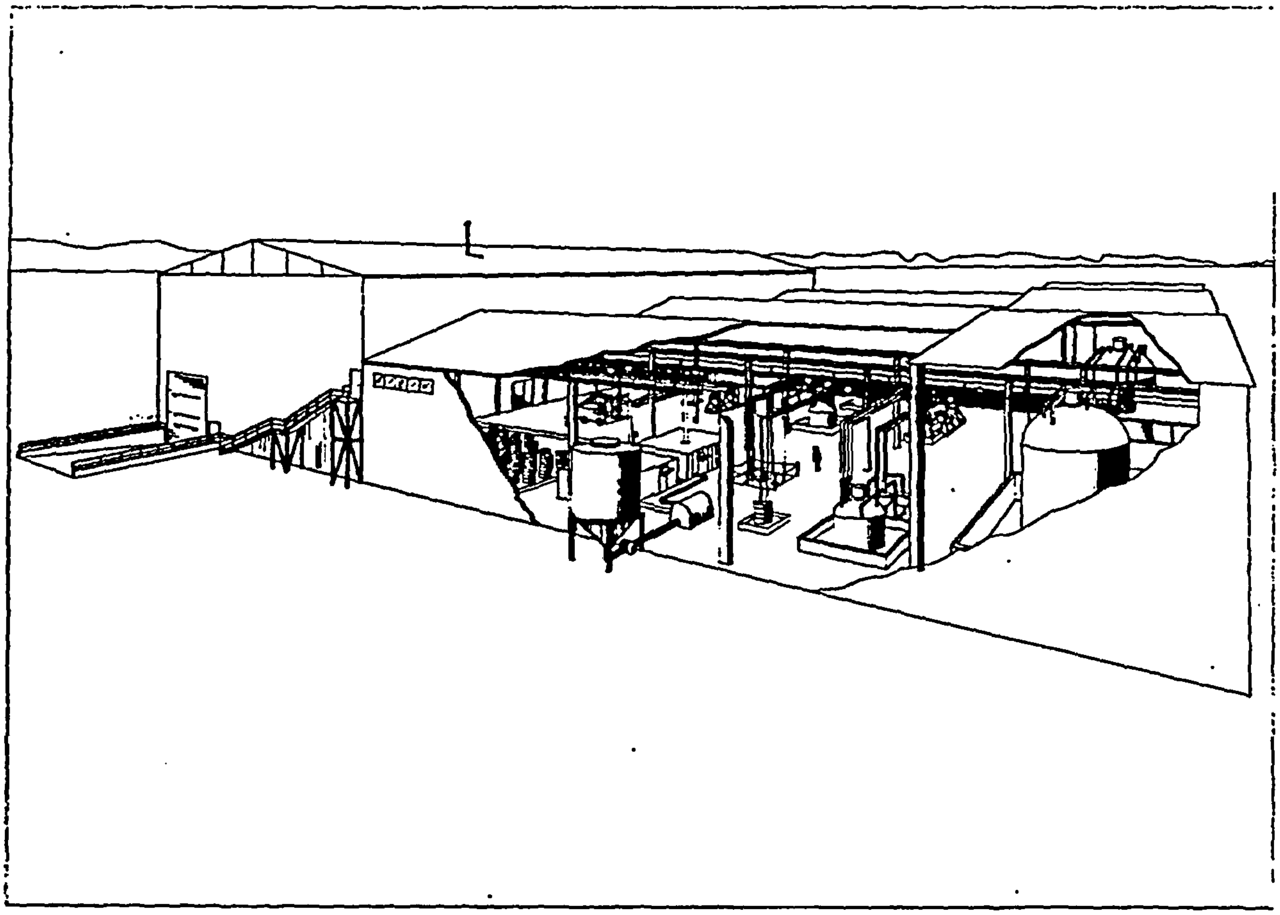


Figure 7.2.4-1. Waste Treatment Operations

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The basic process selected for LLW treatment in the SCP-CDR (SNL 1987) was also selected in the ACD. However the ACD effort provided substantiation of the selection based on a design analysis.

The waste treatment facility arrangement provided in the SCP-CDR (SNL 1987) appeared to be significantly undersized. The size of the WTB in the ACD design was based on actual equipment sizes and a facility layout that provides adequate space for maintenance. The size of the WTB increased about 50 percent despite the decrease in the waste processing rates.

7.2.4.1.3 Design Methodology

The design methodology for the advanced conceptual design of the WTB is described below:

A. Regulations relevant to WTB operations were identified.

B. Available and applicable waste processing technologies were identified based on the SCP-CDR (SNL 1987) waste rates.

C. Waste rates were re-estimated based on an early ACD concept for both surface and subsurface operations.

D. Six candidate configurations for liquid LLW processing and another five candidate configurations for solid LLW processing were selected in a screening evaluation. These eleven cases were screened down to two cases each for solid and liquid LLW processing using a Kepner-Tregoe style decision analysis.

E. A collection, packaging, and accumulation approach was selected for HW and MW. These materials will be transported off-site for treatment and disposal due to the small quantities generated at the repository.

F. The waste generation rates were re-estimated to capture advances in facility design since completion of the previous estimate.

G. The results of the previous evaluation for LLW technologies were reconfirmed for the new waste estimate. The four candidate LLW processing configurations were screened down to one final case each for solid and liquid LLW processing using life cycle cost analysis.

H. Major components for the selected waste technologies were selected and sized, and the layout of the WTB was based on these facility requirements and the natural material and personnel movement.

I. Final WTB ACD documentation was prepared including: design inputs, general arrangement sketches, waste treatment and HVAC system descriptions, annotated major component lists, and estimates of WTB utilities consumption, chemical consumption, waste generation and staffing.

7.2.4.1.4 Design Status

An advanced conceptual design of the WTB has been developed including the solid and liquid LLW treatment systems, the HW and MW transfer systems, and the HVAC system. The ACD design documentation includes the following:

A. Identification of design inputs including requirements, assumptions and data

B. Repository waste generation rates and material balances

C. Design analyses for selecting waste processing technologies

D. Description of the facility and major design features

E. General arrangement sketches for the WTB including plans, sections and elevations

F. Descriptions of the waste treatment systems including block flow sketches, process flow sketches and narrative description

G. Description of the HVAC system including HVAC flow sketches and a narrative description

H. A major component list including descriptions, capacities and Construction Specifications Institute specification references

The ACD is limited to the waste treatment and HVAC considerations. Other conceptual design considerations for the WTB, such as electrical and fire protection, are planned future activities and are only briefly described in this report. Future designs should also address the following recommendations:

A. The RDRD (YMP 1994a) needs to be expanded further to establish a more relevant basis for design of the WTB. Information currently contained in the RDRD (YMP 1994a) is too general to adequately define WTB design requirements.

B. Additional conceptual design development of the secondary waste-producing areas within the RCA, such as decontamination, waste collection and handling, are required to better define the LLW rates.

C. A LLW disposal facility needs to be identified or designed.

D. Packaging criteria for MW needs to be established.

E. The probable radiological characteristics of the LLW and MW need to be characterized.

F. The design of the radiological safety systems (i.e., shielding and dose assessments) need to be developed.

Note that this design is based on the design basis assumptions described in Section 7.2.4.2.2. Significant assumptions, or strategies, that could have the greatest impact on the WTB design are discussed in Section 12, Development Tasks and Issues.

7.2.4.2 Design Inputs

This section provides a detailed list of inputs pertaining to the WTB design including: design requirements, design assumptions, and design data from other groups.

7.2.4.2.1 Design Requirements

The functional requirements and the regulatory requirements for the WTB are described below.

Functional Requirements

The functional requirements (i.e., objectives) for site generated waste treatment are provided in the RDRD (YMP 1994a) as follows:

> RDRD 3.7.3.9.A:
>
> Radioactive waste treatment facilities shall be designed to process any radioactive waste generated at the Geologic Repository Operations Area into a form suitable to permit safe disposal at the Geologic Repository Operations Area or to permit safe transportation and conversion to a form suitable for disposal at an alternative site, in accordance with any regulations that are applicable.
>
> RDRD 3.7.3.9.B:
>
> Facilities shall be provided to manage and dispose of site-generated solid and HW (excluding radioactive wastes) in accordance with requirements of the *Clean Water Act*, unless arrangements are made for off-site disposal.
>
> RDRD 3.7.3.9.E:
>
> Nonradioactive HW disposal facilities shall have sufficient capacity to process the quantities of HW anticipated throughout the operation of the repository [TBD]. Nonradioactive HW disposal facilities shall comply with DOE Orders 5480.3, *Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes*, and 5480.4, *Environmental Protection, Safety, and Health Protection Standards.*

As secondary waste handling functions have not been defined beyond this high level, several assumed functional requirements have been developed and are described below in Section 7.2.4.2.2. In addition, process systems functions have been derived for the assumed waste streams descriptions.

Regulatory Requirements

The general regulations, codes, and standards applicable to the design of the WTB and other repository surface facilities are defined in Sections 3.2 through 3.7 of the RDRD (YMP 1994a). These requirements are summarized in Section 7.1.2.1 of this report volume. The document requires compliance with DOE Order 6430.1A and this order requires compliance with the following federal regulations, which are expected to impact the WTB design:

A. 40 CFR Part 260, *Hazardous Waste Management System: General.*

B. 40 CFR Part 264, *Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.*

C. 40 CFR Part 265, *Interim Status for Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.*

During the WTB engineering analysis several other laws and regulations were identified, which are expected to impact the WTB design. Compliance with these laws and regulations, which are listed below, is expected to be required in future revisions of the RDRD (YMP 1994a).

Additional Federal Laws and Regulations

A. *Low-Level Radioactive Waste Policy Amendments Act of 1985.*

B. *Federal Facilities Compliance Act of 1992.*

C. 10 CFR 61, *Licensing Requirements for Land Disposal of Radioactive Waste.*

D. 40 CFR 268, (Solid Wastes) *Land Disposal Restrictions.*

E. 49 CFR 178, *Specifications for* (Hazardous Materials) *Packagings.*

F. DOE Order 5820.2A, *Radioactive Waste Management.*

Additional Nevada State Laws and Regulations

A. Nevada Revised Statutes Title 40, Chapter 444, Public Health and Safety: Sanitation 1986, Standards for Solid Waste Disposal.

B. Nevada Revised Statutes Title 40, Chapter 445, Public Health and Safety: Water Controls, Air Pollution, 1985, Standards for Air Quality.

C. Nevada Revised Statutes Title 40, Chapter 459, Public Health and Safety: Hazardous Materials, Radioactive Waste, 1985, Standards for Hazardous and Radioactive Waste Management.

D. Nevada Revised Statutes Title 45, Chapter 501, Wildlife; Administration and Enforcement, 1985, Standards for Wildlife Protection.

The RDRD (YMP 1994a) and the laws and regulations listed above were reviewed to identify WTB design constraints that are likely to be imposed as requirements in future issues of the document. These assumed requirements are summarized below.

Low-level Radioactive Waste Treatment Design

A. Liquid LLW must either be treated and packaged into a solid form or packed with materials capable of absorbing twice the amount of liquid.

B. Free liquid or noncorrosive liquid in the solidified LLW must be removed to the extent reasonably achievable, but the remaining liquids must not exceed one percent of the waste volume.

C. Packaged LLW must not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes.

D. LLW disposal containers may not be made of flammable material such as cardboard or fiberboard.

E. Packaged LLW must not be capable of igniting. All combustible LLW must be reduced to noncombustible form unless it can be demonstrated that the LLW packages containing combustible material will not compromise the integrity of other waste packages, if ignited.

F. LLW packages must exhibit structural stability under the expected disposal conditions such as the weight of overburden and compaction equipment, the presence of moisture, microbial activity, and internal factors such as radiation effects and chemical changes.

G. Void spaces within the LLW must be reduced to the maximum extent practicable.

7.2.4.2.2 Design Assumptions

This section lists the assumptions applicable to the design of the WTB. Assumptions generally applicable to surface facilities are listed in section 7.1.2.2. There are two types of design assumptions: CDAs and non-controlled design assumptions.

Controlled Design Assumptions

CDAs applicable to the WTB design are listed below.

Identifier	Subject	Statement of Assumption
Key 024	Site Generated, LLW	Secondary site-generated waste (low-level, hazardous, mixed, and municipal) will be transported to government-approved off-site facilities for disposal. Temporary accumulations would be accommodated on-site to facilitate treatment of LLW, and packaging of all waste types prior to transport to designated facilities. Off-site disposal options are to be assessed.
DCS 011	Underground Waste Generation	Significant quantities of secondary mixed or LLWs will not be generated by underground emplacement operations.
DCS 012	No HLW in WTB	The WTB will not process secondary transuranic or HLW. If such waste materials are generated, they will be packaged at the point of generation and disposed in the underground emplacement area via the WHB.
DCS 013	Waste Generated by Performance Confirmation Activities	Waste quantities generated by the Performance Confirmation operations will be: Negligible during the Construction/ Emplacement phase of the MGDS, Less, during the Caretaker phase, than the waste quantities generated during the Construction/Emplacement phase normal and off-normal operations.

MGDS = Mined Geologic Disposal System

Non-Controlled Design Assumptions

The non-controlled design assumptions applicable to the WTB design are listed below.

A. A suitable binding agent, such as Portland cement, is available that, when mixed with liquid LLW, will produce a solid possessing satisfactory disposal characteristics, including leachability and combustibility.

B. Final LLW packages must meet leachability criteria.

C. The WTB design is based on a single shift operation, with six effective working hours per operating day, 250 days per year.

D. The WTB will be designed to handle the quantities of waste routinely generated by site operations. Any significant quantities of waste generated by off-normal operations will be handled by adding multiple shifts.

E. Gaseous process waste and HVAC streams leaving either radioactive or potentially radioactive operations will be decontaminated by high-efficiency filtration before release to the atmosphere, and will be continuously monitored for radiological activity.

F. The shipping and receiving area of the WTB will remain contamination-free eliminating the need for HVAC confinement.

7.2.4.2.3 Design Data

This section addresses the data defined by other design areas that are inputs to WTB design. General design data for the repository surface design is presented in Section 7.1.2.2.

The design data specifically applicable to waste management are waste types and flow rates from the WHB, CMF, CSS, TMB, and facilities outside the RCA. These data are presented in Section 7.2.4.5, which provides the system descriptions for handling solid and liquid LLW, HW, and MW. Within each system description, the waste type and flow rate from repository facilities are listed. These lists also include the source of the wastes (i.e., floor drains, cask washing, spent resin slurry).

7.2.4.3 Summary of Supporting Studies

This section provides a summary of the studies listed below that directly impacted the WTB design. Each summary addresses the study scope, results, relationship to other studies, and applicability to the selected WTB design concept.

- *Preliminary Investigation of Disposal and Treatment Options for Low-Level Radioactive Mixed and Conventional Hazardous Wastes* (CRWMS M&O 1993j).
- *Low-Level Waste Treatment Analysis Report* (CRWMS M&O 1995z).
- *Hazardous and Low-Level Mixed Wastes Treatment Analysis Report* (CRWMS M&O 1995aa).
- *Waste Treatment Building Interim Design Study for 1995* (CRWMS M&O 1995ab).

***Preliminary Investigation of Disposal and Treatment Options for Low-Level Radioactive Mixed and Conventional Hazardous Wastes* (M&O 1993j)**

The report, issued on August 20, 1993, presents the results of a study effort directed at the following:

A. Identification of the applicable regulations.

B. Identification of potential low level, hazardous and mixed waste sources at the repository.

C. Preliminary estimation of waste characteristics and quantities.

D. Identification of applicable waste treatment technologies and possible waste disposal options.

This study builds on the previous SCP-CDR (SNL 1987) waste treatment effort, with an emphasis on regulatory requirements. This is the first WTB report that addressed secondary waste regulatory requirements with any depth. The waste generation rates were based on the SCP-CDR (SNL 1987) with minor modifications.

The primary contribution to the ACD from this report is in the area of regulatory requirements, description of available technology and disposal practices, and definition of typical composition of solid radioactive waste.

Follow-on WTB reports, described below, included re-estimations of waste generation rates based on the actual ACD concepts, and design analyses to screen and select waste treatment technologies.

Low-Level Waste Treatment Analysis Report (M&O 1995z)

This report, issued on January 26, 1995, presents results of a study effort directed at the following:

A. Estimation of LLW generation rates based on early ACD concepts for both surface and subsurface operations.

B. Selection and description of six candidate configurations for liquid LLW processing and a Kepner-Tregoe style decision analysis for screening down to two alternatives.

C. Selection and description of five candidate configurations for solid LLW processing and a Kepner-Tregoe style decision analysis for screening down to two alternatives.

The final selection of liquid LLW technology for ACD was documented in the *Waste Treatment Building Interim Design Study for 1995* (CRWMS M&O 1995ab) described later in this section. The waste rates estimated in the analysis report formed the foundation for the final ACD waste rates, which were also developed in the *Waste Treatment Building Interim Design Study for 1995* (CRWMS M&O 1995ab).

Hazardous and Low-Level Mixed Waste Treatment Analysis Report (M&O 1995aa)

This report, issued on January 26, 1995, presents results of a study effort directed at the following:

A. Estimation of HW and MW waste generation rates based on early ACD concepts for both surface and subsurface operations.

B. Selection and description of an approach for handling HW at the repository.

C. Selection and description of an approach for handling MW at the repository.

The waste rate estimate determined that the quantity of HW generated at the repository would be small, and MW would only be generated from off-normal operations and in very small quantities. It was determined that due to the low rates it would be cost effective to treat and dispose each type of waste off site. This study established a waste management approach that uses point of generation packaging and accumulation prior to shipment. The WTB was selected as the location to accumulate MW and it was determined that HW should be accumulated outside the WTB where most of this material is generated. An aggressive waste minimization program that includes a request for authorization process which requires each chemical to be evaluated for toxicity and approved prior to purchase, will assist in this process.

The repository HW and MW handling approaches developed in this study were used as the final ACD concept. The waste rates estimated in this study formed the foundation for the final ACD waste rates estimate developed in the *Waste Treatment Building Interim Design Study for 1995* (CRWMS M&O 1995ab) described below.

Waste Treatment Building Interim Design Study for 1995 (M&O 1995ab)

This study, issued on September 31, 1995, presents the interim results of the conceptual design effort for the WTB. Preparation of the FY 1995 WTB conceptual design proceeded in two phases. The first phase was documented in the *Hazardous and Low-Level Mixed Wastes Treatment Analysis Report* and *Low-Level Wastes Treatment Analysis Report* (CRWMS M&O 1995aa), which are described above. This phase consisted of estimating secondary waste generation rates, preparing candidate LLW processing configurations, screening candidates down to two cases each for solid and liquid LLW processing, and selecting HW and MW handling approaches.

The second phase, which was described in the *Waste Treatment Building Interim Design Study for 1995* (CRWMS M&O 1995ab), expanded the design analysis that began in the phase 1 work and developed a cohesive WTB conceptual design based on that analysis. This data is the primary source of information for the WTB design presented in this MGDS ACD Report. This effort included the following tasks:

A. Reassessment of waste generation rates to capture advances in facility design since completion of the previous work.

B. Screening of the previous four candidate LLW processing configurations down to one final case each for solid and LLW processing, using life cycle cost analysis

C. Preparation of the conceptual design for the WTB based on the selected technologies - this conceptual design included flow diagrams, material balances, process descriptions, summary tables listing utility and operating requirements, a description of the arrangement of the WTB, and a component/specification listing.

The results of the design analyses presented in the report are summarized below:

A. *Waste Estimates* - The generation rates for solid and liquid LLW, HW, and MW were re-estimated based on the design concept in effect at the time the study was issued. The results of this estimate are included with the system descriptions later in this MGDS ACD Report.

   The report describes the methodology used to derive the estimates and the inherent uncertainty in the data because the design of the operations generating the waste is only conceptual. Since the waste rates were estimated, the size of the CMF has changed somewhat. Although this change would have a small effect on the calculated waste rates, the rates and WTB design were not updated for the MGDS ACD Report.

B. *Liquid LLWs* - A life cycle cost analysis was performed on the two LLW processing cases to select a liquid waste processing configuration. The selected configuration consisted of filtration, evaporation, and ion-exchange treatment of recyclable water. This configuration had a significantly lower life cycle cost analysis than the other process option which consisted of grouting of all LLW water. The cost savings increases with increased grouted waste disposal (burial) cost. Any LLW water which is judged or proven to be unsuitable for recycle is grouted, as is spent dewatered ion-exchange resin and evaporator bottoms. The conclusions reached are that:

- Operating costs appear to be the primary driver of life cycle cost analysis

- Processing options that reduce waste volume, without increasing operating costs, are recommended.

C. *Solid LLWs* - The life cycle cost analysis of the two solid LLW processing options showed that a system consisting of shredding, compaction, and supercompaction steps presents a significant life cycle cost analysis savings over the competing system which does not include the supercompaction step. As was the case with the liquid LLW, the magnitude of the life cycle cost analysis savings increased with increased grouted waste disposal (burial) cost. As in the liquid LLW analysis, the conclusions reached are that:

- Operating costs appear to be the primary driver of life cycle cost analysis

- Processing options that reduce waste volume, without increasing operating costs, are recommended.

D. *Mixed Waste* - MW is not anticipated to be produced as a result of normal repository operations, due primarily to proper selection and segregation of materials used at the repository. The MW generation rate was estimated at about three drums per year by postulating a series of low probability events. Due to these small waste quantities, any MW generated at the repository will be shipped off-site for treatment and disposal. The exact on-site WTB requirements for packaging/shipping of this material remain to be determined, as the regulatory requirements for the processing of MW are unresolved. The WTB conceptual design includes a small accumulation area for MW. MW will not be treated at the WTB or at the repository.

E. *Hazardous Waste* - Based on commercial practice, the quantity of HW estimated to be generated at the repository facilities appears to be too low to justify construction, and operation of an on-site *Resource Conservation and Recovery Act* (RCRA) treatment facility. Further, based on a DOE memorandum, it can be concluded that on-site disposal of RCRA HW, at the repository, is undesirable. For these reasons, off-site treatment and disposal of HW was selected.

HW, or waste materials likely to be classified as HW in the future, are collected at the point of generation and accumulated in sheds located in the BOP and RCA areas of the North Portal Operations Area. Accumulation time in these sheds will be limited such that an RCRA permit will not be required, although the sheds will be designed to RCRA standards. The BOP shed is also used to accumulate HW generated by underground development operations. The WTB contains no provision for the processing of HW.

7.2.4.4 Structure Description

The WTB will house the equipment and support systems required for the processing and accumulation of LLW and only accumulation of MW. General arrangement sketches (i.e., plans, sections and elevations) of the WTB are provided in Appendix D as sketches WTA-SK-001 through 006. Figure 7.2.4-2 shows the plan view of the first floor (El.-100+0).

The WTB, shown as facility 215-1 on the North Portal Operations Area site plan, Figure 7.2.1-3, is located in the RCA adjacent to the WHB. The WTB is a two-story, metal building with a gable roof. The overall building footprint is approximately 33,000 square feet. Concrete shielding walls are provided around the inner perimeter of the building as well as in the waste movement and accumulation areas as tornado missile barriers and for radiation shielding. The total enclosed work space, including the second-floor HVAC area, is 46,400 square feet. The outer building dimensions are approximately 194 feet by 174 feet with a maximum eave height of 36 feet. This two-story structure will include area for solid and liquid LLW processing, MW accumulation, and for administrative offices and support. HVAC system equipment is housed on the second floor above the general administrative side of the building.

The WTB area consists of

- 15,800 square feet for recyclable and chemical liquid LLW processing
- 8,930 square feet for solid LLW processing
- 620 square feet for MW accumulation
- 7,630 square feet for administrative offices, break room, men's and women's toilet/locker facilities, loading/unloading truck bay, and temporary/interim waste accumulation areas.

The remaining support systems such as the cooling tower, plant air, and chilled water systems are located in a separate centralized utility building, serving all repository surface facilities, including the WTB.

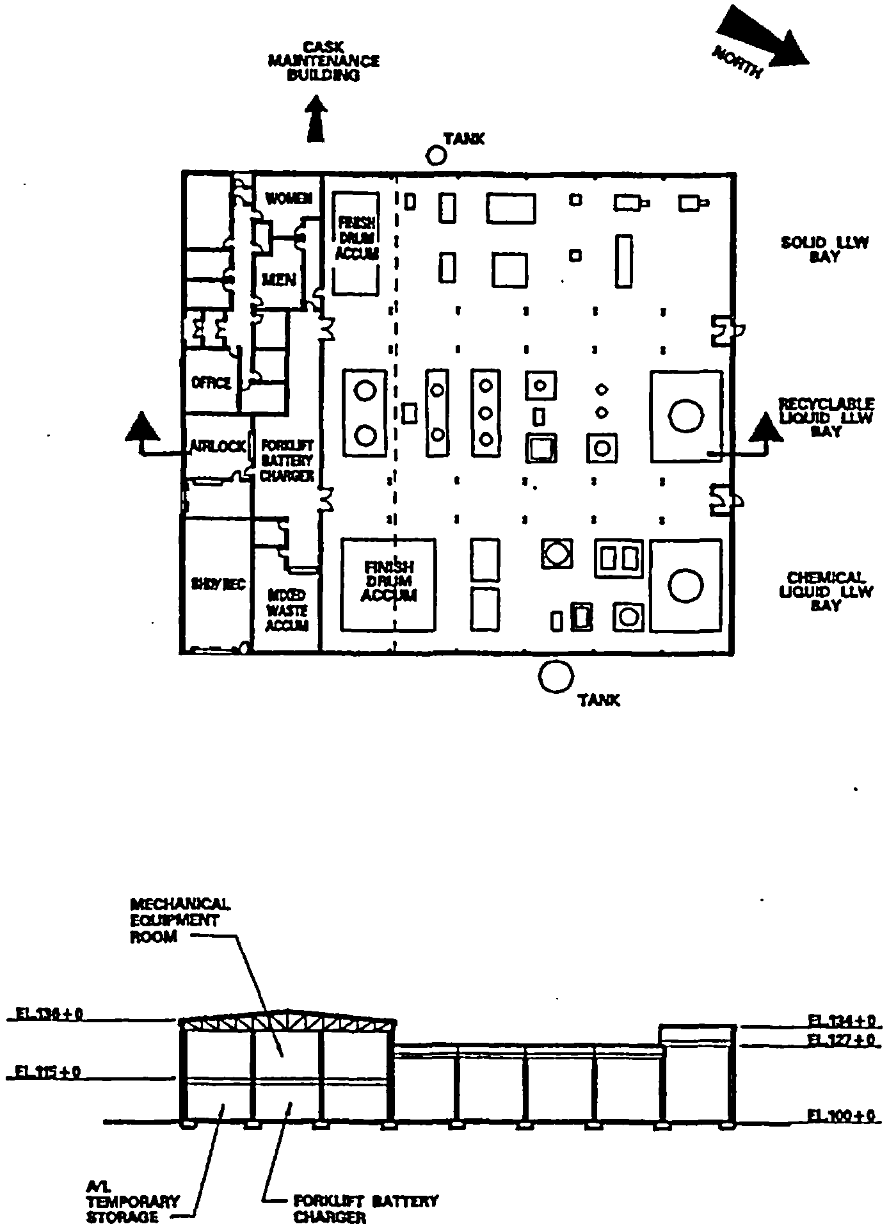

Figure 7.2.4-2. WTB (Floor Plan and Building Section)

Each liquid and solid LLW processing area is sized to accommodate estimated functional space requirements. The liquid LLW processing area is further divided into two sections: a recyclable liquid LLW processing area and a chemical waste processing area. A common 14-foot wide forklift aisle separates these areas. Pipe racks and HVAC ducts as well as vent gas filtration equipment are located above the forklift aisle. The solid LLW processing area is adjacent to the recyclable liquid LLW processing area and separated from it by a partition wall.

The administration and support area is separated from the LLW processing area by a corridor and airlocks. The administration and support areas include:

- Administrative office
- General office
- Health physics room
- Breakroom
- Men's and women's toilet/ locker facilities
- Quality assurance office
- Inventory control office
- Temporary accumulation area
- Truck loading/unloading bay.

HVAC equipment occupies space above the administration area and a portion of the LLW processing area on the second floor.

The recyclable liquid LLW processing area is 6,900 square feet which provides space for process tanks with a dike wall, as well as the other process equipment. The area also provides space for the system piping, pumps, pipeway, control panels, maintenance operations, and operating personnel. A 6,900 square foot area is also provided to house equipment to process chemical waste, which is not suitable for recycle, and interim drum accumulation. The drum accumulation area is sized to accommodate empty and solidified chemical waste drums for curing, inspection, and certification purposes. A forklift corridor of 2,000 square feet divides these two sections, and brings the total floor space occupied by these liquid LLW processing functions to 15,800 square feet.

Solid LLW is packaged into 55-gallon drums and 100 cubic-foot boxes for on-site transfer at the point of generation and is transferred to the WTB using site vehicles. Solid LLW drums and boxes are unloaded using the truck bay. A 6,900 square foot area will provide space for the equipment needed for sorting, shredding, compacting, and stabilizing the waste in cement grout. A forklift corridor of 2,000 square feet will also be provided for material movement. The packaged drums are sent for disposal using the same truck bay. An inventory control room will be provided adjacent to the truck bay.

Architectural Components

Construction materials are noncombustible, Type II in accordance with all applicable codes, standards, regulations, and architectural and engineering principles and practices specified in DOE Order 6430.1A-0109, and are of commercial quality and commonly available in the industry. Interior finish materials have a fire hazard classification flame spread index of 25 (maximum) and smoke developed index of 50 (maximum) when tested.

Structural Design

The structural design of the WTB considered the service loads and the loads associated with natural phenomena hazards such as earthquakes, winds and flooding. The service live loads specified in the Uniform Building Code were used as minimum design live loads. Actual loads will need to be verified in the future. For the loads associated with natural phenomena hazards, DOE Order 5480.28 establishes a graded approach in which natural phenomena hazards requirements are provided for various performance categories, each with a specified performance goal. The structural design of the WTB is based on the assumption that the WTB is performance category 2, as defined in DOE-STD-1020-94. This assumption was selected because the WTB is a nuclear facility that is needed to continue emplacement operations

The building resistance to lateral loads is provided by moment-resisting steel frames at each bend and walls constructed with concrete masonry unit infill along the perimeter of the building. The masonry infill walls satisfy the requirements for tornado missile barriers. The interior bearing walls below the mechanical equipment rooms provide additional lateral load resistance to the lateral forces from the mechanical equipment on the second floor in the event of an earthquake.

The building is supported on reinforced concrete spread footings. The size of the footing was determined by considering the foundation load and allowable soil bearing capacity. Major equipment at grade is supported by individual reinforced concrete footings that are isolated from the slab. Minor equipment at grade is supported on thickened slabs.

In the design of reinforced concrete, members were sized to provide adequate strength in accordance with the provisions, load factors, and strength reduction factors specified by the American Concrete Institute Code. Structural steel members and their connections were designed in accordance with the American Institute of Steel Construction, American Structural Design manual, using the allowable stress design method. Metal decking and composite slabs were designed using the manufacturer's design manual and allowable load data.

The structural design of the WTB will comply with the applicable criteria in the RDRD (YMP 1994a). The ACD included considerations for seismic loads and impacts from a tornado generated missile, which were judged to be the controlling design conditions. Extreme wind and other loading conditions will be considered in subsequent designs.

7.2.4.5 Systems Descriptions

This section describes the systems associated with the WTB. An overview of the major waste treatment systems are shown in Figure 7.2.4-3. The WTB systems are also listed in Table 7.2.4-1 along with a brief description, the key sizing parameters, a list of the applicable flow sketches, and the area within the WTB where the operations take place. The area designations correspond to area descriptions shown on the WTB general arrangement sketches provided in Appendix D. Following the table, the system functions, scope, and operations are described for each major system, and the other WTB support systems are listed. The WTB structure and areas within the WTB are described in Section 7.2.4.4 and the major waste treatment components are described in Section 7.2.4.6. The data provided in the operations sections of the system descriptions are taken from the *Waste Treatment Building Interim Design Study* performed in 1995 (CRWMS M&O 1995ab).

7.2.4.5.1 Liquid LLW Processing System

Functions

The Liquid LLW Processing System converts aqueous and chemical low-level radioactive liquids generated from repository operations into a stable form suitable for disposal. In the selected process, 95 percent of the aqueous liquids are recycled to the waste generators as treated water for reuse. The system stabilizes and packages the residual LLW in drums suitable for off-site shipment to a LLW disposal site.

Liquid LLW is generated as a result of SNF and DHLW handling operations, decontamination operations, housekeeping, and maintenance activities performed within the RCA. Table 7.2.4-2 lists the calculated annual volumes of both chemical and recyclable aqueous liquid wastes. These waste volumes are summarized by the three main areas of the RCA: WHB, CMF, and WTB. Due to the early stage of conceptual design development, some potential secondary waste producing facilities have been assumed to exist, and waste generation rates estimated for them. An example of this is the truck/rail washdown area, the need for which has yet to be determined. For this reason, the volume of wash liquid from this area is shown as a separate entry in the table. The stream numbers shown in the table are keyed to WTP-SK-001 through -011. Process stream flow rates and properties are provided in the material balance table shown on WTP-SK-020.

The system is expected to annually produce 4,370 drums of solid LLW for off-site disposal and 71,350 gallons of treated waste water for reuse by the waste generators.

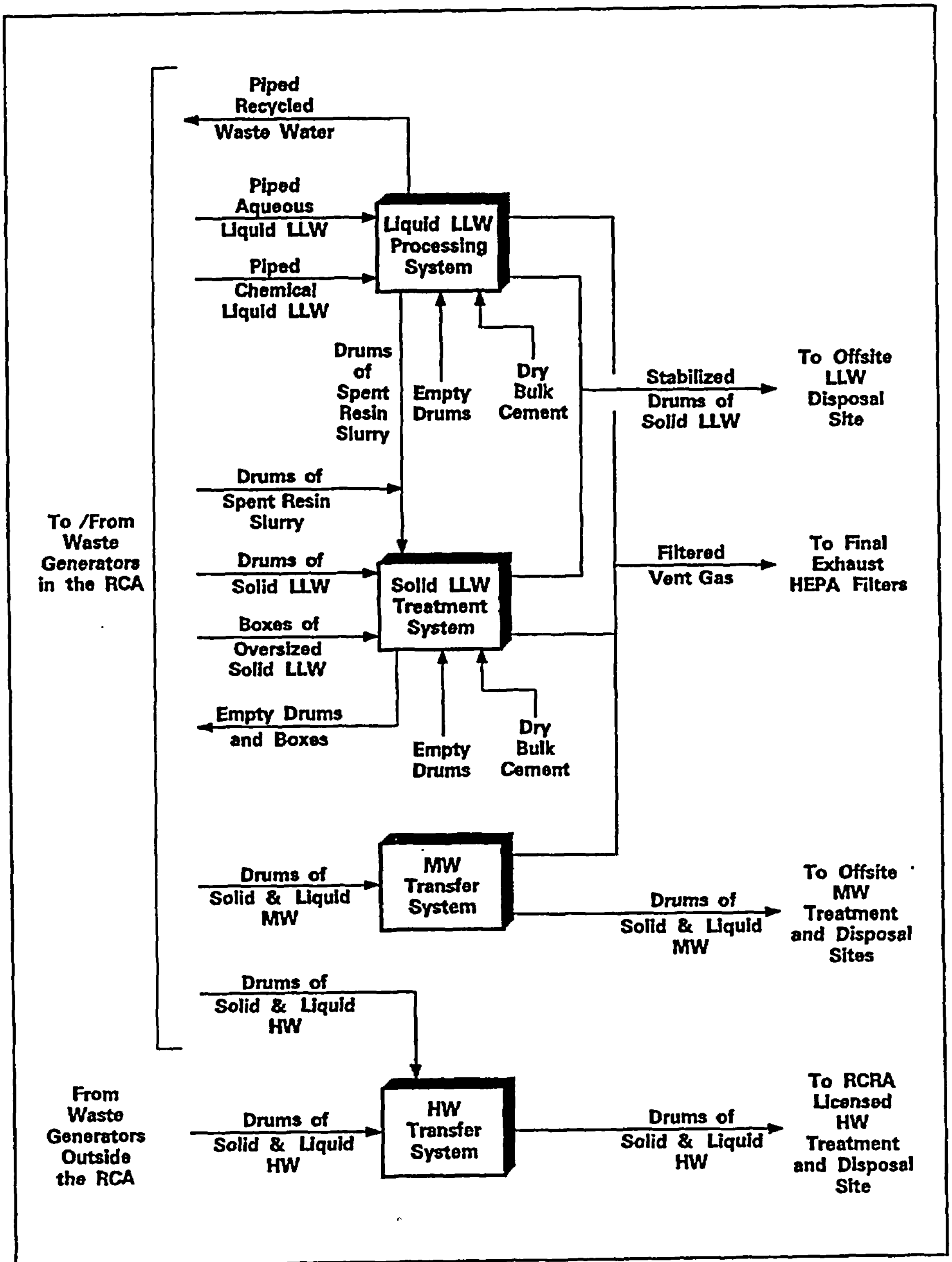

Figure 7.2.4-3 Waste Treatment System Overview

Table 7.2.4-1. WTB Major System Summary

Name	Description	Sizing Parameters	Flow Sketch	Operational Area
Liquid LLW Processing System (Figures 7.2.4-4 & 7.2.4-5)	Aqueous LLW is processed with filtration, evaporation and ion exchange to permit water reuse Non-recyclable chemical liquid LLW is immobilized with cement and packaged in drums for off-site disposal	75,100 gals aq. & 29,800 gals chem. recv' d/yr, 4370 drums LLW & 71,350 gals of recycle water produced/yr	WTP-SK-001 to -011 & -020	Recyclable and Chemical Liquid LLW
Solid LLW Treatment System (Figure 7.2.4-6)	Solid LLW is concentrated with compaction, pressing, cutting and shredding Spent resin slurry LLW is dewatered Concentrated and non-compactible solid LLW is packaged in drums with cement for off-site disposal	37,321 ft³ received/yr, 2005 drums produced/yr	WTP-SK-012 to -020	Solid LLW
Mixed Waste Transfer System (Figure 7.2.4-7)	Drums of solid and liquid MW are collected, packaged and accumulated for transfer to off-site treatment and disposal sites	3 drums transferred/yr	WTP-SK-060 & -061	Mixed Waste Interim Accumulation
Hazardous Waste Transfer System (Figure 7.2.4-8)	Drums of solid and liquid HW are collected, packaged and accumulated for transfer to off-site treatment and disposal sites	12,600 gallons or 233 drums of liquid, 3,930 ft³ or 536 drums solid transferred/yr	WTP-SK-050 to -052	Not in WTB
HVAC	Conditioned air flows through the WTB rooms to control environmental conditions and differential pressures between confinement zones Process vent gases are collected, filtered and released from a stack	3 systems	WTH-SK-101E	Mechanical Equipment Rooms No. 1 & 2

Table 7.2.4-2. Liquid Low Level Radioactive Waste Generation Rates

Source Facility	Category	Stream Number	Annual Rate (gallons)	
			Recyclable	Chemical
WHB	Floor Drains	111	-	20,200
	Floor Drains	103	30,300	-
	Waste Package Wash	105	1,600	-
	Small Equip./Tools Decontamination Water	113	-	6,200
	Small Equip./Tools Decontamination Solution	106	3,100	-
	Total		35,000	26,400
CMF	Truck/Rail Carriage Wash Area Solution	107	1,100	-
	Cask Decontamination Solution	112		21,500
	Floor Drains	102	21,100	-
	Floor Drains	110	-	14,100
	Cask Decontamination Water	104	12,700	-
	Total		34,900	35,600
WTB	Floor Drains	109	-	3,400
	Floor Drains	101	5,200	-
	Total		5,200	3,400
Grand Total			75,100	65,400

Scope

The Liquid LLW Processing System receives aqueous and chemical liquid LLW from a segregated piped LLW liquid collection system and delivers drums of LLW suitable to the on-site transportation system for off-site disposal. The system delivers treated LLW water for reuse by the process operations through a piped distribution system. The system also requires interfaces with the following support systems:

A. Electric power to operate the components such as instruments, agitators, tank and vent heaters, vent blowers, pumps, conveyors, rotary feeders and mixers.

B. Instrument air to operate instruments and pneumatic operators.

C. Cooling water to operate tank coolers and condensers.

D. HVAC system to receive the filtered process vent gas from the equipment processing radioactive materials.

E. WTB structure to house system components.

Operations

The Liquid LLW Processing System is shown on Figures 7.2.4-4 and 7.2.4-5. These block flow sketches provide an overview of the system flow. The numbers in the blocks (e.g., WTP-SK-001) refer to more detailed process flow diagrams provided in Appendix D. The process flow diagrams describe the flow of materials, identify the components required, and provide stream numbers for selected flow paths. Material balances for these flow paths are provided in sketch WTP-SK-020.

Spent chemical and aqueous LLW is generated by operations conducted within the WTB and other surface facilities inside the RCA.

These liquids are segregated and are routed to the Chemical Liquid LLW Collection Tank (TNK-101) and the Recyclable Liquid LLW Collection Tank (TNK-102), respectively.

The nominal 10,000-gallon capacity of each tank equals approximately 30-days production of each type of waste at the average throughput rate. This permits each tank to be used as a surge volume to even out the throughput of downstream operations. Both tanks are located inside the WTB, and are vented to a system consisting of heaters, high efficiency particulate air (HEPA) filters, and blowers. The other process equipment items that handle liquid LLW and that require ventilation are also served by this same system.

The WTB design is based on single-shift operation of equipment downstream from the Chemical Liquid Collection Tank (TNK-101) and the Recyclable Liquid LLW Collection Tank (TNK-102) for 235 days per year. For about one hour during each operating day, aqueous waste is withdrawn at a net forward rate of 5.4 gpm from the Recyclable Liquid LLW Collection Tank (TNK -102) by the top-mounted Recyclable Waste Feed Pump (P-102 A or B). This 320-gallon batch transfer passes first through the Cartridge Filter (FLT-101 A&B) before filling the Evaporator Feed Tank (TNK-103).

The provision of two parallel, 100 percent capacity filters permits the diversion of the liquid stream to the second unit if the first filter becomes plugged with solids. The rejection of these solids is accomplished by removing the loaded filter element and discarding it to the compactible, solid LLW stream. This operation is performed after completion of the batch liquid transfer. In the unlikely event that both parallel filters become plugged during the course of a single transfer, the installed capability is provided to backflush the elements with solids-free water pumped from the Recyclable Water Storage Tanks (TNK-107 A&B). The solids-rich backflush stream is returned to the Recyclable Liquid LLW Collection Tank.

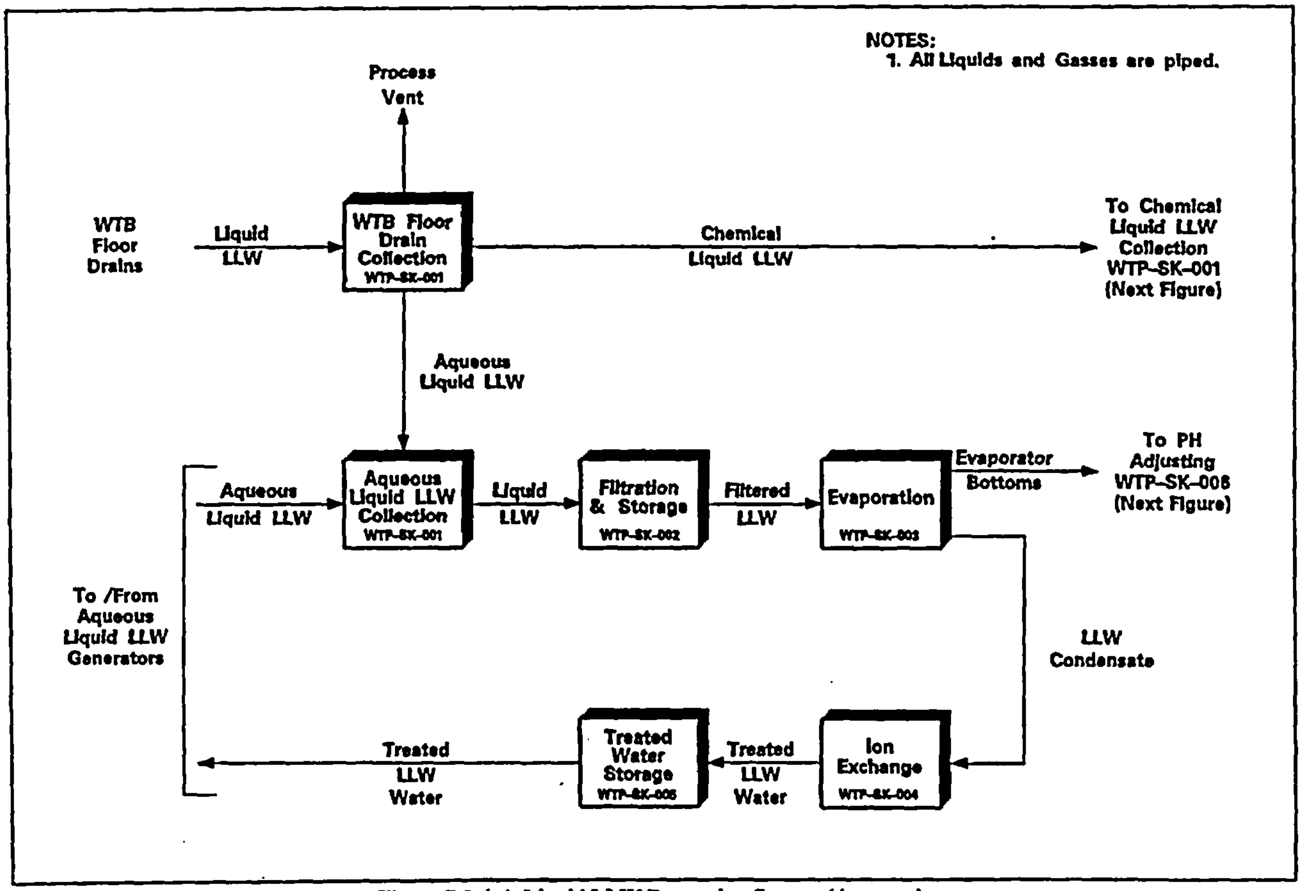

Figure 7.2.4-4 Liquid LLW Processing System (Aqueous)

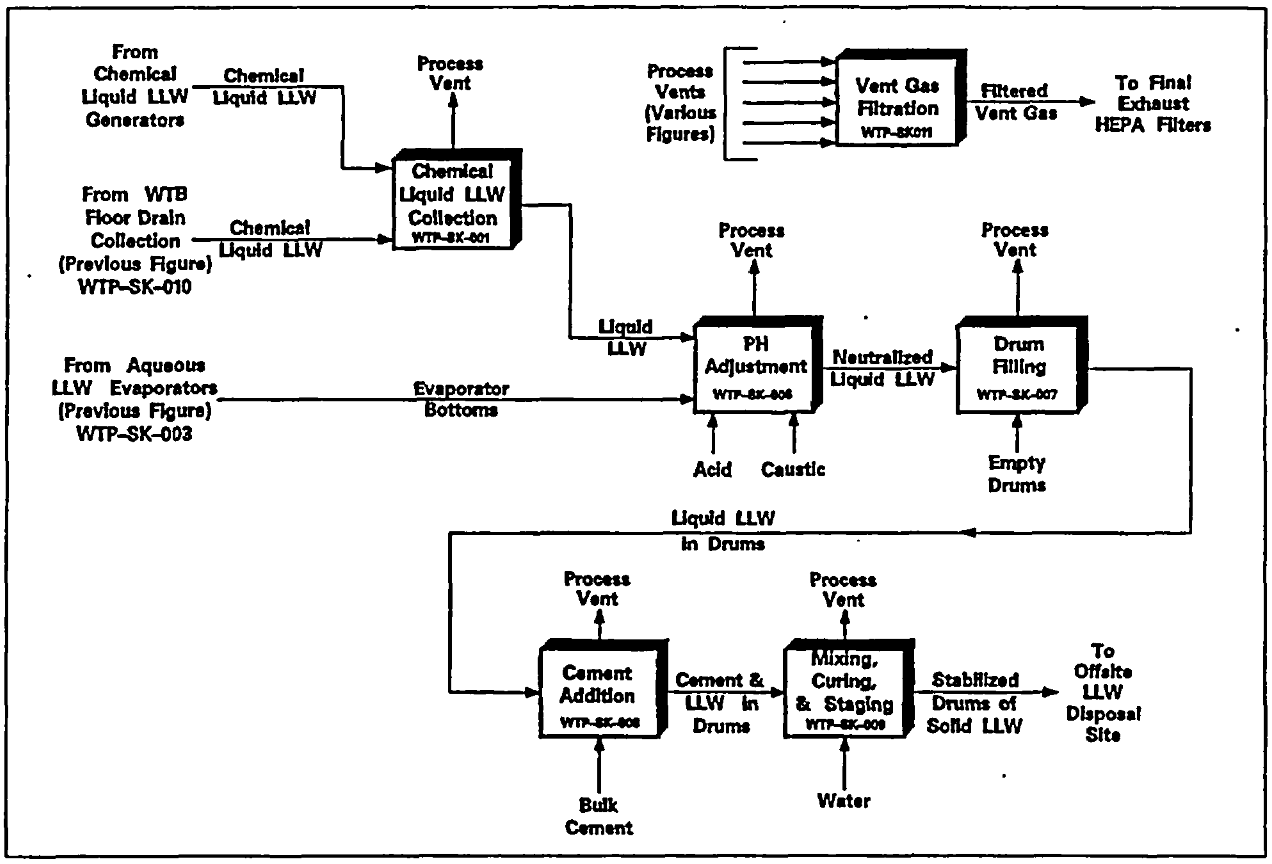

Figure 7.2.4-5. Liquid LLW Processing System (Chemical)

The 480-gallon nominal capacity Evaporator Feed Tank (TNK-103) is filled and emptied once each operating day. After the tank liquid rises to a minimum level, the top-mounted Evaporator Feed Pump (P-103 A&B) can initiate a controlled transfer to the Evaporator Package (EVP-101). This 318-gallon batch transfer typically takes place over about three hours at an average rate of 1.6 gpm. The Evaporator Feed Tank (TNK-103) is located in the WTB and is also served by the vent system previously mentioned.

The Evaporator Package (EVP-101) consists of a vertical, cylindrical tank with a bladed agitator and a transfer pump mounted on top of the tank, a submerged four element electric heater element rated at 125 kW, and a water-cooled cooling coil. The agitator blades, heating element, and cooling coil must be submerged when in operation. At the start of each daily operating cycle, the heating element warms the agitated bottoms liquid to near boiling. Shortly after commencement of the 318-gallon controlled transfer from the Evaporator Feed Tank (TNK-103), the heating element power output increases to initiate boiling. The boiling operation continues for approximately three hours, at a rate slightly less than that of the incoming feed liquid.

Water vapor and possibly air or other noncondensibles pass overhead from the Evaporator Package (EVP-101) and enter the shellside of the water-cooled Condenser (CND-101), which is rated at 1.085 M Btu/hr. The newly-formed aqueous condensate gravity drains from the Condenser (CND-101) liquid outlet to the Condensate Collection Tank (TNK-104) at an average rate of 1.4 gpm. A total of 303 gallons of condensate is typically produced from a 318-gallon batch of Evaporator Package (EVP-101) feed liquid. Water-saturated noncondensibles exit through the Condenser (CND-101) vapor outlet and are drawn by suction to the previously described vent system.

The Evaporator Package (EVP-101) bottoms experience a net accumulation of 26 gallons over the course of a typical boil-off cycle. The daily purge of this excess is achieved at the end of the evaporation cycle by first turning off the heating element and then initiating water flow through the cooling coil. The top-mounted transfer pump may be activated as soon as the bottoms temperature falls low enough to avoid cavitation. The 26-gallon batch transfer is discharged to the pH Adjustment Tank (TNK-108) for further processing. The cooling coil can continue to operate until the remaining bottoms liquid falls to near ambient temperature.

For about three hours during every operating day, the 480-gallon Condensate Collection Tank (TNK-104) receives aqueous condensate at an average rate of 1.4 gpm. After about 30 minutes, when the tank liquid rises to a minimum level, the top-mounted Ion-Exchange Unit Feed Pump (P-104 A&B) can initiate a controlled transfer to the Ion-Exchange Columns. This 303-gallon batch transfer typically takes place over about three hours at an average rate of 1.7 gpm. As is the case with the other process tanks, the Condensate Collection Tank (TNK-104) is served by the vent system previously described.

The Ion-Exchange Unit (INX-101) contains three functionally interchangeable ion-exchange columns. For approximately three hours in each operating day, the unit receives a 1.7 gpm feed of aqueous condensate. Upon entering the lead column, this liquid flows downward through a bed of nonregenerable cation exchange resin. In the second column, the condensate flows downward through nonregenerable anion exchange resin. Leaving this second column, the now polished and decontaminated condensate proceeds to one of the two parallel Recyclable Water Storage Tanks

(TNK-107 A&B). Meanwhile, the third (or standby) column may be undergoing resin changeout, as described below.

The clean condensate from the Ion-Exchange Unit (INX-101) is continuously monitored to verify that it has been adequately decontaminated. An unacceptable radiation dose indicates the need for replacement of one or both of the resin beds. Immediately after the detection of unacceptable resin performance, the Ion-Exchange Unit (INX-101) feed stream must be stopped. If the standby column already contains a fresh charge of that same resin, then the unit valving can be quickly changed to permit the standby column to replace the spent column. Feed to the Ion-Exchange Unit (INX-101) may then be resumed.

The spent column is placed in the standby mode; it must undergo resin change-out before being returned to service. The first step in this operation requires that the top outlet line be opened while a high flow of clean water from the Recyclable Water Storage Tank (TNK-107 A&B) is admitted to the bottom of the column. As the water level rises through the column, it fluidizes the resin particles and carries them overhead to the 310-gallon Spent Resin Catch Tank (TNK-106) where a top-mounted agitator maintains the slurried resin in suspension.

The Spent Resin Transfer Pumps (P-106 A&B) periodically move the slurried resin from the Spent Resin Catch Tank (TNK-106) to the Spent Resin Drum Filling Station (MIS-102). This Filling Station is expected to be a packaged unit consisting of an airtight chamber with an access door and internal components. Based on the preliminary design work performed thus far, it is anticipated that empty, open-topped 55-gallon drums will first be introduced to the Filling Station through the access door. These drums are designed with thick walls to provide radiation shielding against the contaminated resin.

Inside the Filling Station, a hydraulic system positions a specially-designed lid over the open top of the drum. This lid is fitted with a fill connection that is joined to the Spent Resin Transfer Pump (P-106 A&B) discharge line by a flexible hose, as well as a separate vent connection. During resin transfer, the operating Spent Resin Transfer Pump (P-106 A&B) discharges the resin slurry through a recirculation line that empties back into the Spent Resin Catch Tank (TNK-106). A slipstream drawn from this recirculation loop is sent to the Spent Resin Drum Filling Station (MIS-102) where it passes through a volumetric metering device before emptying into the drum. The metering device automatically terminates the forward-flowing slipstream once the drum is filled. Air displaced from the drum exits through the top lid vent connection. This air may be filtered inside the Filling Station chamber before being routed to the same system that handles process tank vents.

Following completion of the fill cycle, the hydraulic device inside the Filling Station retracts the specially-designed lid from the top of the drum. It is then necessary to secure a more conventional solid lid to the top of the drum. Depending on the automatic capabilities of the Filling Station, a plant operator fully suited in protective gear may be needed to secure a drum lid. Once the solid lid is firmly in place, the filled drum is removed from the Filling Station by a forklift and carried to the Drum Lifter (DPR-201). Working off the contents of a full Spent Resin Catch Tank (TNK-106) requires that several such drums be filled. The final dispositioning of spent resin is discussed in the section on Solid LLW Processing.

The next step in a standby column resin changeout is the addition of fresh resin. To prepare for this changeout, a measured volume of decontaminated water from the available Recycle Water Storage Tank (TNK-107 A&B) is first transferred to the 310-gallon Resin Feed Tank (TNK-105). A drum of fresh resin is then made accessible to the top of this tank by a forklift while the tank agitator is activated. Standing on a platform adjacent to the tank, a plant operator opens the tank loading hatch and manually adds the required amount of fresh resin from the drum. Resin transfer is accomplished by opening a top inlet line on the standby column and starting one of the double-diaphragm type Resin Transfer Pumps (P-105 A&B).

Once inside the column, the slurried resin particles are retained by a porous support media to form a bed.. The transfer water flows down through both the bed and the support media before exiting the bottom of the column and proceeding to the Recyclable Liquid LLW Collection Tank (TNK-102). Upon completion of the resin transfer, the associated column inlet line is closed. The standby column is then ready to be returned to service.

As previously noted, the 1:7 gpm intermittent stream of decontaminated aqueous condensate from the Ion-Exchange Unit (INX-101) is routed to one of the two Recyclable Water Storage Tanks (TNK-107 A&B). These 3,240-gallon tanks operate in parallel on staggered cycles, alternating between fill and delivery modes. At an average fill rate of 303 gallons per plant operating day, a single tank is completely filled in eight or nine operating days. At that point, the condensate feed stream must be diverted to the second tank. The liquid in a filled tank is immediately sampled and analyzed to confirm its acceptability for reuse. Unacceptable levels of contamination require that the tank contents be drained to the Floor Drain Collection Tank (TNK-109) and then reprocessed. Acceptable test results permit the tank to be placed in the delivery mode. It then acts as an "on-demand" source of clean recycle water for miscellaneous uses within the plant.

With regard to the handling and treatment of chemical LLW, the 480-gallon pH Adjustment Tank (TNK-108) receives one batch transfer from the Chemical Liquid LLW Collection Tank (TNK-101) and a second batch transfer of aqueous bottoms liquid from the Evaporator Package (EVP-101) each operating day. The volumes of these daily transfers are 278 gallons and 26 gallons respectively, for a total of 304 gallons. The liquid mixture in the filled pH Adjustment Tank (TNK-108) is homogenized by agitation before its pH is measured. In preparation for the downstream processing of this liquid into grout, its pH is then adjusted to an acceptable value by a metered addition from either the Caustic Injection Skid (MIS-105) or the Acid Injection Skid (MIS-106), as appropriate.

The pH Adjustment Tank (TNK-108) is emptied each operating day by as many as 20, 16.4-gallon pumped batch transfers to the Chemical Waste Drum Filling Station (MIS-103). As with the Spent Resin Drum Filling Station described above, the Chemical Waste Drum Filling Station (MIS-103) is expected to be a packaged unit consisting of an airtight chamber with an access door and internal components.

It is currently anticipated that empty, open-topped 55-gallon drums will first be introduced to the Filling Station through the access door where a hydraulic system positions a specially-designed lid over the top of the drum. This lid is fitted with a fill connection that is joined to the Treated Chemical Waste Transfer Pump (P-109 A&B) discharge line by a flexible hose, as well as a separate vent connection. During a batch transfer, the incoming chemical waste passes through a volumetric metering device that automatically stops the flow once the specified 16.4 gallons has been delivered to the drum. Air displaced from the drum exits through the top lid vent connection. This air may be filtered inside the Filling Station before being routed to the same system that handles process tank vents.

Following completion of the fill cycle, the hydraulic device inside the Filling Station retracts the specially-designed lid from the top of the drum. It is then necessary to secure a more conventional solid lid to the top of the drum. Depending on the automatic capabilities of the Filling Station, a plant operator fully suited in protective gear may be needed to secure the drum lid. Once the solid lid is firmly in place, the partially filled drum is removed from the Filling Station by a forklift and carried to the Cement Feeder Package (MIS-108). The metered addition of dry cement to these partially filled drums is performed by the combined operation of the Cement Storage Silo Package (MIS-107), the Rotary Feeder (FED-101), and the Cement Feeder Package (MIS-108). The vertical Cement Storage Silo Package is located outside, but immediately adjacent to, the WTB. It consists of a storage silo, a vent filter, and an exhaust blower discharging to the atmosphere. The 740 cubic-foot silo is refilled once every five operating days by pneumatic transfer from a delivery truck.

The Cement Feeder Package (MIS-108) consists of a feed hopper located outside the WTB, a screw feeder that penetrates the WTB wall, and a chamber where dry grout formers are added to partially filled chemical waste drums. The drums enter this chamber individually through an access door. Once inside, the solid drum lids must be removed. Dry grout formers are then transferred from the feed hopper to the open drum by the screw feeder. A load cell on the feed hopper automatically terminates this transfer upon delivery of the specified solid mass. Chamber vent gases are filtered before leaving the Cement Feeder Package (MIS-108) and before entering the previously described vent system. The variable speed Rotary Feeder (FED-101) periodically refills the feed hopper from the storage silo by gravity flow.

Once a drum is filled, its solid lid is reinstalled to permit its removal from the chamber by a forklift. The current material balance calls for each filled drum to contain 143 pounds of chemical waste (originally in liquid form) plus 651 pounds of dry grout formers, for a total of 794 pounds. Based on this, and the total volume of chemical waste that must be processed, it is estimated that about 18 grout-filled drums will be produced every operating day. Assuming that the Cement Feeder Package (MIS-108) operates for six hours per day, a filled drum must be produced once every 20 minutes.

The filled chemical waste drums are transferred by forklift to the two, parallel operated Cement Mixing Stations (MIX-104). Most of the operating equipment associated with each station is housed inside an airtight chamber. An incoming drum enters the chamber through an access door and is placed on a roller conveyor. Following removal of the drum lid, the access door is closed and the conveyor moves the drum horizontally to a support platform. A hydraulic device then raises the support platform. This operation causes variable speed, fixed-in-place mixing blades mounted above to be submerged in the drum contents. It also causes a dust hood to seal off the open top of the drum. The mixing blades are rotated for as long as necessary to form a homogeneous grout paste, or slurry. Vent gases and entrained particulates from the drum are confined by the dust hood. This gas stream is filtered by the Cement Mixing Station (MIX-104) before being discharged to the previously described vent system for further treatment.

Following completion of the mixing step, the hydraulically-operated support platform lowers the filled drum. A drain pan must then be rotated into position to catch any grout slurry dripping from the mixing blades. At the end of each operating day the mixing blades are washed with clean recycled water. All recaptured drips and wash liquids drain to the Floor Drain Collection Tank (TNK-109), where they are periodically recycled to the Chemical Liquid LLW Collection Tank (TNK-101), or possibly to the Recyclable Liquid LLW Collection Tank (TNK-102) for reprocessing. Each filled drum is moved along the roller conveyor to the chamber access door, where the solid drum lid is again fixed in place. This operation may require the assistance of a fully suited plant operator. Assuming that both Cement Mixing Stations (MIX-104) are in service for six hours out of each operating day, the time available to process each drum is estimated to be 40 minutes.

Following closure the filled drums are moved by forklift to an interim accumulation area. After a specified curing period, the solidified grout is inspected and tested to verify its quality. Acceptable drums are packaged and moved to the disposal area.

Floor drains from both the solid and the liquid LLW processing areas, as well as drips and spent wash liquids from the two Cement Mixing Stations (MIX-104), flow by gravity to the Floor Drain Collection Tank (TNK-109). This 2,070-gallon tank is located inside an underground sump and is used for collection. Following sampling and analysis, the tank contents are periodically pumped out to either the Chemical Liquid LLW Collection Tank (TNK-101) or the Recyclable Liquid LLW Collection Tank (TNK-102), as appropriate. Any leaks from the Floor Drain Collection Tank (TNK-109) or its top-mounted transfer pumps are captured by the 5,940-gallon Sump (SMP-101). From this sump these leaks are transferred to the Chemical Liquid LLW Collection Tank (TNK-101).

As previously noted, a vent system is provided to decontaminate effluent gases from process equipment in the liquid LLW processing area. This vent system consists of a collection header feeding into two parallel, 100 percent capacity gas processing trains. Inside the operating train, the combined vent gases are first warmed by a Heater (HTR-101 A or B) to prevent the downstream condensation of water vapor. The gases then successively pass through a Roughing Filter (FLT-102 A or B) and at least one HEPA filter (FLT-103 A or B) where entrained particulates are removed. The filtered gases are drawn by suction to the inlet of the Vent Blower (BLO-101 A or B) where they are discharged to the HVAC plenum.

7.2.4.5.2 Solid LLW Treatment System

Functions

The Solid LLW Treatment System converts compactible, non-compactible, and oversized low-level radioactive solids generated from repository operations into a stable form suitable for disposal. The system compacts the waste where possible to reduce disposal cost, reduce the size of oversized materials to permit disposal in standard size drums, and immobilize the waste in cement.

Solid LLW is generated from SNF and DHLW handling operations, decontamination operations, house-keeping activities, and maintenance activities conducted within the RCA. Table 7.2.4-3 lists the estimated annual volumes of both compactible and non-compactible wastes. The major sources of solid LLW are the WHB and the CMF, but solid LLW is also generated in the WTB and CSS.

The WTB is not designed to receive any transuranic waste. The stream numbers shown in the table are keyed to WTP-SK-012 through -019.

The system is expected to annually produce 2005 drums of compacted solid LLW for off-site disposal.

Table 7.2.4-3. Solid LLW Generation Rates

Source Facilities	Category	Stream Number	Annual Rate (cubic feet)
WHB, CMF, WTB, CSS	Compactible	202	26,790
	Noncompactible	201	8,986
	Spent Resin Slurry	203	1,545
	Total		37,321

Scope

The Solid LLW Treatment System receives compactible, non-compactible and oversized solid LLW in drums and boxes from the on-site transportation system. The system delivers the following to the on-site transportation system: drums of LLW suitable for off-site disposal and empty drums and boxes for refilling by the waste generators. The system also requires interfaces with the following support systems:

A. Electric power to operate the components such as instruments, presses, cutters, shredders, compactors, vent blowers, pumps, conveyors, rotary feeders, and mixers.

B. Instrument air to operate instruments and pneumatic operators.

C. HVAC system to receive the filtered process vent gas from the equipment processing radioactive materials.

D. WTB structure to house system components.

Operations

The Solid LLW Treatment System is shown on Figure 7.2.4-6. This block flow sketch provides an overview of the system flow. The numbers in the blocks (e.g., WTP-SK-012) refer to more detailed process flow diagrams provided in Appendix D. The process flow diagrams describe the flow of materials, identify the components required, and provide stream numbers for selected flow paths. Material balances for these flow paths are provided in sketch WTP-SK-20.

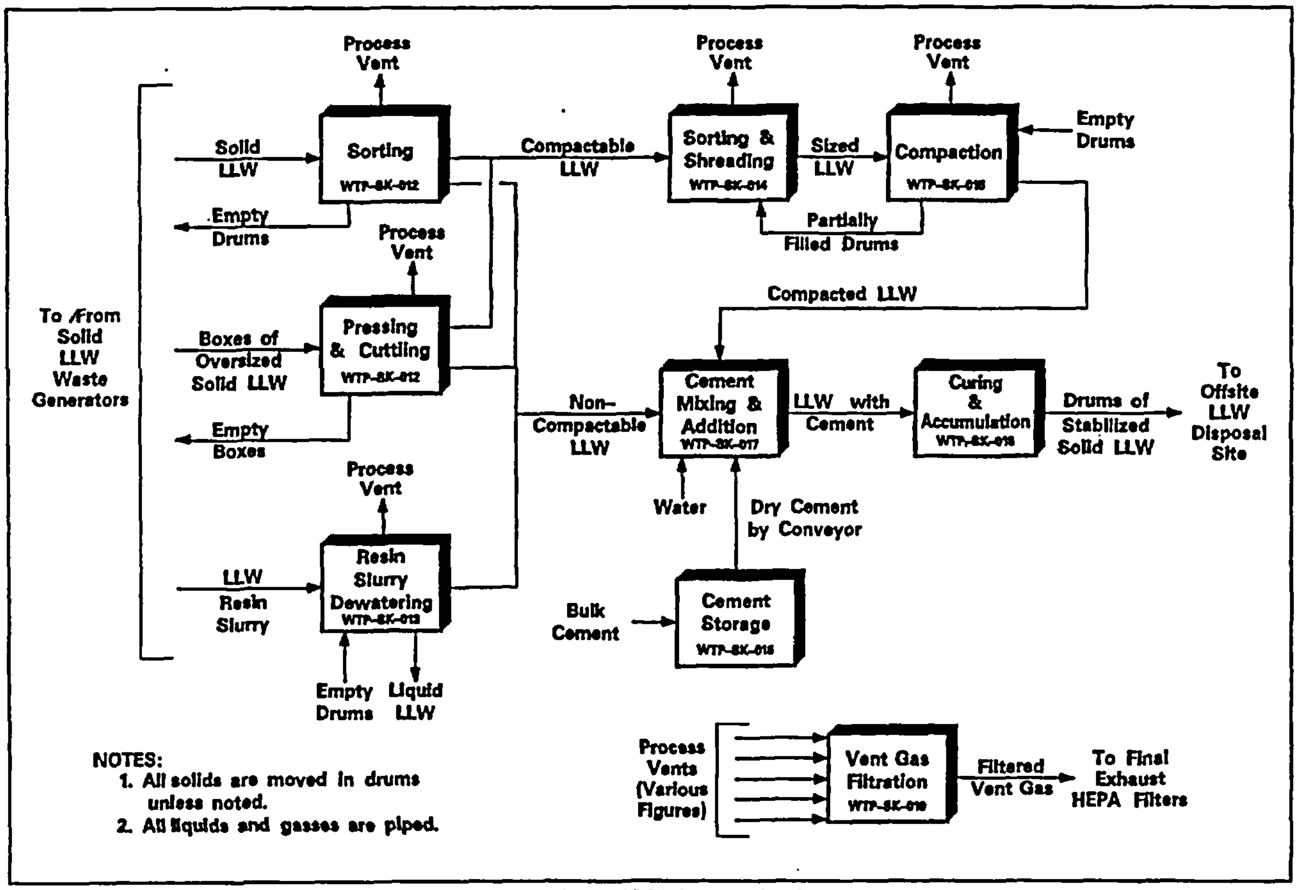

Figure 7.2.4-6 Solid LLW Processing System

Both compactible and noncompactible solid LLW is generated by the WTB and by other repository surface facilities inside the RCA. This unsorted waste is first loaded into specially-designed shielded drums at their points of generation. Once the drums are filled, they are sealed closed and delivered by forklift to an area near the Waste Type Sorting Station (MIS-201). The Waste Type Sorting Station (MIS-201), located inside the WTB, is an airtight chamber equipped with multiple access doors and gloveports, an internal sorting table, a barrel lifter with movable crane, and a HEPA filter and exhaust blower. The Waste Type Sorting Station (MIS-201) performs the function of separating compactible material from noncompactible material, and then reloading these wastes into separate drums.

At the Waste Type Sorting Station (MIS-201), the top of an incoming filled drum is fitted with an adapting collar. The Waste Type Sorting Station (MIS-201) exterior containment door is then opened to reveal a containment collar that will later mate up to the drum adapting collar. Meanwhile, the Sorting Station interior containment door remains closed to prevent the spread of contamination. The drum is next connected to the barrel lifter, which raises it vertically and swivels it into a horizontal position. This movement permits the drum adapting collar to be engaged to the containment collar.

Working through the gloveports, operating personnel remove the interior containment door and the drum lid before unloading the drum contents. The gloveports and shielded viewing windows are then used to manually sort the solid waste, with compactible and noncompactible material being dropped through separate discharge ports in the floor of the Waste Type Sorting Station (MIS-201).

A 55-gallon drum is securely mounted below each of these discharge ports to receive the waste. Once the drums are filled, they are sealed closed before being disengaged from the Waste Type Sorting Station (MIS-201). Similarly, the empty waste delivery drums are sealed closed and removed from the Waste Type Sorting Station (MIS-201) for reuse.

Confinement of contamination is aided by an exhaust blower that maintains a negative gauge pressure inside the Waste Type Sorting Station (MIS-201). The vent gases are filtered through a HEPA filter and are then discharged to the vent system serving the solid LLW process equipment.

Over-sized solid waste items, such as possibly discarded HEPA filter elements, are enclosed inside shielded, 100 cubic-foot boxes and sent to the Mechanical Disassembly Station. The Mechanical Disassembly Station is a sealed room containing a press and a Cutter (CUT-201) and served by an exhaust blower and a HEPA filter. Working inside this room, an operator fully suited in protective gear opens the incoming boxes and removes the solid waste. The operator then uses a press and/or Cutter (CUT-201) to reduce the size of the waste items into pieces small enough to fit into 55-gallon drums. The operator also sorts these pieces by placing the compactible material and the noncompactible material into separate drums. At the end of this operation, the waste delivery box is sealed closed and made available for reuse. The filled waste drums are also sealed closed and removed from the Mechanical Disassembly Station.

Drums of compactible solid LLW from the Waste Type Sorting Station (MIS-201) and the Mechanical Disassembly Station are delivered by forklift to the Waste Size Sorting Station (MIS-203). At this station the feed drums are opened and the contents are divided into undersized and oversized streams before being loaded into separate product drums. This sorting and the subsequent shredding of oversized items improves the efficiency of downstream waste compaction. The Waste Size Sorting Station (MIS-203) is designed and operated in the same manner as the above-described Waste Type Sorting Station (MIS-201). The emptied waste feed drums can be recycled to an upstream point for reuse. Alternately, these drums can be used to receive the size-classified solid waste product streams discharged from the bottom of Waste Size Sorting Station (MIS-203).

A Drum Handler (DHR-201 A&B) and a forklift are used to remove and transport the filled product drums from the Waste Size Sorting Station (MIS-203). The drums containing under-sized pieces of waste are sent directly to the In-Drum Compactor (MIS-205), while those drums filled with over-sized material are first processed through the Shredding Station (MIS-204). It is anticipated that the Shredding Station (MIS-204) will be a specially-designed, packaged unit. There, incoming drums are first loaded onto a drum lifter. Following removal of the drum lid, the drum lifter positions a funnel-shaped transition piece over the open top of the drum. The drum lifter then raises the drum, turns it upside down, and places the outlet of the drum transition piece over a compatible fitting on top of the shredder. The solid waste falls from the inverted drum at a controlled rate, enters the shredder, and is ripped into smaller pieces by cutting wheels attached to two, low-speed, counter-rotating shafts. The shredded material drops through a bottom discharge port and enters a 55-gallon product drum. Shredding Station (MIS-204) vent gases pass through a HEPA filter and an exhaust blower before being discharged for further cleanup downstream. Emptied feed drums can be recycled to an upstream point, or used to receive the shredded product material.

The drummed waste from the Shredding Station (MIS-204) joins the under-sized material from the Waste Size Sorting Station (MIS-203) en route to the In-Drum Compactor (MIS-205), which is housed within an airtight chamber. Inside this chamber, the drum lids are again removed and the drums are positioned in the In-Drum Compactor (MIS-205) frame. After closure of the chamber door, the In-Drum Compactor (MIS-205) lowers a hydraulically-operated steel ram into the top of the open drum, causing compaction of the solid waste to an average density of approximately 40 pounds/cubic foot. The bottom of the drum is supported from below by a solid, contoured plate during this operation. The drum lid is replaced following retraction of the hydraulic ram. Post-compaction drums containing more than a specified void space are returned to the Shredding Station (MIS-204) or to the Waste Size Sorting Station (MIS-203) to receive additional waste. These drums undergo as many refill/compaction cycles as necessary to reduce the residual void space to an acceptable level. Once this objective has been achieved, the drums are again sealed closed before transfer to the Supercompactor (MIS-206). Vent gases from the In-Drum Compactor (MIS-205) pass through a HEPA filter and an exhaust blower upstream of the solid waste vent system.

The Supercompactor (MIS-206) receives sealed drums filled with compacted, solid waste from the In-Drum Compactor (MIS-205). The incoming drums enter an airtight chamber and are mounted in the cylindrical, Supercompactor (MIS-206) drum mold. During compaction, a hydraulically-operated metal ram exerts very high force on the top of the drum, while the surrounding mold maintains its outer diameter. This causes the drum and its contents to deform into a short disk, measuring about 24 inches in diameter, 9 inches in height, and weighing approximately 284 pounds. The density of this disk is estimated to be 127 pounds/cubic foot. If this crushing operation causes the drum wall to breach, some of the contents may escape and contaminate the inside of the

Supercompactor (MIS-206). For this reason, recyclable water can be used to wash down the Supercompactor (MIS-206), as necessary. Spent wash water is then drained to the Floor Drain Collection Tank (TNK-109). Vent gases from the Supercompactor (MIS-206) pass through a HEPA filter and an exhaust blower upstream of the solid waste vent system.

The high-density solid waste disks are lifted from the Supercompactor (MIS-206). These disks are then divided into groups of three disks each prior to being loading into 85-gallon disposal drums. The current design anticipates that empty disposal drums will first receive about 3 inches of grout slurry poured from the Drum Lifter (DPR-202). Following solidification of the grout, the partially filled disposal drums are carried to the Supercompactor (MIS-206) and loaded with three disks, stacked on top of each other. Each drum is then sealed closed and moved by forklift back to an area accessible to the Drum Lifter (DPR-202). After removal of the drum lid, the Drum Lifter (DPR-202) pours grout slurry into the drum to fill all of the remaining void space. The lid is replaced and the filled drum is moved to the Curing/Inspection/Packaging/Certification and Interim Accumulation Room. An alternate approach would be to place a spacer in the bottom of each disposal drum prior to loading of the disks. A single grout pour would then be needed to completely fill all of the internal void space, including the space below the bottom disk. This technique would reduce drum handling and minimize fissures in the solidified grout encasement.

The preparation of fresh grout slurry is achieved by the combined operation of the Cement Storage Silo Package (MIS-207), the Rotary Feeder (FED-201), the Cement Feeder (MIS-208), and the Drum Mixing Station (MIX-201). The vertical Cement Storage Silo Package (MIS-207) is located outside, but immediately adjacent to, the WTB. This package consists of a storage silo, a vent filter, and an exhaust blower discharging to the atmosphere. The 330 cubic-foot silo is refilled once every five operating days by pneumatic transfer from a delivery truck. The Cement Feeder (MIS-208) consists of a feed hopper located outside the WTB and a screw feeder that penetrates the WTB wall and discharges into the Drum Mixing Station (MIX-201).

Empty 55-gallon grout preparation drums are loaded, as necessary, into the Drum Mixing Station (MIS-201). A measured volume of clean recycled water is then added to each drum. Dry cement is then transferred to each drum by the Cement Feeder (MIS-208). A load cell on the feed hopper automatically terminates this transfer upon delivery of the specified solid mass. The variable speed Rotary Feeder (FED-201) periodically refills the feed hopper from the storage silo.

The filled, open top drums are raised by a hydraulic device built into the Drum Mixing Station (MIX-201). Variable-speed, fixed-in-place mixing blades mounted above the station are submerged in the water and cement. A built-in hood also seals the top of the drum to prevent the spread of dust. After the mixing blades are rotated to produce a grout slurry having the desired consistency, the drum is lowered and removed from the Drum Mixing Station (MIX-201). The mixing blades can then be cleaned, as necessary, by a spray of recycle water. The resulting drain-off can be collected in another 55-gallon drum that will then be used to prepare the next batch of grout. These drips may alternately be drained to the Floor Drain Collection Tank (TNK-109).

A forklift is used to move slurry-filled drums from the Drum Mixing Station (MIX-201) to the Drum Lifter (DPR-202). The Drum Lifter then raises each drum and pours the grout to fill in the void space of a receiving, 85-gallon waste disposal drum. As described above, some of these disposal drums contain high-density disks of compacted waste from the Supercompactor (MIS-206). Other disposal drums contain the smaller, 55-gallon drums from the Waste Type Sorting Station (MIS-201) and the Mechanical Disassembly Station that are filled with solid, noncompactible LLW. Finally, other disposal drums contain smaller drums of de-watered, spent ion-exchange resin. The upstream handling of these drums and resin is described below.

Shielded transport drums containing aqueous slurries of spent resin from either the Spent Resin Drum Filling Station (MIS-102) or from repository surface facilities outside the WTB are carried by forklift to the Drum Lifter (DPR-202). Following removal of its lid, each drum is mounted in the Drum Lifter (DPR-202), causing a built-in pour spout to clamp over the open top of the drum. The Drum Lifter (DPR-202) then raises and tilts the drum such that the pour spout discharges to a compatible connection on the airtight chamber housing the Gravity Filtration System (MIS-202). As the resin slurry pours from the drum at a controlled rate, it enters a horizontal filter feed trough. A continuous belt filter moves along the bottom of the trough, from side to side. The liquid phase drains by gravity through the belt filter and is accumulated in a bottom reservoir, where this contaminated water is periodically returned to the Recyclable Liquid LLW Collection Tank (TNK-102) by the externally-mounted Filtrate Transfer Pump (P-201 A&B). Meanwhile, the resin particles form a bed on top of the moving belt filter. Additional dewatering occurs as the belt rises out of the feed pool along a gradual incline. As the dewatered resin is released from the belt filter, it can fall either into a hopper or directly into a waiting 55-gallon drum. Once the drum is filled, this drum is sealed closed and moved by forklift to a suitable point for loading into an 85-gallon waste disposal drum. At the same time, the emptied shielded transport drums may be returned to their points of origin for reuse. Vent gases from the gravity filtration system pass through a HEPA filter and an exhaust filter before being discharged to the solid waste vent system.

Filled waste disposal drums, containing solid LLW encased in freshly poured grout, are moved by forklift from the Drum Lifter (DPR-202) pouring area to the Curing/Inspection/Packaging/Certification and Interim Accumulation Room. The yearly production of these drums, broken down by waste type, is estimated to be as follows:

Waste Type	Drums/year
Noncompactible, solid LLW	1,528
Compacted disks of solid LLW	381
Spent ion-exchange resin	96
Total	2,005

The waste disposal drums remain in interim accumulation for about three days while the grout hardens and cures. If necessary, quality tests can then be performed on the solidified grout. The drums are then labeled and their lids are permanently secured in place. The sealed waste disposal drums are finally moved to the disposal area.

Empty drums and boxes will be provided to the HW generators as needed. Waste movements will be supervised and tracked by on-site waste management personnel in order to ensure compliance with regulations and waste minimization efforts.

A vent system is provided to decontaminate effluent gases from process equipment in the solid LLW processing area. This vent system consists of a collection header feeding into two parallel, 100 percent capacity gas processing trains. Inside the operating train, the combined vent gases are first warmed by a Heater (HTR-201 A or B) to prevent the downstream condensation of water vapor. The gases then successively pass through a Roughing Filter (FLT-202 A or B) and at least one HEPA Filter (FLT-203 A or B) where entrained particulates are removed. The filtered gases are drawn by suction to the inlet of the Vent Blower (BLO-202 A or B) where they are discharged to the HVAC plenum.

7.2.4.5.3 Mixed Waste Transfer System

Functions

The Mixed Waste Transfer System temporarily holds MW awaiting transportation to off-site treatment and disposal sites.

MW is defined as waste material that exhibits the characteristics of both HW and LLW and is produced when HW is contaminated with radionuclides. MW is not anticipated to be generated at the repository as a result of normal operations, as it is expected that only non-hazardous materials will be selected for use in potentially contaminated areas. However, it is also anticipated that small amounts of MW may be infrequently generated due to off-normal operations. The assumed average generation rates for MW are as follows:

A. Liquid MW - 32 gallons or one 55-gallon drum/per year.

B. Solid MW - 11 cubic feet or less than two 55-gallon drums per year.

Currently, regulations relating to treatment of MW are unresolved. Due to the low volume of MW anticipated to be generated at the repository, and the assumption that regulatory requirements will be resolved in the future, it is assumed that MW will be shipped to an off-site location for treatment and disposal. Packaging requirements for this material remain to be determined.

Scope

The Mixed Waste Transfer System receives solid and liquid MW in drums from the on-site transportation system. The system delivers these drums of untreated MW to the on-site transportation system for off-site shipment to permitted MW treatment and disposal sites. The system also requires interfaces with the following support systems:

A. Electric power to operate components such as instruments and vent blowers.

B. Instrument air to operate instruments and pneumatic operators.

C. HVAC system to receive the filtered process vent gas from the equipment processing radioactive materials.

D. WTB structure to house system components.

Operations

The Mixed Waste Transfer System is shown on Figure 7.2.4-7. This block flow sketch provides an overview of the system flow. A process flow sketch, WTP-SK-060 in Appendix D, describes the flow of materials, identifies the components required, and provides stream numbers for selected flow paths. Material balances for these flow paths are provided in sketch WTP-SK-061.

The liquid MW is segregated into oil-based, water-based, or other hydrocarbon-based streams. This MW is collected at the point of generation, in shielded areas isolated from areas handling HW and LLW. Following collection, the liquid MW is packaged in drums (i.e., 55-gallon capacity) suitable for handling and accumulation of MW. The solid MW is also accumulated at the point of generation in storage containers, such as 55-gallon drums.

The filled waste drums are then sealed closed, loaded, and moved to the WTB in trucks from the on-site transportation system. At the WTB the drums are briefly held in a vented accumulation area then shipped to an off-site facility for treatment and disposal.

Empty drums will be provided to the MW generators as needed. Waste movements will be supervised and tracked by on-site waste management personnel to ensure compliance with regulations and waste minimization efforts.

A vent system is provided to decontaminate effluent gases from the MW transfer accumulation area. This vent system consists of a collection header feeding into two parallel, 100 percent capacity gas processing trains. Inside the operating train, the vent gases successively pass through a Roughing Filter (FLT-701 A or B) and at least one HEPA Filter (FLT-702 A or B) where entrained particulates are removed. The filtered gases are drawn by suction to the inlet of the Vent Blower (BLO-701 A or B) where they are discharged to the HVAC plenum.

7.2.4.5.4 Hazardous Waste Transfer System

Functions

The Hazardous Waste Transfer System temporarily holds solid and liquid HW awaiting transportation to permitted off-site commercial treatment and disposal facilities. Off-site treatment is cost effective due to the relatively small amounts of HW generated at the repository. This system is not located in the WTB as the selected design is based on locating the holding facilities where the bulk of the HW is generated, which is not the WTB. The holding facilities are to be adjacent to the TMB for HW generated within the RCA and adjacent to the Motor Pool facility for HW generated outside of the RCA.

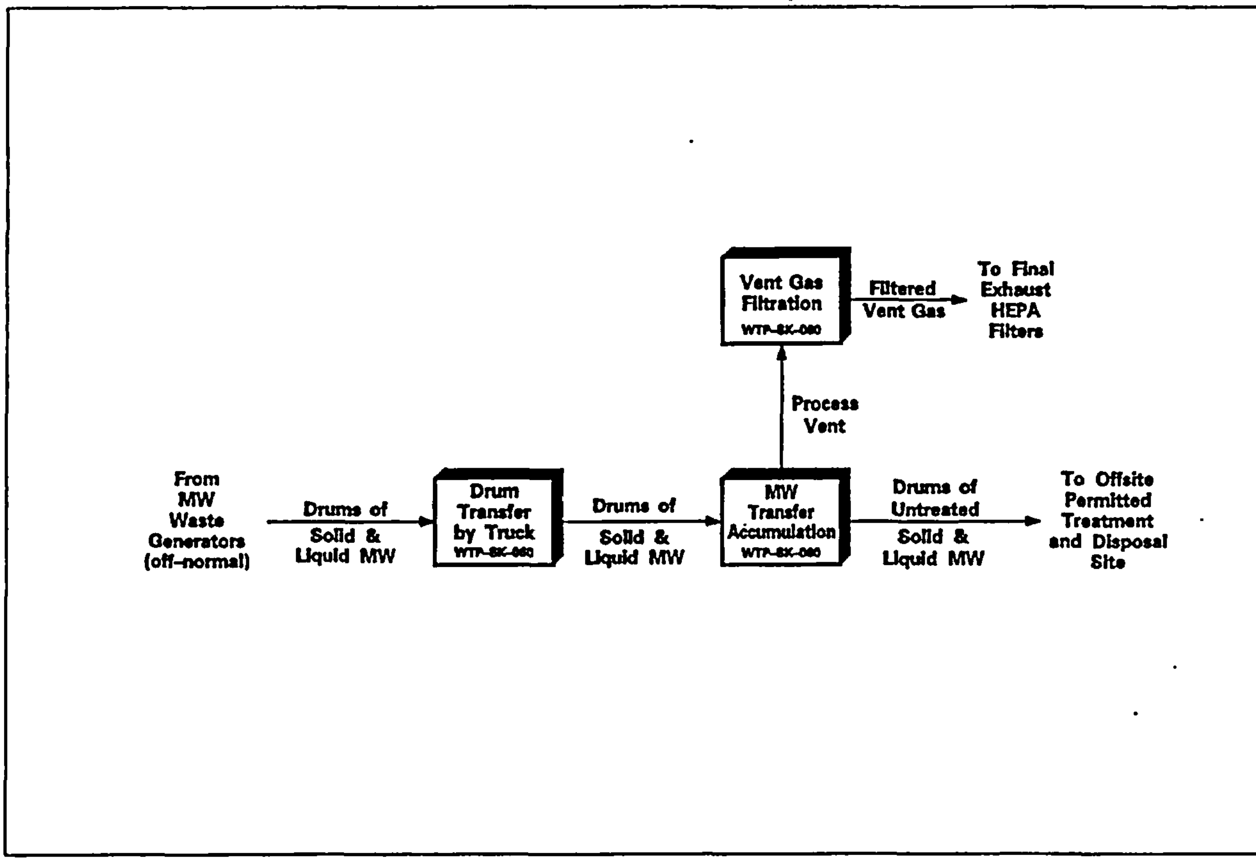

Figure 7.2.4-7. Mixed Waste Transfer System

Liquid HW is collected and packaged at the point of generation. The liquid HW typically includes waste oil, antifreeze coolant, spent solvents, and medical waste. Waste oil includes hydrocarbon-based oils such as lubricating oil, shielding window oil, and hydraulic oil. The source of waste oils is generally site vehicles and other transport equipment. Antifreeze coolant and spent solvents are generated from regular maintenance of site vehicles.

Table 7.2.4-4 presents the estimated annual volumes of liquid HW. This list is broken down by source facility and operations area. Although, in general, waste oils and antifreeze are not expected to be classified as HW, these streams are identified as HW for the purpose of this conceptual design.

Solid HW is also collected and packaged at the point of generation. The solid HW typically includes solid waste such as rags, wipes, packaging materials, and residues contaminated with the liquid hazardous materials described above.

Table 7.2.4-5 presents the estimated yearly volumes of solid HW from the RCA and the BOP. The total volumes from these two areas are 27 and 510 55-gallon drums per year, respectively.

Scope

The Hazardous Waste Transfer System receives solid and liquid HW in drums from the on-site transportation system for temporary accumulation. The system delivers these drums of HW to the on-site transportation system for off-site shipment to RCRA permitted treatment and disposal sites.

Operations

The Hazardous Waste Transfer System is shown on Figure 7.2.4-8. This block flow sketch provides an overview of the system flow. Process flow sketches, WTP-SK-050 and -051 in Appendix D, describe the flow of materials and provide stream numbers for selected flow paths. Material balances for these flow paths are provided in sketch WTP-SK-052.

At the low generation rates of liquid and solid HW generation shown above, it is more economical to prepare HW for treatment and disposal at off-site RCRA permitted facilities. This practice minimizes the burden of having to permit and operate a treatment facility at the repository. The HW from within and outside the RCA are handled separately to avoid the potential for exposing waste generated in the unrestricted area outside the RCA to radionuclide contamination.

As shown on WTP-SK-050 and -051, liquid and solid HW are first collected in 55-gallon drums, or other suitable containers meeting DOT specifications, at or near their points of generation. Partially-filled waste containers will be accumulated in one of several satellite accumulation areas. The HW will be segregated, as needed, by type or characteristics to facilitate off-site treatment.

Table 7.2.4-4. Liquid HW Generation Rates

Area	Facility	Stream No.	Type of Waste	Annual Rate (gallons)
RCA	WHB	501	Waste Oil	486
	CSS	502	Waste Oil	6.2
	CMF	503	Waste Oil	1.6
	WTB	504	Waste Oil	13
	TMB	505	Waste Oil	8.7
	TMB	506	Antifreeze Coolant	4.8
	TMB	507	Spent Solvents	72
	Subtotal Within RCA			592
Outside the RCA	Subsurface	508	Waste Oil	11,816
	Motor Pool	509	Waste Oil	34
	Motor Pool	510	Antifreeze Coolant	27
	Motor Pool	511	Spent Solvents	72
	Medical Center	512	Medical Waste	12
	Subtotal Outside RCA			11,961
Total Liquid Hazardous Waste				12,553

Table 7.2.4-5. Solid Hazardous Waste Generation Rates

Area	Facility	Stream No.	Annual Rate (cubic feet)
RCA	WHB	601	154
	CSS	602	2
	CMF	603	0.5
	WTB	604	4
	TMB	605	27
	Subtotal Within RCA		187.5
Subtotal BOP		606	3,743
Total Solid Hazardous Waste			3,930.5

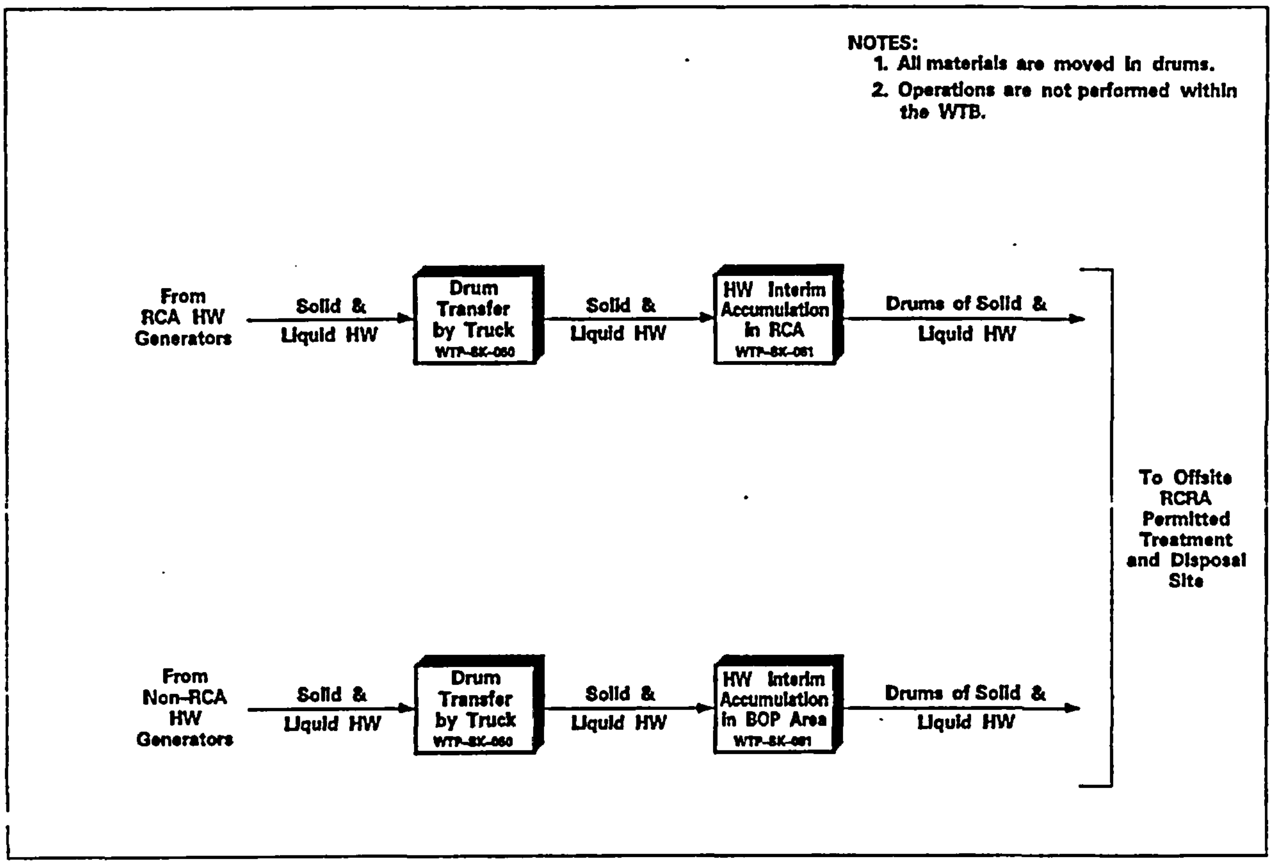

Figure 7.2.4-8. Hazardous Waste Transfer System

Some preparation of solid HW may be performed at the point of generation. If necessary, a portable shearing unit may be used for reduction of oversized waste material prior to packaging. In addition, an absorbent material may be added to the bottom of the HW containers to absorb any free liquid which might be present.

Once a drum contains at or near 55 gallons, the container will be sealed closed and transferred by site vehicles to one of two accumulation sheds. These sheds will be used to accumulate the filled drums for a limited time prior to shipment to an RCRA permitted treatment and disposal facility. The sheds do not require an RCRA permit or license. Each shed is equipped with a perimeter dike and a spill containment system, and is surrounded by a chain-link fence. One shed is located near the TMB to hold HW generated within the RCA. The other shed is located in the BOP area to hold waste generated outside of the RCA. Filled HW drums from the two accumulation sheds will be transferred off site, as needed, by commercial carriers.

Empty drums and absorbents will be provided to the HW generators, as needed. Waste movements will be supervised and tracked by on-site waste management personnel in order to ensure compliance with regulations and waste minimization efforts.

7.2.4.5.5 HVAC System

Functions

The HVAC system for the WTB provides proper environmental conditions for the equipment used in this facility as well as for the health, safety, and comfort of operating personnel. Details of the WTB HVAC system are presented on HVAC Flow Diagrams WTH-SK-101, 102 and 103A through E, and HVAC confinement drawings 104A and B in Appendix D.

Confinement Zones

The HVAC system confines radioactive and hazardous materials within the waste treatment area as close to the point of origin as practicable and also prevents uncontrolled releases to rooms and areas normally occupied by personnel. This confinement is accomplished by a series of successive confinement zones of varying pressures. Each successive confinement zone is at a lower pressure and has a higher potential for contamination.

The primary confinement zone is at the lowest pressure. In the WTB this zone includes the process enclosures (e.g., tanks, drums, and other miscellaneous process items), process off-gas vent system as shown on drawings WTP-SK-011 and WTP-SK-019 in Appendix D, and the associated HEPA-filtered final exhaust air system.

The secondary confinement zone includes enclosures and rooms that contain potentially contaminated process equipment, or rooms supporting primary confinement functions. Examples of areas that are classified as secondary confinement zones include:

- Chemical liquid LLW area
- Recyclable liquid LLW area

- Solid LLW area
- MW accumulation area
- Forklift battery charger area
- Temporary accumulation
- Associated HEPA-filtered final exhaust air system.

The other areas of the facility are normally clean and are required to be maintained at a higher pressure than the secondary zone.

Scope

The HVAC system for the WTB includes the components necessary for continuous operation during normal or off-normal conditions and is designed to maintain the WTB at the proper environmental conditions for the health, safety, and comfort of operating personnel as well as for the equipment used in the facility. The system also collects and provides the final exhaust HEPA filtration of the process vents from the waste treatment systems. The system is comprised of the components listed on the HVAC flow sketches WTH-SK-101, 102 and 103A through E in Appendix D, including:

- Tornado dampers
- Fans (supply, return, and exhaust)
- Air handling units
- Air curtains
- Exhaust HEPA filter units
- Flow measuring elements
- Isokinetic sampling system
- Control dampers
- Ductwork
- Exhaust stack.

The system also requires interfaces with the following support systems:

A. Normal, standby, or emergency electric power to operate the components such as instruments, fans, and air heaters during normal and off-normal operation as confirmed by safety analysis.

B. Instrument air to operate instruments and pneumatic operators.

C. Chilled water to provide air cooling.

D. Fire protection fire panels, smoke and temperature detectors to activate the closure of fire dampers in the ductwork or initiate the HEPA protection deluge systems that are an integral part of the ventilation system.

E. WTB structure to house system components.

Operations

The HVAC System is comprised of three separate, independent subsystems. The first is a HEPA filtered subsystem that mainly serves the primary and secondary confinement zones of the WTB. The second subsystem serves the shipping and receiving area. The third subsystem serves the offices and other miscellaneous rooms. The systems are shown on HVAC flow sketches contained in Appendix D. These sketches describe the rate and flow path of air through the system components.

Primary Confinement Areas HVAC Subsystem

The Primary Confinement Areas HVAC Subsystem provides the exhaust for the waste treatment process vent system. The exhaust is discharged to the outside environment by a dedicated final exhaust unit with two testable stages of HEPA filters, associated primary confinement final exhaust fans, and exhaust air stack. The process vents system negative pressure is maintained by the process vent local blowers. The process vents final exhaust to the outside atmosphere is constant. The final exhaust fans modulate to compensate for variances due to final HEPA filter loading. Corrosive vapors, noxious gases or vapors, and flammable (or combustible) gases are not anticipated from these vents.

Secondary Confinement Areas HVAC Subsystem

The WTB Secondary Confinement Areas HVAC Subsystem is a separate, independent, automatic ventilation subsystem designed to: operate continuously; maintain proper environmental conditions for the health, safety, and comfort of personnel; maintain design conditions for the equipment; and provide contamination confinement. The subsystem serves the areas/rooms of the WTB required to process waste as well as providing the final HEPA filtered exhaust for the process vents. The subsystem is shown on HVAC flow sketches WTH-SK-103A through E.

The waste treatment area/rooms ventilation subsystem is a once-through concept consisting of dedicated supply air handling units and associated supply air fans, and final exhaust units with two testable stages of HEPA filters, associated secondary confinement final exhaust fans, and an exhaust air stack. The negative pressure in these rooms/areas is maintained by modulating the supply air flow and providing constant exhaust. The final exhaust fans modulate to compensate for variances due to final HEPA filter loading

The waste treatment area is classified as a secondary confinement ventilation zone and maintained at a negative pressure of -0.15" wg with respect to the outside atmosphere. The WTB processing areas will be equipped with Continuous Air Monitoring systems.

The HVAC components for the primary confinement as well as for the secondary subsystem are located in a separate, dedicated equipment room. The components are of nuclear-grade quality comprised of air handling units, fans, pumps, air distribution equipment, and instrumentation. The exhaust is comprised of bag-out housings with two stages of HEPA filters and adequate provisions for testing, inspection, monitoring, maintenance, and repair operations. The HEPA filtration has a minimum start-up efficiency of 99.97 percent as tested in accordance with ANSI-N510. Electric heating is selected as the preheating and reheating media for estimating purposes in the absence of an energy conservation analysis (to be performed later). The ductwork is of welded carbon steel constructed in accordance with Sheet Metal and Air-conditioning Contractors National Association high-pressure standards.

Neutral Areas HVAC Subsystem

The Neutral Areas HVAC Subsystem provides the ventilation for various contamination free areas:

A. The Receiving and Shipping Room HVAC Subsystem is of the recirculation type designed to operate normally with approximately 10 percent outside air. The subsystem is also capable of operating once-through as required for removing diesel fumes discharged by truck exhaust. This subsystem consists of a supply air handling unit and a recirculation/exhaust fan. The truck door is provided with air curtains to prevent excessive inlet of dust or loss of treated air. The subsystem is shown on HVAC flow sketch WTH-SK-101.

B. The Offices and Miscellaneous Rooms HVAC subsystem is of the recirculation type designed to operate normally with approximately 10 percent outside air except that the change rooms are provided with once-through ventilation with a single stage of HEPA filters. The subsystem is shown on HVAC flow sketch WTH-SK-102.

The components for the neutral areas subsystem are of industrial-grade quality and are comprised of air handling units, fans, pumps, air distribution, and control instrumentation. The filters are 30 and 90 percent efficiency filters. The change rooms HEPA filters have a minimum start-up efficiency of 99.97 percent as tested in accordance with ANSI-N510. Electric heating is selected as the preheating and reheating media for estimate purposes in the absence of an energy conservation analysis (to be performed later). The ductwork is of galvanized steel construction in accordance with Sheet Metal and Air-conditioning Contractors National Association low-pressure standards.

7.2.4.5.6 Other Systems

The operation of the WTB requires a number of other systems that are not described above. These systems include building utilities, security, monitoring, and control systems required to safely and effectively maintain site generated waste processing and packaging operations. These facility specific support systems are listed below:

A. Power Distribution System including 480/208/120 VAC and the safety bus.

B. Sanitary Waste Collection System for the removal of facility sanitary liquids.

C. Communications Systems including: telephone/public address, video, and data networks.

D. Facility Monitor and Control System to monitor and control building utilities and process control systems.

E. Radiological Monitoring System for monitoring facility radiological performance, and support to health physics activities.

F. Fire Protection and Detection System.

G. Security Systems including the following subsystems: physical protection and safeguards, intrusion alarm system, communications, facility security station.

H. Office Systems for supporting administrative, planning, and engineering activities.

I. Process Control System to provide central and local, monitoring and control of the site generated waste processing, packaging, and handling systems.

J. Water Distribution System for supplying fire water, potable water, chilled water, and secondary cooling water to WTB users; and recycled water to users in the WTB and other facilities.

K. Decontamination Systems for personnel, and equipment decontamination

Systems A through H, listed above, are the same as described for the WHB in Section 7.2.2.5.9. The other WTB support systems are described below:

Process Control System

The WTB process control system provides central and local, monitoring and control of the site generated waste processing, packaging, and handling systems. The Facility Monitor and Control System and the process control system may be integrated as one system. The process control system batch program controls the processing of liquid LLW. The process control system material handling system monitors, and controls the transport and packaging of solid LLW containers, and the transport of MW containers. WTB material handling equipment includes: containers, transporters, and loading station cranes, and lifts. The Main control room and local control stations are as described in Section 7.2.2.5.9 for the WHB Material Handling System.

Water Distribution System

The water distribution system for supplying fire water, potable water and chilled water to WTB users is as described for the WHB in Section 7.2.2.5.9. In the WTB, this system also includes equipment and piping for recycled water distribution and WTB secondary cooling water supply as described below:

A. Recycled Water is produced within the WTB by treating aqueous liquid LLW as described in Section 7.2.4.5.1. Piping is provided to distribute this water to users within the WTB (e.g., floor wash-down stations) and to supply recycled water to the site distribution system which supplies water to the WHB and CMF.

B The WTB secondary cooling water system removes heat from the low level waste processing tanks. This closed loop system provides isolation between the cooling tower water system and LLW system to prevent radioactive contamination of the cooling tower water system. The secondary cooling water system includes a heat exchanger, water pumps, compression tank, piping, valving, and instrumentation. The system is controlled and monitored by the WTB Facility Monitor and Control System: Cooling tower water is valved and metered at the WTB and routed to and from the secondary cooling water heat exchanger.

Decontamination Systems

The Decontamination Systems for personnel and equipment decontamination are as described for the WHB in Section 7.2.2.5.9, except a dry carbon dioxide system is not expected to be required.

7.2.4.6 Components Data

The list for all major components associated with the waste handling systems in the WTB are provided in Table 7.2.4-6. This table includes the component tag number, component description, component capacity, the associated process flow sketch number, and Construction Specifications Institute specification number.

Equipment tag numbers shown in the equipment list are keyed to Flow Diagrams, WTP-SK-001 through -061, contained in Appendix D. The process flow sketch numbers are preceded with WTP-SK-. Where Construction Specifications Institute specification numbers do not exist for a component, a number is assigned and designated with an *.

Pumps in radioactive service are provided with installed 100 percent capacity spares. Whenever possible, failed equipment will be decontaminated, repaired, and returned to service. Items that cannot be repaired must be disassembled inside the WTB before disposal as solid LLW.

The Hazardous Waste System does not have any major components. The components associated with the HVAC System are not included in the table and are instead identified on HVAC flow sketches WTH-SK-101, 102 and 103A through E in Appendix D.

7.2.4.7 Operating Data

This section describes the operating data available for the WTB. The following aspects are addressed: utility consumption, resource consumption, waste generation, and staffing requirements.

Utility Consumption - The WTB and the operations performed in this building will consume cooling water, chilled water, electric power, and sanitary water as discussed below. Rough estimates for peak and annual utility consumption are provided in Table 7.2.4-7. The annual data is based on operating during the emplacement phase only.

A. Cooling water is primarily used for process cooling of tanks and condensers via the WTB secondary cooling water system.

Table 7.2.4-6. Waste Treatment Systems Component List

Tag No.	Component Description	Capacity	Sketch. No.	CSI Spec. No.
LIQUID LLW PROCESSING EQUIPMENT				
Pumps				
P-101A&B	Chemical waste feed pumps -Mounted on TNK-101 submerged	20 gpm	01	15160
P-102A&B	Recyclable waste feed pumps -Mounted on TNK-102 submerged	20 gpm	01	15160
P-103A&B	Evaporator feed pumps - Mounted on TNK-103 submerged	10 gpm	02	15160
P-104A&B	Ion-exchange unit feed pumps -Mounted on TNK-104 submerged	10 gpm	03	15160
P-105A&B	Resin transfer pumps - Double diaphragm	20 gpm	04	15160
P-106A&B	Spent resin transfer pumps - Double diaphragm	20 gpm	04	15160
P-107A&B	Recycle water supply pumps -Centrifugal	100 gpm	05	15160
P-108A&B	Recycle water supply pumps - Centrifugal	100 gpm	05	15160
P-109A&B	Treated chemical waste transfer pumps - Mounted on TNK-108 submerged	10 gpm	06	15160
P-110A&B	Floor drain transfer pumps - Mounted on TNK-109 submerged	10 gpm	10	15160
P-111	Sump pump - Double diaphragm	10 gpm	10	15160
Tanks/Vessels				
TNK-101	Chemical liquid LLW collection tank - 30 days	10,100 gallons	01	13205
TNK-102	Recyclable liquid LLW collection tank - 30 days	10,100 gallons	01	13205
TNK-103	Evaporator feed tank - 1 Batch	480 gallons	02	13205
TNK-104	Condensate collection tank - 1 Batch	480 gallons	03	13205
TNK-105	Resin feed tank - 1 Batch	310 gallons	04	13205
TNK-106	Spent resin catch tank - 1 Batch	310 gallons	04	13205
TNK-107A&B	Recyclable water storage tanks - 8 to 9 days per tank	3,240 gallons	05	13205
TNK-108	pH adjustment tank	480 gallons	06	13205
TNK-109	Floor drain collection tank	2,070 gallons	10	13205
Heaters				
HTR-101A&B	Heaters	68,260 Btu/hr	11	16881*
Heat Exchangers				
CND-101	Condenser	1.085 M Btu/hr	03	15755
Miscellaneous Equipment				
BLO-101A&B	Vent blowers	1,500 cfm	11	15860
EVP-101	Evaporator Package	1.142 M Btu/hr	03	15756*
FED-101	Rotary feeder - Located in Bottom of MIS-107	2.35 cfm	08	14570

Table 7.2.4-6. Waste Treatment Systems Component List (Continued)

Tag No.	Component Description	Capacity	Sketch. No.	CSI Spec. No.
FLT-101A&B	Cartridge filters	5.3 gpm	02	11361*
FLT-102A&B FLT-103A&B	Roughing filters and HEPA filters, respectively - Enclosed in a common housing	1,500 cfm	11	15885
INX-101	Ion exchange columns	3.5 gpm	04	11250
MIS-102	Spent resin drum filling station		04	13095*
MIS-103	Chemical waste drum filling station		07	13095*
MIS-104A&B	Cement mixing station		09	11220
MIS-105	Caustic injection skid	2 gpm	06	11240
MIS-106	Acid injection skid	2 gpm	06	11240
MIS-107	Cement storage silo package	740ft^3	08	11173
MIS-108	Cement feeder package	1.38 cfm	08	14570
MIX-101	TNK-101 mixer	50 HP	01	11220
MIX-102	TNK-102 mixer	50 HP	01	11220
MIX-103	TNK-105 mixer	5 HP	04	11220
MIX-104	TNK-106 mixer	5 HP	04	11220
MIX-105	TNK-108 mixer	3 HP	06	11220
MIX-106	TNK-109 mixer	10 HP	10	11220
SMP-101	TNK-109 containment sump	5,940 gallons	10	13216*
SOLID LLW TREATMENT EQUIPMENT				
Pumps				
P-201A&B	Filtrate transfer pumps	10 gpm	13	15160
Heaters				
HTR-201A&B	Heaters	68,260 Btu/hr	19	16881*
Miscellaneous Equipment				
BLO-201	Blower	500 cfm	12	15860
BLO-202A&B	Vent blowers	2,000 cfm	19	15860
DPR-201	Drum lifter		13	14610
DPR-202	Drum lifter		17	14610
FED-201	Rotary feeder	0.7 cfm	16	14570
FLT-201	HEPA filter	500 cfm	12	15885
FLT-202A&B FLT-203A&B	Roughing filters and HEPA filters, respectively - Enclosed in a common housing	2,000 cfm	19	15885
MIS-201	Waste Type Sorting Station	9 drums/hr	12	11181*
MIS-202	Gravity Filtration System		13	11362*
MIS-203	Waste size sorting station	6 drums/hr	14	11181*
MIS-204	Shredding station		14	11182*

Table 7.2.4-6. Waste Treatment Systems Component List (Continued)

Tag No.	Component Description	Capacity	Sketch. No.	CSI Spec. No.
MIS-205	In-drum compactor	88 psi	15	11172
MIS-206	Supercompactor	10,000 psi	15	11172
MIS-207	Cement storage silo package	330 ft^3	16	11173
MIS-208	Cement feeder	0.44 cfm	16	14570
MIX-201	Drum mixing station	15 HP	17	11220
CRN-201	Small portable crane		17	14680
CUT-201	Press/Cutter -Inside a cell		12	14590*
DHR-201A&B	Drum handler - Portable, to move 55 gal / 85 gal drums		14	14512*
MIXED WASTE TRANSFER SYSTEM				
BLO-701A&B	Vent blowers	1000 cfm	60	15860
FLT-701A&B FLT-702A&B	Roughing filters and HEPA filters, respectively - Enclosed in a common housing	1000 cfm	60	15885

CSI = Construction Specifications Institute

Table 7.2.4-7. WTB Utility Consumption

Utility	Peak	Annual
Cooling Water	350 gpm	9,870,000 gallons
Chilled Water	440 gpm	2,300,000 gallons
Electricity	2,100 kW	10,000,000 kWh
Sanitary Water	1,000 gpd	260,000 gallons

B. Chilled water is used for HVAC cooling.

C. Electric power is used to operate process equipment such as pumps and mixers, HVAC equipment such as fans and heaters, compressors for the air systems, facility lighting, and instruments and controls. The bulk of the use is for process and HVAC.

D. Sanitary water is used for personnel support such as restrooms, change rooms and facility maintenance.

Resource Consumption

The WTB and the operations performed in this building will consume a variety of materials and chemicals as discussed below. Estimates for the annual use of significant consumables are provided in Table 7.2.4-8.

Table 7.2.4-8. WTB Resource Consumption

Consumable	Annual Consumption
55-gallon drums	7,134 drums
85-gallon drums	2,005 drums
Cement, dry	3,668,000 pounds
Ion Exchange Resin	400 cubic feet
Acid (100% H_2SO_4)	18 gallons
Caustic (25 wt% NaOH)	41 gallons

H_2SO_4 = Sulfuric acid
NaOH = Sodium hydroxide

A. Empty 55-gallon drums are used to contain dewatered, spent ion-exchange resin and noncompactible solid LLW. These drums are also used to also receive compactible solid LLW before the material is pressed into disks by the supercompactor.

B. Empty 85-gallon drums are used to overpack all 55-gallon drums and reduced-size disks.

C. Cement is used to fill the void space inside drums and as a solidification agent for liquid LLW.

D. Ion-exchange resin is used to remove trace quantities of dissolved radionuclides from overhead condensates generated by the evaporation of recyclable liquid LLW.

E. Acid and caustic are used, as necessary, to adjust the pH of chemical liquid LLW upstream of grout formation.

Waste Generation

The WTB and the operations performed in this building will generate LLW, a small amount of HW, and sanitary wastes as discussed below. The LLW is processed within the WTB. Rough estimates for the annual generation are provided in Table 7.2.4-9. MW is not included in this table as this material is not expected to be generated from normal operations. If generated from off-normal operations the quantities of MW would be extremely small.

A. Aqueous and chemical liquid LLW is generated from area and equipment washdown and collected through floor drains. Solid LLW is generated from maintenance activities and by the ion exchange systems in the form of spent resin slurry.

B. HW is generated from equipment and vehicle maintenance in the form of waste oils, contaminated rags, and packaging materials.

Table 7.2.4-9. WTB Waste Generation Rates

Waste Material	Annual Generation	
	Liquid (gals)	Solid (cubic feet)
Low-Level	8,600	2,700
Hazardous	13	4
Sanitary/Industrial	260,000	500

C. Sanitary waste water and solid industrial waste are generated by personnel support functions such as restrooms, change rooms, facility maintenance, and office work.

Staffing Requirements

The WTB normally operates five days per week, with one eight-hour shift per day, 250 days per year, except for some utility and security systems which operate continuously. Surge capacity can be accommodated by operating multiple shifts. The number of operators expected to routinely work in the WTB are estimated to be 17. Of these workers, about 57 percent are line operators with the balance performing support functions such as supervision, administration, and maintenance.

7.2.5 Carrier Staging Shed

7.2.5.1 Introduction

7.2.5.1.1 Mission

The mission of the CSS is to prepare a waste transportation cask for entering the WHB or the CMF or for leaving the repository. The primary functions performed in the CSS before entering the WHB or CMF include:

A. Removing the personnel barriers from truck and rail carriers.

B. Performing a radiological survey to determine if contamination on the transportation cask surface exceeds allowable limits.

C. Removing or retracting the impact limiters.

D. Staging the carrier until the WHB or CMF is ready to receive the transportation cask.

The primary functions performed in the CSS before exiting the repository include:

A. Reinstalling the impact limiters.

B. Reinstalling the personnel barriers.

C. Staging the carrier until it can be moved from the CSS to the truck/rail parking area.

7.2.5.1.2 Background

The first conceptual design of repository surface facilities from the SCP-CDR (SNL 1987), produced in 1987, included the CSS operational functions within the WHB shipping and receiving bay. For a background description of the prior conceptual design for the WHB refer to Section 7.2.2 in this report volume. The ACD of the CSS was developed as a stand alone structure located approximately one-half mile north of the WHB. In the selected ACD concept, a separate building was designed to facilitate unimpeded access for four rail lines into the CSS operations bay and to improve the rail/truck carrier movements and overall site operational throughput.

7.2.5.1.3 Design Methodology

The CSS design methodology encompasses identification of requirements and/or assumptions, and the development of block flow diagrams that define the sequence of operations and task durations. This information was then used as input to a throughput simulation model that estimated equipment utilization and led to the determination of the CSS building size.

7.2.5.1.4 Design Status

An ACD of the CSS has been developed. The ACD design documentation includes the following:

A. Identification of design inputs including requirements, assumptions, and data.

B. Design analyses for selecting waste handling designs.

C. Description of the facility and major design features.

D. General arrangement sketches for the CSS including plans, sections, and elevations.

E. Descriptions of the CSS including a block flow sketch and operations description.

F. A major component list including descriptions, capacities, and Construction Specifications Institute specification references.

G. CSS operating data including utilities consumption, resource consumption, waste generation, and staffing.

The above scope of work is limited to the mechanical handling considerations. Other conceptual design considerations for the CSS (e.g., heating, ventilation, and air conditioning [HVAC], electrical, fire protection) are planned future activities and are only briefly described in this report.

Note that this design is based on the design basis assumptions described in Section 7.2.5.2.2. Significant assumptions, or strategies, that could have the greatest impact on the CSS design are discussed in Section 12, Development Tasks and Issues.

7.2.5.2 Design Inputs

This section provides the design inputs, such as functional and regulatory requirements, controlled and non-controlled design assumptions, and Transportation Segment interface criteria, that are pertinent to the CSS design.

7.2.5.2.1 Design Requirements

The functional requirements and the regulatory requirements for the CSS are described below.

Functional Requirements

Several functional requirements specific to the carrier staging operations are presented in Section 3 of the RDRD (YMP 1994a) and are restated as follows:

RDRD 3.2.3.1.3.E:

Provision shall be made for inspection of loaded transportation cask systems upon receipt. This inspection includes measurement of radiation levels external to the cask, levels of contamination on the cask surface, and the surface temperatures of the cask.

RDRD 3.2.3.1.3.F:

Area shall be provided for queuing transportation casks/transporters awaiting access to the Repository Segment cask handling facility as designated below.

Transportation Cask/Transporter Type	Number of Truck Casks	Number of Rail Casks
Loaded From-Reactor	[TBD]	[TBD]
Unloaded From-Reactor	[TBD]	[TBD]
Loaded From-MRS	N/A	8
Unloaded From-MRS	N/A	10

RDRD 3.2.3.1.3.G:

The Repository Segment shall provide queuing space sufficient to allow 20 feet separation between loaded transportation casks awaiting access to the cask handling facility.

Other functional requirements of a general nature that apply to the CSS are addressed in Section 7.1.2.1.1 in this report volume.

Regulatory Requirements

The federal regulations, codes, and standards applicable to the design of the CSS and other repository surface facilities are defined in Section 2.1 of the RDRD (YMP 1994a). These general requirements are summarized in Section 7.1.2.1.2 in this report volume. The following regulatory requirement was taken from Section 3.2.3.2.3.1.1.E of the *Transportation System Requirement Document* and is expected to be included in future revisions of the RDRD (YMP 1994a).

Loaded and unloaded Transportation Cask Subsystems shall permit visual inspection and testing prior to shipment from the Repository Segment as necessary and appropriate to show compliance with 10 CFR 71 and DOE Order 5480.3, Section 10.d.

7.2.5.2.2 Design Assumptions

This section lists the assumptions applicable to the design of the CSS. Assumptions are required because the analyses needed to establish design requirements or qualified design solutions have not been completed. These assumptions are based on engineering judgement with the best available data.

There are two types of design assumptions: CDAs and non-controlled design assumptions.

Controlled Design Assumptions

As shown below, there is only one CDA applicable to the CSS design. This assumption is fully described in the CDA Document (CRWMS M&O 1995a).

Identifier	Subject	Statement of Assumption
Key 001	Cask Arrival Scenario	The transportation cask arrival scenario at the MGDS is as indicated in Table 7.1.2-2.

Non-Controlled Design Assumptions

The non-controlled design assumptions applicable to the CSS design are listed below:

A. Shipments arrive at the repository around the clock but are prepared in the CSS during working hours only. CSS working hours are five days a week, two shifts a day.

B. The rail cask personnel barriers are retractable and are stored on the railcar. The truck cask personnel barriers are tarpaulin type and are removed manually by the CSS crew. The truck cask personnel barriers are staged in the CSS.

C. Rail and truck cask impact limiters are removed with their bolts retained and are stored on the rail cask car or truck cask trailer.

7.2.5.2.3 Transportation Segment Interface Criteria

This section addresses the interface criteria defined by other system elements that are inputs to CSS design. General design data for the repository surface design is presented in Section 7.1.2.2.

RDRD 3.2.3.1.3.A:

Transportation provides the Repository Segment with all information needed to mate on-site equipment with the cask/transporter, off-load the cask from the transporter with the correct crane apparatus, prepare the cask for opening, and ultimately open and mate the cask with the transfer cell so the waste constrained within can be unloaded. Transportation also relays information about the next waste shipment to be made so that the unloaded cask can be refitted at the CMF with the correct basket and ancillary equipment after being closed, cleaned, decontaminated, maintained, and repaired.

RDRD 3.2.3.1.3B:

The Repository Segment is responsible for inspecting and decontaminating the cask using transportation procedures. The Repository Segment also performs minor cask repairs using materials and instructions provided by transportation.

RDRD 3.2.3.1.3.D:

Access points for vehicles carrying transportation casks shall have an area for detaching and removing the transportation prime mover from the site and attaching an on-site vehicle to the transporter.

RDRD 3.2.3.1.3.H:

The Repository Segment shall be capable of handling Nuclear Regulatory Commission-certified transportation cask systems provided by Transportation.

RDRD 3.2.3.1.3.K:

The Repository Segment shall provide a queuing area sufficient to accommodate loaded cask storage or waiting times of 24 hours.

7.2.5.3 Summary of Supporting Studies

This section provides a summary of the supporting studies that directly impacted the CSS design. This study is titled *Preliminary Dose Assessment for the MGDS Surface Facility Waste Handling Operations* (CRWMS M&O 1995t). A general description of the purpose and results of this study was previously provided in Section 7.2.2.3 of this report volume. Dose rate calculations for rail and truck shipping casks were used as a basis for refining the repository CSS operations to reduce operator exposure. For example, exposure was reduced by modifying the operation time, distance from the shipping cask, or by reducing the total number of operators doing the operation. An example of an operation that was re-evaluated is that two health physics technicians were performing a radiation and contamination survey from within two feet of a shipping cask. As a result of the dose rate analysis, the radiation survey is now performed by a gantry-mounted remotely-operated robotic arm. The dose analysis also showed that the manual removal of impact limiters creates a radiation exposure problem for CSS personnel. The role of the gantry-mounted arm that does the radiation survey was then expanded to make the impact limiter removal process as remote as is feasible. The iterative process of developing a concept of operations, assessing the operator exposure based on the concept of operations, and refining the operations to reduce the exposure to ALARA is still continuing.

7.2.5.4 Structure Description

The CSS will house the equipment and support systems required for receipt/dispatch of transportation casks, removal/installation of personnel barriers and impact limiters, inspection of transportation casks, and staging carriers awaiting transfer to other repository facilities or off-site. A general arrangement sketch illustrating the floor plan, elevation, and building section of the CSS is provided in Appendix D as sketch CSA-SK-100. Figure 7.2.5-1 shows the building floor plan and building section.

The CSS, shown as facility 215-2 on the North Portal operations site plan Figure 7.2.1-3, is located in the RCA approximately one-half mile northeast of the WHB and one-third mile southwest of the

RCA truck/rail portal (Security Station 3). The CSS is a single-story, metal building with a gable roof. The overall building footprint is approximately 19,550 square feet. The outer building dimensions of the main operations area are approximately 120 feet by 160 feet with a maximum eave height of 31 feet.

A 350 square foot administrative support office area, including a restroom and a storage room, with a maximum eave height of 12 feet, is provided adjacent to the operations area. The CSS structure will include floor space for staging a maximum combination of eight truck or rail transportation carriers. The transportation carriers enter and/or exit the building through one of eight remote-controlled metal roll-up doors that are 14 feet wide and 18 feet high. The CSS operations area consists of four individual truck/rail transportation carrier lines, with each truck/rail line accommodating two transportation carriers.

The configuration of the operations area is divided into two identical transportation carrier staging bays. Each carrier staging bay is comprised of two truck/rail lines separated by a dual function work platform and equipment laydown area. The work platform is constructed of metal grating and is approximately 4-feet high and 16-feet wide. A 10-ton overhead bridge crane provides service for lifting the impact limiters. A 2-ton gantry crane provides service for removing impact limiter bolts. All cranes will have hand-held push-button motion controllers. The administrative support office area is separated from the carrier staging bays by a doorway located in the southeast corner of the operations area. An artists conception of the CSS is shown in Figure 7.2.5-2.

Architectural Components

The construction materials are noncombustible, Type II in accordance with all applicable codes, standards, regulations, and architectural and engineering principles and practices specified in DOE Order 6430.1A-0109, and are of commercial quality and commonly available in the industry. Interior finish materials have a fire hazard classification flame spread index of 25 (maximum) and smoke developed index of 50 (maximum) when tested.

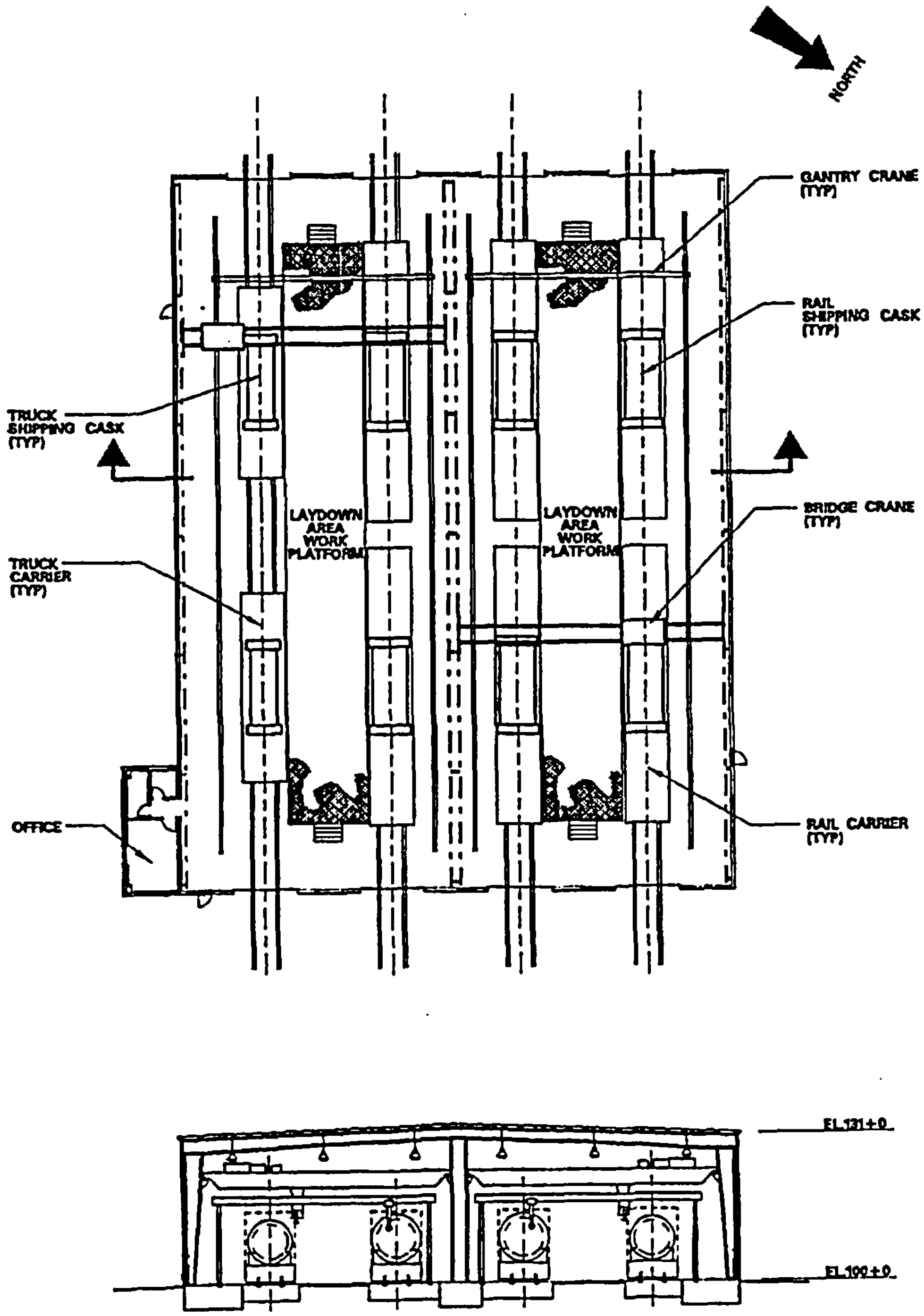

Figure 7.2.5-1. CSS (Floor Plan and Building Section)

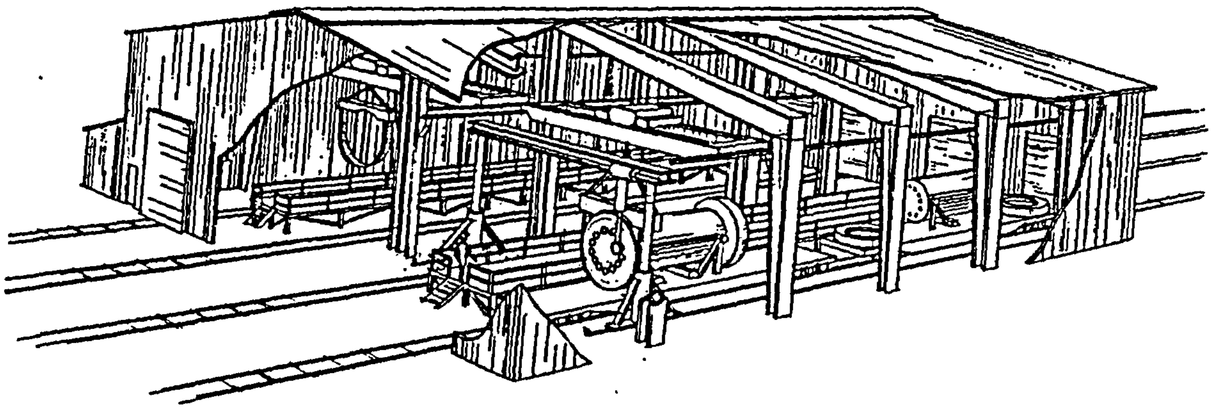

Figure 7.2.5-2. Cask Staging Shed

Structural Design

The structural design of the CSS considered the service loads and the loads associated with natural phenomena hazards such as earthquakes, winds, and flooding. The service live loads specified in the Uniform Building Code were used as minimum design live loads. Actual loads will need to be verified in the future. The structural design of the CSS is based on the assumption that the CSS is performance category 2 as defined in DOE-STD-1020-94. This assumption was selected because the CSS is not expected to require radiological confinement features.

The minimum design wind load is based on Table 3-2 of DOE-STD-1020-94. Both seismic and wind design criteria will need to be verified in the future. The building resistance to lateral loads is provided by moment-resisting steel frames at each bend, and by braced steel frames.

The building is supported on reinforced concrete spread footings. The size of the spread footing was determined by the foundation load in proportion to allowable soil bearing capacity. The rail tracks are supported on concrete pads isolated from the building foundations. The heavy railcar loads will not impose its loads on the building foundations.

Reinforced concrete members were proportioned for adequate strength in accordance with the provisions of American Concrete Institute code, using loads factors and strength reduction factors specified in the code. Structural steel members and their connections were design in accordance with American Institute of Steel Construction, American Structural Design manual, using the allowable stress design method. Metal roofing and siding were designed using the manufacture's design manuals and allowable load data.

7.2.5.5 Systems Descriptions

This section describes the carrier staging system associated with repository operations. The CSS functions, system scope, and staging operations are described below. A block diagram of the carrier staging system is shown in Figure 7.2.5-3.

7.2.5.5.1 Functions

The carrier staging system performs the following key functions in support of the repository surface facilities.

A. Inspect loaded transportation cask and carrier systems. Inspection activities include measurement of radiation levels external to the cask, levels of contamination on the cask surface, and the surface temperatures of the cask. The inspection function is a requirement provided in the RDRD (YMP 1994a), Section 3.2.3.1.3.E.

B. Stage loaded transportation cask and carrier systems awaiting access to the WHB. The cask and carrier staging (or queuing) function is a requirement provided in the RDRD (YMP 1994a), Section 3.2.3.1.3.F.

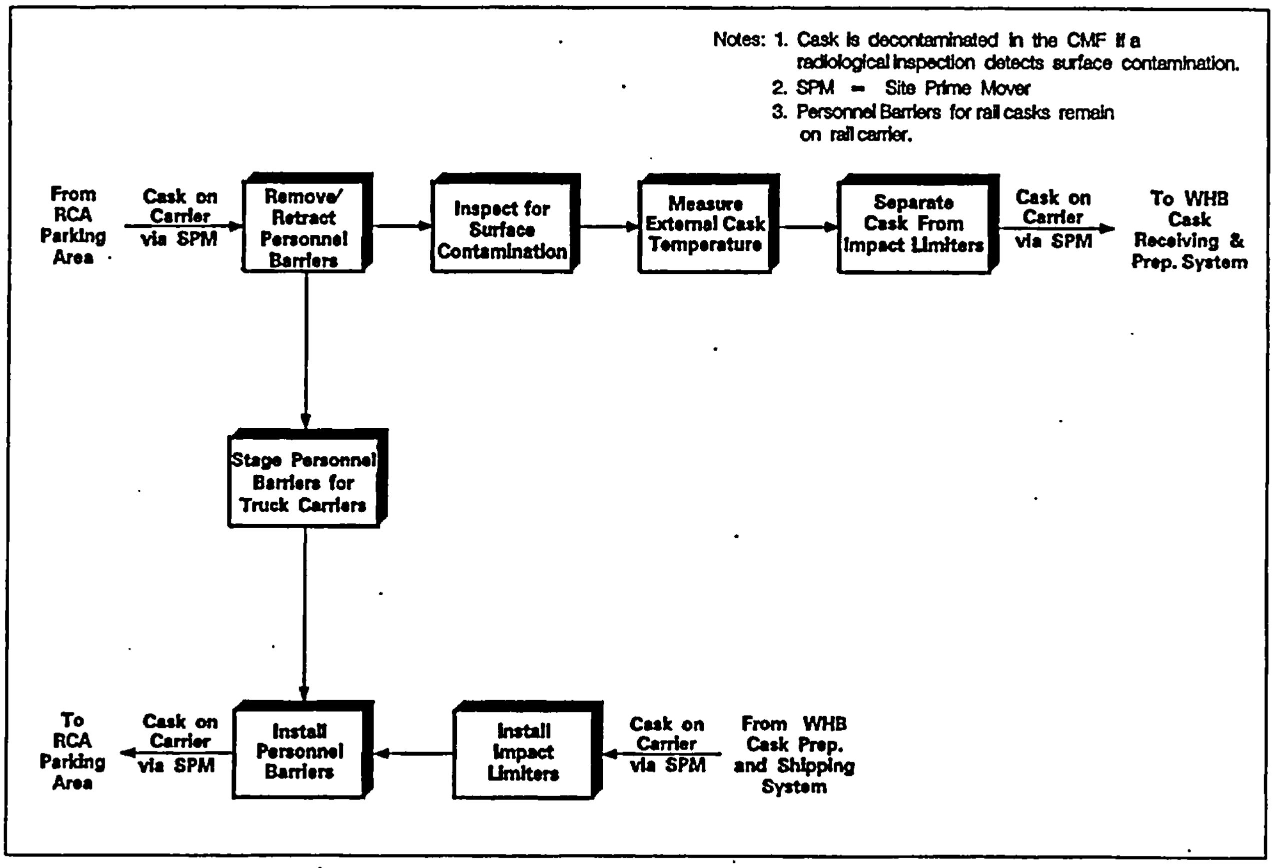

Figure 7.2.5-3. Carrier Staging System

C. Stage unloaded transportation cask and carrier systems awaiting transfer to the RCA carrier parking area.

D. Remove the loaded transportation cask personnel barriers upon receipt to the CSS. Reinstall the unloaded transportation cask personnel barriers prior to dispatch from the repository.

E. Remove the loaded transportation cask impact limiters upon receipt at the CSS. Reinstall the unloaded transportation cask impact limiters prior to dispatch from the repository.

7.2.5.5.2 Scope

The Carrier Staging System receives loaded and unloaded transportation casks from off-site sources. Loaded and unloaded transportation casks may arrive by either truck or rail transport. Loaded transportation casks may contain canistered or uncanistered SFAs, canistered DHLW, or other DOE owned reactor waste that is destined for emplacement in the repository. The unloaded transportation casks are destined for the CMF for repair, maintenance, internal reconfiguration, or Certificate of Compliance inspection.

The carrier staging system also requires interfaces with the following support systems:

A. Electric power to operate the components such as cranes, instruments, monitors, power tools, evaporative cooler fan motors, radiative heaters, pumps, roll-up doors, lighting, and miscellaneous office equipment.

B. Compressed air to operate instruments and pneumatic operators.

C. Sanitary water to feed evaporative coolers.

D. Communication system is required to provide coordination of operations with the WHB, CMF, Security Station 3, and the site prime mover.

7.2.5.5.3 Operations

The site prime mover connects to the carrier and delivers it from the RCA parking area to one of the eight staging positions within the CSS. In the CSS, a health physicist measures the radiation levels external to the cask to assess conformance to applicable regulatory requirements. The bridge crane lifts and removes the personnel barrier from around a truck cask and stores the personnel barrier on the laydown area. A rail carrier has self-powered retractable personnel barriers that do not require CSS equipment interface. Following removal of the personnel barriers, the health physicist repeats the inspection for radiation contamination on the exposed external surfaces of the transportation cask. Due to the high radiation field expected for a loaded cask, the health physicist performs this operation remotely by using a gantry-mounted electromechanical manipulator holding the radiation monitoring instruments. The carrier and external surfaces of the personnel barrier are also inspected at this time for indications of radioactive contamination. Temperature measurements of the external cask surface are also taken at this time.

The final staging activity, before transfer to the WHB or the CMF, is the removal of the transportation cask impact limiters. The gantry-mounted electromechanical manipulator is used to loosen the impact limiter bolts. Before removing the bolts, a sling is set in place around the impact limiter and attached to the overhead bridge crane. The sling is lifted vertically, being careful to only lift the impact limiter load and not the cask itself. Once the impact limiter load is fully lifted, the bolts are removed and the bridge crane pulls the impact limiter away from the cask and sets it down on the carrier. The impact limiters remain on the carrier as it is moved on-site. The loaded transportation cask is now ready for transfer to the WHB for unloading.

Unloaded transportation casks undergo the reverse of the loaded cask operations. When a space is available in the CSS, an unloaded cask is transferred from the WHB or the CMF to an open staging position, the impact limiters are reinstalled, a final radiation contamination inspection is performed, the personnel barrier is reinstalled, and the transportation cask is sent to the RCA parking area to await off-site transfer.

7.2.5.5.4 Other Systems

CSS support systems include building utilities; security, monitoring, and control systems required to safely and effectively maintain waste shipment surveys; and preparation for handling. Facility specific support systems are listed below:

A. Power Distribution System including 480/208/120 VAC and the safety bus.

B. Water Distribution System for supplying fire water and potable water.

C. Sanitary Waste Collection System for the removal of facility sanitary waste.

D. Communications Systems including, telephone/public address, video, and data networks.

E. Facility Monitor and Control System to monitor and control building utilities.

F. Radiological Monitoring System for monitoring facility radiological performance, and support to health physics activities.

G. Fire Protection and Detection System for manual, and automatic initiation of fire suppression, and alarm equipment.

H. Security Systems including the following subsystems: physical protection and safeguards, intrusion alarm system, communications.

I. Material Handling System to control the electromechanical equipment dedicated to preparing the transportation casks and carriers for receipt at the waste handling areas.

J. HVAC System to provide the proper environmental conditions for the equipment used in this facility as well as for the health, safety, and comfort of operating personnel.

Systems discussed in A. through H. above, are the same as described for the WHB in Section 7.2.2.5.9. The Facility Monitor and Control System, Water Distribution System, Radiological Monitoring System, and Security System are a minimum configuration of those described for the WHB in Section 7.2.2.5.9. Other CSS support systems are described as follows:

Material Handling System

The Material Handling System controls the electromechanical equipment dedicated to preparing the transportation casks, and carriers for receipt at the waste handling areas. Electromechanical equipment include the cranes, automated tooling, and inspection instruments dedicated to cask preparation. Crane operator stations are installed at cask receiving bays throughout the CSS. Local panel equipment includes a main control panel, video displays, and the controls, indicators, and annunciators customized for the equipment at that location.

HVAC System

The HVAC System for the CSS is designed as a once-through evaporative cooling system with heating provided by electric radiant heaters. The cooling for the CSS main operations area is provided by six modular evaporative cooling units with integral two-speed motors mounted on the roof above the high bays. The office area is cooled by a single evaporative cooling unit mounted above the office area roof. The toilet is provided with an exhaust fan. The office and toilet room are heated by electric baseboard or wall mounted radiant heaters. The carrier bays are heated by overhead suspended, radiant heating elements. The HVAC equipment is of industrial grade quality.

7.2.5.6 Components Data

The list for all major components associated with the carrier staging system in the CSS are provided in Table 7.2.5-1. This table includes the component tag number, component description, component capacity, the associated process flow sketch number, and Construction Specifications Institute specification number.

7.2.5.7 Operating Data

This section describes the operating data available for the CSS. The following aspects are addressed: utility consumption, resource consumption, waste generation and staffing requirements.

Table 7.2.5-1 Carrier Staging System Component List

Tag No.	Component Description	Capacity/Size	CSI Spec. No.
HI-010A	Overhead bridge crane	10 ton	14630
HI-010B	Overhead bridge crane	10 ton	14630
HI-020A	Gantry crane	2 ton	14640
HI-020B	Gantry crane	2 ton	14640
HI-025A	Electromechanical manipulator - gantry mounted	250 lb	14650
HI-025B	Electromechanical manipulator - gantry mounted	250 lb	14650
ME-005A	Staging bay roll-up door	14'W x 18'H	N/A
ME-005B	Staging bay roll-up door	14'W x 18'H	N/A
ME-005C	Staging bay roll-up door	14'W x 18'H	N/A
ME-005D	Staging bay roll-up door	14'W x 18'H	N/A
ME-005E	Staging bay roll-up door	14'W x 18'H	N/A
ME-005F	Staging bay roll-up door	14'W x 18'H	N/A
ME-005G	Staging bay roll-up door	14'W x 18'H	N/A
ME-005H	Staging bay roll-up door	14'W x 18'H	N/A
ME-010A	Impact limiter sling and spreader bar	2 ton	N/A
ME-010B	Impact limiter sling and spreader bar	2 ton	N/A
ME-015A	Impact limiter bolter	N/A	N/A

N/A = Not Applicable
CSI = Construction Specifications Institute

7.2.5.7.1 Utility Consumption

The CSS and the operations performed in this building will consume plant water, electric power, compressed air and sanitary water as discussed below. Rough estimates for peak and annual utility flow rates are provided in Table 7.2.5-2.

A. Sanitary water is primarily used for the evaporative coolers, restrooms, and miscellaneous housekeeping tasks in the operations area.

B. Electric power is used to operate the components such as cranes, instruments, monitors, power tools, evaporative cooler fan motors, radiative heaters, pumps, roll-up doors, facility lighting, and miscellaneous office equipment.

C. Compressed air is used to operate instruments and pneumatic operators.

Table 7.2.5-2 CSS Utility Consumption

Utility	Peak	Annual
Compressed Air	10 cu.ft./day	2,350 cu.ft.
Electricity	900 kW	4,900,000 kWh
Sanitary Water	2000 gpd	240,000 gallons

7.2.5.7.2 Resource Consumption

The CSS operations are expected to consume minimal resource materials to perform cask staging activities. Further analysis of the operations during preliminary design phase may identify and quantify resource consumption estimates.

7.2.5.7.3 Waste Generation

The CSS and the operations performed in this building will generate sanitary wastes and solid industrial wastes as discussed below. There is a low probability that during the course of receiving all the shipments during the emplacement operations phase a transportation cask may arrive with small amounts of surface contamination. In this event the surface contamination will be removed as a LLW or fixated before transfer to the CMF for further decontamination. The LLW is transferred to the WTB for processing. Rough estimates for the annual generation rate are provided in Table 7.2.5-3.

A. Solid LLW is generated from equipment and vehicle decontamination in the form of contaminated rags.

B. Liquid HW is generated in the form of the waste oils, cleaning solutions, and miscellaneous equipment lubricants. Solid HW is generated in the form of soiled rags and absorbents.

C. Sanitary waste water and solid industrial waste is truck/rail generated by personnel support functions such as restrooms, facility maintenance, and office work.

Table 7.2.5-3 CSS Waste Generation Rates

Waste Material	Annual Generation	
	Liquid (gals)	Solid (ft^3)
Low-Level	None	2
Hazardous	6.2	2
Sanitary/Industrial	150,000	275

7.2.5.7.4 Staffing Requirements

The CSS normally operates five days per week, with two eight-hour shifts per day, 250 days per year, except for some utility and security systems which operate continuously. Extended operations can be accommodated by operating a third shift. Nine workers are expected to routinely work during a single shift in the CSS. Of these workers, six are cask staging operators, two are health physicists, and one is an operations supervisor.

7.2.6 Transporter Maintenance Building

7.2.6.1 Introduction

This section addresses the TMB mission, the background of the TMB design prior to the ACD effort, the design methodology used for the ACD, and the current status of the design.

7.2.6.1.1 Mission

The mission of the TMB is to maintain, inspect, and repair the equipment that is used for underground rail haulage and equipment that is used to haul shipping cask carriers and empty disposal containers between surface locations.

7.2.6.1.2 Background

The SCP-CDR (SNL 1987), published in 1987, included a conceptual design for a Waste Operations Garage, which had the same mission as the TMB. The design report provided general arrangement drawings and a brief facility description. The design of this facility is not applicable to the ACD concept as the mix and types of transporters used for underground emplacement have changed significantly. In the SCP-CDR (SNL 1987) design, underground transportation was accomplished with rubber wheeled vehicles with about seven waste package emplacements per day. The ACD concept is based on a much larger and heavier waste package, uses a rail transportation system, and requires about three emplacements per day.

7.2.6.1.3 Design Methodology

The design methodology for the ACD of the TMB is described below.

A. The transportation fleet characteristics were identified including number and types of vehicles.

B. The number and types of maintenance bays and battery charging stations were estimated using engineering judgement based on the fleet characteristics.

C. The sizes of storage and support areas were estimated.

D. The TMB ACD documentation was prepared including general arrangement sketches and an annotated major component list.

7.2.6.1.4 Design Status

An ACD of the TMB includes the following documentation.

A. Identification of design inputs including transporter fleet characteristics.

B. Brief description of the facility and major design features.

C. General arrangement sketches for the TMB including plans, sections, and elevations - Figure 7.2.6-1 shows the floor plan and building section of the TMB.

D. A major component list including descriptions and capacities.

The ACD is limited to the vehicle maintenance operations. Other conceptual design considerations for the TMB, such as HVAC, electrical, and fire protection are planned future activities and are only briefly described in this report. Note that this design is based on the design basis assumptions described in Section 7.2.6.2.2.

7.2.6.2 Design Inputs

This section provides a list of inputs pertaining to the TMB design including design requirements, design assumptions, and design data from other groups.

7.2.6.2.1 Design Requirements

The functional requirement for a TMB is derived from the site surface and subsurface transport functions and the following general maintenance functional requirement.

RDRD 3.7.4.4.G:

Maintenance facilities, equipment, and tools shall be provided to support the maintenance concept of the Repository Segment to be developed based on the policy and criteria specified by DOE Order 4330.4A.

The general regulations, codes, and standards applicable to the design of the TMB and other repository surface facilities are summarized in Sections 3, 4, and 7.1.2.1 of this report volume.

7.2.6.2.2 Design Assumptions

Assumptions identified specifically for the TMB are non-controlled assumptions and are listed below:

A. Charging battery room will need a separate ventilation system.

B. The TMB design is based on a single shift operation, with eight effective working hours per operating day, 250 days per year.

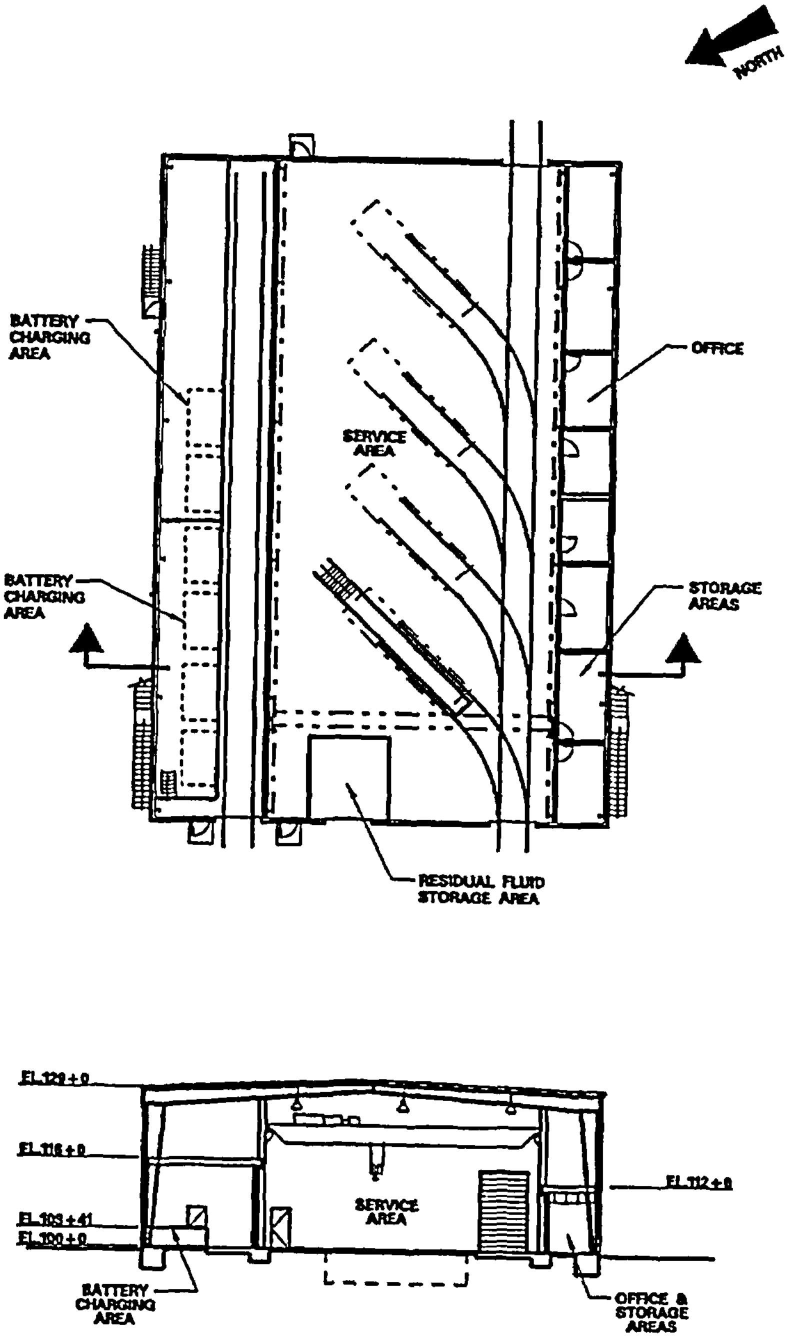

Figure 7.2.6-1. TMB (Floor Plan and Building Section)

7.2.6.2.3 Design Data

This section addresses the data defined by other design areas that are inputs to TMB design. The design data specifically applicable to the TMB includes the characteristics of the on-site transportation fleet. The fleet characteristics are summarized in Table 7.2.6-1.

7.2.6.3 Structure Description

The TMB will house the equipment and support systems required for the maintenance of the rail transportation equipment required for underground and on-site surface emplacement operations. General arrangement sketches (i.e., plans, sections, and elevations) of the TMB are provided in Appendix D as sketches TMA-SK-001 through 003.

The TMB, shown as facility 220-4C on the North Portal operations site plan, Figure 7.2.1-3, is located in the RCA adjacent to the North Portal. The metal building is single-story, with two mezzanines and a gable roof. The outer building dimensions are approximately 80 feet by 120 feet with a maximum eave height of 29 feet. This structure includes a transporter maintenance shop, battery charging rooms and various support rooms. The transporter maintenance shop requires 7,200 square feet and includes the following operating areas:

- One pit bay
- Electronic/electric repair station
- Mechanical repair station
- Welding station
- Mechanical parts storeroom
- Electrical and electronic parts storeroom
- Lubricants storeroom
- Tool room.

The mezzanine areas are located above the storage rooms and the battery charging areas. These areas house the HVAC equipment. A 1.44 m rail track with six spurs at a 45° angle provide transporter access to the service bays.

The battery charging rooms require 1,450 square feet and include the following operating areas: battery charging stations with supports for charged and uncharged batteries, battery repair room and battery charging transformer room for low voltage systems. The battery areas, separated from the maintenance operations, are provided with an independent ventilation system to remove hydrogen gasses generated by charging operations. A 1.44 m rail track is provided adjacent to two raised platform battery charging stations. These platforms are the same height as the locomotives batteries to allow for easy transfer from locomotive to charging station and back.

Support areas include residual water treatment, oil and grease storage, offices and restrooms. The operators performing transporter maintenance will also be responsible for responding as needed to underground transporter breakdowns.

Table 7.2.6-1. On-site Emplacement Transportation Fleet

Vehicle	Vehicle Description	No. Required	No. Active
Transport Locomotive	32 MT capacity electric trolley and battery powered locomotive to haul the Waste Package Transporters to/from the emplacement drifts; or Materials Rail Carriers, Personnel Rail Carriers and Low-Boy Rail Carriers to/from the work areas (see Figure 8.6.4-2)	3	2
Waste Package Transporter	Shielded railcar used to transport a waste package on a railcar to the emplacement drifts (see Figure 8.6.4-1)	3	2
Transfer Locomotive	Battery powered locomotive used to haul the Emplacement Locomotive Carrier to/from the emplacement drifts, 10 MT capacity (see Figure 8.6.4-4)	3	2
Emplacement Locomotive Carrier	Rail carrier, pulled by the Transfer Locomotive, used to transport the Emplacement Locomotive to/from the emplacement drifts, 10 MT capacity (see Figure 8.6.4-5)	3	2
Emplacement Battery Locomotives	Battery powered locomotive used to push emplacement rail/cars into an emplacement drift, 10 MT capacity (see Figure 8.6.4-6)	3	2
Personnel Rail Carrier	10-12 seat railcar, pulled by the Transport Locomotive to transport personnel to/from the underground work areas	4	2
Locomotive for personnel, materials and inspection	15 MT battery powered locomotive used to transport personnel and materials to/from underground work areas	3	0
Materials Rail Carrier	10 to 15 MT capacity railcar, pulled by the Transport Locomotive to haul heavy materials to/from the underground work areas	4	2
Low Boy Rail Carrier	20 to 30 MT capacity railcar, pulled by the Transport Locomotive to move heavy materials to/from the underground work areas	2	2
Empty Disposal Container Railcar	Railcar to transport a waste package railcar and empty disposal container from the receiving shed to the WHB, pulled by the Site Prime Mover	1	1
Site Prime Mover	Rubber tired diesel tractor with retractable rail guides for the on-site, above ground movement of shipping cask carriers	1	1

MT = Metric Tons

Two Rail track spurs are provided outside the building to store rail vehicles that are not in use. Storage for up to 16 vehicles is provided. A covered area, meeting *Resource Conservation Recovery Act of 1976 as Amended* standards, is provided adjacent to the building for the interim accumulation of HW and waste oils.

Transporters are not expected to become contaminated. Should a transporter become contaminated the equipment will be decontaminated in the CMF or at the point of detection prior to entering the TMB. The HVAC system for the TMB is not designed for radiological confinement.

Architectural Components

The construction materials throughout are noncombustible Type II in accordance with all applicable codes, standards, regulations, and architectural and engineering principles and practices specified in DOE Order 6430.1A-0109, and of commercial quality and commonly available in the industry. Interior finish materials have a fire hazard classification flame spread index of 25 (maximum) and smoke developed index of 50 (maximum), when tested.

Structural Design

The structural design of the TMB considered the service loads and the loads associated with natural phenomena hazards such as earthquakes, winds, and flooding. The service live loads specified in the Uniform Building code were used as minimum design live loads. Actual loads will need to be verified in the future. The structural design of the TMB is based on the assumption that the TMB is performance category 2, as defined in DOE-STD-1020-94. This assumption was selected because the TMB is a non-nuclear facility that may be needed to continue emplacement operations.

The minimum design wind load is based on Table 3-2 of DOE-STD-1020-94. Both seismic and wind design criteria will need to be verified in the future. The building resistance to lateral loads is provided by moment-resisting steel frames at each bend, and by braced steel frames. The moment-resisting frame consists of four columns. The bridge crane is supported by the interior columns.

The building is supported on reinforced concrete spread footings. The spread footings were sized so the foundation load does not exceed the allowable soil bearing capacity.

In the design of reinforced concrete, members were proportioned for adequate strength in accordance with the provisions of the American Concrete Institute code, using load factors and strength reduction factors specified in the code. Structural steel members and their connections were designed in accordance with American Institute of Steel construction, American Structural Design manual, using the allowable stress design method. Metal roofing and siding were designed using the manufacture's design manuals and allowable load data.

7.2.6.4 Systems Description

The operation of the TMB requires a number of systems. These include transportation maintenance, battery charging and loading, building utilities, security, monitoring and control systems required to conduct TMB operations. Facility specific systems are listed below.

A. Power Distribution System including 480/208/120 VAC and the safety bus.

B. Water Distribution System for supplying fire and potable water.

C. Sanitary Waste Collection System for the removal of facility sanitary waste.

D. Communications Systems including telephone/public address, video, and data networks.

E. Facility Monitor and Control System to monitor and control building utilities and material handling equipment.

F. Fire Protection and Detection System for manual and automatic initiation of fire suppression and alarm equipment.

G. Security Systems including the following subsystems: Physical protection, intrusion alarm system, and communications.

H. Industrial Air System for supplying pneumatic control equipment and servicing industrial air stations.

I. Transporter Maintenance System to maintain rail transportation equipment supporting the underground emplacement operations and the site prime mover.

J. Battery Support System to maintain and charge battery packs for battery powered locomotives.

K. Material Handling System to control the electromechanical equipment dedicated to repairing and maintaining the locomotives, carriers, and associated furnishings.

L. Oily Water Separation System for collecting waste water and separating and accumulating the oily waste products.

M. HVAC to provide proper environmental conditions for the equipment used in this facility as well as for the health, safety, and comfort of operating personnel.

Systems discussed in A. through H. above, are the same as described for the WHB in Section 7.2.2.5.9. The Facility Monitor and Control System, Water Distribution System, and Security System are a minimum configuration of those described in WHB section 7.2.2.5.9. The other TMB support systems are described below.

Transporter Maintenance System

Transporter Maintenance System to maintain, inspect, and repair rail transportation equipment and the site prime mover. Six service bays are provided for mechanical and electrical repair and welding.

Battery Charging System

Battery Support System to maintain and charge battery packs for battery powered locomotives. The system includes six charging/loading stations, battery charging equipment (e.g., transformers), and a battery maintenance area. A locomotive parks next to an empty charging/loading station, the battery pack is transferred with a sliding mechanism from the locomotive to the station. The locomotive is then moved to another station that has a fully charged battery, where this battery pack is transferred to the locomotive. Charging/loading stations are located at two levels to be compatible with locomotives of different heights. Battery charging stations are also provided underground.

Material Handling System

The Material Handling System controls the electromechanical equipment dedicated to repairing and maintaining the waste package transporter locomotives, carriers, and associated furnishings. Electromechanical equipment includes the cranes, automated tooling, battery chargers, and inspection instruments. The Material Handling System local operator stations are installed at specific material handling stations throughout the TMB, as required. Each local station includes a main control panel, annunciators, workstation, and television video displays, customized for the equipment at that location.

Oily Water Separation System

The Oily Water Separation System collects waste water from the maintenance and cleaning of waste package transporter locomotives, carriers, and parts. Oil and grease products are separated and accumulated for later packaging and off-site disposal as HW. Process water is piped or pumped to the waste water collection system. The process equipment is not determined at this time.

Heating Ventilation and Air Conditioning

The HVAC system for the TMB provides proper environmental conditions for the equipment used in this facility as well as for the health, safety, and comfort of operating personnel. The system consists of air handling units, dampers, heaters, fans, and ductwork. Chilled water is used for cooling and electricity is used for heating.

7.2.6.5 Components Data

The list for all major components associated with the transporter maintenance and battery charging systems in the TMB are provided in Table 7.2.6-2. This table includes the component tag number, component description, and Construction Specifications Institute specification number.

Table 7.2.6-2. Transporter Maintenance Systems Component List

Tag No.	Component Description	CSI Spec. No.
CRN-201	15 MT Overhead bridge crane for the service bay area	14630
MIS-100	Battery charging/loading system with 6 charging/loading stations and integral locomotive loading mechanisms	16630
MIS-101	Portable Steam System	15555
MIS-102	Electric transformer for battery charging, 480V AC - 12V DC	16630
PKG-101	Electronic diagnostic station	16910
PKG-102	Welding Station	05050

DC = Direct current
CSI = Construction Specifications Institute

7.2.7 North Portal Support Structures

7.2.7.1 Introduction

This section describes the North Portal support buildings. These structures are located in the RCA, BOP area, and just outside the BOP area. There are 14 stand-alone structures with a combined net floor space of about 260,000 square feet. The North Portal support structures provide direct operational support to the waste handling operations and provide general support for the repository and North Portal operations. The waste handling support structures are used to maintain the security and safety of the RCA, maintain and store waste handling vehicles, track the movement of off-site waste shipments, and conduct operations training and development. The general support structures are used to support personnel (e.g., medical administration, food service and general training), maintain structures and equipment, warehouse components and supplies, and support plant safety (e.g., fire protection, general security, operations monitoring, and health safety).

This section addresses the background of the design prior to the ACD effort, the design methodology used for the ACD, and the current status of the design. Following the introduction the design inputs are presented and the individual structures are briefly described.

Background

The SCP-CDR (SNL 1987) included a conceptual design for almost all of the support structures. This design report provided general arrangement drawings and a brief structure description. These structures were not redesigned during the ACD effort. The SCP-CDR (SNL 1987) did not include the off-site transportation control.

Design Methodology

In general, the support structures are as designed in the SCP-CDR (SNL 1987) and were not redesigned during the ACD effort. The following structure modifications or additions were required:

A. The size of Security Station 3 was developed by combining the following SCP-CDR (SNL 1987) structures: Security Station 3 (220-3C) and Health Physics Building. Separate structures were required due to the existence of the Waste Receiving and Inspection Area. In the ACD this area was eliminated by providing adequate parking within the RCA and driving off-site prime movers onto the RCA.

B. The off-site transportation control operations were folded into the Administration Building. The control center is required to maintain communications with the off-site shipping cask transportation network to manage inventories and support the security and safeguards requirements. The specific functional requirements and design for this building have not been developed. The space required to house the center is expected to be small, therefore the size of the Administration Building was not increased.

Design Status

In general, the design of the support structures did not advance during the ACD and are based on the SCP-CDR (SNL 1987) design, which produced general arrangement drawings and brief structure descriptions. The facility designs will be impacted by the design of the primary waste handling operations, the availability of support infrastructure near the repository (e.g., Nevada Test Site at Area 25), and the repository staffing requirements. As these impacting features are not the same as in the SCP-CDR (SNL 1987) design, the design of the support structures will need to be redesigned in the future in order to provide a credible design with a reasonable cost estimate.

7.2.7.2 Design Inputs

Design inputs include design requirements, design assumptions, and design data from other groups. The design inputs specific to the support structures are provided below. Section 7.1.2 provides a detailed list of general inputs pertaining to all repository surface design structures.

7.2.7.2.1 Design Requirements

Design requirements are categorized as either functional requirements or regulatory requirements and are extensions of the surface inputs defined in Sections 3, 4, and 7.1.2.1 that are specific to the North Portal support operations.

Functional Requirements

RDRD (YMP 1994a) requirements that mandate support functions, capabilities, or facilities impacting repository support structures are provided below.

Records Management Design Requirements

> RDRD 3.7.4.4.F.1:
>
> Facilities and equipment shall be provided to preserve and maintain accident records in accordance with 29 USC 651.
>
> RDRD 3.7.4.4.F.4:
>
> Facilities and equipment shall be provided to collect, store, and maintain quality assurance records in accordance with the requirements of the *Quality Assurance Requirements and Description* (DOE 1995c).
>
> RDRD 3.7.4.4.F.3:
>
> If a local records center is required and authorized, it shall be designed and outfitted to meet the requirements specified by DOE/RW-0194P, *Records Management Policies and Requirements*.

RDRD 3.7.4.4.F.2:

Facilities and equipment shall be provided to preserve and maintain the records as required by DOE Order 1324.2A, *Records Disposition.*

RDRD 3.7.4.4.F.5:

Additional record storage facilities shall be provided as necessary to support the operation and management of the repository.

Warehouse and Storage Design Requirements

RDRD 3.5.3.1:

Warehouse space shall be provided for the storage of all spare parts, consumable equipment, and replaceable equipment in an environment conducive to their safe-keeping and protection.

RDRD 3.7.4.4.M:

Provisions shall be made for the storage of private and DOE equipment (including test equipment and construction/drilling equipment).

RDRD 3.7.4.4.I.3:

Space for storage of emergency equipment shall be provided.

Receiving and Shipping Facilities

RDRD 3.5.3.2.A:

A facility shall be provided for receipt of maintenance and repair materials and tools, and shipment and return receipt of items shipped off site for repair.

RDRD 3.5.3.2.B:

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

RDRD 3.2.2.7:

The Repository Segment shall be provided with the capability to comply with the requirements for packaging and transporting radioactive materials contained in 10 CFR 71 and 49 CFR 173 when shipping licensed radioactive material from the MGDS.

Visitors' Center

RDRD 3.7.4.4.O:

A visitors' center that includes adequate space for displays and presentations shall be provided to serve as an information center for visitors to the repository. An overlook area shall be provided at the visitors' center or elsewhere on the site to provide a visitor view of the repository surface area.

Training Facility Requirements

RDRD 3.7.4.4.C:

The Repository Segment design shall provide facilities, equipment, manuals, and training aids to support training programs required by 10 CFR 60.161; 29 CFR 1910; 29 CFR 1926; 29 CFR 1960, Subpart H; 30 CFR 48; 30 CFR 57; 49 CFR 172, Subpart H; the QARD; and DOE Orders 3790.1A, 4330.4A and 5000.3A.

Maintenance Facility Requirements

RDRD 3.7.4.4.G:

Maintenance facilities, equipment, and tools shall be provided to support the maintenance concept of the Repository Segment to be developed based on the policy and criteria specified by DOE Order 4330.4A.

RDRD 3.7.4.4.H:

Test and Maintenance Facility Requirements. The Repository Segment shall include facilities to test and maintain intrusion alarms, emergency alarms, communications equipment, physical barriers, and other security-related devices or equipment utilized pursuant to 10 CFR 60. [TBV]

Change Rooms

RDRD 3.7.4.4.A:

Change facilities shall be provided to comply with DOE Order 6430.1A, 1300-6.8.

Health Physics Facility

RDRD 3.7.4.4.N:

Health physics facilities shall be provided to incorporate the features necessary to ensure compliance with 10 CFR 20.

Licensing Support System Facility

RDRD 3.5.3.4:

The repository design shall include facilities and equipment to support the Licensing Support System as described in 10 CFR 2.1011(b)(1).

Medical Facility Requirements

RDRD 3.7.4.4.D:

The Repository Segment shall include facilities to support the medical services required by DOE Order 3790.1A, Chapter VIII.

RDRD 3.7.7.B:

Occupational health facilities shall be designed in accordance with DOE Order 6430.1A, Division 1.

Office Requirements

RDRD 3.7.4.4.E.1:

Office spaces shall be based on a minimum of 100 square feet per office and a maximum per the Federal Property Management Regulations.

RDRD 3.7.4.4.E.2:

The Repository Segment shall include, within the Geologic Repository Operations Area, unfurnished office space dedicated for the use of NRC inspection personnel. The office space shall be equipped with heating, ventilation and air-conditioning, lighting, electrical outlets, visual and acoustic privacy provisions, full access to the repository, and a minimum of 250 square feet of floor area. The office space that is provided will be subject to the approval of the Director, Office of Nuclear Material Safety and Safeguards.

RDRD 3.7.4.4.E.3:

Office space including a clearly marked mining office shall be provided as necessary to support the management and operation of the repository, and to support MSHA, OSHA, and other oversight agencies.

Other Facility Requirements

RDRD 3.5.3.5:

Facilities and equipment shall be provided to implement support functions, such as administration (security, visitor center, etc.) and logistics (maintenance, utilities, etc.) not specified above.

RDRD 3.5.1.1.2.B:

Facilities, tools, and parts for shop repairable items shall be provided at the repository.

RDRD 3.7.4.4.K:

Facilities shall be provided to support the working staff at the Repository Segment to include vehicle access, parking, food service, restrooms, sleeping accommodations as required, and others as determined by analysis of the concept of operations.

Regulatory Requirements

The general regulations, codes, and standards applicable to the design of the repository surface support facilities are defined in Sections 3.2 through 3.7 of the RDRD (YMP 1994a). These requirements are summarized in Section 7.1.2.1 of this report volume. The RDRD (YMP 1994a) requires compliance with DOE Order 6430.1A which covers most of the criteria for the design of the support facilities.

7.2.7.2.2 Design Assumptions

This section lists the assumptions applicable to the design of the support structures. Assumptions generally applicable to surface structures are listed in section 7.1.2.2. There are two types of design assumptions: CDAs and non-controlled design assumptions.

Controlled Design Assumptions

There are no CDAs specific to the North Portal support structures. The CDAs noted in Section 7.2.7.2.3 are described in the Table 7.1.2-1.

Non-Controlled Design Assumptions

This section describes the non-controlled design assumptions that were made to develop the North Portal surface facility site layout. These assumptions were selected in order to establish a reasonable preliminary site layout within the budget and schedule constraints.

A. The size and arrangement of the North Portal surface support structures will be as described in the SCP-CDR (SNL 1987).

B. Nuclear structures will not be located within the maximum probable flood zone.

C. The North Portal surface structures will include the personnel support facilities (e.g., showers and offices) for about 15 subsurface workers.

D. Underground development operations (i.e., excavation and construction) will only be conducted from the south portal development area after start-up of the repository.

7.2.7.2.3 Input Data

This section summarizes the site conditions that impact the support structures design. The conditions include:

- Site topography
- Soil conditions
- Weather conditions
- Existing structures at the start of repository construction
- Characteristics of off-site transportation and utility systems.

The site is described in more detail in Section 6.

A. The site topography will be as shown in Figure 7.2.1-2 and is relatively flat (e.g., about 2 percent slope) where facilities are to be constructed. The topographical data are based on CDA TDS-002.

B. The North Portal support structures will be constructed on gently sloping alluvial fans that are composed of a mixture of fine sand, gravel, and boulders. The soil conditions are based on CDA TDS-003.

C. The late quaternary faults in the area of the North Portal are shown in Figure 7.2.1-2. Faults in this area run north-south. The fault locations were extracted from the *Existing and Planned Boreholes with Geological Structure* (YMP 1995e), which is consistent with CDA TDS-001.

D. The North Portal site is adjacent to Midway Valley Wash. The maximum depth of water in this wash was estimated based on a probable maximum flood. The probable maximum flood zone is shown on Figure 7.2.1-2. The design basis flood data for the probable maximum flood 500 year storm and 100 year storm is provided in CDA TDS-008.

E. The North Portal area experiences diurnal wind reversals with wind from the south in the daytime and wind from the north at nighttime. Wind direction also changes seasonally with wind from the south during the summer and wind from the north during the winter.

The wind rose for the North Portal is shown in Figure 7.2.1-2. This data was from the *Yucca Mountain Site Characterization Project Meteorological Monitoring Program Summary Report January 1992 Through December 1992* (SAIC 1993). The data are consistent with, but more specific than, the data identified in CDA TDS-007. This assumption is based on historic weather data gathered from 1962 to 1978 at a location 26 miles northeast of Yucca Mountain.

F. The North Portal site has an arid climate, which exhibits a wide variation in daily and seasonal temperatures. Summer maximum and winter minimum temperatures are about 108°F and -14°F, respectively. Annual precipitation, which normally occurs as rainfall, averages less than 7 inches. Annual snowfall amounts to less than 9 inches. The North Portal's weather conditions are provided in CDA TDS-004. As described above, TDS-004 is based on historic weather at a location remote from the North Portal. North Portal weather data for calendar year 1992 is provided in the *Yucca Mountain Site Characterization Project Meteorological Monitoring Program Summary Report January 1992 Through December 1992* (SAIC 1993).

G. The ESF structures that are expected to be constructed and available when repository construction begins are described in Table 7.2.7-1. This table includes a site map reference, structure name, a list of the functional areas, type of construction, principle structure dimensions, and gross floor space. The facility information was developed from current construction drawings and various design analyses.

In general, the ESF structures are designed as non-qualified, non-permanent, non-nuclear structures with a 25-year maintainable life. It is expected that these structures could be used for non-nuclear operations at the repository. These structures could likely comply with the repository surface structure design life. Extending the life would require periodically replacing limited life components (e.g., heating, ventilation, and air conditioning equipment, computer equipment, steel siding) and conducting routine structure maintenance.

Table 7.2.7-1. ESF Surface Structures at the North Portal

Site Map Ref.	Structure Name	Functional Areas	Type of Construction	Principal Dimensions (feet)	Floor Space (square feet)
5010	Switchgear Building with Transformer	Electrical switchgear, control room, mechanical room, office, restrooms, external transformer	Single-story, pre-fabricated steel frame with insulated metal siding with concrete pad for transformer	60 x 140	8,400
5008	Change House	Locker rooms, showers, restrooms, first aid, safety/fire control, garage, bullpen and training area	Single-story with a mezzanine, pre-fabricated steel frame with insulated metal siding	110 x 127	14,200

7.2.7.3 Structures Descriptions

The North Portal support structures for the repository are described in Table 7.2.7-2. This table includes the following data for each structure: site map reference, structure name, list of primary and support functional areas, construction type, principle structure dimensions, and gross floor area. This table also includes the five non-support structures: WHB, WTB, CMF, CSS, and TMB for comparison purposes. Where available, the general arrangement drawings for support structures are included in Appendix D.

Table 7.2.7-2. North Portal Surface Structures

Site Map Ref.	Structure Name	Primary Functional Areas	Support Areas	Type of Construction	Principal Dimensions (ft)	Floor Space (ft^2)
RCA Structures						
211	WHB	Carrier bay, airlock, cask preparation area, consolidation cell, cask port room, waste transfer cell, disposal container welding, performance conformation cell, operating gallery, remote maintenance cell and disposal container staging	Mechanical equipment rooms, control room, change room, laboratories, health physics, area, offices, and rest rooms	High-bay, reinforced concrete receiving and shipping area; multilevel, reinforced-concrete hot cells; a steel frame, metal decking with concrete fill personnel annex	353 x 454	320,800
N213	CMF	Preparation/decontamination areas; basket storage pool; cask reconfiguration pool; testing, inspection maintenance & repair stations; contaminated shops; laydown area, warehouse and storage areas	Mechanical rooms, pool purification equipment area, health physics, lockers and showers, laundry, training rooms, lunchroom, document control, calibration lab, offices	Steel frames with concrete masonry unit infill walls for the cask handling area and two-story support area; below-grade reinforced-concrete pools and preparation/ decontamination areas.	360 x 226	116,700
N214	Disposal Container Receiving Shed	Staging for emplacement railcars and empty disposal containers	None	Single-story structural steel frame with open sides	100 x 225	22,500
215-1	WTB	Liquid radioactive waste treatment area, waste solidification area, solid radioactive waste treatment area and loading and unloading area, mixed waste accumulation	Mechanical equipment rooms, control room, laundry, health physics area, change rooms, offices and rest rooms	Steel frames with concrete masonry unit infill walls.	174 x 194	46,800
215-2	CSS	Staging/cask preparation area (i.e.,impact limiter removal/installation and radiological inspection)	Office, restrooms	Single-story structural steel frame metal building.	140 x 160	22,400
220-4C	TMB	Maintenance service bays, Battery charging and maintenance rooms, parts and materials storage, tooling storage, HW accumulation	Lockers and showers, offices, restrooms	Single-story structural steel frame metal building	60 x 120	7,200
5008	Change House (Existing)	Locker rooms, showers, restrooms, first aid, safety/fire control, garage (repository use has not been established)	Bullpen and training area	Single-story with a mezzanine, pre-fabricated steel frame with insulated metal siding	110 x 127	14,200
5010	Switchgear Building with Transformer (existing)	Electrical switchgear, integrated data control system control room, external transformer	Mechanical room, office, restrooms	Single-story, pre-fabricated steel frame with insulated metal siding with concrete pad for transformer	60 x 140	8,400

Table 7.2.7-2. North Portal Surface Structures (Continued)

Site Map Ref.	Structure Name	Primary Functional Areas	Support Areas	Type of Construction	Principal Dimensions (ft)	Floor Space (ft^2)
BOP Area Structures						
220-3A	Security Station 1 (Main BOP portal)	Waiting room, badge distribution, communications center, records storage, security administration	Offices, lockers and showers	Two-story, architectural-steel frame with insulated metal siding	50 x 80	8,000
220-3B	Security Station 2 (RCA/BOP portal)	Security check station, health physics offices	None	Single-story, architectural-steel frame with insulated metal siding	65 x 80	3,000
220-3C	Security Station 3 (RCA truck/rail portal)	Storage for contamination equipment, security check station, health physics offices	None	Single-story, architectural-steel frame with insulated metal siding	40 x 70	2,800
220-5A	Administration Building	Offices, laboratories, training rooms, off-site transportation control facilities	Mechanical areas	Two-story, architectural-steel frame with insulated metal siding	100 x 220	44,000
220-5B	Food Service Facility	Kitchen, lunchroom, serving area, food/supplies storage	Rest rooms	Single-story, architectural-steel frame with insulated metal siding	60 x 180	11,000
220-5C	Training Auditorium	Auditorium	None	Single-story, architectural-steel frame with insulated metal siding	25 x 40 50 seat capacity	1,000
220-1B	Medical Center	Examination rooms, X-ray, medical labs, waiting room, ambulance garage	Mechanical rooms, offices	Single-story, architectural-steel frame with insulated metal siding	40 x 175	8,200
220-2	Fire Station	Apparatus room, communications room, equipment storage, firemen's quarters	Offices, lunchroom, lockers and showers	Single-story, architectural-steel frame with insulated metal siding	85 x 100	7,600
220-22	Computer Center	Computer room	Mechanical equipment areas, offices	Single-story, reinforced-concrete structure	60 x 65	4,000
220-7	Central Warehouse	Storage space, receiving and shipping dock	Offices, lunchroom, lockers and showers	Single-story, (clear height 23 feet) architectural-steel frame with insulated metal siding	200 x 285	57,000

Table 7.2.7-2. North Portal Surface Structures (Continued)

Site Map Ref.	Structure Name	Primary Functional Areas	Support Areas	Type of Construction	Principal Dimensions (ft)	Floor Space (ft^2)
220-4A	Central Shops	Craft shops (electrical, mechanical, plumbing, welding, automotive, machining), central covered work area (not included in floor area)	Offices, lunchroom, first aid, lockers	Single-story, architectural-steel frame with insulated metal siding	120 x 240	28,800
220-4B	Motor Pool and Facility Service Station	Dispatch office, carwash, fuel storage, light maintenance, parking (heavy maintenance is off-site)	None	Single-story, architectural-steel frame with insulated metal siding	30 x 40	1,200
220-6	Mockup Building	High-bay mockup room, classrooms	Offices	Single-story, architectural-steel frame with insulated metal siding	72 x 136	9,800
N221-2	Utility Building	Water chillers, cooling tower water make-up treatment, plant and instrument air compression	Mechanical room, office, restrooms	Single-story, architectural-steel frame with insulated metal siding	50 x 110	5,500
Site Services Area						
N221-3	Visitors Center	Theater, meeting/conference rooms, reception/display area, food service, offices, restrooms	Mechanical room, storage	Two-story, architectural-steel frame with glass	160 x 145	19,800

7.2.8 North Portal Site Support Systems

7.2.8.1 Introduction

The North Portal site support systems are located in the vicinity of the North Portal Operations Area and include utility systems, communication systems, monitoring and control systems, and site management systems such as security, administration, transportation, maintenance, and engineering. Some systems are designed to support North Portal operations while others support operations in other repository areas.

This section addresses the background of the design prior to the ACD effort, the design methodology used for the ACD, and the current status of the design. Following the introduction, the design inputs are presented and individual systems are described.

Background

The SCP-CDR (SNL 1987), published in 1987, included a conceptual design concept for water and power systems. This design report provided brief descriptions. These systems were re-evaluated for the ACD design to incorporate existing infrastructure.

Design Methodology

In general, the support systems were not designed in the ACD. An attempt was made to identify the needed systems and provide descriptions based on engineering judgement, a general knowledge of nuclear storage support requirements, and specific inputs from the facilities that have been designed.

Design Status

The North Portal site support systems are listed and described. Descriptions are general, as key data to establish the system designs are not yet available (e.g., utility consumptions, utility balances, vehicle inventories). The design of the support systems will need to be developed in the future to provide a credible design with a reasonable cost estimate.

7.2.8.1.1 Design Inputs

Design inputs include design requirements and design assumptions. The design inputs specific to the support systems are provided below. Section 7.1.2 provides a detailed list of general inputs pertaining to all repository surface systems.

7.2.8.1.2 Design Requirements

The general regulations, codes, and standards applicable to the design of the support systems and repository surface facilities are summarized in Sections 3, 4, and 7.1.2.1 of this report volume.

7.2.8.1.3 Assumptions

This section lists the assumptions applicable to the design of the support systems. Assumptions generally applicable to surface facilities are listed in section 7.1.2.2. There are two types of design assumptions: CDAs and non-controlled design assumptions. CDAs are recorded in the CDA Document (CRWMS M&O 1995a) and non-controlled design assumptions were derived as necessary for the individual engineering analyses. No non-controlled design assumptions have been identified at this time.

Controlled Design Assumptions

CDAs specific to the support systems are listed below:

CDA	Title	Assumption
RDRD 3.2.1.6.D	Physical Barriers	Facilities shall be provided to support active institutional controls at the repository site, including physical barriers to human intrusion. Facilities to maintain the institutional controls and physical barriers shall also be provided.
RDRD 3.2.3.4.B	Non-Potable Water	The Repository Segment will connect with the existing Nevada Test Site water supply system.
RDRD 3.2.3.4.D	Telephone Communications	The Repository Segment shall connect to the existing Nevada Test Site telephone system.

7.2.8.2 Systems Descriptions

The North Portal site support systems are listed and described below. The system purpose, components, and interfaces are described. Systems associated with other operations areas (e.g., South Portal Development Operations Area) are described in the sections addressing those areas. Systems dedicated to, and associated with, the WHB, CMF, WTB, CSS, and TMB structures are described in Sections 7.2.2 through 7.2.6, respectively.

Utility Systems

- Water Systems
- Electric Power Systems
- Liquid Fuel Systems
- Air Systems
- Sanitary Waste Water Systems.

Communications Systems

- Communications Backbone
- Radio Frequency
- Telephone
- Public Address
- Teleconferencing.

Monitoring and Control Systems

- Utility Monitor and Control System
- Facility Monitoring and Control System
- Emergency Control System
- Material Control and Accountability System
- Radiation Monitoring System
- Site Effluent Monitoring System
- Off-site Transportation Monitoring and Control System.

Site Management Systems

- Administration and Planning
- Engineering and Analysis
- Training and Certification
- Emergency Response
- Physical Security
- On-Site Transportation
- Site Maintenance
- Warehousing
- Secondary Waste Management.

Utility Systems

Water Systems

The Water Systems provide the following types of water to user systems in the North Portal Operations Area: well/fire water, potable water, cooling tower water, and chilled water. The Water Systems are shown on Figure 7.2.8-1. The systems include pumps, tanks, distribution piping, and metering stations.

Unconditioned (well) water is provided by the existing J-13 pump station located approximately 3-1/2 miles southeast from the North Portal. This station includes a well pump, storage tank, and booster pumps. Water is piped to an existing booster pump station about one-quarter mile south of the North Portal. The booster station includes two storage tanks and three dedicated pumps, one for each of the following areas: North Portal Operations Area, South Portal Development Operations Area, and Emplacement Shaft Surface Operations Area.

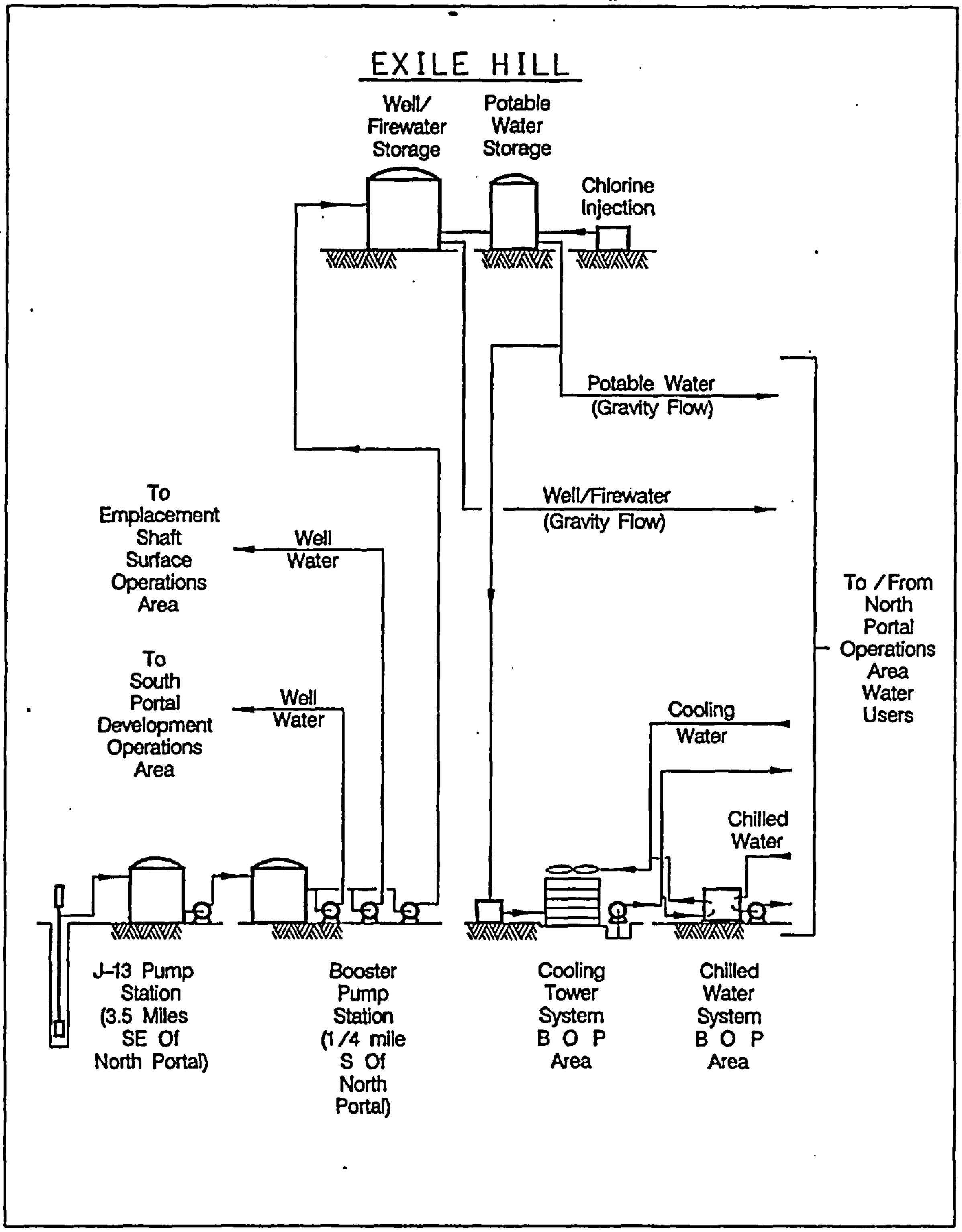

Figure 7.2.8-1. North Portal Water Systems

Water for the North Portal is pumped to two existing storage tanks on Exile Hill. Water gravity flows to users in the North Portal Operations Area. One tank and piping system provides potable (chlorinated) water treated by a packaged chlorination unit. Potable water is used for sanitary water purposes (such as drinking, food preparation, showers, laundry, and restrooms). The other tank provides untreated well water for process, fire, and facility industrial water purposes. Water will be metered at the wells, booster pump station, reservoirs, and the North Portal to support maintenance and leak detection. The water system components will be upgraded and/or expanded as required to meet capacity, reliability, and regulatory requirements for repository operations.

A cooling tower, associated pumps, and make-up water treatment equipment is provided to supply cooling water for removing heat from the chilled water system and secondary cooling water systems in the WTB. The water treatment equipment is located in the Utility Building.

Water chillers, pumps, and compression tanks are provided to supply chilled water to North Portal facility HVAC air handling units. The chilled water equipment is located in the Utility Building.

Recycled water is produced in the WTB by treating aqueous LLW. The site water distribution system provides this water to the WHB and CMF for decontamination, floor washdown, and pool make-up.

Electric Power System

The Electric Power System receives power from an off-site transmission line, generates standby power, and distributes electrical power to users at the North Portal. The system includes step-down transformers, associated switchgear, grounding systems, control/distribution panels, cable/conduit, duct banks/cable trays, and electrical panels required to support each user. The users include surface facilities, utilities, and various site systems (e.g., security, safety, lighting, and surface transportation). The electrical distribution and standby power systems are supported by the Utility Monitor and Control System.

Normal electrical power is supplied from a 69 kV power line to an existing electrical substation at the North Portal. The substation transformers produce 480 V and 12.5 kV power. The Emplacement Shaft Surface Operations Area is provided 12.5 kV power for underground ventilation equipment. The North Portal surface facilities receive 480 V power. The existing electrical components will be upgraded and/or expanded as required to meet capacity, reliability, and regulatory requirements for repository operations.

Standby Power is provided from diesel generators located near the North Portal. The generators automatically start, synchronize, and switch power to the safety bus if the main power fails. The major standby power loads are expected in the nuclear facilities' HVAC systems.

Liquid Fuel Systems

The Liquid Fuel Systems include the generator fuel supply system, transportation diesel fuel supply system, and the transportation gasoline supply system. These systems are supported by the Utility Monitor and Control System. The fuel tanks are filled from trucks.

The generator fuel supply system receives, stores, and dispenses the diesel fuel to the standby generators. The system is located near the standby generators and consists of an underground diesel storage tank with temperature control, leak detection instruments, fuel pumps, fuel filters, fuel distribution lines, heat tracing, and a fuel supply controller. Diesel fuel is automatically pumped to the generator day tanks. Fuel level, flow metering, cleanliness, and temperature are automatically monitored and maintained. Tank capacity is sized to sustain standby generator operation over the required period, and under maximum equipment loads. The fuel tanks are filled from trucks.

The transportation diesel fuel supply system receives, stores, and dispenses the diesel fuel to on-site vehicles. The system is located convenient to the Motor Pool and Facility Service Station and includes underground fuel tanks, fuel pumps, metering, leak detection, and vapor control systems. The transportation gasoline supply system is similar to the above.

Air Systems

The North Portal air systems include an Industrial Air System and Breathing Air Systems. Standalone instrument air systems will be provided as needed at selected facilities to support pneumatic instrumentation.

The Industrial Air System includes a central air plant located in the Utility Building and the piping to distribute the air to surface facilities at the North Portal. The air plant operates automatically and includes multiple electrical compressors, a backup diesel compressor, compressor controller, and the required after-coolers, moisture separators, filters, and air receivers. The primary air users are pneumatic tooling and door operators associated with waste handling activities. The air plant is supported by the Utility Monitor and Control System.

The Breathing Air Systems will provide breathing air from portable or bottled containers located at the facilities where emergency and hazardous maintenance operations are planned or anticipated.

Sanitary Waste Water Systems

The Sanitary Waste Water Systems collect and process sanitary sewage, water collected from the underground emplacement sump, and treated waste water from the transporter maintenance operations.

Sanitary sewage is piped from North Portal surface facilities with a gravity collection system to an existing septic system and leach field. The existing components will be upgraded and/or expanded as required to meet capacity and regulatory requirements for repository operations. Consideration will be given to replacing the septic system with a water treatment plant capable of providing reclaimed water for use in irrigation and cooling tower make-up.

Subsurface waste water and water from transporter maintenance operations is pumped to an evaporation pond near the North Portal. The pond residue will be surveyed for HW content and disposed of by the site waste disposal system as required. Flow to the evaporation pond is monitored by the Utility Monitor and Control System.

Communications Systems

The Communications System supports data, voice, and video signals throughout the repository, Nevada Test Site, and off site. The system consists of fiberoptic communications networks, a back-up microwave or cellular communication system, and a satellite earth station. An overview of the communications systems is shown in Figure 7.2.8-2.

Communications Backbone

The communications backbone is an assemblage of industry standard networks that are routed throughout the repository and Nevada Test Site. The backbone consists of fiberoptic bundles, wiring closets, network bridges, repeaters, and a communications center with computers and servers. Networks supporting related systems are installed in a redundant, automatic fail-over configuration. The network branches to subnetworks as required to integrate equipment operation throughout the site. Subnetworks are provided to support security, Utility Monitor and Control System, Facility Monitor and Control System, telephone, hazardous and radiological monitoring, transportation, engineering, video, and office systems.

Radio Frequency

The Radio Frequency System provides a reliable back-up for the off-site fiber communications line. If the site has access to a cellular communications system, this backup system will use cellular technology, otherwise a microwave tower will be provided. A satellite earth station will also be provided to support a continental U.S. transportation communications system required for the off-site transportation control room. Refer to Off-Site Transportation Monitoring and Control System.

Telephone

The Telephone System connects the site private telephone exchanges to the central telephone facility via the site-wide network backbone. The need for hand-held radio transceivers will diminish if a cellular system is available. Subsurface telephone systems will be connected to the site network.

Public Address

The Public Address System provides voice message and audible alarm warnings throughout the surface operations areas, facilities, and emergency centers. Surface and subsurface Public Address Systems will be connected into the site network.

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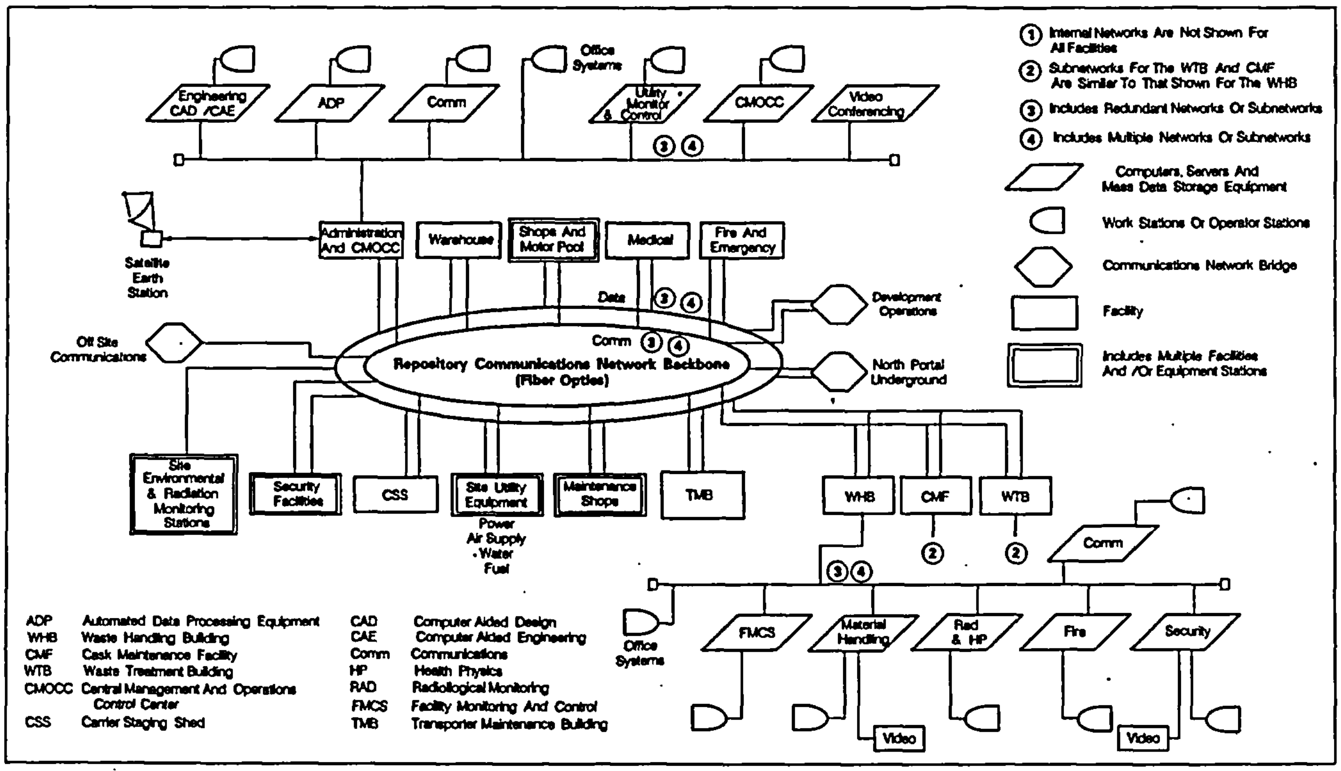

Figure 7.2.8-2. North Portal Communications

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Teleconferencing

A Teleconferencing System is provided in the Administration Building, and is supported by the land- or earth station-based systems.

Monitoring and Control Systems

Utility Monitor and Control System

The Utility Monitor and Control System is a Supervisory Control/Data Acquisition system that monitors and controls utility systems such as electric power, water, air, fuel, and sanitary waste water. Remote Terminal Units, which are located at the utility equipment, communicate with the utility central control station via the communications backbone.

Facility Monitoring and Control System

Facility Monitor and Control System is a supervisory control/data acquisition system located in each major facility to monitor the process control, material handling, HVAC, and power systems associated with the facility. The dedicated Facility Monitor and Control System for the WHB, CMF, WTB, and CSS is managed from a dedicated local control room along with data from the facility Radiological Monitoring, Fire Protection and Detection, Security, and Administration systems. The facility networks are bridged to the communication backbone and include multiple levels of password access. The Facility Monitor and Control System for other facilities includes local multiplexers and Facility Monitor and Control System workstations, which communicate to the site-wide network and the Utility Monitor and Control System.

Emergency Control System

Emergency Control Systems provide fault tolerant monitoring and control of safety systems. The safety systems are expected to include:

- Backup power generators
- Critical HVAC and support equipment
- Critical material handling and transportation systems
- Powered radiological confinement systems
- Emergency communications
- Alarm and warning systems
- Security systems
- Fire protection systems
- Safety and emergency lighting systems.

Systems important to public and occupational safety are installed using redundant and fault-tolerant equipment architectures to satisfy single and common mode failure criteria.

Material Control and Accountability System

The Material Control and Accountability System monitors, controls, and records the location and movement of SNF and defense HW at the repository. The Facility Monitor and Control Systems for the transportation, material handling, and emplacement systems maintain Material Control and Accountability records. The off-site transportation control automatically acquires accountability data from the Facility Monitor and Control Systems and maintains the site archives which are maintained on non-volatile memory such as compact disk, write only, or optical disc. Access to accountability data and data entry is password protected. Data entry will be by manual keyboard and bar code readers. Accountability of the waste form is verified by review of the records, visually, and with the aid of remotely operated video systems, as required.

Radiological Monitoring System

The Radiological Monitoring System includes site, surface, and subsurface facility radiological monitoring, and the health physics subsystems. Each subsystem includes the required radiation instruments, alarm panels, networks, data processors, and workstations for the area or facility. Radiological operations are mentioned for safe limits using portal, operating area, exhaust, and in-cell radiation instruments and analyzers.

Site Effluent Monitoring System

Surface and subsurface ventilation exhausts are monitored, alarmed, and recorded by the radiological and hazardous monitoring and warning systems. Air quality analyzers and groundwater monitors are provided at strategic site locations. These monitors provide tagged data and alarms to the site-wide network. Soil, water, waste water, vegetation, and spill samples are collected, stored, and analyzed.

Off-Site Transportation Monitoring and Control System

The Off-Site Transportation Monitoring and Control System supports central off-site transportation planning, dispatch, and communications activities. The operational equipment includes the central computer, transportation communications center, operator and dispatch workstations, staff support systems, and a satellite earth station. The system will be operated from a control center which is located in the Administration Building. This system is bridged to the site data network for non-satellite communications with the transportation carriers, escorts, support/emergency facilities, state authorities, and the repository operations center.

Site Management Systems

Administration and Planning

The Administration and Planning System includes contractor/government management and staff management, automated data processing, video conferencing, payroll, accounting, purchasing, visitor management, and food service. Administration and engineering computers and workstations communicate on the site network backbone. The central facilities and equipment are primarily located in the Administration Building.

Engineering and Analysis

The Engineering and Analysis System includes responsibilities associated with performance confirmation, health physics, emplacement/transportation planning, simulation, design, engineering and environmental analysis, energy conservation, and other related activities.

These activities are coordinated on the site network, which supports a true distributed processing architecture with the computers in various facilities. The main engineering workforce is housed in the Administration Building.

Training and Certification

The Training System utilizes classrooms, audio visual aids, mock up facilities, and field and on-the-job training. Personnel are certified and re-certified, as required, and the records are maintained in the Administration Building central computer. The facilities and associated training systems will be located at various facilities throughout the site including the Administration Building, Training Auditorium, and Mock-up Building.

Emergency Response

The Emergency Response System responds to and mitigates the consequences from off-normal events at the repository. The system consists of the facilities, systems, and trained personnel required to respond to off-normal conditions. The primary site facilities are the fire station, emergency response centers, and medical facility. The emergency response centers include a variety of special on-site and off-site capabilities to respond to subsurface, radiological, environmental, medical, security, and natural events. Emergency response support systems are coordinated through existing site safety systems including communications/public address, fire protection/detection, security, radiological and hazardous monitoring, medical, and weather systems. The data networks for these systems are bridged to site and off-site communications. Automatic and manually entered hazardous alarms are time tagged, identified, and prioritized. Alarm data are automatically routed to the appropriate control room, annunciator station, fire station, medical facility, emergency response center, and law enforcement agency.

Physical Security

The Security System maintains authorized access for personnel and equipment at the repository. The system consists of trained security and emergency response personnel, fences, barriers, guard houses, control rooms, offices, and equipment. The equipment includes the vehicles, weapons, and the control and monitoring systems required to maintain security.

The control and monitoring systems include site/emergency communications, badge/vehicle access and accounting, automated data processing systems, video and electronic detection equipment, central monitor and control, and alarm systems. A secure site network with assigned priority to the emergency response system integrates surface facility, subsurface facility, and site security stations.

On-Site Transportation

The On-site Transportation System directs and coordinates the on-site movement and maintenance of the shipping cask transportation vehicles. The system includes the installed rail and road equipment, transporters, and associated instrumentation, communications, safety equipment, and central control facilities. The control stations may be collocated with the off-site transportation monitoring and control system control stations.

Site Maintenance

The Site Maintenance System maintains repository facilities, systems, equipment, instruments, and vehicles. The system will schedule and perform the maintenance, maintain records of failures and repairs, manage spares inventories, report on failure histories and trends, and issue advisories for preventive maintenance procedures. The Facility Monitor and Control System and site Supervisory Control/Data Acquisition systems provide on-line data and records of the failure and maintenance histories. Certain failures will be logged automatically. Most equipment failures and the associated repair data will be recorded by manual input on in-place or portable workstations.

Maintenance workstations are provided for all repair activities associated with primary equipment and facilities. The Administration Building central computing facility will acquire maintenance data from the site Supervisory Control/Data Acquisition, Facility Monitor and Control System, and the local workstations.

The major maintenance facilities include the CMF, TMB, Motor Pool and Facility Service Station, and Central Shops.

Warehousing

The Warehouse System maintains the inventory and records for general-purpose site equipment and materials. The system consists of warehouse space, material handling and packaging equipment, and inventory systems. The materials are stored at the Central Warehouse. The Administration Building automated data processing maintains the central records for all site inventories. Inventory records are also maintained at the Central Warehouse, WHB, and CMF for special equipment associated with maintaining the cask fleet and material handling equipment. The Administration Building staff maintains the central inventory and maintenance records, and manages the purchasing activities.

Secondary Waste Management

The Secondary Waste Management System handles all on-site generated wastes, maintains waste generation records, issues empty containers, coordinates waste minimization and recycling activities, and provides compliance reports. Site generated wastes include LLW, mixed waste, HW, and sanitary wastes. Section 7.2.4 on the WTB provides descriptions on waste handling systems. Administrative waste management functions are conducted in the Administration Building and records are maintained on the WTB automated data processing.

7.3 SOUTH PORTAL DEVELOPMENT OPERATIONS

The South Portal Development Operations Area covers 320 m x 225 m, approximately 12 acres, and is located adjacent to the South Portal. The area includes eight structures and various support areas. Facilities are provided to support subsurface development, and for operation of the development side ventilation intake fans (CDA Document, CRWMS M&O 1995a, Key 010, and DCSS 005). The South Portal Operations Area will function independently of the emplacement side support area at the North Portal, and will include facilities for personnel support, equipment maintenance, warehousing, material staging, security, and transportation of materials to the subsurface development area. From this operations area, excavated muck from repository development will be transported by overland conveyor to the muck pile.

On completion of repository development, the South Portal Operations Area will be modified to support the caretaker operations and for possible waste package retrieval should this occur.

7.3.1 Previous Work

Previous work relating to the South Portal Operations Area is discussed in Section 7.1.

7.3.2 Design Inputs

Design inputs for the South Portal Operations Area are contained in Section 7.1.

7.3.3 Site Description

The layout of the South Portal facility is shown in Figure 7.3-1. Figure 7.3-2 depicts a proposed route for the overland conveyor from the South Portal, and three potential areas for storage of excavated muck. Individual structures and components are described below.

A. *Covered Laydown & Storage Area (warehouse)* – is a steel structure (100 m x 40 m) with concrete floor. The two rail tracks (1.44 m gauge) are embedded in a concrete floor to facilitate loading and unloading of rubber tired equipment. Items to be stored in this area include rails, pipes, rockbolts, steelsets, welded wire fabric, ventilation duct, fans, conveyor parts and belt, electric cables, disc cutters and spare parts for the tunnel boring machine, roadheader parts, and steel inverts. The building will have large doors to facilitate access for portable cranes. The warehouse will have a fire water line with an automatic sprinkler system, warehouse office, heating and cooling systems, and electrical power.

B. *Locomotive and Railcar Repair Shop including Battery Charger Station* – is a steel structure with similar construction to that designed for the North Portal. The battery charger area, however, will be larger to accommodate 10 to 14 battery charging bays.

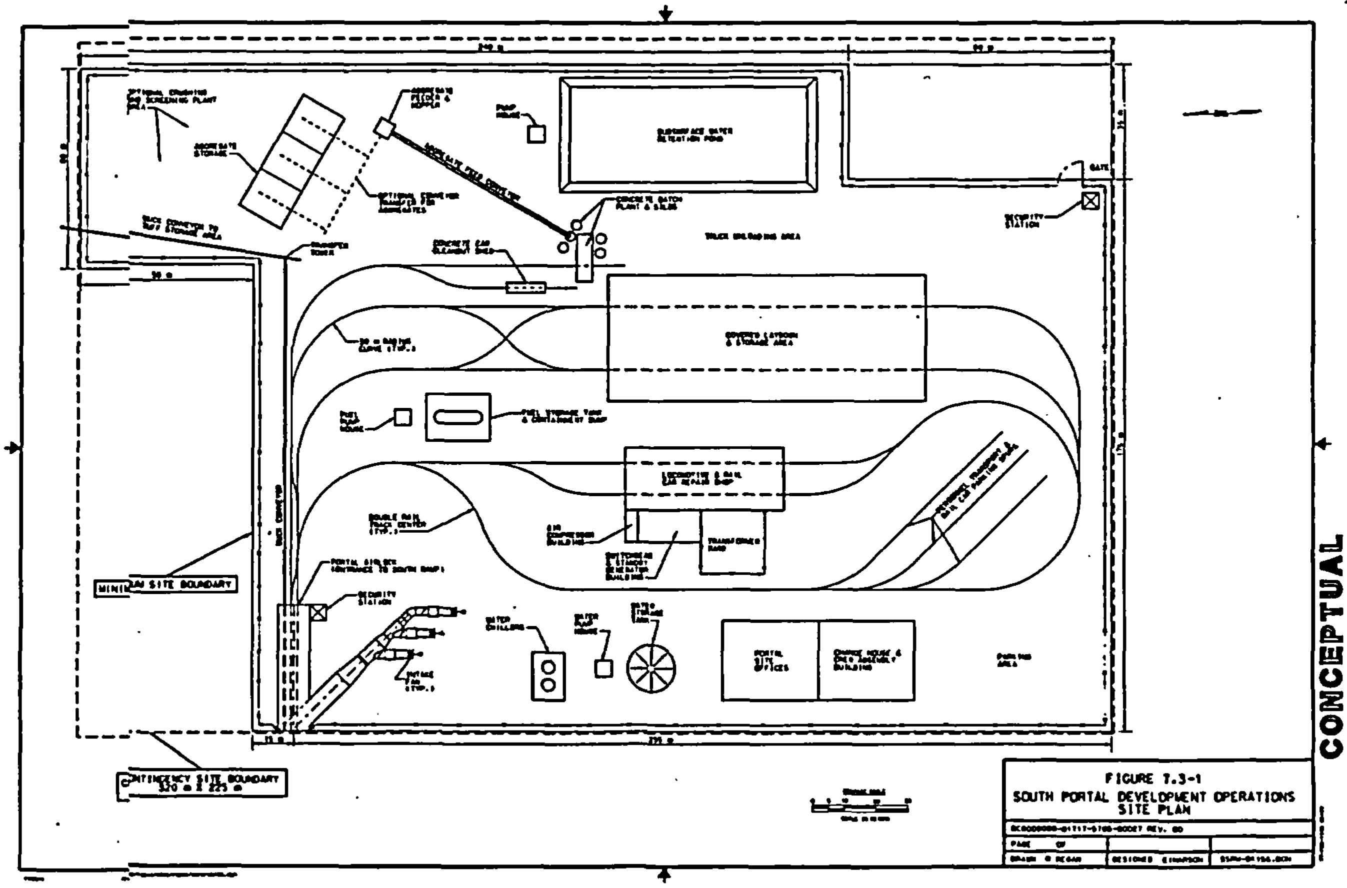

FIGURE 7.3-1
SOUTH PORTAL DEVELOPMENT OPERATIONS SITE PLAN

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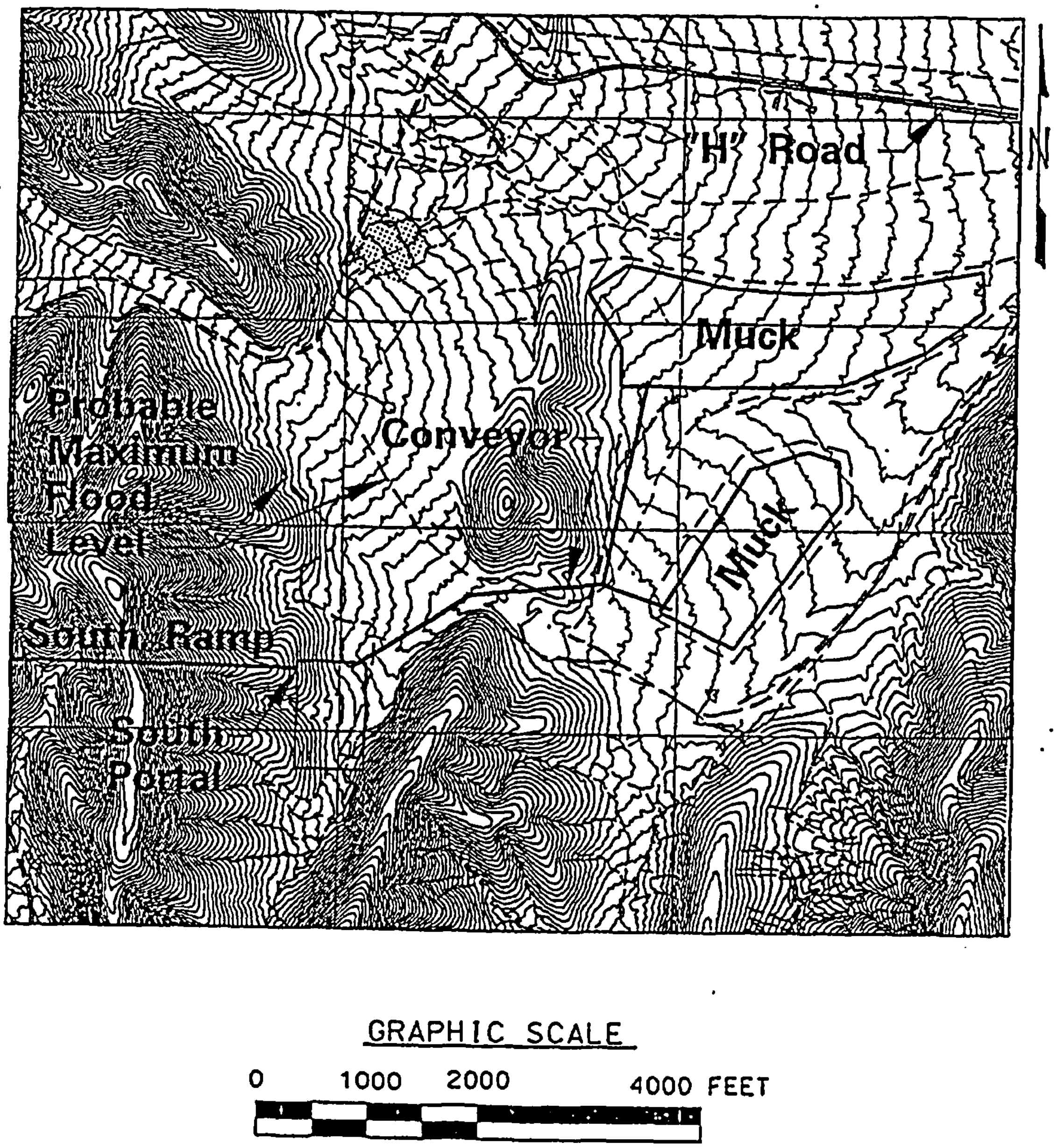

Figure 7.3-2. South Portal Development Operations Area – Muck Storage and Transfer

C. *Transformer Yard* – is an open fenced area, 20 m x 20 m, where the 69 kV utility line extended from the North Portal to the South Portal terminates. A transformer will reduce the utility line voltage from 69 kV to 12.47 kV. Two 12.47 kV lines will supply power to the South Portal operations. One line, routed through the South Ramp, will supply the subsurface development operations, and the other the development side exhaust shaft surface facilities.

D. *Switchgear & Standby Diesel Generator Building* – is a steel frame building, 20 m x 10 m, with a concrete floor. The building will be located next to the transformer yard, and will house a standby diesel generator. In the case grid electric power is cut off, the standby generator will power the intake fan (1250 HP) at the South Portal entrance, the emergency hoist at the development exhaust shaft (400 HP), and secondary face ventilation for the subsurface development headings.

E. *Air Compressor Building* – is a steel frame building, 20 m x 5 m, with a concrete floor. The air compressor building will be located adjacent to the switchgear and generator building, and will house three electrocompressors, each of 43 m^3/min capacity and one diesel standby unit. The building will be equipped with a fire line with automatic sprinklers and a ventilation system.

F. *Intake Ventilation Fans and Duct* – two ventilation fans, each with 94.4 to 236.0 m^3/sec capacity and 1250 HP electric motors (note: one unit is on standby status), will be installed for intake air at the South Portal entrance. To operate these main fans, a transformer station, 12.47 kV/4.16 kV, and a switchgear unit will be required. All instrumentation monitoring data will be transmitted directly to the dispatch office. Fire protection equipment will also be included.

G. *Portal Airlock* – an airlock structure will be required for effective operation of the intake air fans which are located at the portal where the muck conveyor and the rail haulage equipment travel between surface and underground. The airlock structure will be approximately 10 m x 10 m and will have double doors on both sides for pedestrian traffic, and a 20 m x 7 m airlock with double doors for rail traffic. These airlocks should be solid, tightly sealed, and easy to maintain. See Figure 8.7.9-2 for the South Ramp portal arrangement.

H. *Change House for the Development Crews* – is a steel frame building, 30 m x 25 m, with concrete floor, located adjacent to the portal site offices. The change house will have hot water boilers, cold water lines, showers, lockers for street clothes, and facilities to dry damp work clothes. Separate facilities will be provided for men and women. Facilities will be included for checking any radiation contamination of work clothes. Waste water from these facilities will be treated before pumping to the evaporation pond.

I. *Portal Site Offices* – is a concrete block building, 30 m x 25 m, with a concrete and linoleum floor. This building will house the technical and subsurface development supervisory personnel. In the same building, a dispatch room will track, on each shift, the development activity, materials traffic, and will maintain permanent contact with the underground safety inspector in the event of an emergency.

J. *Surface Space for an Optional Tuff Crushing and Screening Plant for Emplacement Drifts or Inverts Backfilling* – this will require an area of 40 m x 40 m, for the crushing and screening plant and where trucks can dump excavated muck from underground development. The tuff will be crushed, sorted, and transported to the subsurface operations in special railcars. If emplacement drifts will be backfilled, crushed material can be transported underground by conveyor. The area will be provided with water and 480 V electrical power utilities. The waste water will be collected in a sump before pumping to the evaporation pond.

K. *Aggregate Storage with Optional Feed Conveyor* – will cover an area of 40 m x 20 m, which is enough space for three segregated stockpiles that will be separated by partitions.

L. *Concrete Batch Plant* – will occupy an area 30 m x 30 m, and will include concrete mixers, cement silos, and space for fabricating and curing the tunnel inverts. The area will have a rail track and facilities for loading railcars, a concrete lab, water supply, and 480 V electric power supply.

M. *Concrete Car Cleanout Shed* – this facility will occupy a pad 12 m x 5 m, and will be provided with a spur rail track and high pressure water to wash the concrete cars that travel between the batch plant and tunnel invert fabrication plant. The waste water will be collected in a sump and treated before discharge to the evaporation pond.

N. *Diesel Fuel Storage Tank with Containment Sump* – the area occupied by this tank will be approximately 20 m x 15 m, with a dirt dike capable of containing the diesel fuel if the storage tank ruptures. Diesel fuel will be required for the diesel-powered generator, standby air compressor, and surface rubber tired equipment. There will be a 5 m x 5 m fuel pump house with concrete floor that will be equipped with an automatic fire extinguishing system.

O. *Water Chiller Building* – this facility (if required by the retrieval ventilation system) will occupy a 15 m x 10 m area, and will have a pump station, water tanks, and refrigeration equipment. Chilled water will be circulated through coils at the main intake fan to cool the air before it is sent underground. The chilled water will be contained in a closed circuit system.

P. *Water Storage Tanks* – to satisfy the Standard Review Plan presented in NUREG-0800, the fire water supply will be sized for both the surface and subsurface facilities. Accordingly, two 1,135,500 liter tanks will be installed near the South Portal at an elevation of 1180 m. This gravity water feed system will satisfy the fire protection needs of the surface buildings and facilities. By means of a parallel line, the water storage tanks will fill a smaller tank (227,100 to 378,500 liter capacity) located on the pad. This tank, in tandem with a water pump housed in a 5 m x 5 m building, will feed the 152 mm diameter subsurface water line.

Q. *Discharge Water Evaporation Pond* – the evaporation pond area will be approximately 75 m x 30 m in area, and will include a 5 m x 5 m pump house. All residual water accumulated from the surface facilities or underground development will be stored in the evaporation pond. This pond will be lined with heavy plastic sheets to prevent ground contamination. Sludge residue will be removed for permanent storage or disposal.

R. *Security Station* – there will be two security stations at the South Portal area, at the main gate where traffic is checked in and out, and at the South Portal entrance, to check access to the subsurface. The security buildings will be 5 m x 5 m concrete bricks structures with concrete floors and heat and air conditioning systems. Security personnel will be able to monitor activities throughout the site, and will be familiar with emergency procedures.

S. *Truck Unloading Area* – this area will be located adjacent to the covered laydown and storage area for trucks to unload materials and supplies, including equipment parts and construction materials. Portable cranes, forklifts, and rubber tired transporters will transport materials to the warehouse and storage areas.

T. *Surface Rail Parking Area for Locomotives, Personnel, and Materials Railcars* – two rail tracks will be constructed in the South Portal and the subsurface service main. Outside the portal entrance, the main rail tracks will split on different spurs to access the various buildings and facilities such as the covered laydown and storage area, the maintenance and battery charging shops, the concrete car cleanout area, and the batch plant. Spurs will be provided for the standby locomotives, and personnel and material cars. A minimum 30 m curve radius will be needed for the tracks.

7.4 EMPLACEMENT SHAFT SURFACE OPERATIONS

On the emplacement side, a single 6.1 m diameter concrete lined shaft will function as the only exhaust airway to the surface while the North Ramp will provide the intake air (see Figure 7.1.1-1). The shaft will be excavated to the depth of the lower emplacement block and located on the side of a ridge between the Drill Hole and Teacup Washes. Subsurface operations will be divided into two distinct functions: waste emplacement and subsurface development. Each functional area requires separate and complete ventilation systems so that air from the emplacement side cannot enter the development side. Refer to Subsurface Layout, Section 8.3, for a description of the shaft; and to Subsurface Ventilation, Section 8.7, for a more complete description of the ventilation system. The shaft will be under negative pressure, using exhaust fans on the surface to draw air through the subsurface emplacement area and accesses. Air flowing to the surface is directed through a sub-collar structure leading to HEPA filter units and main exhaust fans. The sub-collar structure makes a smooth transition from the vertical shaft to horizontal ducting which emerges on the surface and interfaces with the filter unit structure. The main exhaust fans are in line with the filter units, and will exhaust air in an upward direction to avoid interference and/or damage to personnel, equipment, and the environment.

7.4.1 Previous Work

Previous work relating to this section is discussed in Section 7.1

7.4.2 Design Inputs

Design inputs for this section are contained in Section 7.1

7.4.3 Surface Facilities

The emplacement shaft surface site will occupy an area approximately 90 m x 60 m, and will have fencing, security lights, warning devices, and monitored entry at a guard station. Sufficient yard space will be provided for operation of rubber tired equipment and a minimal storage area for maintenance supplies. Normally, the site will be unmanned; personnel and materials will be dispatched, as needed, from the North Portal operations area for inspections and maintenance.

A building will house the electric-powered inspection hoist and the shaft monitoring systems, and cover the shaft collar. A small four- to five-man conveyance running on a single guide attached to the shaft wall will be provided for inspections and emergency egress. Doors over the collar will prevent leakage and recirculation of the exhaust air. There will be two ventilation fans with steel duct work connecting to the shaft elbow and to the HEPA filters. Each fan will be fitted with an evase to diffuse exhaust air as it leaves the fan. The HEPA filter unit and fans do not require buildings for protection from the elements. See Figure 7.4-1 for a schematic of the emplacement side exhaust shaft fans, HEPA filters, and headframe structure.

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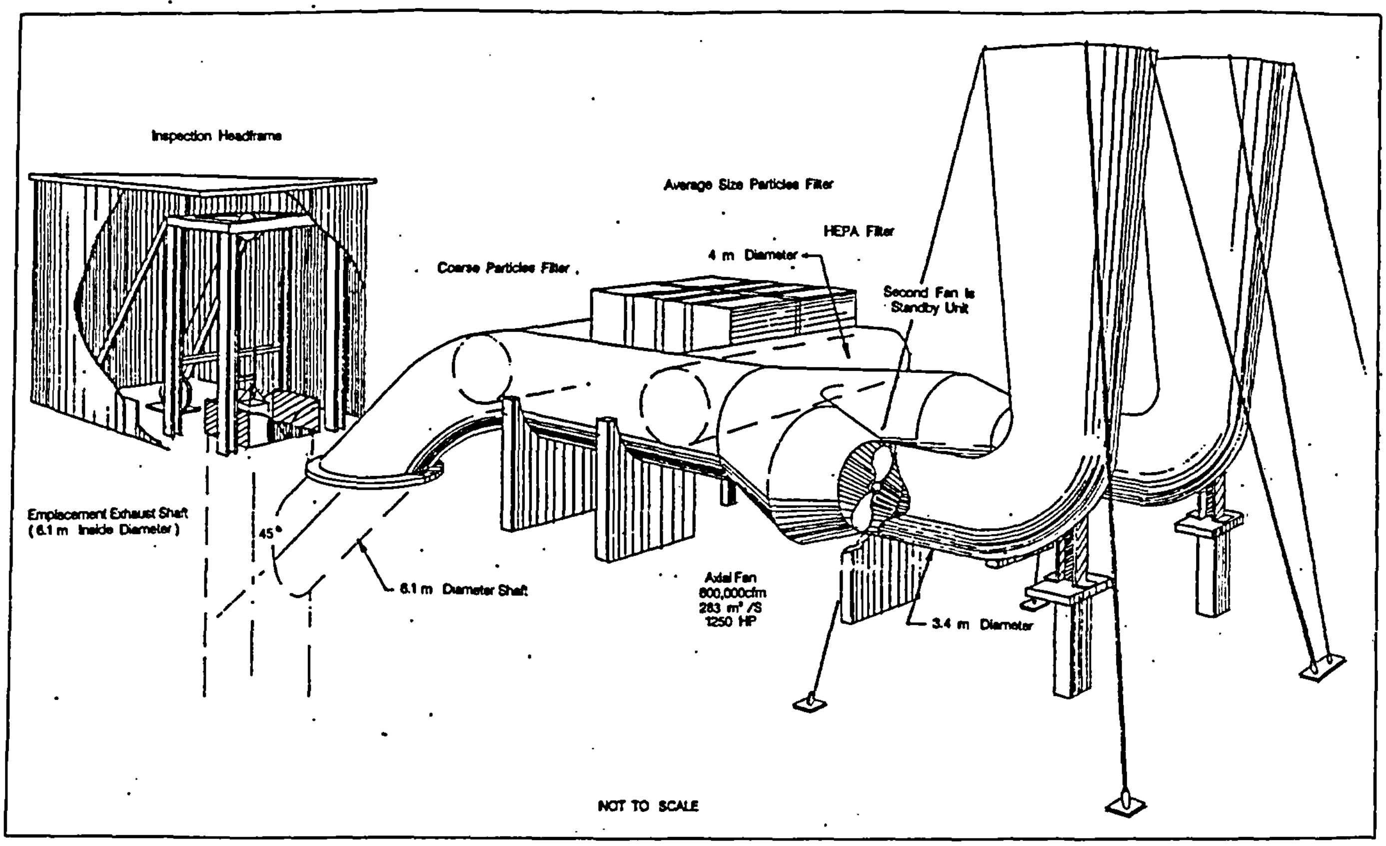

Figure 7.4-1.
Emplacement Side Exhaust Shaft
Fans & HEPA Filters Schematic

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Hot air and the potential for airborne radioactive particles and gasses in the emplacement exhaust shaft make it an undesirable travelway. For this reason entry into this shaft will be limited to inspection and maintenance, and, in extreme cases only, for personnel evacuation if no other means is available. Inspections can be carried out by remote controlled equipment, such as a video camera, placed in the shaft conveyance. The concrete lining will require very little maintenance over the life of the repository, but if maintenance is required it would necessitate personnel entering the shaft. For human entry, the exhaust air temperature will be lowered by closing off or diluting hot air from the emplacement drifts and bypassing fresh air from the North Ramp directly into the exhaust shaft.

The emplacement exhaust shaft surface area will include the following facilities:

A. Main Exhaust Fans - Two 3.4 m diameter axial fans each with a capacity of 94.4 to 283.2 m^3/sec, and driven by a 1250 horsepower electric motor. One fan will be in continual operation and the other on standby. The fans are installed in 3.4 m diameter ducts which transition to 6.1 m duct connecting the shaft to the HEPA filter structure. Fan discharge is through an upcast stack, approximately 7.62 m in diameter and 12.2 m in height.

B. HEPA Air Filter Structure - The structure contains two sets of HEPA filter units, only one of which will be brought on-line if radiation exceeds a predetermined limit in the airstream. The filters will be by-passed in the normal operating mode, while an off-normal mode will redirect the airstream through the filters.

C. Transformer Station and Switchgear - This unit will be of 12.47/4.16/480 V capacity and fed from the North Portal area. The transformer will be located in an open, controlled fenced area.

D. Monitoring Instrumentation - Instrumentation will be provided for automatic monitoring of airstream conditions for radiation, air temperature, and particulate/gas content. Other instruments will monitor fan performance, bearing temperature, vibration, motor voltage, current drawn (amperage), and lubrication oil temperature. All instruments will be housed in a building within the shaft compound fenced area.

Future design activities will include specific shaft siting studies to investigate the geologic conditions, as well as the radiation safety and isolation aspects of a candidate site. These studies will also examine the need for back up power and means for providing it if required. Future work will also examine various shaft sizes and power costs to optimize the diameter.

7.5 DEVELOPMENT SHAFT SURFACE OPERATIONS

For repository development, a single 6.1 m diameter concrete-lined shaft will function as the development exhaust air shaft, and the South Ramp will provide the fresh air intake. The shaft will also serve as an emergency escapeway if needed for this purpose. Refer to Section 8.7 for the subsurface ventilation description. The shaft will be excavated to the depth of the lower block horizon.

The development shaft surface operations site will require a small half-acre site, which will include one main structure, and will be located as shown on the repository surface site map, see Figure 7.1.1-1. The surface area includes a fenced compound of approximately 60 m x 40 m, with sufficient yard space for operation of mobile equipment and with minimal storage for maintenance supplies. A guard station will control access to the shaft area. Refer to Figure 7.5-1 for a site plan and Figure 7.5-2 for shaft collar, head frame, and air duct.

During the repository development and emplacement phases, ventilation fans at the shaft collar are not required because the fans at the South Portal will provide the airflow. Exhaust air from the development operations will exhaust directly to the atmosphere. There will be no provisions made for high efficiency particulate air filters because the ventilation system design precludes radioactive particulates entering the ventilation air in the development operations.

Hoisting in this shaft will be limited to inspection and maintenance, and only in extreme cases for emergency personnel evacuation if no other means are available. In the event of an underground fire, emergency egress via an exhaust air shaft should be avoided because of the danger from smoke inhalation. Maintenance work is unlikely in both the emplacement and development shaft, but if maintenance is needed the necessary equipment (including a multi-stage sinking deck, winches, and a larger hoisting system) would be provided by a contractor.

7.5.1 Previous Work

Previous work relating to the shaft area is discussed in Section 7.1.

7.5.2 Design Inputs

Design inputs for this section are discussed in Section 7.1.

7.5.3 Site Description

The development shaft surface area will include the following facilities:

A. A head frame and electric-powered emergency hoist capable of carrying four to five workers per trip. This equipment will be housed in a corrugated steel head frame building 12 m x 12 m x 17 m. This building will contain the shaft conveyance and the monitoring equipment for the shaft.

B. The shaft collar will be concrete lined and 6.1 m internal diameter, below the collar a ventilation elbow, also 6.0 m in diameter, will be constructed at 45° to the shaft axis to create a streamlined pathway for the exhaust air. The ventilation elbow will facilitate entry into the shaft by eliminating duct work at the collar. The shaft collar will be covered with doors to eliminate air leakage. The doors will be opened when the shaft cage is in use for inspections and in an emergency situation such as hoisting personnel from the underground.

C. Monitoring Instrumentation – Instrumentation will be provided for monitoring airstream conditions such as airflow volume and dust particulate.

D. A small building at the site will house the electrical equipment, and will include a high-voltage disconnect switch to shut off incoming power to the site, a transformer to reduce redundant subsurface power feed from the incoming surface voltage to a desired underground feed voltage, a small transformer to provide power for site and building lighting, and switchgear for site and building lighting.

B. The shaft collar will be concrete lined and 6.1 m internal diameter, below the collar a ventilation elbow, also 6.0 m in diameter, will be constructed at 45° to the shaft axis to create a streamlined pathway for the exhaust air. The ventilation elbow will facilitate entry into the shaft by eliminating duct work at the collar. The shaft collar will be covered with doors to eliminate air leakage. The doors will be opened when the shaft cage is in use for inspections and in an emergency situation such as hoisting personnel from the underground.

C. Monitoring Instrumentation – Instrumentation will be provided for monitoring airstream conditions such as airflow volume and dust particulate.

D. A small building at the site will house the electrical equipment, and will include a high-voltage disconnect switch to shut off incoming power to the site, a transformer to reduce redundant subsurface power feed from the incoming surface voltage to a desired underground feed voltage, a small transformer to provide power for site and building lighting, and switchgear for site and building lighting.

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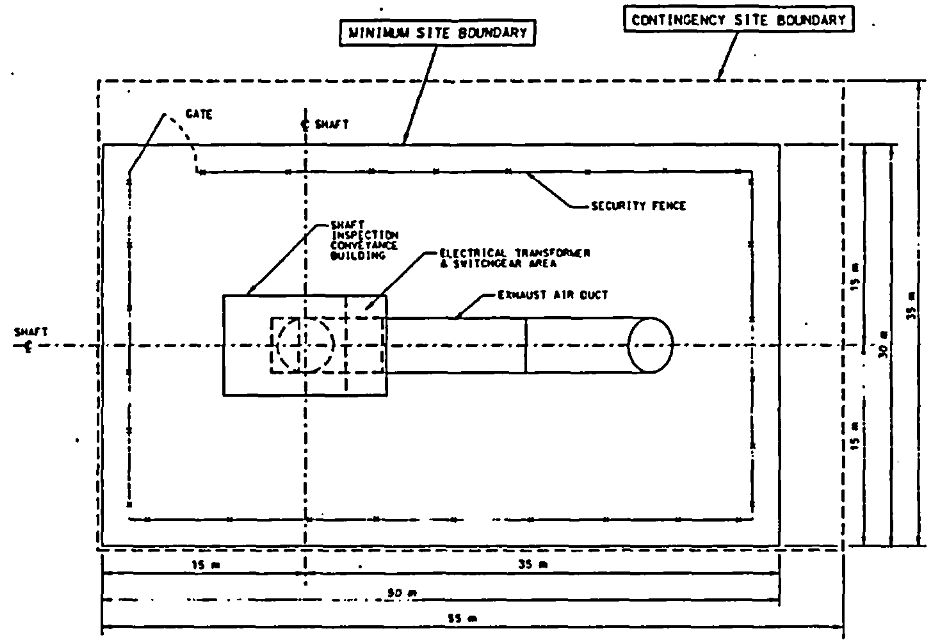

Figure 7.5-1
DEVELOPMENT SHAFT SURFACE
OPERATIONS-SITE PLAN

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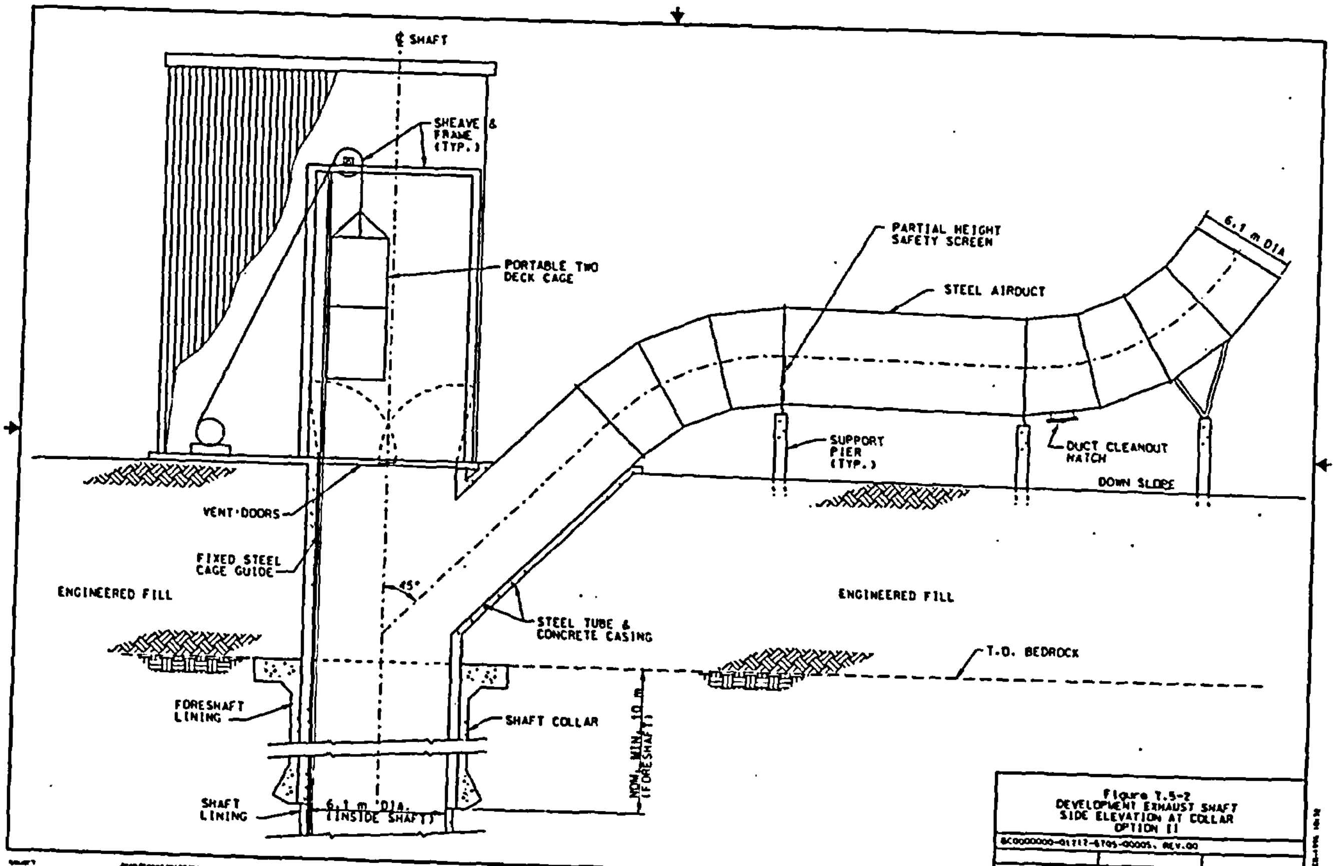

Figure 7.5-2
DEVELOPMENT EXHAUST SHAFT
SIDE ELEVATION AT COLLAR
OPTION II

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