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NM5507

QA: QA

Civilian Radioactive Waste Management System
Management & Operating Contractor

Monitored Geologic Repository Project Description Document

TDR-MGR-SE-000004 REV 01 DCN 01A

May 2000

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May 2000

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REVISION RECORD

Revision Number	ICN/DCN No.	Effective Date	Description of Change
00	--	06/09/99	Initial issue. Only Sections 1, 2.5, and 5 and Appendices A, B, C, and D. Supersedes *the Controlled Design Assumptions Document*, B00000000-01717-4600-00032 Rev. 05.
00	DCN 01	11/24/99	Added performance criteria in Section 2.1.1 and design constraints in Section 2.1.1 and design constraints in Section 2.2.1.1 to capture Guidelines for Implementation of Enhanced Design Alternative II. Added one assumption to Section 2.5 to indicate that the design constraints are to provide assumed design solutions for use in Performance Assessment to support Site Recommendation decision. Updated one assumption and withdrew two assumptions based on LADS results. Updated another assumption to eliminate conflict with current design and performance assessment efforts in support of Site Recommendation decision. Modified Section 1.1.2 to define expanded phasing of the development of the document to reflect this change and a planned revision to capture Interim Regulatory Guidance and other requirements imposed by DOE prior to completing the other parts of the document. Included related changes in Preface, Acknowledgements, Section 6, Appendix A, and Appendix D. Affected pages: title page, signature page, v, vi, vii, viii, ix, x, xi, 1, 2, 2a, 6, 7, 9, 9a, 9b, 9c, 20, 34, 35, 41, 42, 44, 54a, 54b, 57, 60, 61, 62, 67, 68, 69, 70, 71, A-1, A-2, C-1, C-2, C-3, C-4, C-5, C-9, C-14, C-15, D-1, D-2, D-3, E-1, and E-2.
01	--	03/30/00	Document identifier changed, supersedes B00000000-01717-1705-00003 REV 00. Reorganized document structure due to expanded scope. Added Section 2 to capture the current SR design and to include a description of repository operations. Added Section 3 to address repository safety. Added Section 4 to address repository architecture, functions, and interfaces. Revised and amended Section 5 (previously Sections 2.1-2.4) to reflect current SR design as per the *Approach to Implementing the Site Recommendation Design Baseline*. Updated Section 6 (previously Section 2.5) to reflect the current design assumptions. Reorganized appendices for clarity and appropriate support for changes described above.
01	01	05/XX/00	Added clarification to Section 2 for subsurface facility description. Added explanatory text for Section 5.1.4 for ease of traceability of inventory. Provided miscellaneous editorial changes to improve readability. Withdrew assumptions in Section 6 as appropriate to the SR design. Changes throughout document in

REVISION RECORD

Revision Number	ICN/DCN No.	Effective Date	Description of Change
			response to DOE and CCB comments. This document supersedes "Monitored Geologic Repository Architecture," B00000000-01717-5700-00011 REV 03 ICN 01.

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ACRONYMS AND ABBREVIATIONS

A list of the system designator acronyms is located in Appendix A.

ALARA	As Low As Reasonably Achievable
AP	Absorber Plates included in waste package
AR&TP	Applied Research and Testing Programs
BWR	Boiling Water Reactor
CPA	Controlled Project Assumptions
CRWMS	Civilian Radioactive Waste Management System
CR	Control Rods included in waste package
CSNF	Commercial Spent Nuclear Fuel
DCN	Document Change Notice
DHLW	Defense High-Level Waste
DIS	Disposability Interface Specification
DOE	U. S. Department of Energy
DPC	Dual-Purpose Canister
EBDRD	Engineered Barrier Design Requirements Document
EDA	Enhanced Design Alternative
EIS	Environmental Impact Statement
ECD	Environmental Compliance Department
ESF	Exploratory Studies Facility
ES&H	Environmental Safety and Health
HLW	High-Level Waste
IPWF	Immobilized Plutonium Waste Form
LA	License Application
LADS	License Application Design Selection
LD	Licensing Department
LLW	Low-Level Waste
M&O	Management and Operating Contractor
MCO	Multi-Canister Overpak
MGR	Monitored Geologic Repository
MGR RD	Monitored Geologic Repository Requirements Document
MSHA	Federal Mine Safety and Health Administration
N/A	Not Applicable
NCRP	National Council on Radiation Protection & Measurement
NRC	U. S. Nuclear Regulatory Commission
NTS	Nevada Test Site
OATI	Office of Acceptance, Transportation, and Integration

OCRWM	Office of Civilian Radioactive Waste Management, DOE
PAD	Performance Assessment Department
PDD	Monitored Geologic Repository Project Description Document
PTn	Paintbrush Tuff nonwelded
PWR	Pressurized Water Reactor
R&RSD	Radiological and Regional Studies Department
RT	Regional Transportation
SFD	Surface Facilities Department
S&HD	Safety and Health Department
SDD	System Description Document
SED	Systems Engineering Department
SNF	Spent Nuclear Fuel
SPC	Single-Purpose Canister
SR	Site Recommendation
SSFD	Subsurface Facilities Department
SSCs	Structures, Systems, and Components
TCw	Tiva Canyon welded
TEDE	Total Effective Dose Equivalent
TSw	Topopah Spring welded
WP	Waste Package
WPD	Waste Package Department
YMSCO	Yucca Mountain Site Characterization Office

SYMBOLS AND UNITS

°C	degrees Celsius
°F	degrees Fahrenheit
cm	centimeters
ft	feet
Hz	Hertz
kg	kilogram
kW	kilowatt
lb	pounds
mg	milligram
ml	milliliter
mm	millimeters
mrem	milli-Roentgen equivalent man
MT	metric ton
MTHM	metric tons heavy metal
MTU	metric tons of uranium
pH	potential of Hydrogen

1. INTRODUCTION

1.1 OBJECTIVES

The primary objective of the Monitored Geologic Repository Project Description Document (PDD) is to allocate the functions, requirements, and assumptions to the systems at Level 5 of the Civilian Radioactive Waste Management System (CRWMS) architecture identified in Section 4. It provides traceability of the requirements to those contained in Section 3 of the *Monitored Geologic Repository Requirements Document* (MGR RD) (CRWMS M&O 2000b) and other higher-level requirements documents. In addition, the PDD allocates design related assumptions to work products of non-design organizations. The document provides Monitored Geologic Repository (MGR) engineering design basis in support of design and performance assessment in preparing for the Site Recommendation (SR) and License Application (LA) milestones. The engineering design basis documented in the PDD is to be captured in the System Description Documents (SDDs) which address each of the systems at Level 5 of the CRWMS architecture. The design engineers obtain the engineering design basis from the SDDs and by reference from the SDDs to the PDD. The design organizations and other organizations will obtain design related assumptions directly from the PDD. These organizations may establish additional assumptions for their individual activities, but such assumptions are not to conflict with the assumptions in the PDD. The PDD will serve as the primary link between the engineering design basis captured in the SDDs and the design requirements captured in U.S. Department of Energy (DOE) documents. The approved PDD is placed under Level 3 baseline control by the CRWMS Management and Operating Contractor (M&O) and the following portions of the PDD constitute the Technical Design Baseline for the MGR: the design characteristics listed in Table 2-1, the MGR Architecture (Section 4.1),the Engineering Design Bases (Section 5), and the Controlled Project Assumptions (Section 6).

1.2 SCOPE

The PDD addresses the design basis and design related assumptions associated with the engineered components of the MGR. Where appropriate, it provides the background and rationale for the design basis and design related assumptions. The PDD includes a summary of the elements and structure of the MGR architecture; summarizes the performance functions, interfaces, requirements, design criteria, design constraints, and assumptions that apply to the MGR engineered components; and allocates the design basis to the appropriate MGR systems and/or work products. These PDD requirements, criteria, constraints, and goals are supplementary to the requirements in the MGR RD. The PDD also addresses the concepts for verifying that the designs are compliant with the design basis.

1.3 BACKGROUND

The PDD is being developed in phases. The first phase, which resulted in REV 00, consisted of Controlled Project Assumptions (CPAs). The second phase, which resulted in REV 00 Document Change Notice (DCN) 01, provided performance criteria and design constraints to capture the "Guidelines for Implementation of EDA II" (Enclosure 2 to Wilkins and Heath 1999). The third phase, which resulted in this revision (REV 01), ensures that all DOE design requirements are captured and allocated to the appropriate Level 5 system (SDD level). Because this is a living document that must remain viable in a dynamic design environment, other additions and changes are expected on a regular basis leading up to and beyond the LA milestone.

1.3.1 PDD REV 00–Controlled Project Assumptions

The purpose of the CPAs is to provide a consistent program-wide framework for planning and conducting both design and non-design activities. The initial focus of the CPAs contained in PDD REV 00 was on consistent assumptions for design; however, design related assumptions also are included to support non-design activities, such as performance assessment or environmental impact analysis. These assumptions are applicable to the SR design, and replace the *Controlled Design Assumptions Document* (CRWMS M&O 1998a) which was applicable to Viability Assessment design. The CPA documentation lists each assumption, provides its rationale, allocates it to MGR systems and/or work products/activities, allocates its applicability to M&O user organizations, and assigns responsibility for establishing and maintaining the assumption to one or more M&O organizations.

1.3.2 PDD REV 00 DCN 01–Design Constraints and Criteria for Implementing Enhanced Design Alternative (EDA) II

Guidelines for implementing the EDA II that had been selected as a result of the License Application Design Selection effort were issued in Enclosure 2 to Wilkins' and Health's letter providing *Direction to Transition to Enhanced Design Alternative II* (Wilkins and Heath 1999). This revision captures these "Guidelines for Implementation of EDA II" (Enclosure 2 to Wilkins and Heath 1999) in the form of performance criteria and design constraints. It also updates the CPAs by adding assumptions to reflect the EDA II characteristics and support its implementation.

1.3.3 PDD REV 01

This revision adds descriptions of the MGR physical features and operational concepts. Also included are the CRWMS architecture and the results of updated functional and requirements development. The design basis is expanded to include appropriate requirements from the MGR RD (CRWMS M&O 2000b), any new or modified design criteria or constraints (Stroupe 2000), and the allocation of design basis to Level 4 of the MGR architecture.

1.4 HIERARCHY

The ultimate role of the PDD is to pass along design basis from higher level requirements documents by allocating functions, interfaces, requirements, criteria, constraints, and assumptions to the systems reflected in SDDs as depicted in Figure 1-1. Figure 1-1 represents the ultimate objective of the hierarchy of requirements documents. As indicated in Figure 1-1, the documents are shown in order of their precedence (level of authority with respect to other requirements documents); i.e., the order of precedence from top to bottom is *Civilian Radioactive Waste Management System Requirements Document* (CRD), MGR RD, PDD, and SDDs. The PDD Rev 01 is in transition from a document containing the project assumptions to the document depicted in Figure 1-1. Until all of the requirements from the MGR RD have been addressed in future revisions of the PDD, the PDD should be treated as a supplemental source of requirements to the MGR RD.

As indicated in Section 1.1, design engineers will obtain the design basis from the SDDs and, by reference where appropriate, from the PDD.

1.5 QUALITY ASSURANCE

The QAP-2-0 activity evaluation for the development of the PDD (CRWMS M&O 1999a) indicated that the activity is subject to the requirements of the *Quality Assurance Requirements and Description* (DOE 2000a). Consequently, this document is being updated and maintained in accordance with AP-3.11Q, *Technical Reports*.

This document may be affected by technical product input information that requires confirmation. Any changes to the document that may occur as a result of completing the confirmation activities will be reflected in subsequent revisions. The status of the input information quality may be confirmed by review of the Document Input Reference System database.

1.6 DOCUMENT ORGANIZATION

This document is organized to give the reader an overall description of the repository and how it is expected to operate.

Section 2 provides the design and operational descriptions necessary to create the context of a total, operational repository.

Section 3 provides a discussion of the safety argument important in the development and operation of the repository.

Section 4 provides the architectural structure of the facilities, structures, systems, subsystems, and major components that make up the repository. It also provides the start of a functional description of the repository. The important functions of the repository are identified and discussed, and related to the architectural items.

Section 5 provides the design envelope for those already familiar with the description and architecture of the MGR, and should be the most useful section in the document for those with this knowledge. This section also provides a table that allocates the design basis components to the appropriate items of the architectural structure.

Section 6 provides the assumptions that have been carried forward from the Viability Assessment phase of the Site Characterization program. These assumptions are intended to provide consistent guidance to all organizations working on the program. It is anticipated that, with time, these assumptions will either work their way into the design basis, the design solution, or will be eliminated.

Section 7 provides the description of how to verify that the design solution is in compliance with the appropriate design basis (to be provided in later revisions).

Section 8 provides a list of the documents, regulations, standards, etc., that are cited throughout this document.

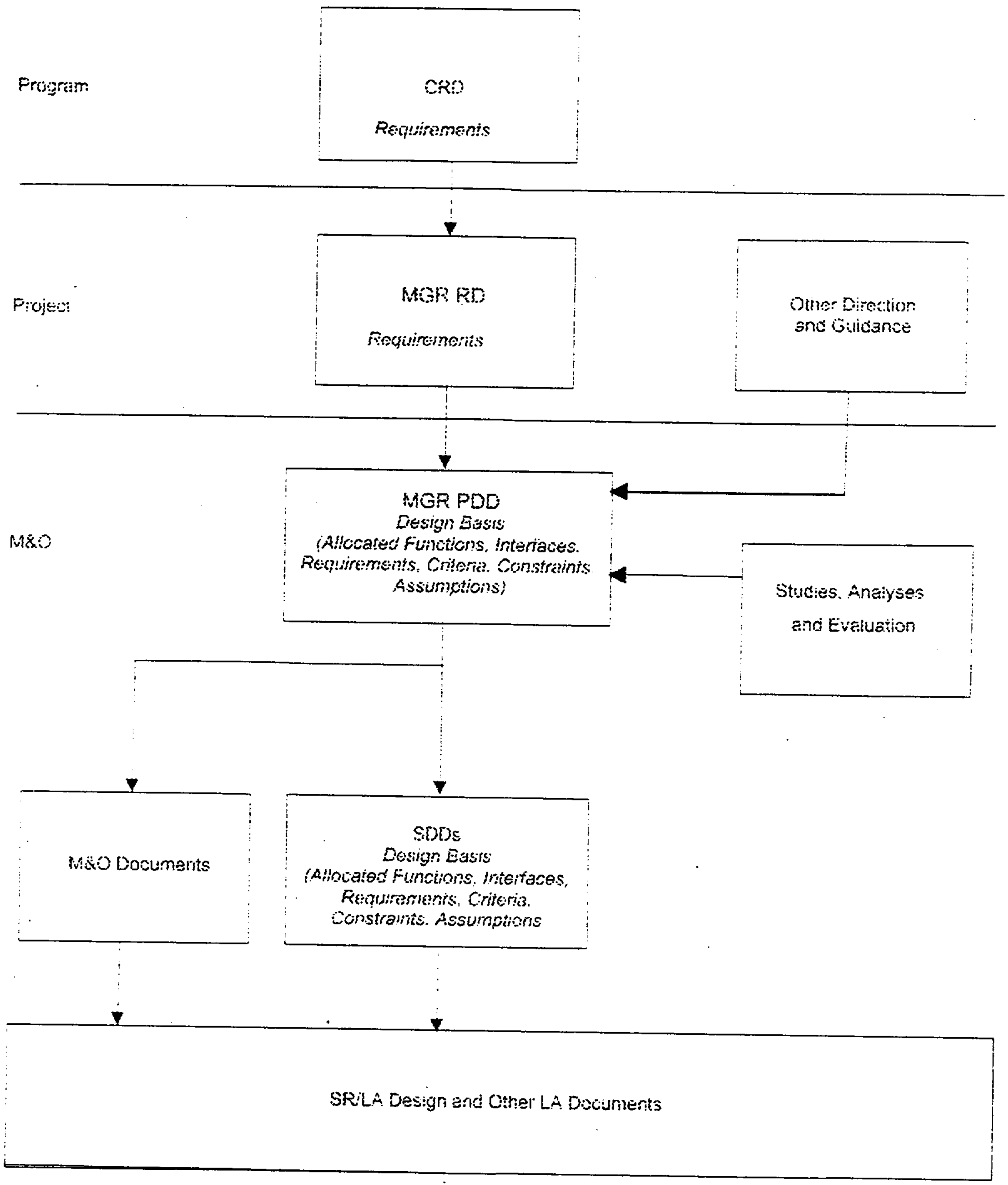

Figure 1-1. Document Hierarchy for SR/LA Design Basis

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2. REPOSITORY DESCRIPTION

The proposed MGR at Yucca Mountain is designed to safely receive, handle, emplace, and monitor radioactive waste and to provide a combination of natural and engineered features to contain and isolate waste for 10,000 years (Dyer 1999, Section 113(b)), and is expected to continue to contain and isolate waste for hundreds of thousands of years. This combination of natural and engineered features serves to provide an environment that is safe for workers and the public during the period that the repository is open. Additionally, after closure of the repository, the features limit the water contacting the waste packages (WPs), provide a long WP lifetime, ensure a low rate of release from breached WPs, and reduce the radionuclide concentration during transport from the WPs (CRWMS M&O 2000a, Executive Summary).

The MGR consists of surface facilities and subsurface facilities with the nuclear waste being permanently stored in the waste emplacement block of the subsurface facility. The surface facilities at the North Portal to the underground area provide waste handling capability, Balance of Plant facilities, and engineering and operations support. The surface facilities at the South Portal to the underground area support the subsurface development activities conducted through the period that the repository is open.

Highly radioactive material (spent nuclear fuel (SNF) and high-level waste (HLW)) from commercial and government nuclear reactors and government processing plants will be sent to the MGR for underground disposal. Disposal of this waste will be handled in compliance with applicable regulations governing SNF and HLW to protect the public and environment.

2.1 MGR PHASES

There are six phases in the evolution of this repository:

- Site Characterization
- Construction
- Operations
- Monitoring
- Closure
- Postclosure

The Site Characterization Phase includes those activities associated with:

- Gathering and evaluating data to determine the suitability of the site
- Predicting the performance of the repository
- Preparing conceptual, preliminary, and final repository designs
- Assessing the system performance
- Preparing the application for construction authorization and supporting its review
- Preparing the environmental impact statement and supporting its review
- Planning for the remainder of the phases

The Construction Phase includes:

- Constructing surface and subsurface facilities
- Initial excavating of subsurface facilities
- Gathering data to support predictions of the repository performance
- Fabricating disposal containers
- Developing operational procedures
- Recruiting and training operational personnel
- Installing operational equipment
- Demonstrating some repository operations
- Preparing an application for a license to receive and possess waste

The Operations Phase includes:

- Receiving the waste
- Preparing WPs (disposal containers loaded with waste and sealed)
- Emplacing WPs in the repository
- Packaging and disposing of site generated waste

The Monitoring Phase includes:

- Safeguarding the waste
- Maintaining surface and subsurface facilities as required
- Protecting the retrieval option
- Gathering data to support predictions of the repository performance
- Completing designs of closure systems
- Preparing an application to amend the repository license for permanent closure

The Closure Phase includes:

- Placing drip shields over the WPs

- Closing and sealing the subsurface facilities

- Decontaminating and removing the surface facilities

- Placing fences, warning signs and monuments to secure the site

- Creating institutional barriers

- Returning the site to as natural a condition as required by the U.S. Nuclear Regulatory Commission (NRC)

Following repository closure, the WPs will contain the radioactive waste for tens of thousands of years. Even after the WPs have degraded, the surrounding geologic environment is expected to prevent nearly all of the released radioactive materials from leaving the repository region, thereby complying with the regulatory requirements.

2.2 DESCRIPTION OF FACILITIES

The Yucca Mountain characterized area is located within the area bounded by the Solitario Canyon fault on the west, Yucca Wash on the north, Bow Ridge fault on the east, and Abandoned Wash on the southeast. It is also bounded on the south by the N227000 meter map coordinate line in the Nevada State Plane Coordinate System.

The surface facilities at the North Portal consist of those systems and components used to receive, prepare, and package the waste for underground emplacement, and are arranged as shown conceptually in Figure 2-1 (DOE 1998b, Volume 2, Figure 4-1).

The repository host horizon of the MGR is located more than 200 m below the surface of Yucca Mountain, wholly contained within the Topopah Spring Welded Tuff stratigraphic unit shown in Figure 2-2 (CRWMS M&O 1999c, Figure 5-1). This repository host horizon is also located more than 100 m above the groundwater table (DOE 1998b, Vol. 2, Figure 4-21). The waste emplacement areal footprint for emplacement drifts occupies approximately 1,100 acres for 63,000 MTU of commercial SNF (CSNF) and approximately 7,000 MTU of DOE SNF and HLW; however, full inventory design for approximately 97,000 MTU of waste (CRWMS M&O 2000e), including 83,800 MTU of CSNF plus DOE SNF and HLW will occupy approximately 1,500 acres of emplacement drifts (Wilkins and Heath 1999, Enclosure 2, A 1.0 and 3.0). The layout of the emplacement and access drifts and shafts is shown in Figure 2-3.

At the North Portal to the repository, there will be an approximately 80-acre area where nuclear waste is handled. For worker safety, operations at the North Portal are divided into two work areas: a protected area and a Balance of Plant area. All radioactive materials will be handled in the protected area. The Balance of Plant area will perform the administrative and support functions that do not involve handling radioactive materials. These areas are shown conceptually in Figures 2-4 and 2-5, with some structures moved or eliminated for simplicity.

The protected area includes the following facilities:

Waste Handling Building–Prepares incoming waste for transfer to the underground emplacement area. This building contains bays, radiation confinement rooms, welding systems, and other operational support systems.

Waste Treatment Building–Collects and packages site-generated, low-level radioactive and mixed (hazardous and radioactive) wastes for off-site disposal.

Carrier Preparation Building–Prepares incoming casks for transfer to the Waste Handling Building. All shipping hardware and personnel barriers are removed from the casks at this point.

Transporter Maintenance Building–Services and maintains the locomotives, transporters, and emplacement drift gantry cranes used to place WPs underground.

Security Station–Controls entry of waste into the radiologically controlled area.

The radiologically controlled area can accommodate several days' worth of transportation casks between the transporter parking area, the Carrier Staging Building, and the Waste Handling Building.

The Balance of Plant area has a general administration building, medical center, training center, shops, motor pool, central warehouse, and other support facilities.

Surface facilities are also provided at other operational areas:

- The Emplacement Exhaust Shaft Areas include fans, power supplies, headframes, and hoist systems. Accommodations are provided to house the emplacement ventilation exhaust fans and to support the maintenance of these fans.

- Air Intake Areas are located at the North and South Portals and at intake-shaft areas above the eastern portion of the repository, within the repository footprint. The North and South Portals and east and west main drifts are shown in Figure 2-3.

- The South Portal Development Operations Area is the second largest surface facility area, and includes multiple structures. This area is located adjacent to the South Portal to support the excavation of the underground and operation of the development ventilation intake fans. This area functions independently of the emplacement area and includes the basic facilities needed for personnel support, maintenance, warehousing, material staging, security, and transportation (CRWMS M&O 1998b, paragraph 7.6.2).

- The solar power electrical generation facility will be located east of Yucca Mountain across the 40 Mile Wash.

2.3 CONCEPT OF REPOSITORY OPERATIONS

Repository operations will begin when sufficient repository construction is completed to ensure safe operations, and when the repository has been licensed to receive waste. This phase will overlap part of the construction and monitoring phases, and elements of these phases will occur during repository operations.

The following major activities will occur during the Operations Phase (includes activities from Construction and Monitoring phases which will occur concurrently, as the phases overlap):

Receiving Waste at the Repository–Transportation casks will be loaded with waste at various sites throughout the country and transported to the repository by rail and truck. The casks will be moved to the Waste Handling Building carrier bay and removed from their carriers. They will then be opened and the waste removed.

There are several types of waste currently being considered in the design of the repository: two different types of CSNF assemblies (one from BWR power plants and the other from PWR power plants); DOE SNF assemblies from experimental nuclear reactors; Naval reactor SNF canisters; and pour canisters filled with a mixture of glass and defense HLW (DHLW).

Transportation cask carriers will be delivered by diesel locomotives or truck tractors to the protected area of the repository. The carriers will pass through the security station on their way to the Carrier Preparation Building. Impact limiters and weather, radiation, and intrusion barriers will then be removed and transportation casks inspected for external radiological contamination. When inspection is complete, the transportation cask carriers will be moved into the Waste Handling Building carrier bay to await unloading of the casks (Figure 2-6).

The repository must safely accommodate a broad range of canisters and casks that may be used to deliver nuclear waste for disposal.

Preparing Waste Packages–There are two steps in the loading process. The first is to load the waste into a disposal container and seal the container, thus creating a WP. The second step is to load the WP into a transporter to be taken to the emplacement location.

In the Waste Handling Building, waste will be transferred from casks or canisters to disposal containers (Figure 2-7). (There are two Assembly Transfer System lines for handling uncanistered SNF under water, or "wet," and one Canister Transfer System line for handling canistered waste "dry.") They will then be moved to the welding station for sealing.

All movement of fuel assemblies and HLW canisters will be performed by qualified, certified operators. The NRC will certify each individual fuel handling operator after extensive training and testing of their skills and knowledge. All fuel movement and handling will be performed in accordance with explicit operating procedures.

There will be several types of disposal containers:

- An *uncanistered disposal container* designed to hold fuel assemblies that are not in a canister. Fuel assemblies for this container could be taken from casks or from canisters that are not compatible with canistered disposal containers (see Figure 2-8).
- A *canistered disposal container* designed to hold canisters containing fuel assemblies (see Figure 2-9).
- A Naval fuel *disposal container* designed to hold canisters containing spent Navy fuel (see Figure 2-9).
- A DHLW *disposal container* designed to hold pour canisters containing DHLW mixed with glass and DOE SNF (see Figure 2-10).
- A Non-Fuel Components *disposal container* designed to hold activated non-fuel components contained in canisters (see Figure 2-9).

Uncanistered Fuel Handling–In the uncanistered waste cask room, the lids of loaded casks will be removed.

The casks to be unloaded will vary in the number of fuel assemblies they contain, and the fuel assemblies will vary in their characteristics. Several casks or canisters may have to be unloaded before the fuel pool contains enough fuel assemblies with compatible characteristics to fill a single disposal container. When the right set of fuel assemblies has been collected, a disposal container will be moved into position and loaded from the fuel pool. The disposal container will be inspected, decontaminated as required, and moved into another room for final welding of the disposal container lids.

The loading of individual disposal containers will be performed in accordance with explicit operating procedures, by qualified and licensed operators. The blending of individual assemblies from the fuel pools into a disposal container will be predetermined by engineering calculations taking into account thermal output, criticality, and compatibility of waste forms. Operators will perform only that blending that is specified by those calculations. Precise fuel assembly identification will ensure that the blending is performed in accordance with the planned blending calculations. Independent verification of the assemblies placed into the disposal container will be performed prior to closing and welding the disposal containers.

Disposable Canister Handling–The processes for canistered fuel assemblies and canistered DHLW will be similar but less complex. In the Waste Handling Building, lids of the casks will be removed and the loaded canisters of fuel assemblies or DHLW withdrawn and immediately placed into disposal containers. Each filled disposal container will be moved to an area for welding of both the inner and outer lids.

All of these activities will be remotely controlled and will take place in sealed and shielded rooms that protect the workers and the environment. Precise canister identification will ensure that the loading is performed in accordance with the planned WP and repository loading activities. Independent verification of the canisters placed into the WP will be performed prior to closing and welding the WPs.

Final Sealing of Disposal Containers–Welding the lids on the loaded disposal container will be accomplished in the disposal container handling cell in the Waste Handling Building. Disposal containers that have been loaded in other rooms will be transferred to the welding area. The disposal containers will have three lids welded onto them. The inner lid (316 Stainless Steel) is not credited as a barrier. The middle lid (alloy 22) is welded, laser peened for stress relief, and inspected. The outer lid (alloy 22) is welded, induction annealed for stress relief, and inspected. The uncanistered SNF disposal container will have had its inner lid welded in the loading room before transfer to minimize the risk of spreading contamination. Following the acceptance of all lid welds, the container is then referred to as a WP.

For the canister filled containers, the inner lids will be welded and inspected in place under remote control. Then, for all types of containers, the outer lids will be welded in place and inspected. As many as 15 welding stations may be needed to maintain a desired rate of emplacement.

The final Waste Handling Building operations will involve decontaminating a WP and placing it in a WP staging area for future emplacement, or inside the WP transporter for delivery to the emplacement area. The WP will be lifted and rotated to a horizontal position, placed on a horizontal transfer cart, and moved to a separate cell where it will be lifted by a crane for decontamination. Following decontamination, the WP will be moved to the WP staging area or placed on a pallet on a rail car and pushed up to the transporter. A remote-controlled transfer mechanism will reach out from the transporter, connect to the rail car, and pull it into the transporter. The transporter will close its doors and the WP will be ready to be moved underground for emplacement (Figure 2-11).

Precise WP identification will ensure that the loading is performed in accordance with the planned repository loading activities. Independent verification of the WP placed into the transporter will be performed prior to loading the transporter.

A summary of the various handling operations is graphically presented in Figures 2-12 through 2-17.

Emplacing Waste Packages in the Repository–The rail car on which the WP will be transported will have four fixed axles.

Each WP will be transported from the surface Waste Handling Building into and through the subsurface drifts using a WP transporter to reduce external radiation to safe levels for workers.

There will be a WP loading mechanism within the transporter which will move the WP/rail car unit into and out of the transporter. At the emplacement drift, the loading mechanism will push the unit out of the transporter. If necessary for retrieval, the loading mechanism could be used to pull the rail car back into the transporter at the emplacement drift entrance.

The doors of the transporter will be remotely controlled. If necessary, they can be opened or closed manually from a shielded position behind the transporter.

Transferring Waste Packages to Emplacement Drifts–The WP/rail car unit will be carried within the WP transporter from the surface facility to the entrance of an emplacement drift. Travel speed underground will be limited in the main drifts and in the emplacement drifts.

The transporter will be moved by electrically powered transport locomotives, one on each end. Braking systems will be incorporated on both the transport locomotives and transporter. The systems will normally work together, but each will be capable of independently stopping the loaded unit on the steepest grade (2.6 percent).

The transport locomotives that move the transporter through the underground ramps and drifts will have both manual and remote operations capabilities (Figure 2-18).

Excavating the Emplacement Drifts–Approximately 10 percent of the emplacement drifts will be completed prior to the start of waste emplacement operations. The remaining 90 percent will be completed while waste is being emplaced in the repository.

These concurrent operations will allow the repository to begin waste emplacement operations within six years from the start of the construction phase.

To ensure worker safety, the excavation and emplacement operations will be physically separated from each other, and each will have its own ventilation system and its own ramp access.

2.4 SUBSURFACE LAYOUT

The subsurface portion of the repository will be more than 200 m underground. The subsurface layout will be composed of two inclined access ramps, vertical ventilation shafts, and relatively horizontal main drifts and waste emplacement drifts.

The repository subsurface layout consists of main drifts and emplacement drifts with one potential layout for the expansion of the emplacement area within the characterized area shown in Figure 2-3. The repository host horizon is located above the water table in the dry unsaturated zone, consisting of volcanic tuff, to take advantage of the features of the natural barrier (Figure 2-2). Main drifts provide travelways for equipment, personnel, ventilating air, and WPs. Emplacement drifts are the tunnels in which the WPs will be placed. Subsurface access is provided by two inclined access ramps. WP transport into the subsurface facility is via the North Ramp. No waste is moved into the subsurface facility via the vertical shafts. Vertical shafts are exclusively used for ventilation intake and exhaust.

A remotely controlled emplacement gantry is used to emplace the WPs in the emplacement drifts. This gantry is powered electrically by a third rail energized with a direct-current power supply (Figure 2-19).

The emplacement drift spacing for the MGR is nominally 81 m from the center of one emplacement drift to the center of the adjacent emplacement drift (Wilkins and Heath 1999, Enclosure 2, A 2.0). A WP spacing of 10 cm results in an areal mass loading of approximately 60 MTU/acre (Wilkins and Heath 1999, Enclosure 2, B 15.0). A portion of the repository layout shown will accommodate 70,000 MTHM or equivalent (63,000 MTHM CSNF + 640 MTHM or equivalent commercial HLW + 4,027 MTHM or equivalent DHLW + 2,333 MTHM or equivalent DOE SNF)) (CRWMS M&O 2000b, 3.2). Additional inventory can be accommodated in the repository layout shown, if needed and authorized.

The repository layout could include additional emplacement drifts to accommodate additional SNF and HLW if authorized (CRWMS M&O 2000b, 3.2.A and 3.2.B). The total emplacement drift length will be a function of the WP inventory and WP spacing (Wilkins and Heath 1999, Enclosure 2, B 16.0).

The repository is capable of accommodating up to 105,000 MTHM of CSNF and additional DHLW and DOE SNF at a nominal WP spacing of 10 cm.. This would involve an additional 42,000 MTHM of CSNF and 11,250 additional canisters of HLW/DOE SNF above and beyond the inventory described above (CRWMS M&O 1999d, Section 6.4.2.2).

The subsurface facilities will be divided into two sets of waste emplacement drifts called blocks. These are shown graphically in Figures 2-2 and 2-3.

Main Drifts–There will be two different types of main drifts: service main, and exhaust main.

The service main drifts, including the North Ramp, will be used to transport waste to the emplacement drifts and to support service operations. These will be 7.6 m (25 ft) in diameter and provide the inlet ventilation air for the emplacement drifts. The drift size will be large enough to allow waste transport, ventilation, service utilities, and personnel access. The maximum grade in the ramps will be approximately 2.6 percent (compared to Interstate Highway

System grades of up to 8 percent). Including portions of the main drifts constructed during site characterization work, about 33 km (20 miles) of main drifting will be required.

The exhaust main is below the emplacement drifts, approximately perpendicular to them. This drift accommodates the flow of exhaust ventilation after it has passed through the emplacement drifts and down the ventilation raise. It is connected in several locations to the vertical exhaust shafts.

Emplacement Drifts–WPs will only be placed in the emplacement drifts, not in any of the main drifts.

The WPs are emplaced into parallel emplacement drifts having a nominal diameter of 5.5 m (Wilkins and Heath 1999, Enclosure 2, A 4.0). This accommodates large WPs, drip shields, and ground support, while allowing space for handling equipment and adequate clearances and the potential use of backfill if that option is selected in the future.

The WPs are supported on an alloy 22 pallet, supported during emplacement with stainless steel structural members. These pallets are laid on top of the steel invert during emplacement. This invert is filled with granular material as ballast (Wilkins and Heath 1999, Enclosure 2, A 6.0).

The WPs will be positioned in the emplacement drifts with a nominal 10 cm spacing between adjacent WPs (Wilkins and Heath 1999, Enclosure 2, A 8.0). This is referred to as "line loading" and results in less drift excavation and fewer drip shields, than widely spaced ("point loading") WPs. WPs of varying types can be placed adjacent to one another to affect temperature distribution (Figure 2-20).

Each emplacement drift will have two sets of doors at its entrance or one door at its entrance and a control valve at the exhaust raise of the drift. The doors will control access and will have ventilation regulators (or louvers) to control the flow of ventilation air through the emplacement drift. Double doors, if used, will serve as an airlock. The opening and closing of the doors will be remotely controlled.

The ground support in the repository drifts will be carbon steel (steel sets and/or rock bolts and mesh). Cementitious grout will be used as necessary to help anchor the rock bolts (Wilkins and Heath 1999, Enclosure 2, A 5.0). This system, installed during the excavation of the facility, provides the means to ensure stability of the subsurface openings during the preclosure period. The steel invert frame and ballast are independent of the ground control system.

Once WPs are placed in an emplacement drift, no human entry into that emplacement drift will be allowed under normal conditions.

2.5 BARRIERS

The features of the repository that contain and isolate the waste are divided into two categories: engineered barriers and natural barriers. The engineered barriers will provide the first means of containment for the waste. The drip shields and the heat from the WPs will keep the WPs dry for thousands of years, which reduces the corrosion rate of the WPs. The components of the WP in the dry environment are intended to confine the waste for tens to hundreds of thousands of years. The drip shield protects the WP from rock falls that could compromise the corrosion barrier of the WP. After the WPs eventually corrode and deteriorate and the engineered barrier function is degraded, the natural barriers will provide another means of isolation. The various rock layers in the potential repository at Yucca Mountain, due to low water content and water movement, will retard the movement of released radioactive material to the accessible environment.

Waste Packages–The MGR is designed to receive, package, emplace, and isolate CSNF, Navy SNF, DOE SNF, vitrified DHLW, vitrified CHLW, and immobilized plutonium waste form (IPWF) in accordance with the Nuclear Waste Policy Amendments Act of 1987, and implementing regulations, at the annual rates bounded by those specified in the MGR RD (CRWMS M&O 2000b, 3.2.C).

The MGR uses a single WP design concept that will be available in sizes to accommodate different waste forms.

The WP is a two layer, right-circular cylinder consisting of an inner shell of stainless steel and an outer barrier of nickel-based alloy ASTM B 575 N06022, hereafter referred to as alloy 22 (Wilkins and Heath 1999, Enclosure 2, A 10.0). The most common size WP will hold 21 PWR fuel assemblies (Figure 2-8).

The proposed WP for co-disposal of DHLW and DOE SNF is shown in Figure 2-10. The co-disposal WP is designed to hold five DHLW canisters arranged around a center position for co-disposal of a canister of DOE SNF. The amount of highly enriched DOE SNF that can be safely disposed of in a single disposal container is limited to reduce the potential for nuclear criticality. Co-disposal of the DOE SNF with the DHLW makes use of additional space in the WP and eliminates the need for very small WPs for highly enriched DOE SNF.

All WPs for uncanistered SNF are designed with internal baskets to provide a framework for holding the fuel assemblies. These baskets ensure a stable, predictable internal geometry for the period of time that the baskets remain intact. In addition to providing secure stability of the assemblies in the WP during handling and emplacement, the baskets serve to assist in criticality control by preventing movement and maintaining local fuel geometry. There are two design options that may be implemented for criticality control. The first is to introduce a parasitic neutron absorber into the basket structure. The second is to fabricate control fingers to insert into the thimbles of PWR fuel assemblies.

Along with the WP, the repository design includes a drip shield installed over the WP at the time of repository closure to provide defense-in-depth for postclosure performance (Stroupe 2000).

2.6 VENTILATION CONCEPT

Each drift segment in the repository will be ventilated during preclosure. The ventilation system is designed to remove at least 70 percent of the heat generated by the WPs from the emplacement drifts during the first 50 years of preclosure (Wilkins and Heath 1999, Enclosure 2, A 12.0). The ventilation flowrate may vary with time to meet thermal performance requirements in the emplacement drift.

The subsurface ventilation system consists of two separate and independent fan systems and flow networks separated by moveable air locks. One system provides air to the development operations area while another system ventilates the waste emplacement operations area. Development of new emplacement areas and emplacement of waste in previously prepared areas, take place simultaneously over a period of approximately 20 years. Air pressure in the development side is always higher than the pressure in the emplacement side. In the unlikely event that radioactive particulates are released into the subsurface airstream on the emplacement side, the pressure differential will prevent the spread of these particles to the development operations area.

The ventilation system and other repository elements are designed such that temperature and radiation values can allow limited-time personnel access for evaluating and remediation planning to deal with operational upset situations (Wilkins and Heath 1999, Enclosure 2, C 20.0).

In the event that subsurface contamination is detected, automated devices will sound alarms and emplacement operations will be shut down until the source of contamination is found and fixed. The combination of the pressure arrangement and the procedural controls will ensure worker safety and protect the environment. Such a contamination event is extremely unlikely, but has been accounted for in the design.

After the excavation activities have been completed, only the emplacement ventilation system will be operated.

2.7 PERFORMANCE CONFIRMATION

By NRC regulation (Dyer 1999, Subpart F), a performance confirmation program must be established during the site characterization phase and continue through all subsequent phases until the repository is closed. The performance confirmation activities must provide data that show subsurface conditions during construction and waste emplacement operations are within limits derived in support of the application for a license to receive and possess waste. It must also show that natural and engineered systems and components are functioning as intended. The performance confirmation approach is divided into a baseline period and a confirmation period.

Activities during the baseline period will develop information on subsurface conditions and natural systems important to postclosure performance. These activities will also monitor and analyze changes in this baseline information as a result of site characterization activities. This information will be used to predict changes resulting from construction and operation. These baseline period activities were begun during the site characterization phase.

Activities during the confirmation period will verify that actual subsurface conditions and changes resulting from construction and operation are within predicted limits. These activities will also verify that the natural and engineered systems and components are functioning as intended and anticipated. This information will be used to support the application sent to the NRC requesting a repository license amendment to permanently close the repository.

2.8 REPOSITORY MONITORING

The repository will be monitored and maintained between the time the first WP is emplaced and the time the repository is permanently closed. Permanently installed and/or temporary sensors will be used to monitor WPs, drifts, and the surrounding rock, and to provide the data required by the performance confirmation activity. Robots will be used as required to investigate conditions in the emplacement drifts. This will eliminate risk to workers from heat and radiation coming from the WPs.

Specific facilities and equipment will continue to be maintained after waste package emplacement to support the performance confirmation activities. Facilities and equipment needed to respond to emergencies and treat low-level waste will also be maintained. Some activities can also be performed to protect a cost effective retrieval option. Planning and preparation will be conducted in anticipation of closing the repository.

When emplacement of the waste inventory has been completed, and when it has been determined that the repository will perform as expected, an amendment to the repository license will be sought to close the facility.

2.9 REPOSITORY CLOSURE

Closure is a process intended to place the repository in a configuration that will require little or no human support to continue to isolate the waste for hundreds of thousands of years. The process includes installing the drip shields, sealing all openings to the subsurface repository, dismantling the surface facilities, restoring the surface area, and protecting the repository from unauthorized intrusion.

The drip shields will be placed over each line-loaded group of WPs at the time of repository closure. This drip shield is made of Titanium Grade 7 (Wilkins and Heath 1999, Enclosure 2, A 9.0). The drip shield location is shown in Figure 2-20.

Seals–The repository subsurface is designed such that all ramps and shafts can be sealed at the time of repository closure. Plugs and seals will be installed at the surface entrance to the ramps and shafts. The plugs and seals are designed to inhibit future human intrusion into the repository, and prevent the ramps and shafts from providing preferential pathways for water to enter into the repository host horizon or for radionuclides to escape into the biosphere (DOE 1998b, Volume 2, p. O-4).

Decontamination and Decommissioning Of Surface Facilities–During closure operations (following the monitoring phase, or retrieval activities if required), the surface facilities, including contaminated components, will be dismantled and decontaminated, as necessary, to restore the site to near its pre-repository condition.

The surface facilities will be designed to include features that will facilitate final decontamination and dismantling operations. The Waste Treatment Building will serve to support the decontamination and decommissioning activities by providing solid and liquid low-level radioactive waste treatment and packaging for transport to a low-level waste disposal site. Mixed wastes, if generated, will be collected and packaged for transport to off-site licensed facilities for treatment and disposal.

2.10 POSTCLOSURE

Institutional Barriers and Warning Signs–As part of the closure activities, detailed records and information on the repository will be distributed to government offices at the local, state, and national level. These government offices will use this information and legal means (such as laws, permits, and zoning) to control access to the site, thus creating institutional barriers. Fences and warning signs will be maintained and modified as required. Permanent monuments will also be put in place.

There are two arguments regarding permanent monuments. The first argument is that, after the institutional barriers have stopped functioning, a monument will serve to identify the location where something of value is buried, thus inviting excavation and the release of radioactive material. The other argument is that a properly designed monument will warn future generations away from the site long after the institutional barriers have disappeared.

The materials used for marker construction must be durable but not be attractive for souvenir hunters or recyclers. Good candidates are:

- Synthetic rock (SYNROC-B) with glass-like properties
- Mortar patterned after an ancient lime
- Mortar similar to that found in the great pyramids
- Natural rock such as granite
- A type of concrete that has survived for more than 5,000 years from ancient civilizations

A vault could be constructed within a central marker to contain more details about the location and characteristics of the repository. This information would be supplementary to the institutional barriers.

Postclosure Performance–During the first few thousand years after closure the protection of the drip shield and the heat released from the emplaced waste, together with naturally low water movement within the rock, will limit the moisture near the WPs so that they are protected from corrosion. During this time, some of the hazardous radioactive material will decay to very low levels. After most of the heat has dissipated, liquid water could return and contact the WPs. When corrosion of the WP finally allows water to contact the enclosed waste material, it is expected to be in very small quantities, which will limit how much radioactive material could be picked up and removed from the WP. Human intrusion into the repository and disruptive events, such as vulcanism, could also affect the mobility of radioactive material in the future.

Approximately 200 m (660 ft) of unsaturated rock separate the repository and the water table. Given the small quantities of water expected to contact the waste and the long distances that must be traveled, only a small amount of the very long-lived radioactive material could be present at any given time in the future in quantities that could be of concern. If these small quantities of radioactive material were to enter the saturated zone, where volumes of water are moving to the southeast from Yucca Mountain, the likelihood of an excessive environmental hazard is very low within the expected regulatory time period. The amount of radiation that could eventually occur at an inhabited location would be comparable to or less than the naturally occurring background radiation at that location.

2.11 BASELINED MGR DESIGN CHARACTERISTICS

Those items shown in Table 2-1 that have been described in this section are included in the Technical Design Baseline in support of the SR. All other information in this section is provided for information only and is not considered part of the technical baseline.

Table 2-1. Baselined MGR Design Characteristics

Design Characteristics	PDD Location
The waste emplacement area for the 70,000 MTU case is approximately 1,100 acres, and for the 97,000 MTU case is approximately 1,500 acres	2.2
WP loading and sealing takes place in facilities located near the North Portal	2.2
Emplacement drifts will be at least 200 m below the surface and at least 100 m above the water table	2.2
The loaded WPs are transported from the surface facilities to the entrance of the emplacement drifts in a shielded transporter connected to an electrically powered locomotive	2.3
The nominal areal mass loading of the repository is 60 MTU/acre	2.4
All non-emplacement drifts, shafts, boreholes, and ramps will be backfilled and sealed during the closure phase	2.9
WPs will employ three closure lids in their design	Figures 2-8, 2-9, 2-10
There are two Assembly Transfer System wet lines for handling uncanistered waste, and one Canister Transfer System dry line for handling canistered waste	2.3

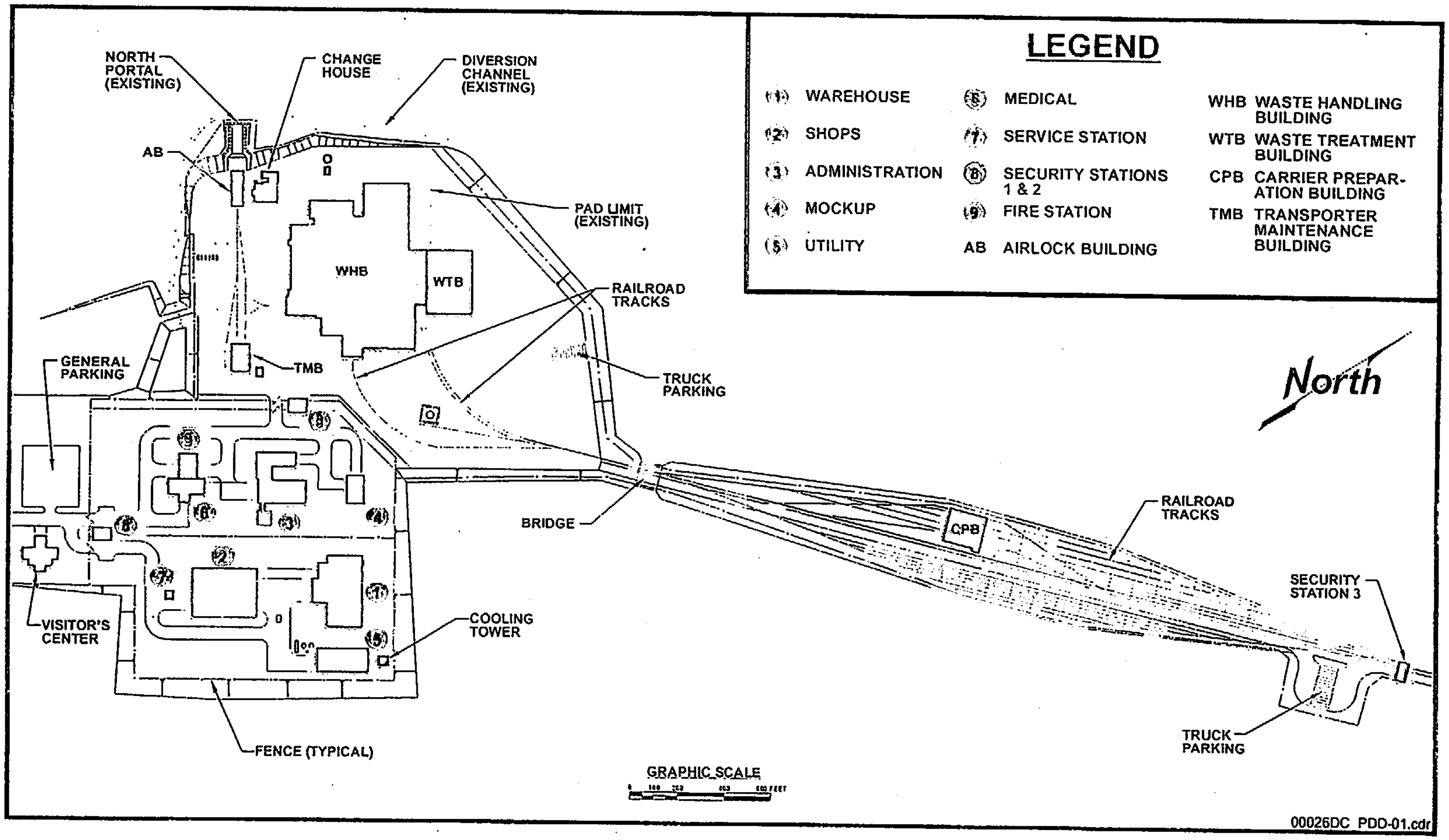
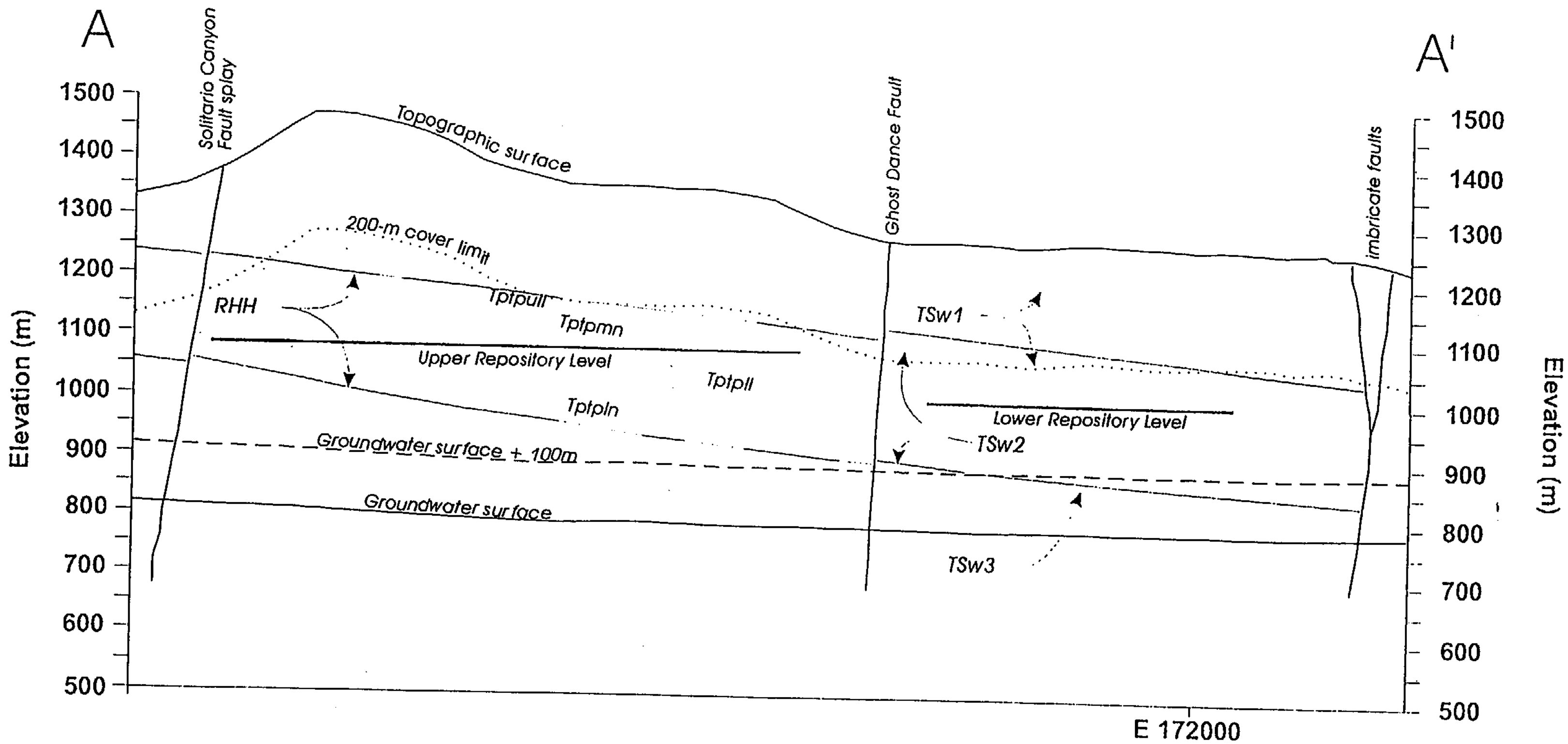
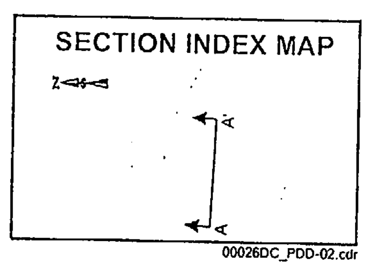


Figure 2-1. North Portal Surface Facilities





RHH = Repository Host Horizon
TSw1 = TSw1 Thermal/Mechanical unit
TSw2 = TSw2 Thermal/Mechanical unit
TSw3 = TSw3 Thermal/Mechanical unit
Tptpull = lower part of upper lithophysal zone
Tptpmn = middle nonlithophysal zone
Tptpll = lower lithophysal zone
Tptpln = lower nonlithophysal zone

Figure 2-2. Yucca Mountain Stratigraphy

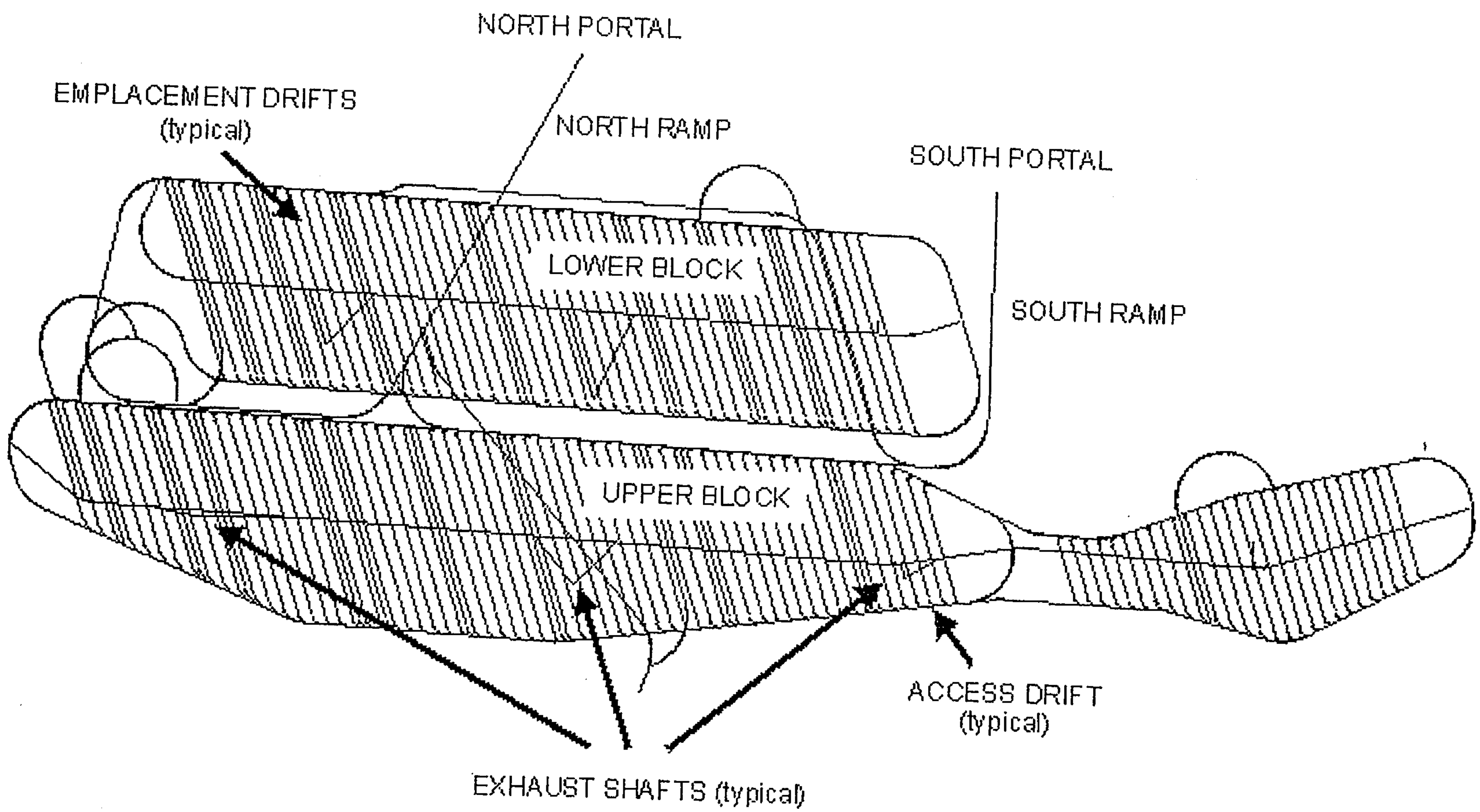


Figure 2-3. Subsurface Conceptual Layout

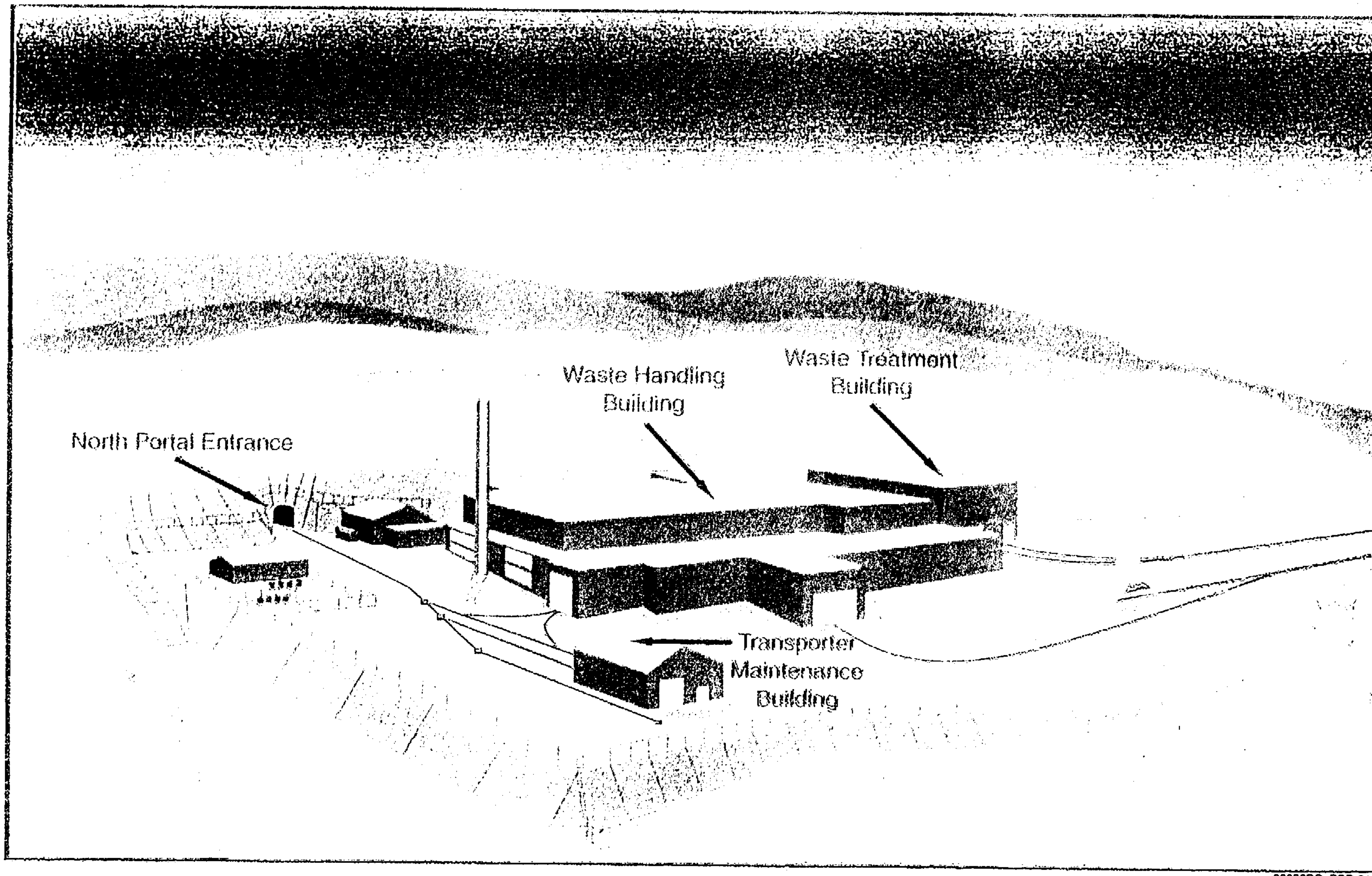


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Figure 2-4. Surface Facility: Protected Area

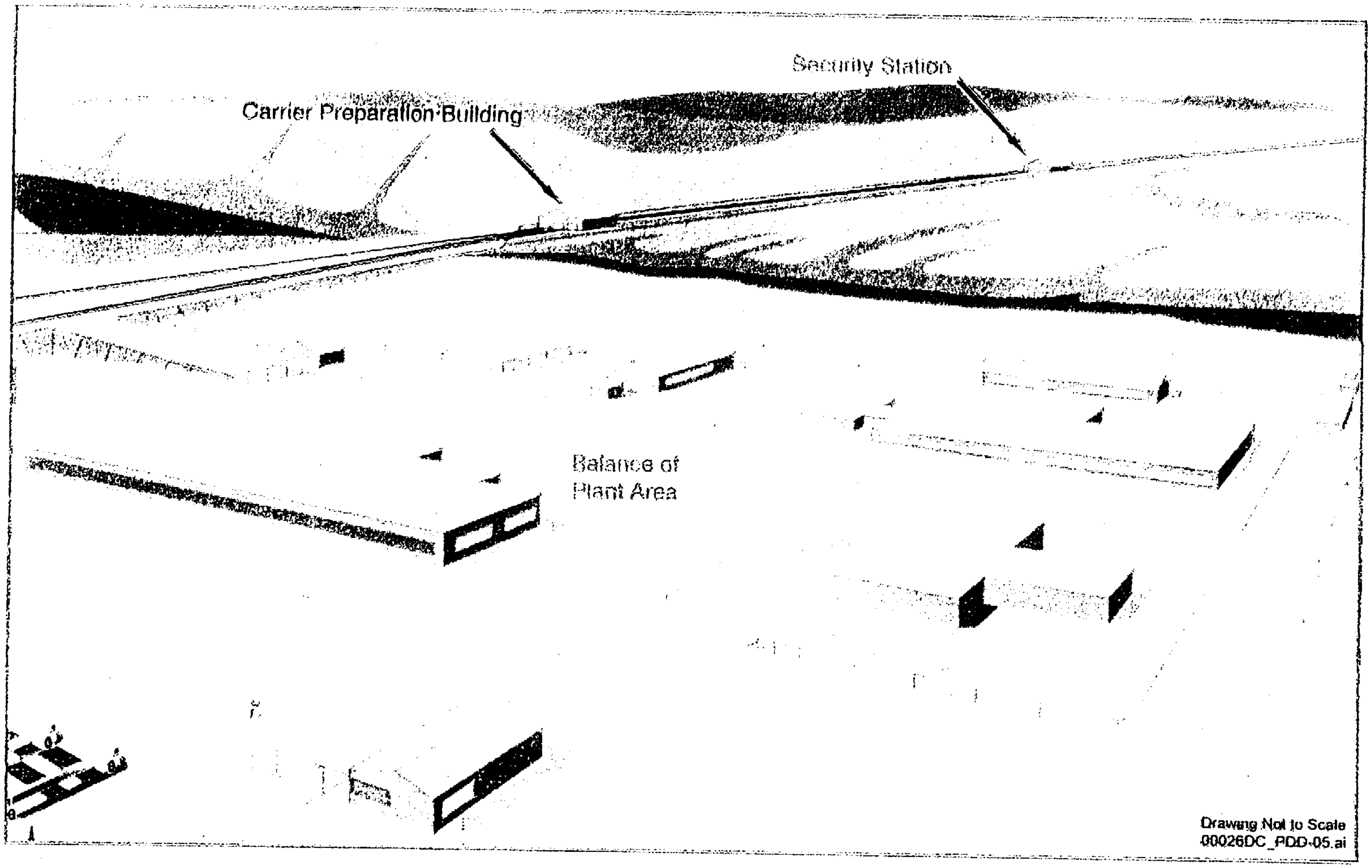


Figure 2-5. Surface Facility: Balance of Plant

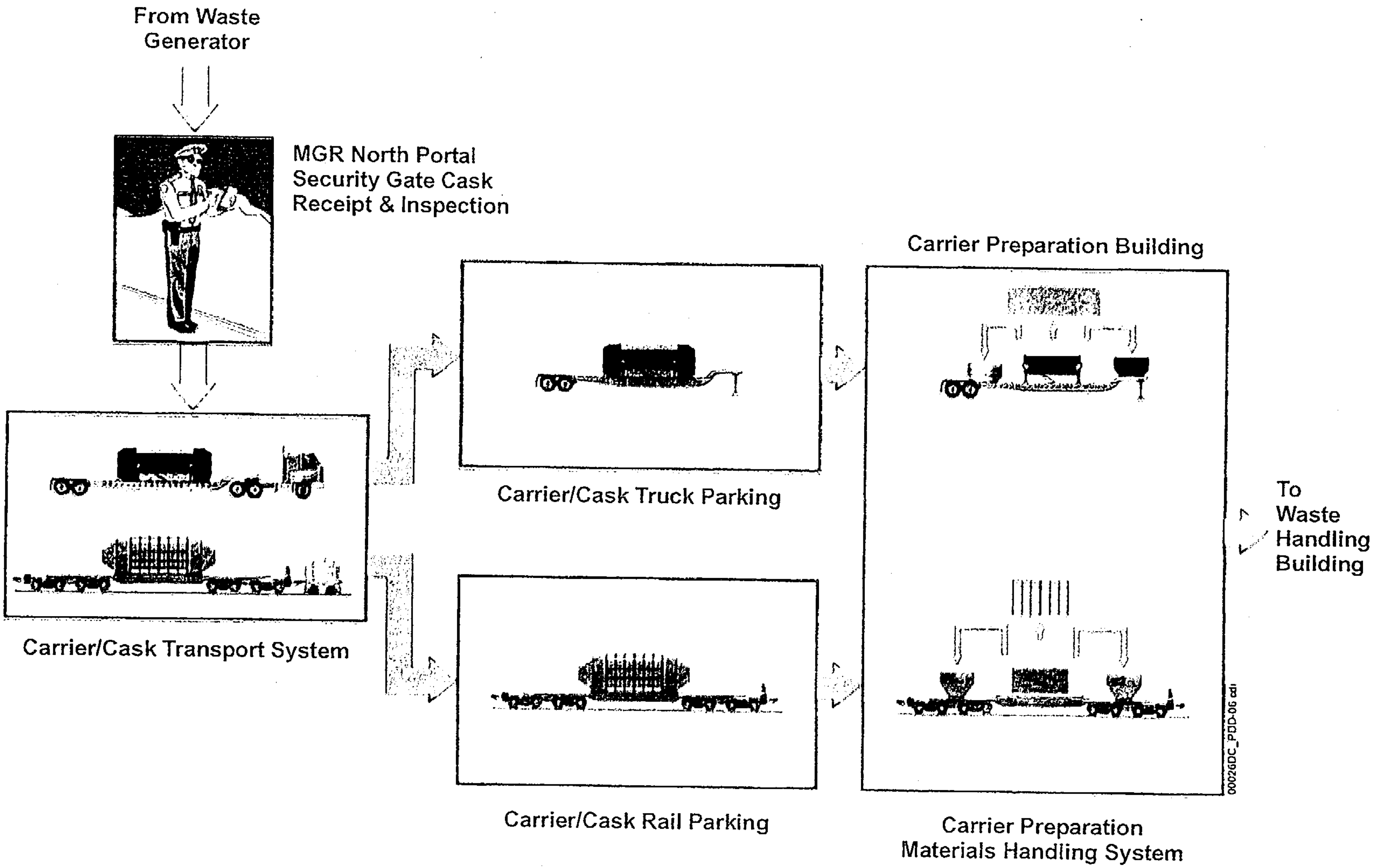


Figure 2-6. Carrier/Cask Transport System to Waste Handling Building

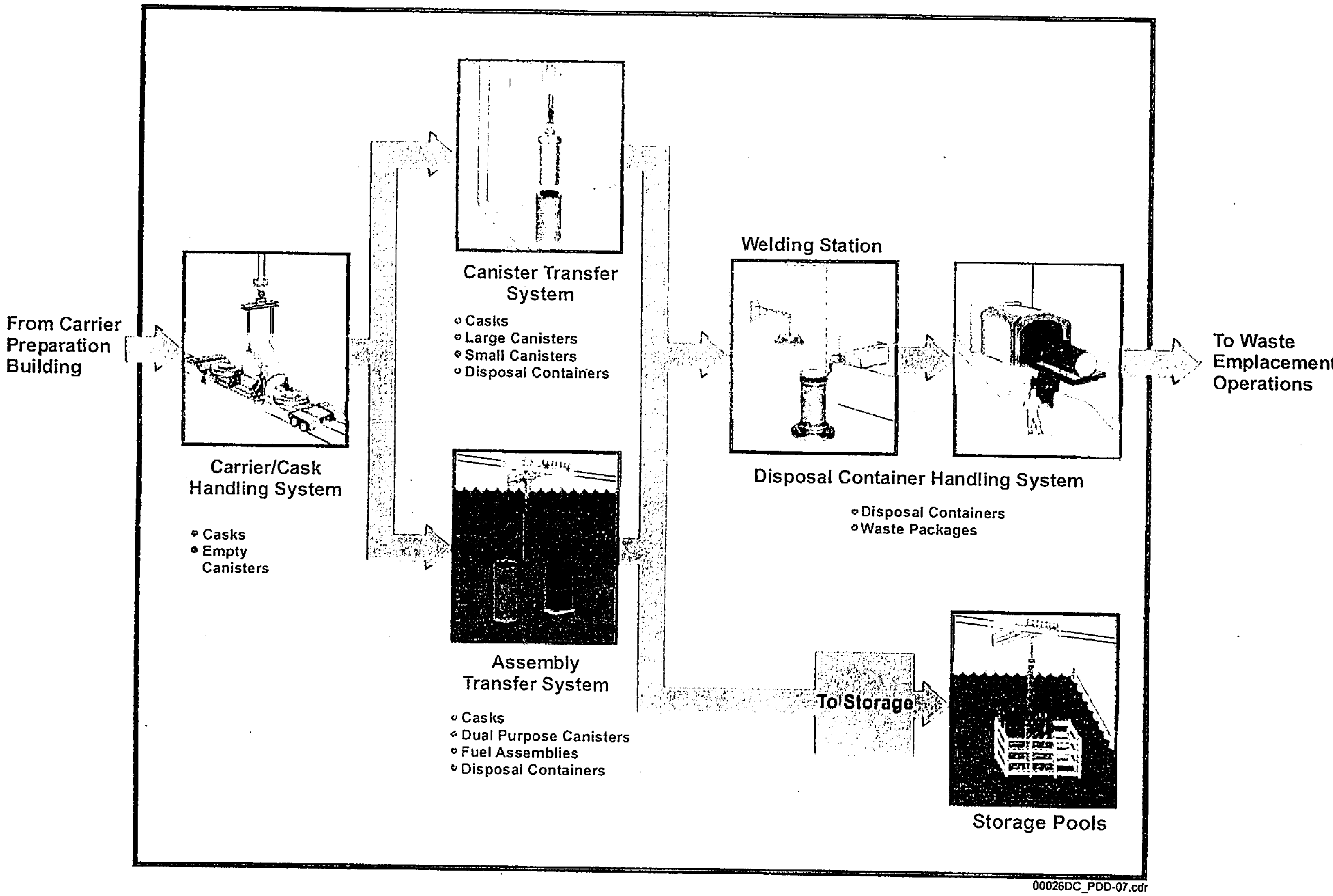


Figure 2-7. Carrier Preparation Building to Waste Emplacement Operations

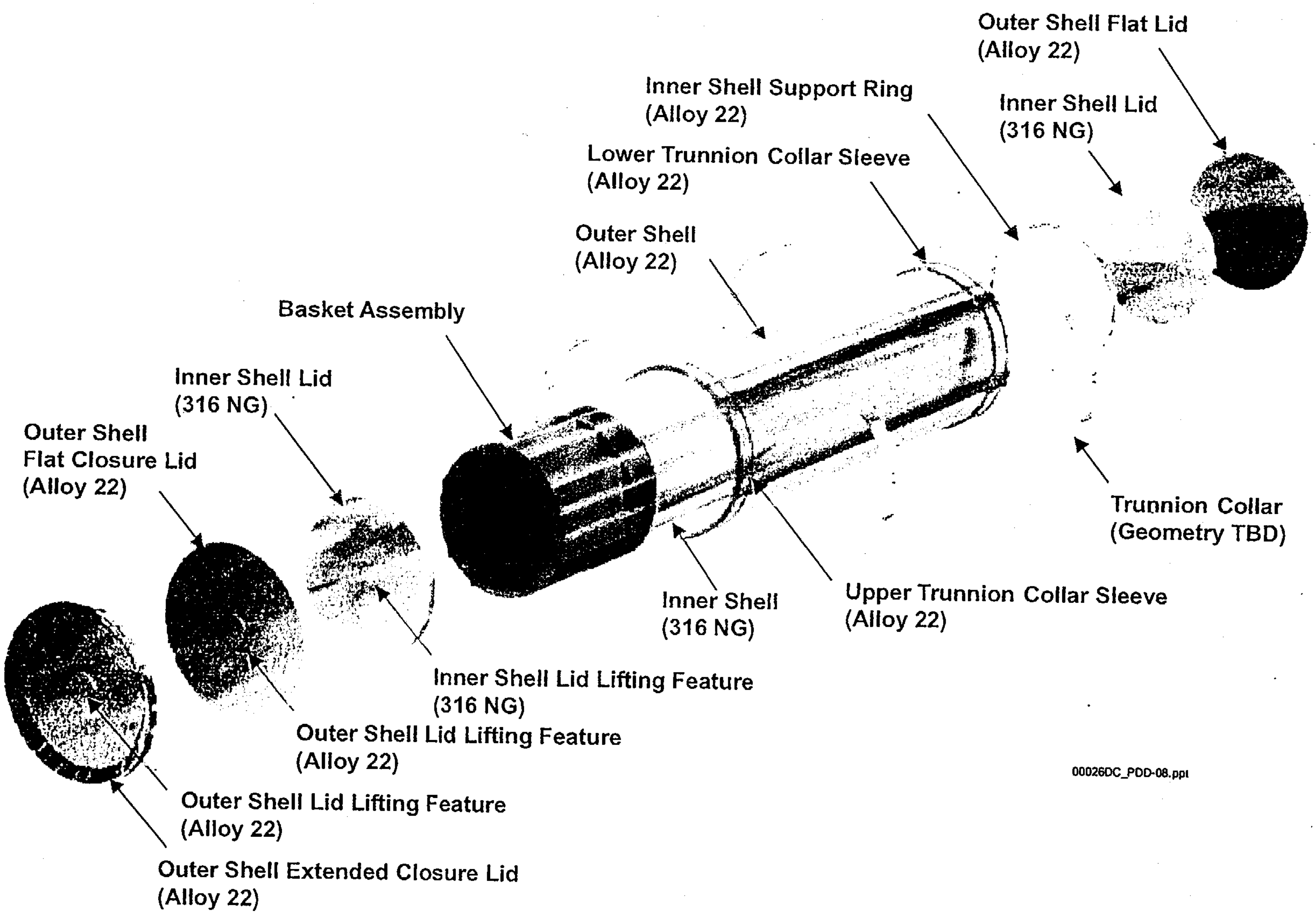


Figure 2-8. Uncanistered CSNF Waste Package

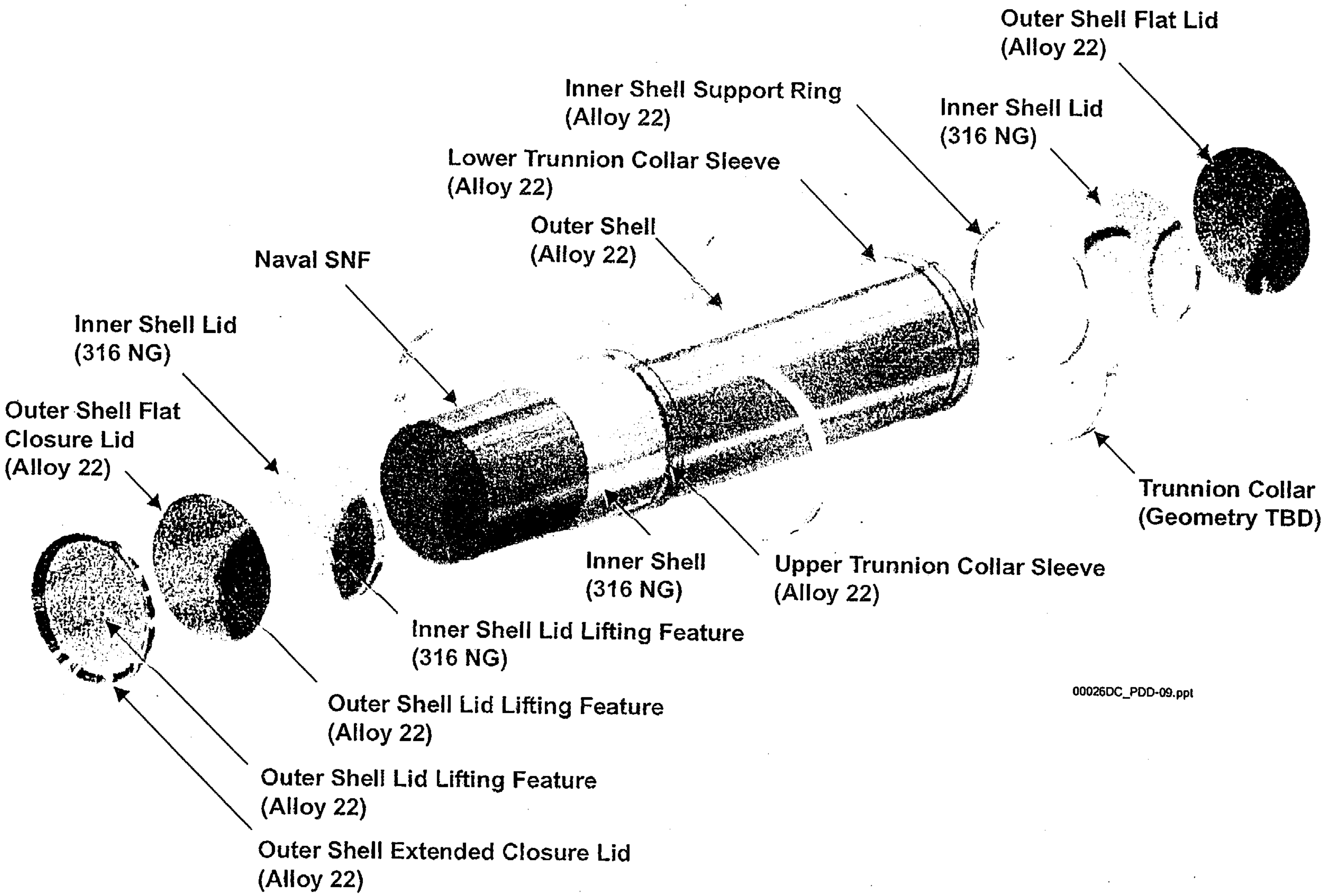


Figure 2-9. Canistered CSNF/Naval SNF Waste Package

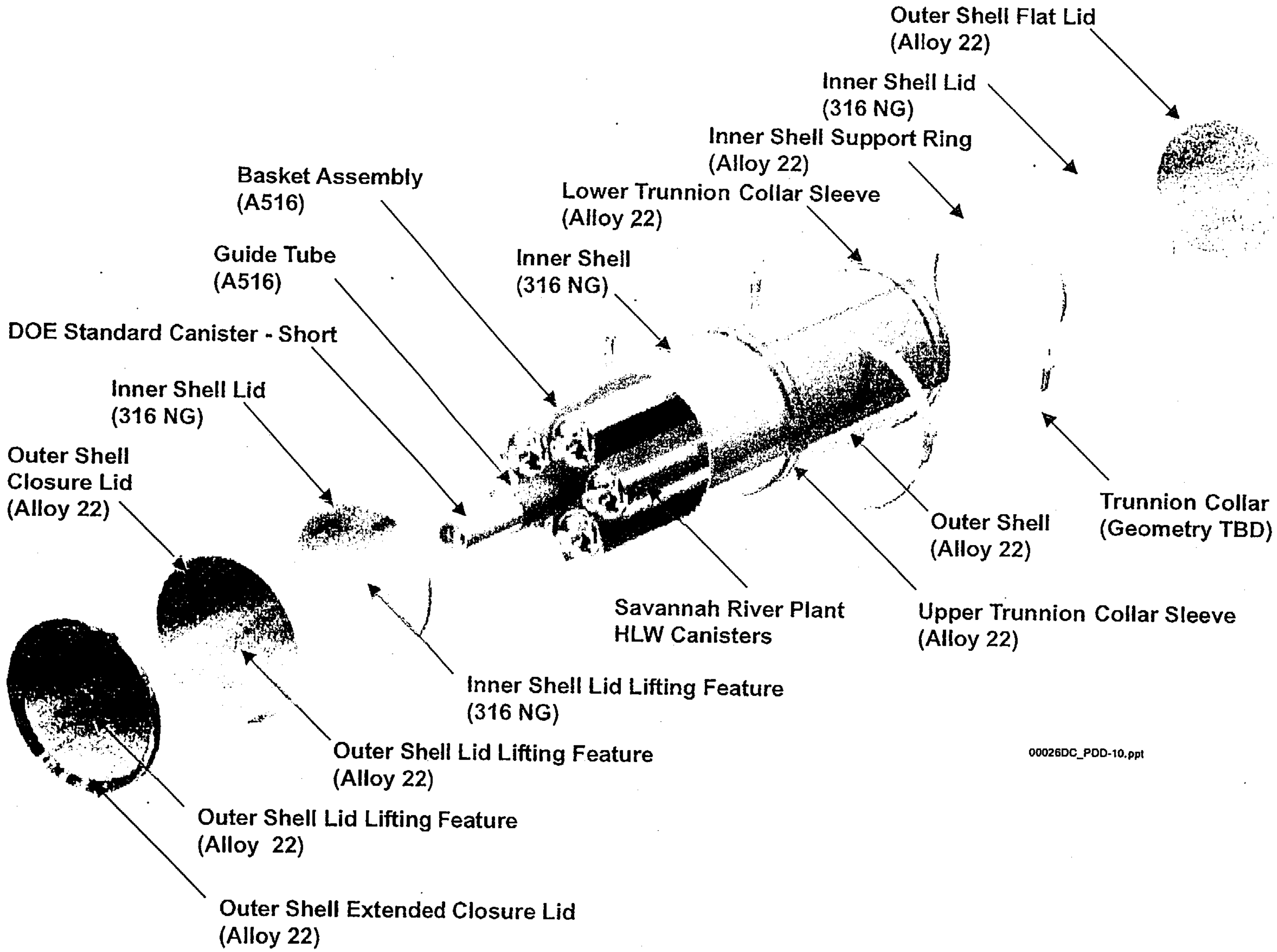
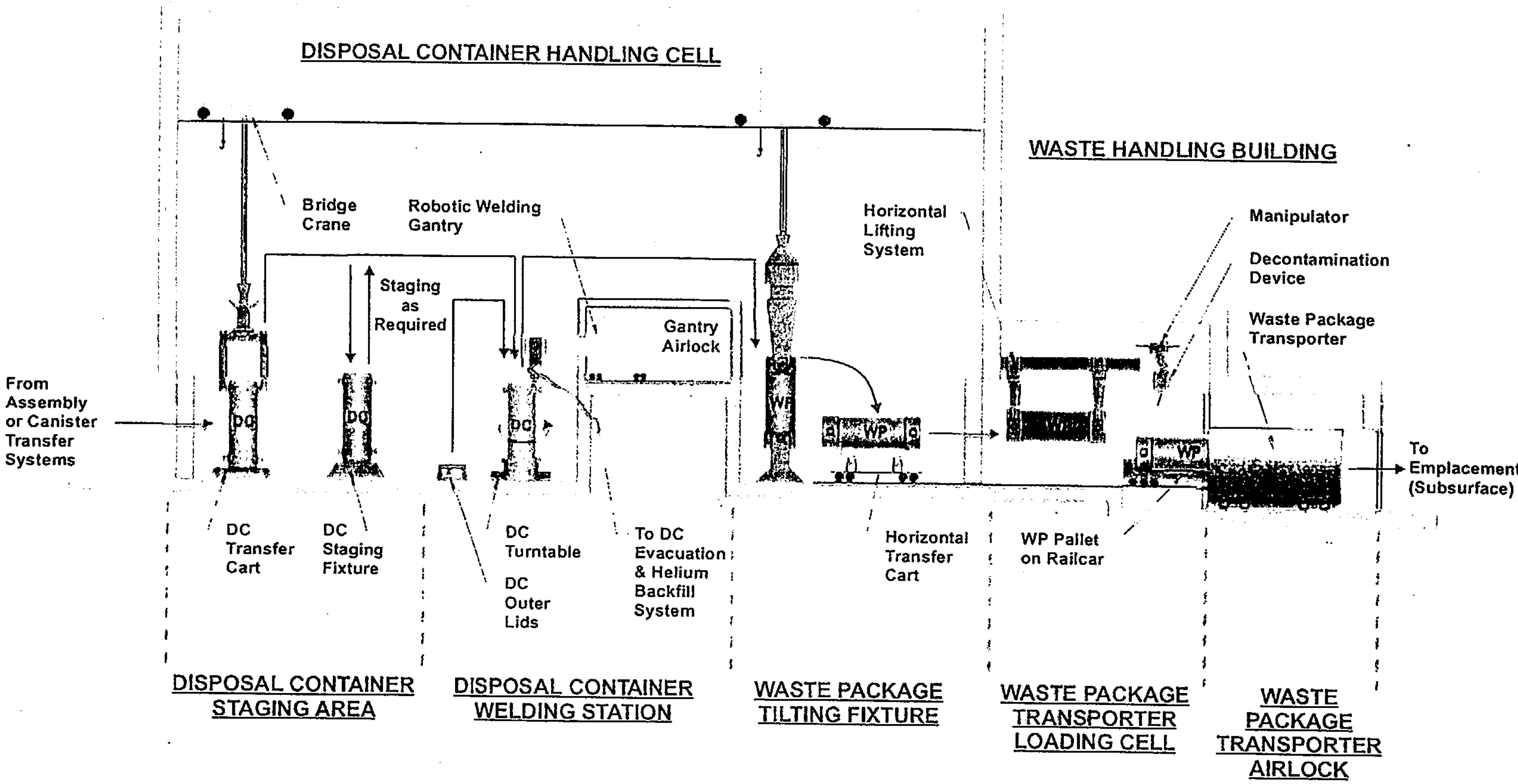


Figure 2-10. DHLW and DOE SNF Waste Package



DC - Disposal Container
WP - Waste Package

Figure 2-11. Disposal Container Handling System

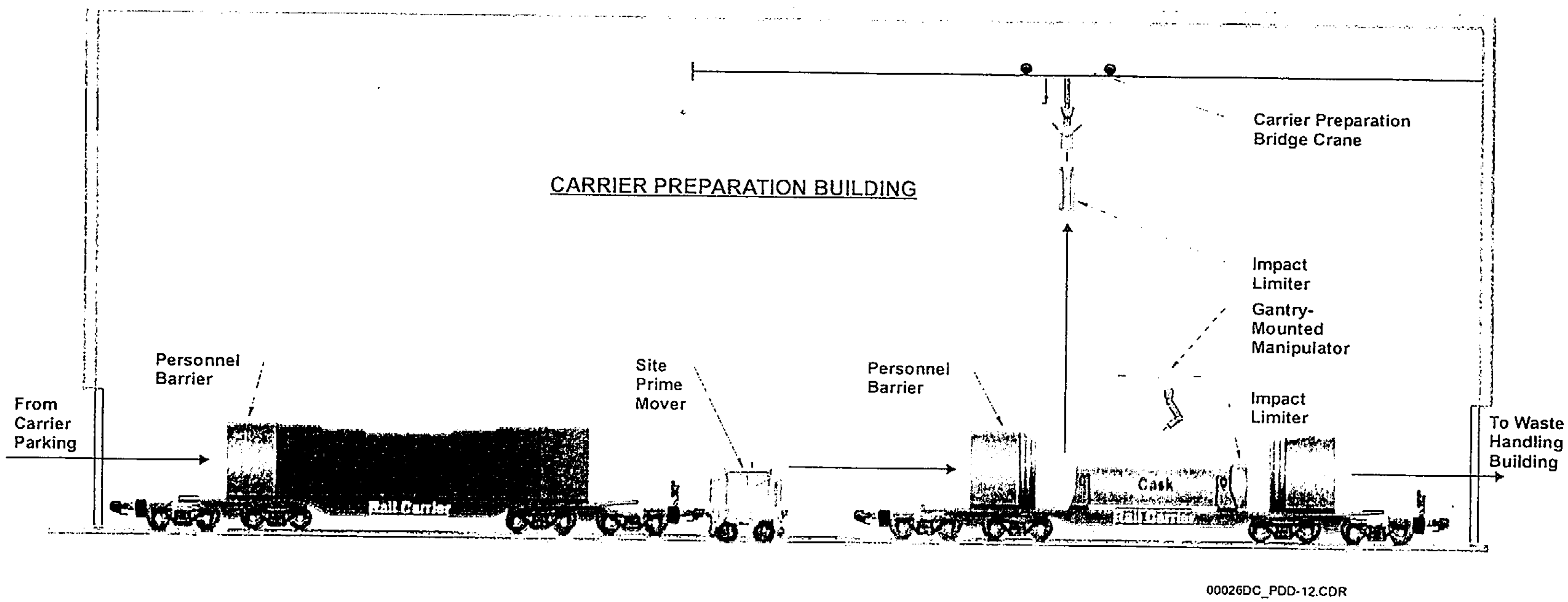


Figure 2-12. Carrier Preparation Building Materials Handling System

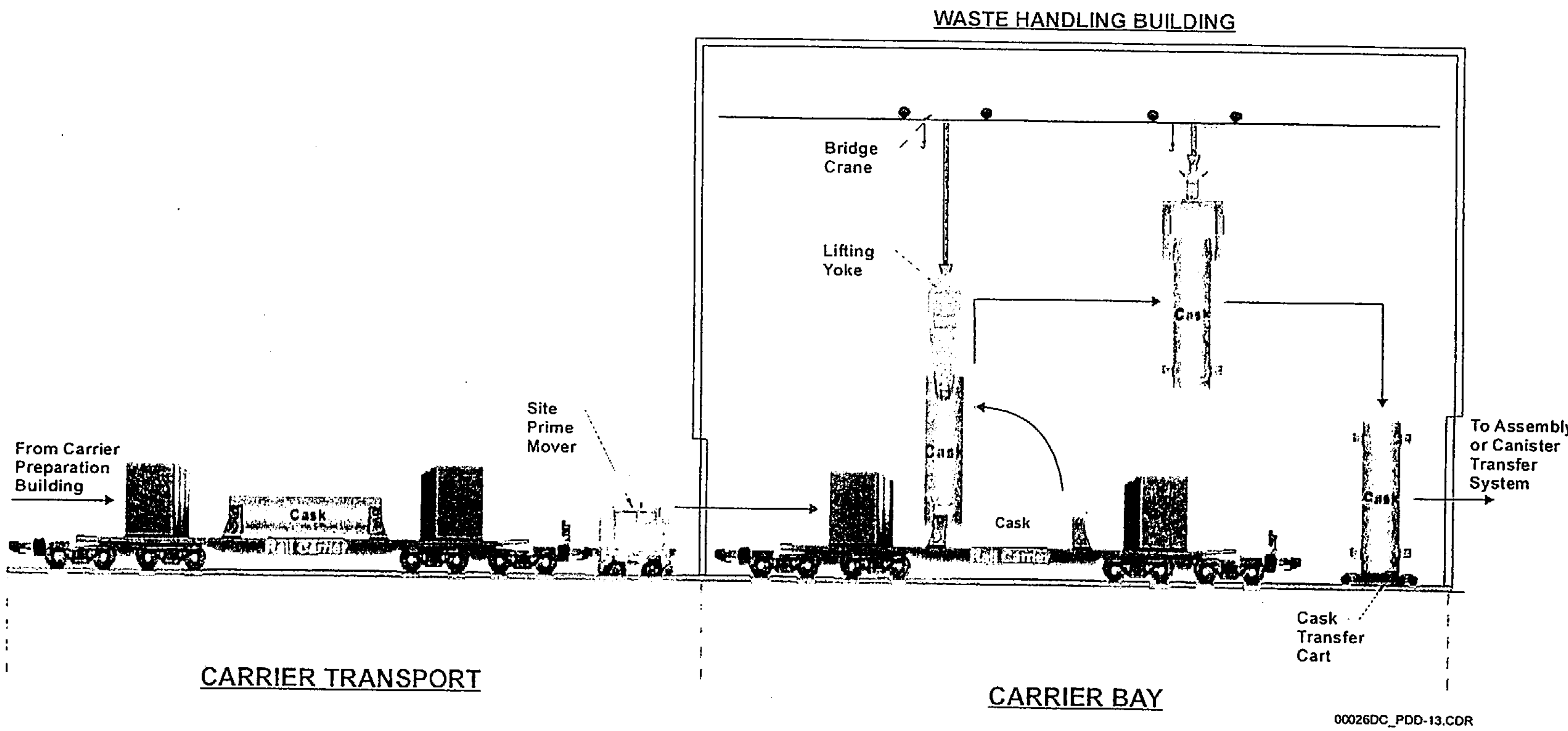


Figure 2-13. Carrier/Cask Handling System

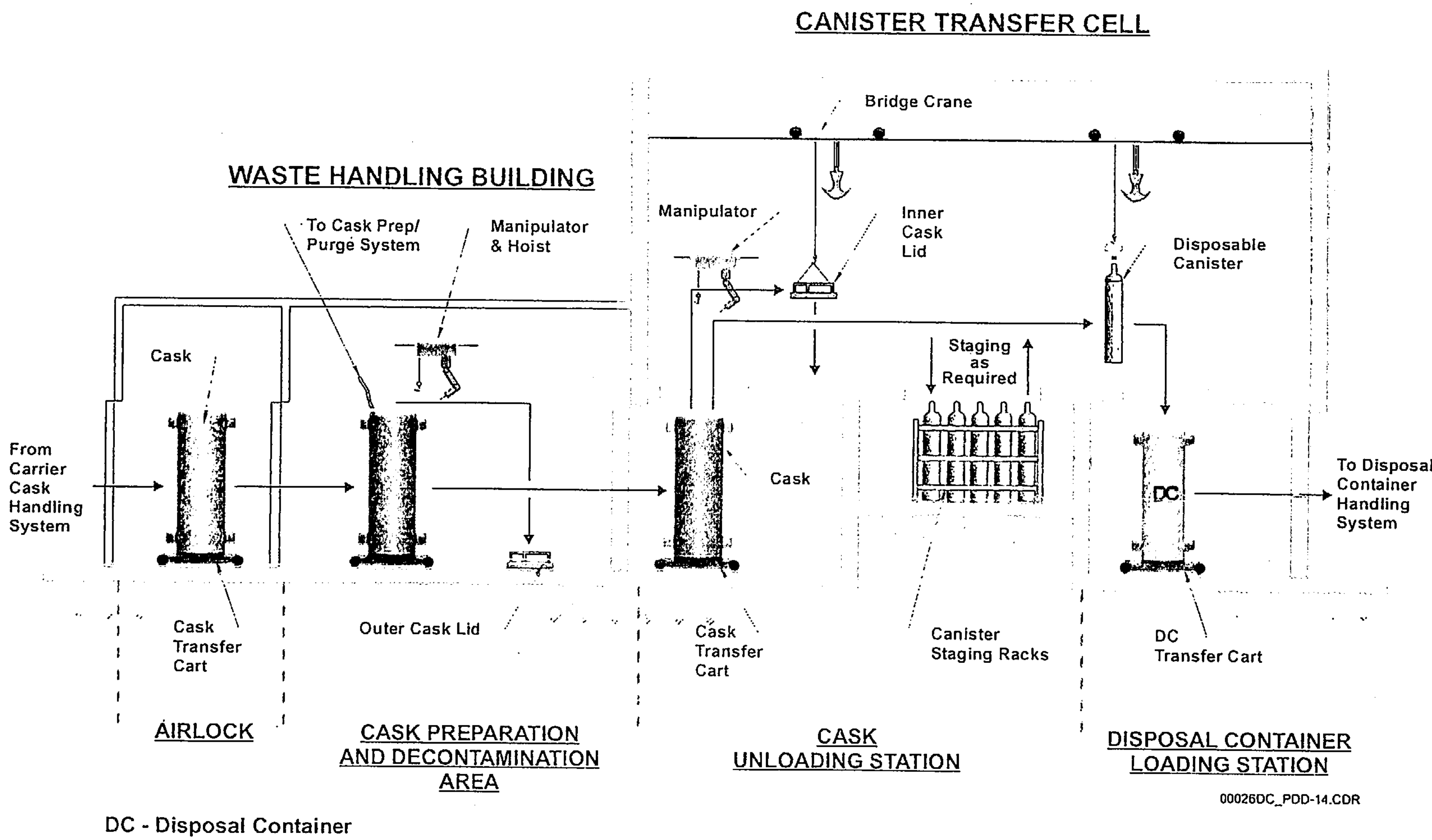
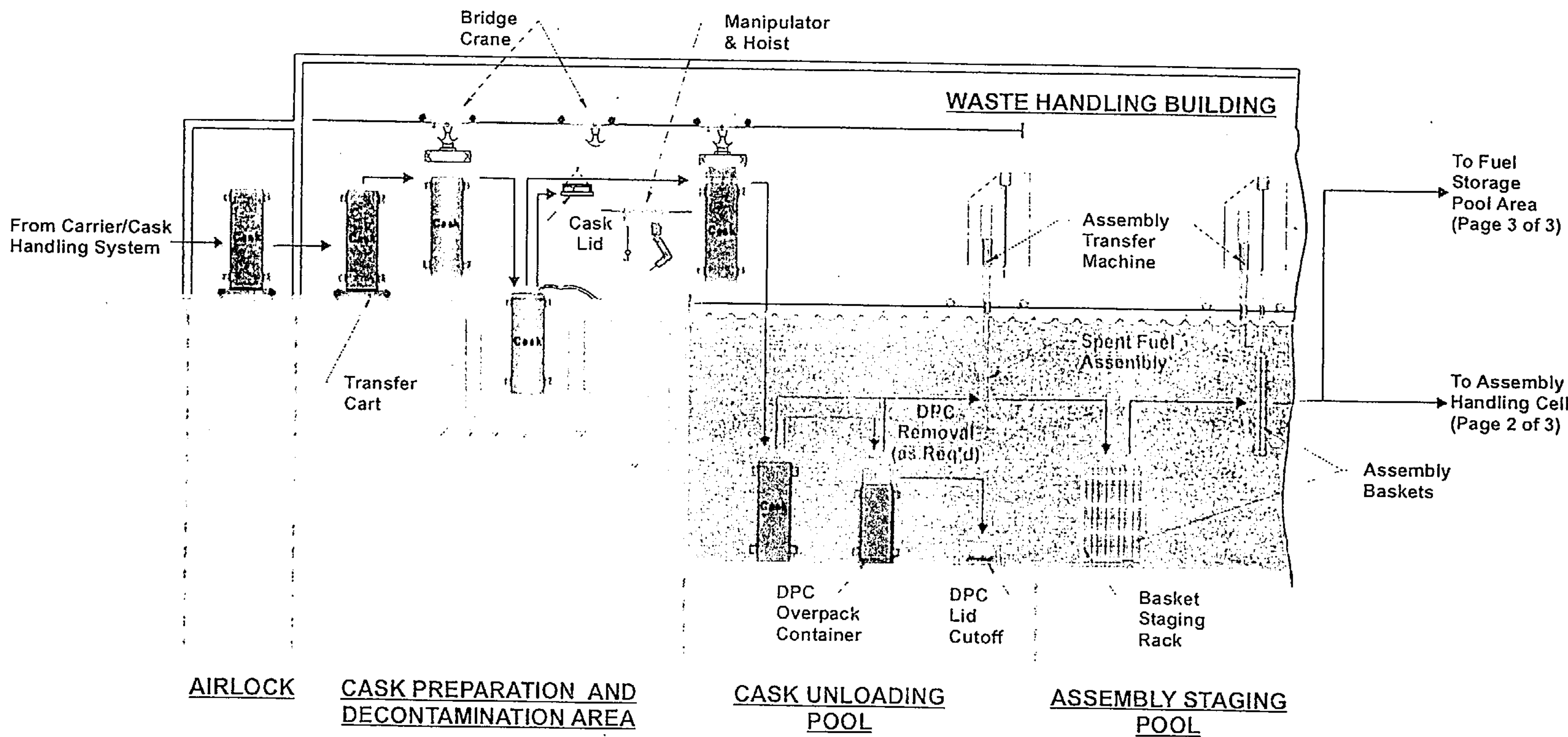
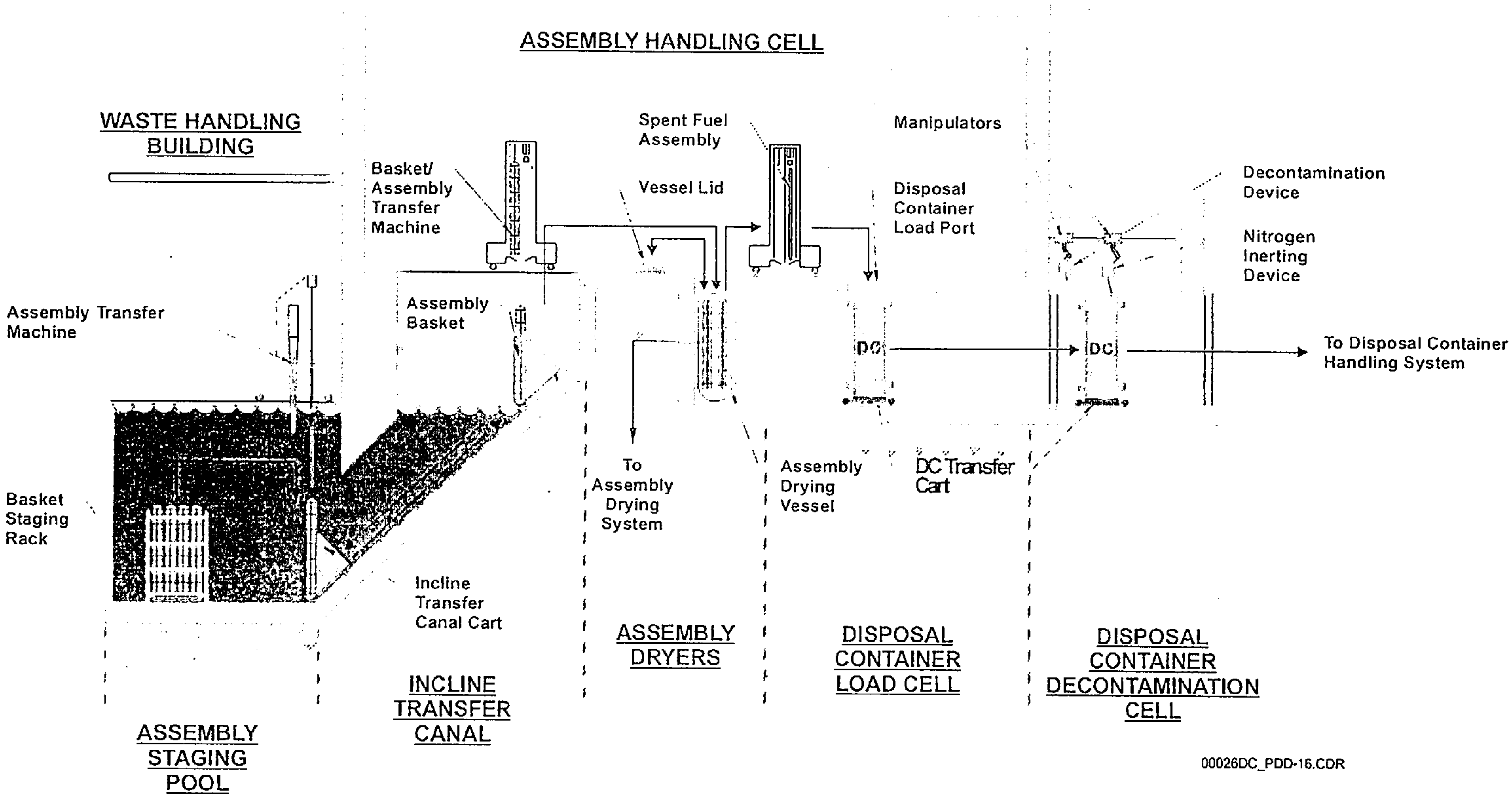


Figure 2-14. Canister Transfer System



DPC - Dual Purpose Canister

Figure 2-15. Assembly Transfer System-1



DC - Disposal Container

Figure 2-16. Assembly Transfer System-2

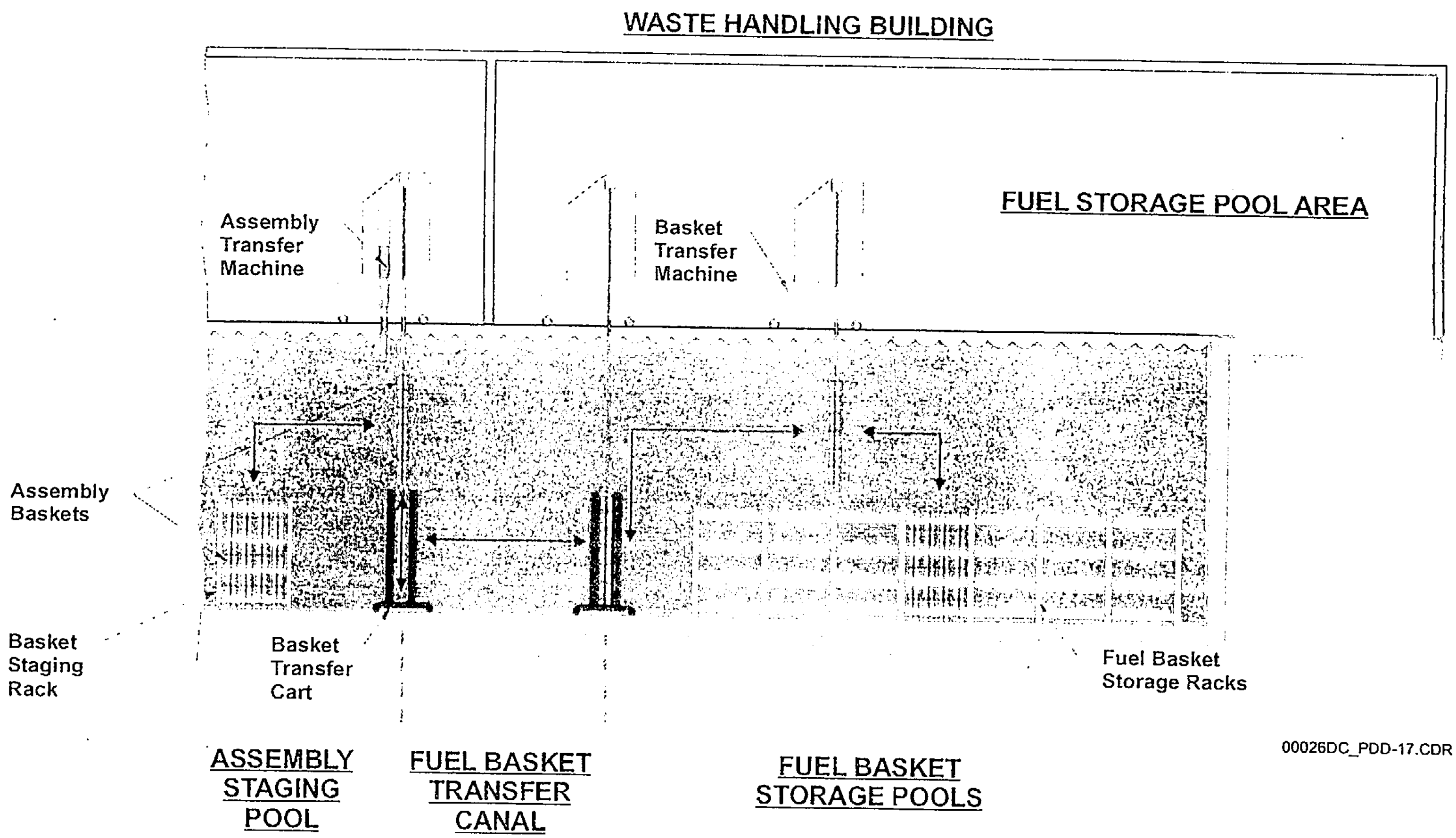


Figure 2-17. Assembly Transfer System-3

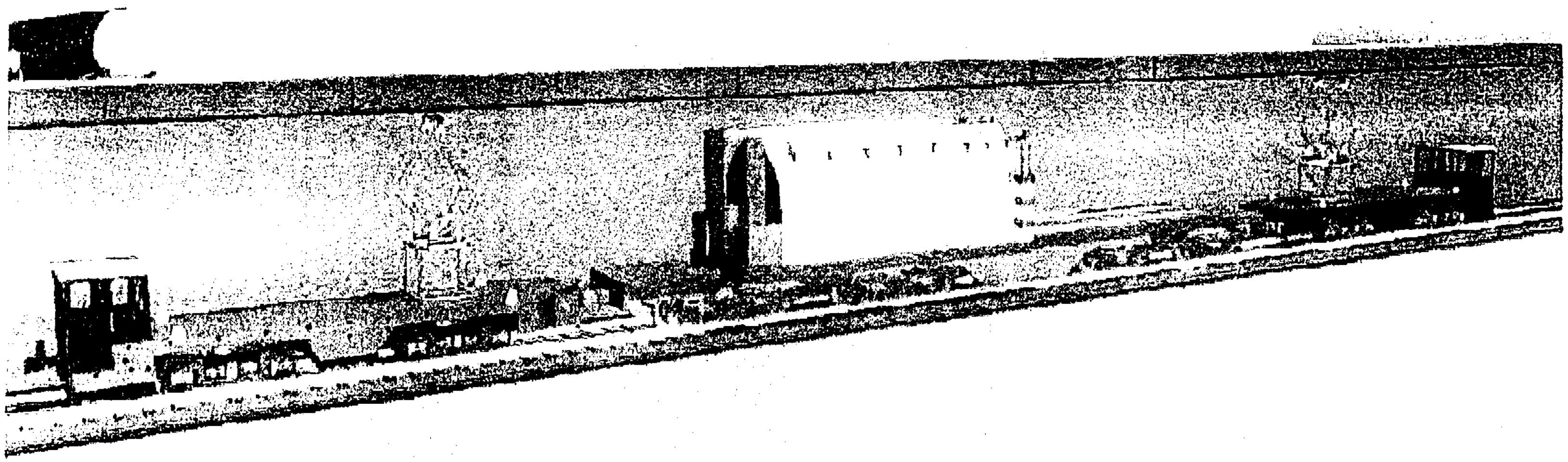


Figure 2-18. Transporter

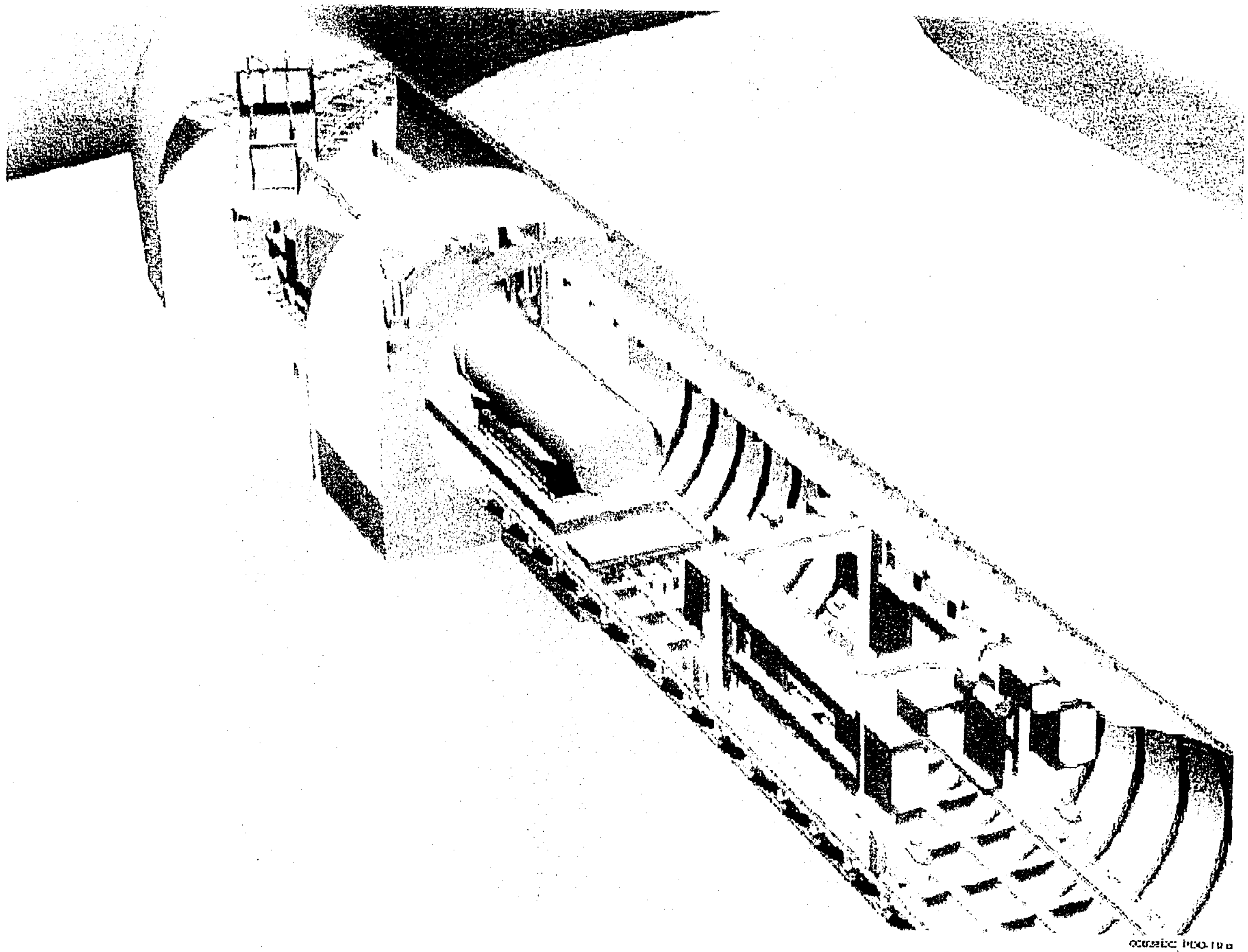


Figure 2-19. Emplacement Drift Gantry

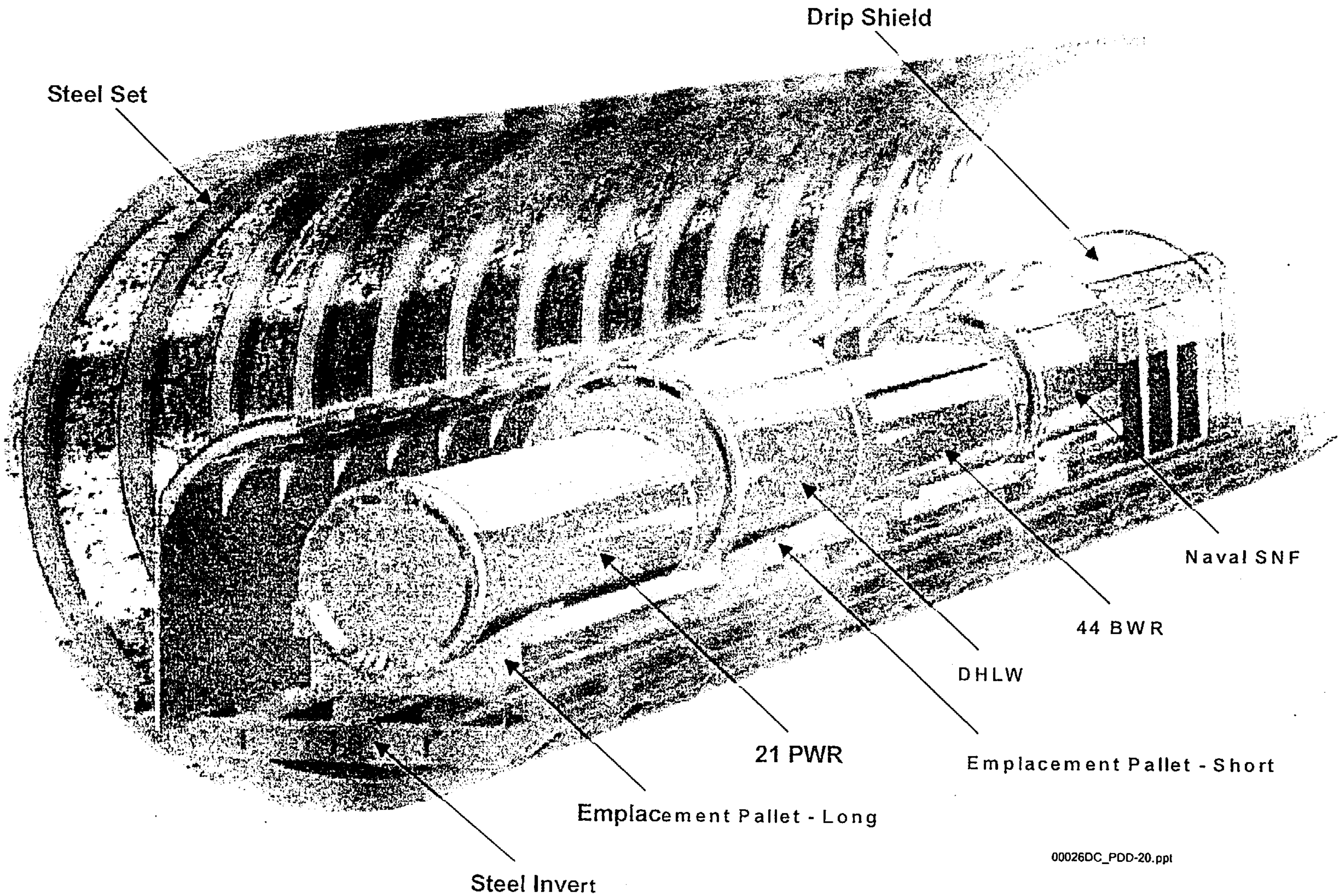


Figure 2-20. Typical Emplacement Drift Arrangement

3. MGR SAFETY

3.1 PRECLOSURE SAFETY

This section to be completed in a subsequent revision.

3.2 POSTCLOSURE SAFETY

The issue of postclosure safety is based on protecting the public from any unreasonable long-term risk after permanent closure of the repository. This long-term risk is identified as potential exposure to radionuclides (contained within the initially emplaced waste or decay products of those radionuclides) that could eventually mobilize and migrate to the accessible environment. There are two categories of radionuclides that would dominate long-term performance (CRWMS M&O 2000a, p. v).

Categories of Radionuclides

The first category includes those radionuclides sufficiently insoluble that only trace amounts can dissolve into the water that might seep into the repository. This comprises the vast majority of the radionuclides that would be in the repository. In addition to these radionuclides' limited solubility, sorption and other natural processes retard their movement in the rock and dilute their concentration at the site (CRWMS M&O 2000a, p. v).

The second category includes the small fraction (less than 0.004 percent) of radionuclides that are relatively soluble and those that might attach to colloids. There is potential that these might become mobilized and migrate through the rock if exposed to liquid water. Risk from these radionuclides is eliminated if the waste is not exposed to water (CRWMS M&O 2000a, p. v).

Postclosure Principal Factors

The postclosure safety issue will focus on the following principal factors (CRWMS M&O 2000a, p. v):

- Limited seepage of water into the emplacement drifts
- Performance of the drip shield
- Performance of the WP
- Solubility limits of dissolved radionuclides in Yucca Mountain water
- Retardation of radionuclide migration in the unsaturated zone
- Retardation of radionuclide migration in the saturated zone
- Dilution of radionuclide concentrations during migration

Additional features, processes, and events that have potential to disrupt the repository system will also be addressed, but are not considered principal factors (CRWMS M&O 2000a, p. vi).

The current understanding of the postclosure safety case strongly suggests that an adequate basis for judging the postclosure safety of the repository exists. This safety case will continue to evolve and mature as future work is accomplished. A completed safety case will be available in time to support the site suitability and licensing decisions (CRWMS M&O 2000a, p. vii).

3.3 SDD SAFETY CLASSIFICATION

This section to be completed in a subsequent revision.

4. ARCHITECTURE, FUNCTIONS, AND INTERFACES

4.1 MGR ARCHITECTURE

The identification, structure, and relationships of the items in the MGR Architecture are considered to be part of the technical baseline. The MGR Architecture captures, by logical groupings, the hierarchical arrangement of the MGR project design and represents the physical system that will meet MGR requirements. The structures, systems, and components (SSCs) included in the architecture are controlled by the Preclosure Safety and Systems Engineering Section.

SDDs are key system documents for defining and describing the MGR. Because of the importance of SDDs to the development of the MGR design, any system requiring an SDD is shown within the MGR Architecture. Further architecture decomposition of those systems into their subsystems, components, etc., is captured in the SDDs as part of the design process. A list of system designators is given in Appendix A.

In general, repository operational activities are not controlled through the Configuration Management Program and do not lend themselves to a physical architecture. Many activities do identify requirements that must be met by the MGR design. These requirements typically become part of the design input for an SDD and are traceable through design output products that can be directly related to the physical architecture.

Although the Natural Barrier System is included in the top-level architecture, no further decomposition of its characteristics is provided at this time. Descriptions of the Natural Barrier System are captured in the scientific database and provided as design input as discussed above. Most construction and development activities do not lend themselves to the architecture because of the temporary nature of those activities.

If Yucca Mountain is found suitable as a repository site, some parts of the Exploratory Studies Facility will likely become permanent parts of the MGR. Those permanent SSCs will be integrated into the MGR Architecture. The architectural element called Exploratory Studies Facility is not currently a part of the MGR architecture.

- The MGR Architecture is depicted in Figures 4-1 through 4-4. These figures were taken from the *Monitored Geologic Repository Architecture* (CRWMS M&O 1999i, Figures A-1 through A-4). Figure 4-1 shows the architecture breakdown to Level 4. Figures 4-2, 4-3, and 4-4 show the architecture breakdown to Level 5. An SDD will be written for each architecture Level 5 system.

All systems in the MGR Architecture (CRWMS M&O 1999i) have a unique three-letter system designator that is shown in each block. This designator will be included in document identifiers to enable traceability of information and activities to the affected systems.

4.2 PERFORMANCE FUNCTIONS

4.2.1 Introduction

An effective method of identifying requirements associated with the operation of a system is the development of flow charts with Performance Functions that define the operational flow of the products. These flow charts show dependencies between the elements of the system architecture when the elements are performing in accordance with the operations concept depicted for the system. From these interfaces, as well as from the actual flow chart functions, requirements are defined that are then allocated to the appropriate system architecture elements and that ultimately impact the system design.

4.2.2 MGR Functional Flow

The MGR functional flow is shown in Figure 4-5. The transportation casks arrive at the gate to the MGR via the Waste Acceptance and Transportation element.

The Waste Handling System processes the transportation casks, the carriers, and the SNF and HLW for emplacement, then emplaces the SNF and HLW in the Emplacement Drifts.

The disposal container fabricator delivers disposal containers to the Waste Handling System for loading with SNF and HLW. The disposal containers are manufactured and delivered to the Waste Isolation System via the Waste Acceptance and Transportation element.

Once the SNF and HLW are loaded into disposal containers and the resulting WPs are emplaced in the Emplacement Drifts, the Waste Isolation System function monitors and analyzes the condition of the WPs and the response of the natural environment resulting from the emplacement operation.

4.2.3 Waste Handling System Process Functional Flow

The Waste Handling System process functional flow is shown in Figure 4-6.

The second level flow chart (Figure 4-6) begins with a reference function, as shown by block reference Ref 1.0, TCs Arrive at MGR. The Carrier/Cask Shipping & Receiving Systems process the transportation casks and carriers to the Waste Preparation Systems. Here the SNF and HLW are processed for emplacement. Waste Emplacement and Retrieval Systems provide the actual emplacement. Block reference Ref 4.0 indicates the disposal container fabricator delivers disposal containers to the Waste Processing System for loading and disposal.

During the processing of the transportation casks, carriers, SNF and HLW, Site Generated Radiological Waste is processed by the Waste Treatment System. Because this is a lower level flow chart, the flow ends with a reference function as shown by block reference Ref 3.0, PC Monitors and Evaluates MGR.

4.2.4 Carrier/Cask Shipping and Receiving Systems Process Functional Flow

Carrier/Cask Shipping and Receiving Systems process functional flow is shown in Figure 4-7. As with the second level flow chart, this (third level) flow begins with a reference function, block reference Ref 2.1, CSR Processes TC & Carriers. From there the flow indicates the transportation casks and carriers are received at the MGR interface with the Waste Acceptance and Transportation element by the Carrier/Cask Transport System and moved to the Carrier Preparation Building System.

The Carrier Preparation Building Materials Handling System prepares the transportation casks and carriers for movement to the Waste Handling Building. Here the transportation casks are separated from the carriers, which are returned to the Carrier Preparation Building for final processing and inserted into the Waste Acceptance and Transportation element.

The transportation casks are moved to the appropriate processing line (i.e., the Assembly Transfer System or the Canister Transfer System) in preparation for removal of the SNF or HLW. The transportation casks are returned to the Carrier Preparation Building for final processing and insertion into the Waste Acceptance and Transportation element.

The flow ends with block reference Ref 2.2, WPS Unloads TCs.

The performance functions will be further developed and incorporated into a subsequent revision of this document.

4.3 INTERFACES

This section will be prepared in a subsequent revision.

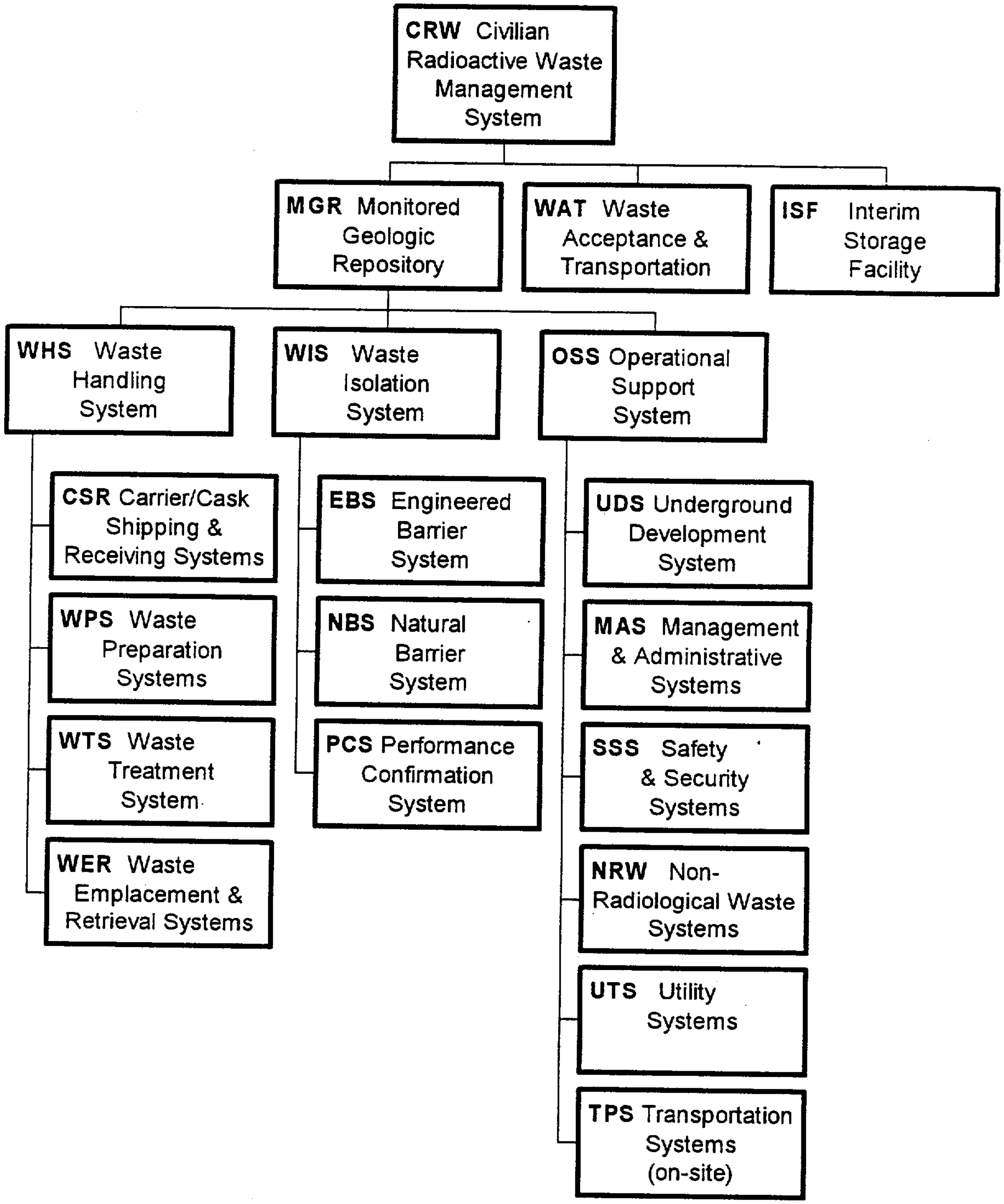


Figure 4-1. CRWMS Architecture

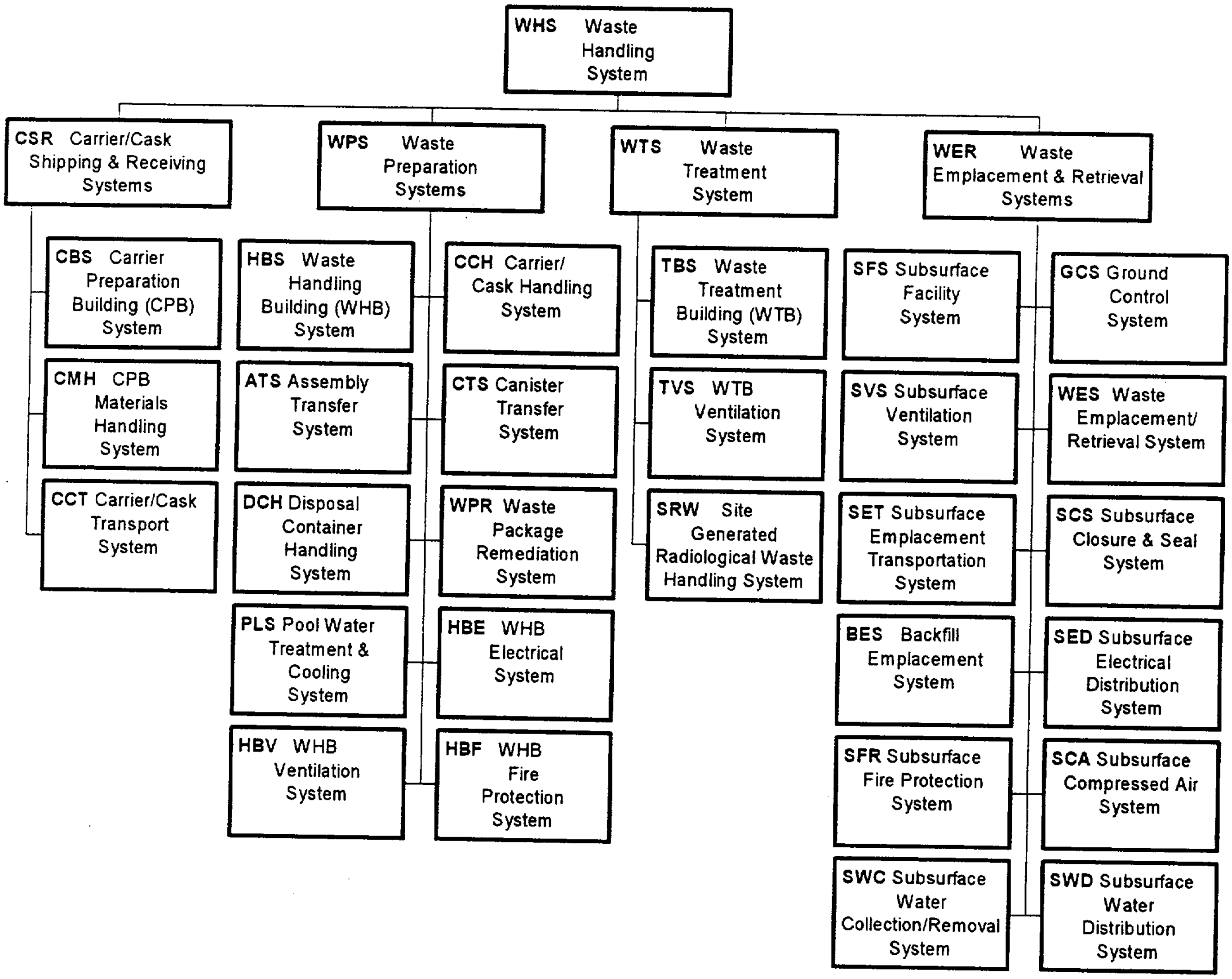


Figure 4-2. Waste Handling System

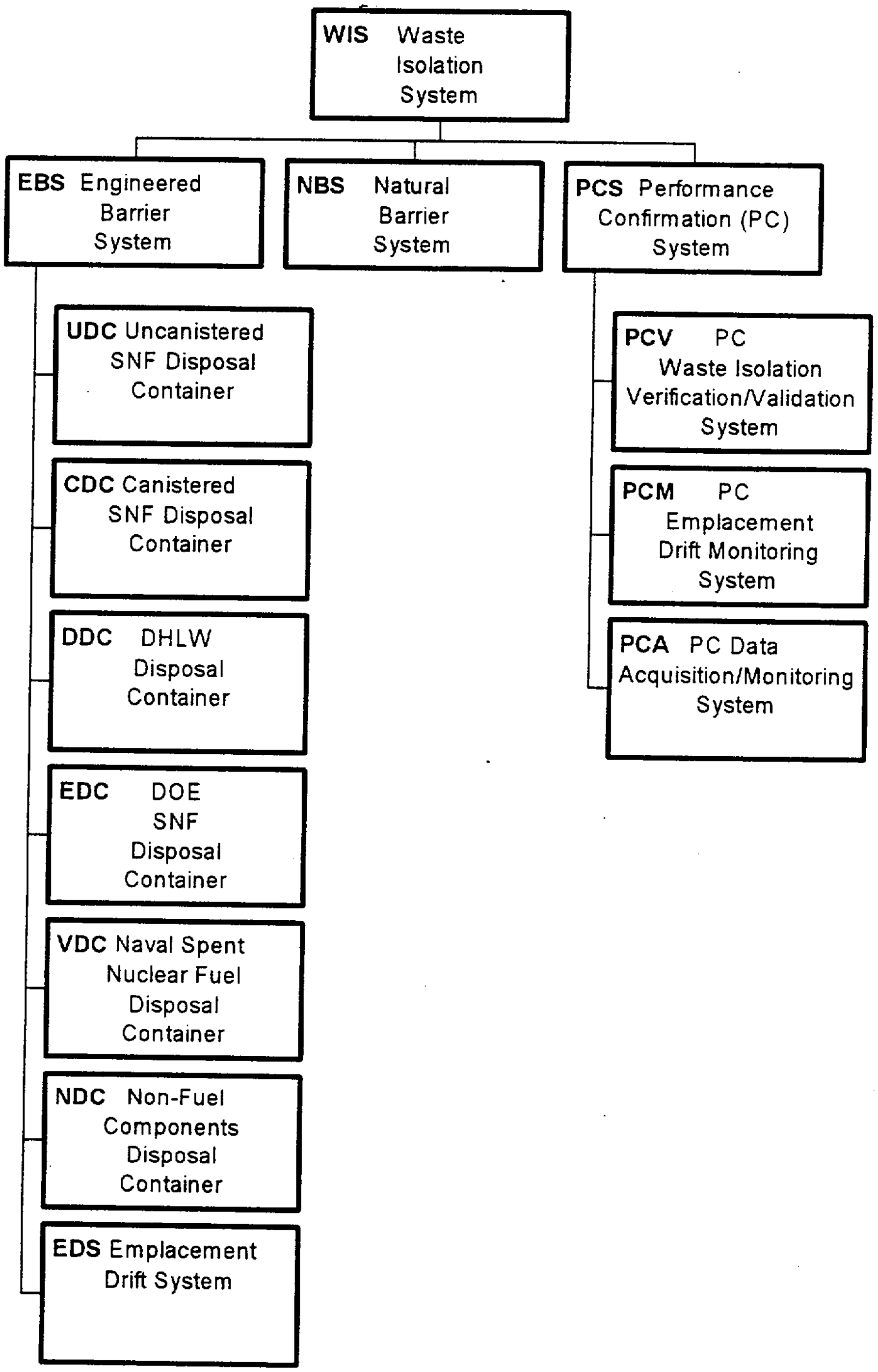


Figure 4-3. Waste Isolation System

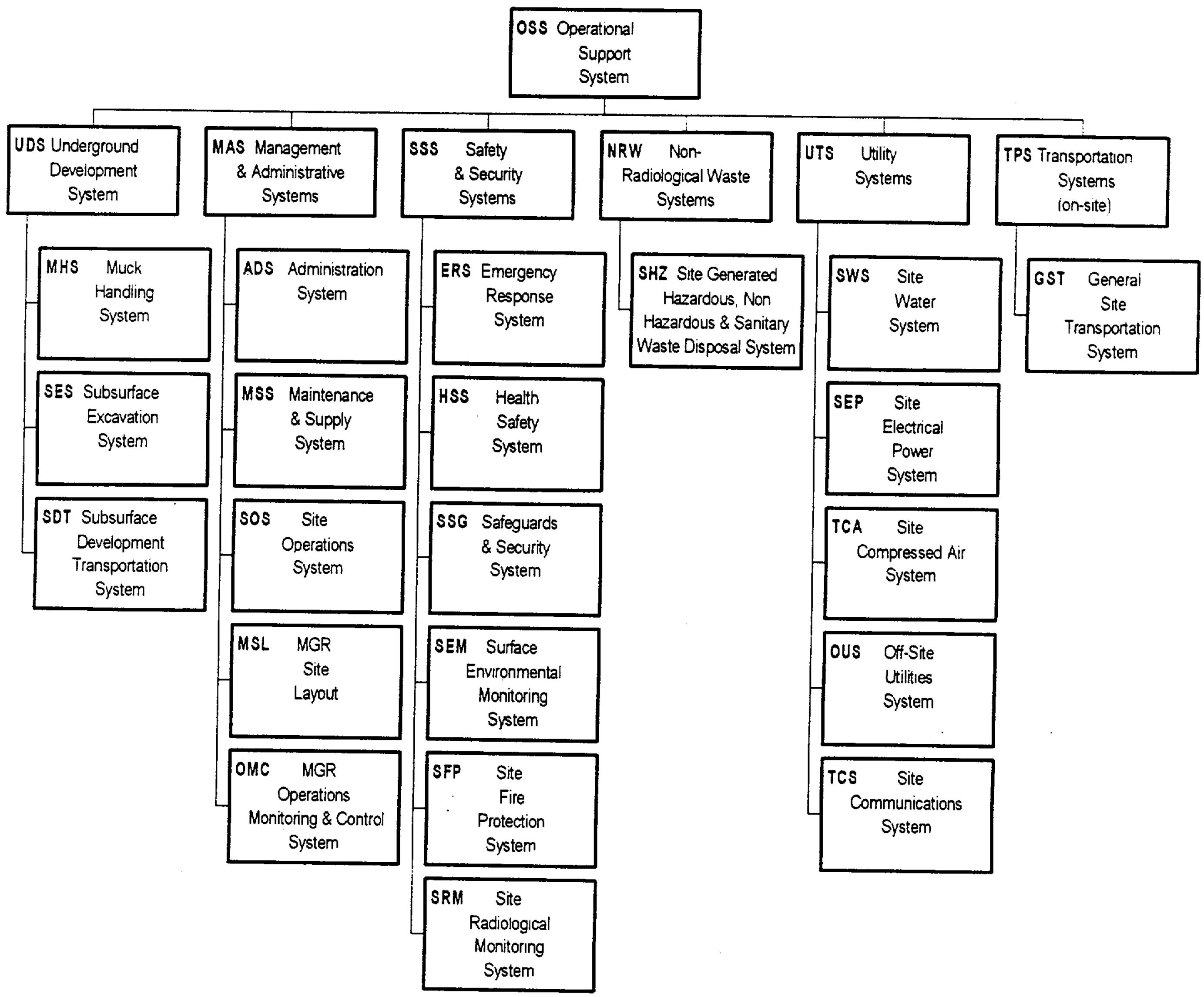
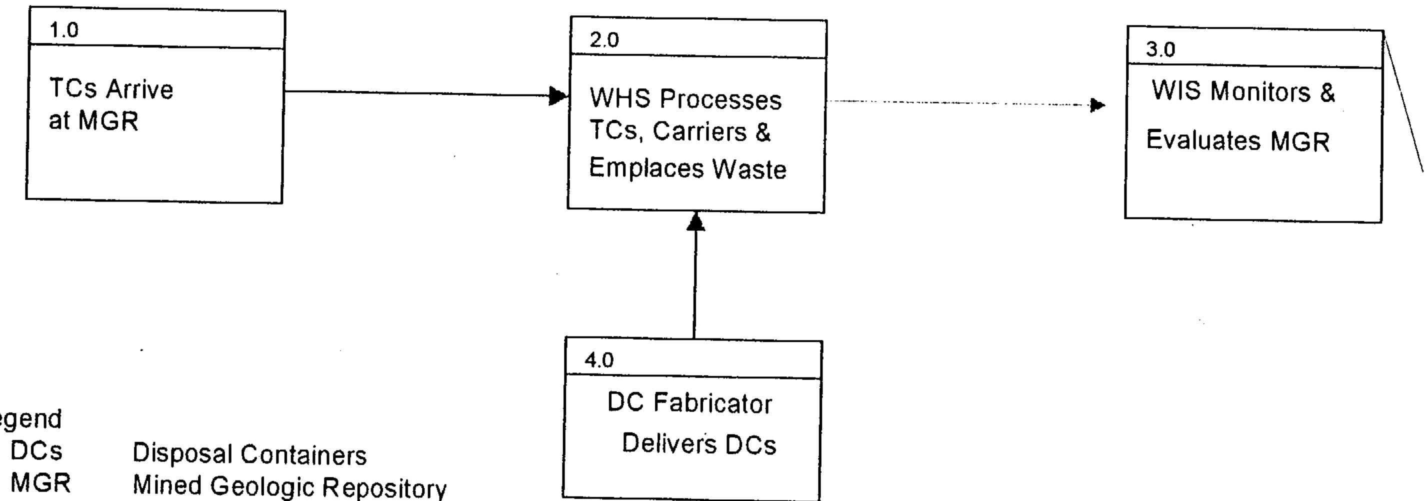


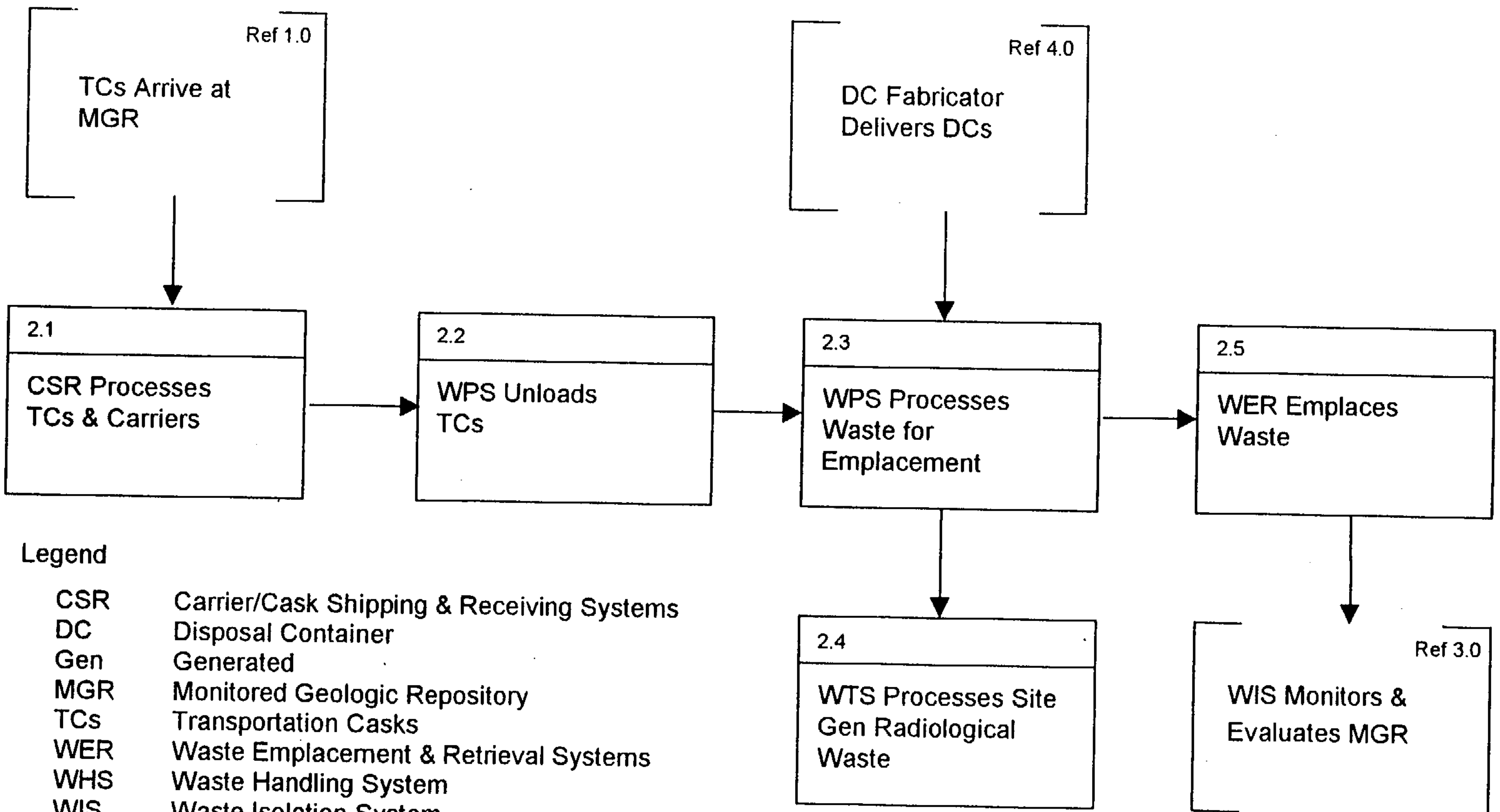
Figure 4-4. Operational Support System



Legend

DCs	Disposal Containers
MGR	Mined Geologic Repository
PC	Performance Confirmation
TCs	Transportation Casks
WHS	Waste Handling System
WIS	Waste Isolation System

Figure 4-5. MGR Functional Flow



Legend

CSR	Carrier/Cask Shipping & Receiving Systems
DC	Disposal Container
Gen	Generated
MGR	Monitored Geologic Repository
TCs	Transportation Casks
WER	Waste Emplacement & Retrieval Systems
WHS	Waste Handling System
WIS	Waste Isolation System
WPS	Waste Preparation Systems
WTS	Waste Treatment Systems

Figure 4-6. Waste Handling System Process Functional Flow

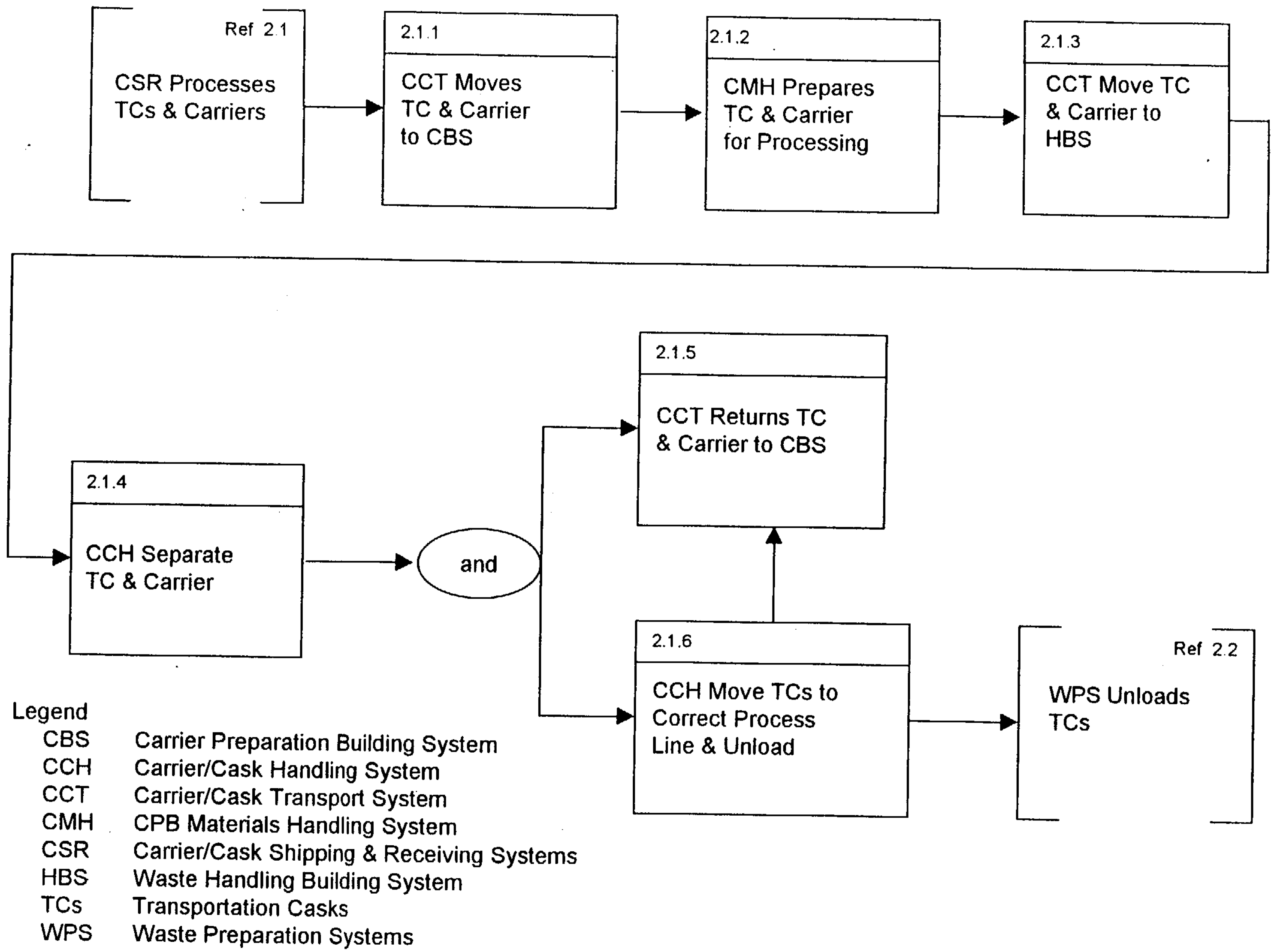


Figure 4-7. Carrier/Cask Shipping and Receiving Systems Process Functional Flow

5. ENGINEERING DESIGN BASES

The elements of the engineering design basis in Sections 5.1, 5.2, 5.3, and 5.4 are established to implement the current repository design concept as described in Section 2. These requirements, criteria, constraints, and goals are considered part of the technical baseline, are supplementary to the requirements in the MGR RD (CRWMS M&O 2000b), and in conjunction with those requirements, compose the engineering design basis for the detailed design process. All requirements, criteria, and constraints below, that are not referenced to another document, will be treated as management edicts once this document is baselined and, consequently, are not referenced to other management directives. Each engineering design basis element is allocated to one or more architectural elements, and an allocation arrangement is shown in Section 5.5.

The requirements, criteria, constraints, and goals in this section are assigned unique paragraph numbers for ease of reference.

5.1 DESIGN PERFORMANCE

The requirements and criteria below reflect the current design strategy. The performance goals in Section 5.1.5 represent those design attributes that the current design effort is aiming toward, but is not required to achieve. These goals may be achieved through further refinements of the design.

5.1.1 Performance Requirements

5.1.1.1 The MGR design shall allow the repository to be closed as early as 26 years after emplacement of the last WP contingent upon meeting the remainder of the thermal requirements. The MGR shall include provisions that support a deferral of closure for up to 300 years from initiation of waste emplacement, with appropriate monitoring and maintenance (CRWMS M&O 2000b, 3.2.H; and Stroupe 2000).

5.1.1.2 The MGR design under preclosure and postclosure normal operating conditions shall preserve/not impair the condition of the zirconium-alloy cladding of the CSNF as received at the repository (CRWMS M&O 2000b, 3.2.L).

5.1.1.3 Following closure, the repository shall avoid long-term accumulation of water in the rock above the emplacement drifts by controlling the rock temperatures so that there is free drainage between the emplacement drifts (CRWMS M&O 2000b, 3.2.N).

5.1.2 Regulatory Requirements

The "Revised Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations (Revision 01, July 22, 1999), for Yucca Mountain, Nevada" (Dyer 1999) is the controlling regulatory requirement for the MGR. An allocation of the regulatory requirements contained within this guidance is correlated to the MGR Level 5 systems that support SR as shown in Table 5-8. A comprehensive allocation of this guidance and additional regulatory requirements, will be provided in a later revision of this document.

5.1.3 Performance Criteria

5.1.3.1 At least 70 percent of the total heat generated by the WPs within the emplacement drifts during the first 50 years of the preclosure period shall be removed by ventilation. In combination with other criteria and constraints, this will ensure that the majority of the pillar space between the emplacement drifts will remain below the boiling temperature of water at the repository altitude, following repository closure (Wilkins and Heath 1999, Enclosure 2, A 12.0).

5.1.3.2 Two annual hazard frequencies of exceedance shall be considered for seismic events during the preclosure period: one occurrence per 1,000 years (Frequency Category 1) and one occurrence per 10,000 years (Frequency Category 2) (taken from Dyer 1999, Section 2). There are also two design input earthquakes, one referred to as the 1 to 2 Hz earthquake, and the other referred to as the 5 to 10 Hz earthquake. Vibratory ground motions corresponding to both earthquakes for both categories shall be considered in the design of SSCs. Additional seismic design criteria will be provided in future revisions of this document.

5.1.4 Interface Criteria

5.1.4.1 The MGR shall accommodate up to 70,000 MTHM or equivalent, including 63,000 MTHM of CSNF. The MGR shall accept the following example of this waste inventory (CRWMS M&O 2000e):

- 94,230 PWR assembles
- 126, 580 BWR assemblies
- 475 canisters of IPWF
- 5,260 short canisters of DHLW
- 10,878 long canisters of DHLW
- 1,178 short canisters of DOE SNF
- 1,406 long canisters of DOE SNF
- 298 multi-canister overpacks of DOE SNF
- 200 short Naval fuel canisters
- 100 long Naval fuel canisters

NOTE: These values are taken from the Truncated Site Recommendation (SR) Design Case. Values were obtained by multiplying the number of waste packages in this case by the number of canisters or assemblies each is designed to contain.

5.1.4.2 The MGR shall not preclude the capability (by adding additional components and features) of accommodating up to 97,000 MTHM or equivalent, as shown in the following example of inventory of nuclear materials. The MGR shall also not preclude the capability of accommodating up to 115,000 MTHM or equivalent (CRWMS M&O 2000e):

- 125,232 PWR assemblies
- 166,560 BWR assemblies
- 635 canisters of IPWF
- 7,015 short canisters of DHLW
- 14,503 long canisters of DHLW
- 1,570 short canisters of DOE SNF
- 1,874 long canisters of DOE SNF
- 398 multi-canister overpacks of DOE SNF
- 200 short Naval fuel canisters
- 100 long Naval fuel canisters

NOTE: These values were taken from the Full Inventory Case. Calculated values were obtained by multiplying the number of waste packages in this case by the number of assemblies each is designed to contain.

5.1.4.3 The MGR shall accommodate any of the CSNF annual arrival scenarios depicted in Tables 5-1, 5-2, and 5-3.

There are three annual arrival scenarios for the CSNF. These three scenarios span a broad range of potential arrival possibilities with Scenario 1 (see Table 5-1) assuming a maximum number of truck casks arriving, Scenario 2 (see Table 5-2) assuming a maximum number of single-purpose canister (SPC) rail casks arriving, and Scenario 3 (see Table 5-3) assuming a maximum number of dual-purpose canister (DPC) rail casks arriving each year (CRWMS M&O 2000d, Tables 6, 7, and 8).

Table 5-1. Scenario 1 - Annual CSNF Arrival Assuming Maximum Truck Casks

Year	Cask Type	Average[1] Assemblies Per Cask	BWR		PWR		Total		
			Casks	Assembly	Cask	Assembly	Cask	Assembly	MTUs
	Truck	4	16	64	12	48	28	112	32
2010	SPC Rail	24	27	648	20	480	47	1,128	324
	DPC Rail	38	3	114	2	76	5	190	53
	Total		46	826	34	604	80	1,430	409
	Truck	4	25	100	18	72	43	172	49
2011	SPC Rail	24	40	960	30	720	70	1,680	483
	DPC Rail	38	4	152	3	114	7	266	77
	Total		69	1,212	51	906	120	2,118	609
	Truck	4	49	196	37	148	86	344	99
2012	SPC Rail	24	79	1,896	60	1,440	139	3,336	963
	DPC Rail	38	9	342	6	228	15	570	160

Table 5-1. Scenario 1 - Annual CSNF Arrival Assuming Maximum Truck Casks (Continued)

Year	Cask Type	Average[1] Assemblies Per Cask	BWR		PWR		Total		
			Casks	Assembly	Cask	Assembly	Cask	Assembly	MTUs
	Total		137	2,434	103	1,816	240	4,250	1,221
	Truck	4	80	320	60	240	140	560	161
2013	SPC Rail	24	130	3,120	98	2,352	228	5,472	1,576
	DPC Rail	38	14	532	11	418	25	950	276
	Total		224	3,972	169	3,010	393	6,982	2,013
2014	Truck	4	131	524	99	396	230	920	265
To	SPC Rail	24	215	5,160	162	3,888	377	9,048	2,606
2022	DPC Rail	38	23	874	17	646	40	1,520	436
	Total		369	6,558	278	4,930	647	11,488	3,307
2023	Truck	4	51	204	39	156	90	360	104
To	SPC Rail	24	185	4,440	139	3,336	324	7,776	2,238
2033	DPC Rail	38	50	1,900	38	1,444	88	3,344	965
	Total		286	6,544	216	4,936	502	11,480	3,307
2034	Truck	4	23	92	17	68	40	160	46
To	SPC Rail	24	47	1,128	35	840	82	1,968	565
2041	DPC Rail	38	141	5,358	106	4,028	247	9,386	2,702
	Total		211	6,578	158	4,936	369	11,514	3,313

[1] Average values were used to facilitate the computer modeling for the throughput studies.

Table 5-2. Scenario 2 - Annual CSNF Arrival Assuming Maximum SPC Rail Casks

Year	Cask Type	Average[1] Assemblies Per Cask	BWR		PWR		Total		
			Casks	Assembly	Cask	Assembly	Cask	Assembly	MTUs
	Truck	4	12	48	9	36	21	84	24
2010	SPC Rail	24	27	648	20	480	47	1,128	324
	DPC Rail	38	3	114	2	76	5	190	53
	Total		42	810	31	592	73	1,402	401
	Truck	4	18	72	14	56	32	128	37
2011	SPC Rail	24	41	984	31	744	72	1,728	498
	DPC Rail	38	5	190	4	152	9	342	100
	Total		64	1,246	49	952	113	2,198	635
	Truck	4	36	144	27	108	63	252	73
2012	SPC Rail	24	80	1,920	60	1,440	140	3,360	967
	DPC Rail	38	9	342	7	266	16	608	176
	Total		125	2,406	94	1,814	219	4,220	1,216
	Truck	4	58	232	44	176	102	408	118
2013	SPC Rail	24	132	3,168	99	2,376	231	5,544	1,595
	DPC Rail	38	16	608	12	456	28	1,064	306
	Total		206	4,008	155	3,008	361	7,016	2,019
2014	Truck	4	96	384	72	288	168	672	193
To	SPC Rail	24	217	5,208	163	3,912	380	9,120	2,625
2022	DPC Rail	38	26	988	19	722	45	1,710	489

Table 5-2. Scenario 1 - Annual CSNF Arrival Assuming Maximum SPC Rail Casks (Continued)

Year	Cask Type	Average[1] Assemblies Per Cask	BWR		PWR		Total		
			Casks	Assembly	Cask	Assembly	Cask	Assembly	MTUs
	Total		339	6,580	254	4,922	593	11,502	3.308
2023	Truck	4	18	72	14	56	32	128	37
To	SPC Rail	24	205	4,920	155	3,720	360	8.640	2.490
2033	DPC Rail	38	41	1,558	31	1,178	72	2.736	789
	Total		264	6,550	200	4,954	464	11,504	3,316
2034	Truck	4	3	12	2	8	5	20	6
To	SPC Rail	24	80	1,920	60	1,440	140	3,360	967
2041	DPC Rail	38	122	4,636	92	3,496	214	8,132	2,343
	Total		205	6,568	154	4,944	359	11,512	3,315

[1] Average values were used to facilitate the computer modeling for the throughput studies.

Table 5-3. Scenario 3 - Annual CSNF Arrival Assuming Maximum DPC Rail Casks

Year	Cask Type	Average[1] Assemblies Per Cask	BWR		PWR		Total		
			Casks	Assembly	Cask	Assembly	Cask	Assembly	MTUs
	Truck	4	3	12	2	8	5	20	6
2010	SPC Rail	24	28	672	21	504	49	1,176	338
	DPC Rail	38	4	152	3	114	7	266	77
	Total		35	836	26	626	61	1,462	421
	Truck	4	5	20	3	12	8	32	9
2011	SPC Rail	24	42	1,008	32	768	74	1,776	513
	DPC Rail	38	5	190	4	152	9	342	100
	Total		52	1,218	39	932	91	2,150	621
	Truck	4	9	36	7	28	16	64	19
2012	SPC Rail	24	83	1,992	63	1,512	146	3,504	1,011
	DPC Rail	38	11	418	8	304	19	722	206
	Total		103	2,446	78	1,844	181	4,290	1,236
	Truck	4	15	60	11	44	26	104	30
2013	SPC Rail	24	136	3,264	103	2,472	239	5,736	1,654
	DPC Rail	38	17	646	13	494	30	1,140	329
	Total		168	3,970	127	3,010	295	6,980	2,013
2014	Truck	4	24	96	18	72	42	168	48
To	SPC Rail	24	224	5,376	169	4,056	393	9,432	2,717
2022	DPC Rail	38	29	1,102	22	836	51	1,938	559
	Total		277	6,574	209	4,964	486	11,538	3,325
2023	Truck	4	45	180	34	136	79	316	91
To	SPC Rail	24	166	3,984	125	3,000	291	6,984	2,011
2033	DPC Rail	38	63	2,394	47	1,786	110	4,180	1,201
	Total		274	6,558	206	4,922	480	11,480	3,304
2034	Truck	4	77	308	58	232	135	540	156
To	SPC Rail	24	26	624	19	456	45	1,080	309
2041	DPC Rail	38	148	5,624	112	4,256	260	9,880	2,848
	Total		251	6,556	189	4,944	440	11,500	3,313

[1] Average values were used to facilitate the computer modelling for the throughput studies.

5.1.4.4 The MGR shall accommodate the DOE SNF, Naval SNF, IPWF, and HLW annual arrival scenario depicted in Table 5-4 (CRWMS M&O 2000d, Table 11).

Table 5-4. Annual Cask Receipt Rate of DOE SNF and HLW

Year	DOE SNF Note 1		Naval SNF		DOE HLW Note 2		Immobilized Plutonium Note 2		Total	
	Casks	Cans.	Casks	Cans.	Casks	Cans.	Casks	Cans	Casks	Cans
2010	3	15	1	1	33	165	12	60	49	241
2011	6	30	1	1	48	240	12	60	67	331
2012	13	65	3	3	83	415	12	60	111	543
2013	16	80	6	6	98	490	12	60	132	636
2014	19	95	8	8	113	565	12	60	152	728
2015 Until end of receipt	30	150	14	14	168	840	12	60	224	1064

Notes: 1. Assumes five canisters are shipped in each cask, which represents a 50 to 60 percent efficiency for the casks that can hold nine canisters.
2. Assumes five canisters are shipped in each cask.

5.1.5 Performance Goals

The emplacement drift wall temperature should remain below 96°C following repository closure, based on nominal/expected values of repository properties.

5.2 DESIGN CONSTRAINTS

5.2.1 The nominal emplacement drift spacing shall be 81 m, drift center to center. In combination with other criteria and constraints, this will ensure that the majority of the pillar space between the emplacement drifts will remain below the boiling temperature of water at the repository altitude following repository closure.

5.2.2 RESERVED.

5.2.3 The MGR shall be capable of accommodating the emplacement of 70,000 MTHM of the WP inventory with the size and heat output up to that shown in Table 5-5 (CRWMS M&O 2000e).

Table 5-5. Design Basis Waste Package Inventory

Type of WP	WP Length (m)	Average Heat Output/Package (kW)	Quantity*
21 PWR AP	5.06	11.330	4500
21 PWR CR	5.06	3.260	100
12 PWR AP Long	5.54	8.970	170
44 BWR AP	5.06	7.000	3000
24 BWR AP	5.00	0.540	90
5 IPWF	3.48	2.450	100
5 DHLW Short/1 DOE SNF Short	3.48	2.575	1100
5 DHLW Long/1 DOE SNF Long	5.11	2.575	1500
2 MCO/2 DHLW	5.11	1.230	160

Table 5-5. Design Basis Waste Package Inventory (Continued)

Type of WP	WP Length (m)	Average Heat Output/Package (kW)	Quantity*
5 HLW Long/1 DOE SNF Short	5.11	2.575	130
Type of WP	**WP Length (m)**	**Average Heat Output/Package (kW)**	**Quantity***
HLW Long Only	5.11	2.450	600
Naval Short	5.32	3.100	210
Naval Long	5.96	3.100	110

* These quantities are rounded up to two significant figures from the values in the cited reference, and represent "not to exceed" values for each WP category. It is recognized that if the total quantity of each type of WP were emplaced, the repository would exceed the 70,000 MTHM (or equivalent) described in 5.1.4.1. This constraint applies to the capability of the subsurface emplacement, and is not intended to conflict with, or violate, any other design requirement, criterion, or constraint.

NOTE: See Acronyms and Abbreviations for acronym definitions.

5.2.4 The MGR shall not preclude the capability of accommodating the emplacement of the WP inventory with the size and heat output up to that shown in Table 5-6 (CRWMS M&O 2000e).

Table 5-6. Waste Package Inventory for Maximum Subsurface Emplacement

Type of WP	WP Length (m)	Average Heat Output/Package (kW)	Quantity*
21 PWR AP	5.06	11.330	5700
21 PWR CR	5.06	3.260	110
12 PWR AP Long	5.54	8.970	300
44 BWR AP	5.06	7.000	3750
24 BWR AP	5.00	0.540	100
5 IPWF	3.48	2.450	130
5 DHLW Short/1 DOE SNF Short	3.48	2.575	1410
5 DHLW Long/1 DOE SNF Long	5.11	2.575	1880
2 MCO/2 DHLW	5.11	1.230	200
5 HLW Long/1 DOE SNF Short	5.11	2.575	170
HLW Long Only	5.11	2.450	800
Naval Short	5.32	3.100	210
Naval Long	5.96	3.100	110

* These quantities, which are rounded up to two significant figures from the values in the cited reference, represent "not to exceed" values for each WP category. It is recognized that if the total quantity of each type of WP were emplaced, the repository would exceed the 97,000 MTHM (or equivalent) described in 5.1.4.2. This constraint applies to the capability of the subsurface emplacement, and is not intended to conflict with, or violate, any other design requirement, criterion, or constraint.

NOTE: See Acronyms and Abbreviations for acronym definitions.

5.2.5 The excavated emplacement drift diameter shall be nominally 5.5 m. This diameter provides adequate space to accommodate the largest WP, the associated handling and emplacement equipment, the ground support, and drip shield installation.

5.2.6 The ground support in the repository emplacement drift shall be carbon steel (e.g., steel sets and/or rock bolts and mesh) with cementitious grout allowed, where necessary, to anchor the rock bolts.

5.2.7 With periodic maintenance, if necessary, the emplacement drift ground support shall keep the emplacement drift open and stable for the entire preclosure period. This ensures a pathway for emplacement drift ventilation and allowance of remote controlled equipment and/or human access for off-normal conditions. Additionally, this ensures the ability to emplace a drip shield and backfill prior to repository closure.

5.2.8 The invert along the bottom of drifts shall be constructed of a carbon steel frame with granular natural material used as ballast.

5.2.9 The MGR design shall not preclude the options of physically installing the emplacement drift backfill during the repository closure phase.

5.2.10 The emplacement drifts shall be line loaded with WPs spaced with a nominal distance of 10 cm between the ends of adjacent WPs. (In this context, the "ends" of the WPs include any skirts or other structures that extend beyond the lid of the WP.) The maximum linear heat load shall be 1.5 kW/m, averaged over a fully loaded emplacement drift at the time of completion of loading an entire emplacement drift.

5.2.11 A free-standing drip shield, fabricated from Titanium, Grade 7 with a minimum thickness of 15 mm, shall be installed, at the time of repository closure, above, but not in contact with the WP.

5.2.12 Each disposal container shall be a two-layer device consisting of an inner structural barrier of nominally 50-mm thick nuclear grade 316 stainless steel and an outer barrier of nominally 20-mm thick alloy 22 material. This constraint is intended only to address the corrosion environment. The design must also address other functions such as structural (handling) and seismic conditions, and, if needed, consider additional thickness.

5.2.13 Individual WPs shall have a maximum heat output of 11.8 kW at the time of emplacement. In combination with other criteria and constraints, this will ensure that the conditions of the zirconium-alloy cladding of the CSNF will not be impaired.

5.2.14 The surface facilities shall accommodate a blending inventory of up to 5,000 MTU.

5.3 OPERATING CRITERIA

5.3.1 Operation of systems and components that have been identified as important to safety in the Safety Analysis Report and in the license shall be performed only by trained and certified personnel or by personnel under the direct visual supervision of an individual with training and certification in such operation. Supervisory personnel who direct operations that are important to safety shall also be certified in such operations (Dyer 1999, Subpart H, Section 151).

5.3.2 The repository shall be designed to allow limited-time personnel access, in consideration of workers' radiation protection, into the emplacement drifts for the purpose of evaluating and remediating operational upset conditions after initiation of waste emplacement.

This section will be further developed in a subsequent revision.

5.4 RELIABILITY, AVAILABILITY, MAINTAINABILITY, AND INSPECTION CRITERIA

This section is to be completed in a subsequent revision.

5.5 ALLOCATION OF ENGINEERING DESIGN BASES

Table 5-7 provides the primary allocation of the MGR PDD engineering design bases for the MGR design. This allocation is to the fourth level of the MGR Architecture (CRWMS M&O 1999i, Appendix A). This allocation identifies the architecture that is assigned the primary responsibility for meeting each PDD engineering design basis. Additional applications and/or traces to the PDD engineering design bases are also allowed, as necessary, to successfully complete the MGR design.

Table 5-7. Allocation of PDD Engineering Design Bases for MGR Design

MGR PDD Engineering Design Basis Number	Fourth Level MGR Architecture*
5.1.1.1	EBS, WER, WPS
5.1.1.2	EBS
5.1.1.3	EBS
5.1.3.1	WER
5.1.3.2	EBS, CSR, WPS, WTS, WER, UDS
5.1.4.1	CSR, UDS, WPS, WTS, WER, EBS
5.1.4.2	CSR, UDS, WPS, WTS, WER, EBS
5.1.4.3	CSR, UDS, WPS, WTS, WER, EBS
5.1.4.4	CSR, UDS, WPS, WTS, WER, EBS
5.1.5	WPS, WTS, WER, EBS, PCS, MAS, SSS, NRW, UTS, TPS
5.2.1	WER, EBS
5.2.2	RESERVED
5.2.3	EBS, WER
5.2.4	EBS, WER
5.2.5	WER
5.2.6	WER
5.2.7	WER
5.2.8	EBS
5.2.9	EBS
5.2.10	WER, EBS
5.2.11	EBS
5.2.12	EBS
5.2.13	EBS, WPS
5.2.14	WPS
5.3.1	MAS
5.3.2	WER

* These MGR architecture designators are defined in Figure 4-1.

Table 5-8 provides the primary allocation of the regulatory requirements from the "Revised Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations (Revision 01, July 22, 1999), for Yucca Mountain, Nevada" (Dyer 1999) for the SR design. This allocation is to the fifth level of the MGR Architecture (CRWMS M&O 1999i, Appendix A). This allocation identifies the architecture that is assigned the primary responsibility for meeting each regulatory requirement.

Table 5-8. Allocation of Regulatory Requirements from 10 CFR 63 for MGR Design

Regulatory Requirement	Fifth Level MGR Architecture
63.21(c)(17)	Assembly Transfer System
63.78	Assembly Transfer System
63.111(a)(1)	Assembly Transfer System
63.111(a)(2)	Assembly Transfer System
63.111(b)(2)	Assembly Transfer System
63.112(e)(2)	Assembly Transfer System
63.112(e)(6)	Assembly Transfer System
63.112(e)(8)	Assembly Transfer System
63.112(e)(10)	Assembly Transfer System
63.112(e)(13)	Assembly Transfer System
63.113(b)	Assembly Transfer System
63.21(c)(17)	Backfill Emplacement System
63.111(a)(1)	Backfill Emplacement System
63.111(a)(2)	Backfill Emplacement System
63.111(b)(2)	Backfill Emplacement System
63.112(e)(8)	Backfill Emplacement System
63.112(e)(13)	Backfill Emplacement System
63.21(c)(17)	Canister Transfer System
63.78	Canister Transfer System
63.111(a)(1)	Canister Transfer System
63.111(a)(2)	Canister Transfer System
63.111(b)(2)	Canister Transfer System
63.112(e)(2)	Canister Transfer System
63.112(e)(6)	Canister Transfer System
63.112(e)(8)	Canister Transfer System
63.112(e)(10)	Canister Transfer System
63.112(e)(13)	Canister Transfer System
63.21(c)(17)	Carrier Preparation Building Materials Handling System
63.78	Carrier Preparation Building Materials Handling System
63.111(a)(1)	Carrier Preparation Building Materials Handling System
63.112(e)(10)	Carrier Preparation Building Materials Handling System
63.112(e)(13)	Carrier Preparation Building Materials Handling System
63.21(c)(17)	Carrier/Cask Handling System
63.78	Carrier/Cask Handling System
63.111(a)(1)	Carrier/Cask Handling System
63.112(e)(8)	Carrier/Cask Handling System
63.112(e)(10)	Carrier/Cask Handling System
63.112(e)(13)	Carrier/Cask Handling System

Table 5-8. Allocation of Regulatory Requirements from 10 CFR 63 for MGR Design (Continued)

Regulatory Requirement	Fifth Level MGR Architecture
63.78	DHLW Disposal Container
63.111(a)(2)	DHLW Disposal Container
63.111(b)(2)	DHLW Disposal Container
63.111(e)(1)	DHLW Disposal Container
63.112(e)(2)	DHLW Disposal Container
63.112(e)(6)	DHLW Disposal Container
63.112(e)(8)	DHLW Disposal Container
63.113(a)	DHLW Disposal Container
63.113(b)	DHLW Disposal Container
63.114(d)	DHLW Disposal Container
63.114(e)	DHLW Disposal Container
63.21(c)(17)	Disposal Container Handling System
63.78	Disposal Container Handling System
63.111(a)(1)	Disposal Container Handling System
63.111(a)(2)	Disposal Container Handling System
63.111(b)(1)	Disposal Container Handling System
63.111(b)(2)	Disposal Container Handling System
63.111(d)	Disposal Container Handling System
63.112(e)(6)	Disposal Container Handling System
63.112(e)(8)	Disposal Container Handling System
63.112(e)(13)	Disposal Container Handling System
63.113(b)	Disposal Container Handling System
63.131(b)	Disposal Container Handling System
63.134(d)	Disposal Container Handling System
63.111(e)(1)	Emplacement Drift System
63.112(e)(8)	Emplacement Drift System
63.113(a)	Emplacement Drift System
63.113(b)	Emplacement Drift System
63.111(a)(2)	Ground Control System
63.111(b)(2)	Ground Control System
63.111(d)	Ground Control System
63.111(e)(1)	Ground Control System
63.112(e)(8)	Ground Control System
63.113(b)	Ground Control System
63.132(a)	Ground Control System
63.132(e)	Ground Control System
63.111(a)(1)	Monitored Geologic Repository Operations Monitoring and Control System
63.111(a)(2)	Monitored Geologic Repository Operations Monitoring and Control System
63.111(b)(2)	Monitored Geologic Repository Operations Monitoring and Control System
63.112(e)(7)	Monitored Geologic Repository Operations Monitoring and Control System
63.112(e)(8)	Monitored Geologic Repository Operations Monitoring and Control System
63.112(e)(10)	Monitored Geologic Repository Operations Monitoring and Control System
63.112(e)(13)	Monitored Geologic Repository Operations Monitoring and Control System
63.131(b)	Monitored Geologic Repository Operations Monitoring and Control System
63.132(a)	Monitored Geologic Repository Operations Monitoring and Control System
63.132(e)	Monitored Geologic Repository Operations Monitoring and Control System
63.134(d)	Monitored Geologic Repository Operations Monitoring and Control System
63.78	Naval Spent Nuclear Fuel Disposal Container

Table 5-8. Allocation of Regulatory Requirements from 10 CFR 63 for MGR Design (Continued)

Regulatory Requirement	Fifth Level MGR Architecture
63.111(a)(2)	Naval Spent Nuclear Fuel Disposal Container
63.111(b)(2)	Naval Spent Nuclear Fuel Disposal Container
63.111(e)(1)	Naval Spent Nuclear Fuel Disposal Container
63.111(e)(2)	Naval Spent Nuclear Fuel Disposal Container
63.112(e)(2)	Naval Spent Nuclear Fuel Disposal Container
63.112(e)(6)	Naval Spent Nuclear Fuel Disposal Container
63.112(e)(8)	Naval Spent Nuclear Fuel Disposal Container
63.113(a)	Naval Spent Nuclear Fuel Disposal Container
63.113(b)	Naval Spent Nuclear Fuel Disposal Container
63.114(d)	Naval Spent Nuclear Fuel Disposal Container
63.114(e)	Naval Spent Nuclear Fuel Disposal Container
63.21(c)(17)	Pool Water Treatment and Cooling System
63.111(a)(1)	Pool Water Treatment and Cooling System
63.112(e)(2)	Pool Water Treatment and Cooling System
63.112(e)(3)	Pool Water Treatment and Cooling System
63.112(e)(8)	Pool Water Treatment and Cooling System
63.112(e)(13)	Pool Water Treatment and Cooling System
63.21(c)(17)	Site-Generated Radiological Waste Handling System
63.111(a)(1)	Site-Generated Radiological Waste Handling System
63.111(b)(1)	Site-Generated Radiological Waste Handling System
63.112(e)(2)	Site-Generated Radiological Waste Handling System
63.112(e)(13)	Site-Generated Radiological Waste Handling System
63.111(d)	Subsurface Facility System
63.113(a)	Subsurface Facility System
63.113(b)	Subsurface Facility System
63.131(a)(1)	Subsurface Facility System
63.131(a)(2)	Subsurface Facility System
63.131(c)	Subsurface Facility System
63.132(b)	Subsurface Facility System
63.132(e)	Subsurface Facility System
63.133(a)	Subsurface Facility System
63.133(c)	Subsurface Facility System
63.133(d)	Subsurface Facility System
63.134(a)	Subsurface Facility System
63.134(b)	Subsurface Facility System
63.111(a)(1)	Subsurface Ventilation System
63.111(e)(2)	Subsurface Ventilation System
63.112(e)(3)	Subsurface Ventilation System
63.112(e)(5)	Subsurface Ventilation System
63.78	Uncanistered SNF Disposal Container
63.111(a)(2)	Uncanistered SNF Disposal Container
63.111(b)(2)	Uncanistered SNF Disposal Container
63.111(e)(1)	Uncanistered SNF Disposal Container
63.112(e)(2)	Uncanistered SNF Disposal Container
63.112(e)(6)	Uncanistered SNF Disposal Container
63.112(e)(8)	Uncanistered SNF Disposal Container
63.113(a)	Uncanistered SNF Disposal Container

Table 5-8. Allocation of Regulatory Requirements from 10 CFR 63 for MGR Design (Continued)

Regulatory Requirement	Fifth Level MGR Architecture
63.113(b)	Uncanistered SNF Disposal Container
63.114(d)	Uncanistered SNF Disposal Container
63.114(e)	Uncanistered SNF Disposal Container
63.78	Waste Emplacement/Retrieval System
63.111(a)(1)	Waste Emplacement/Retrieval System
63.111(a)(2)	Waste Emplacement/Retrieval System
63.111(b)(2)	Waste Emplacement/Retrieval System
63.111(d)	Waste Emplacement/Retrieval System
63.111(e)(1)	Waste Emplacement/Retrieval System
63.111(e)(3)	Waste Emplacement/Retrieval System
63.112(e)(1)	Waste Emplacement/Retrieval System
63.112(e)(8)	Waste Emplacement/Retrieval System
63.112(e)(10)	Waste Emplacement/Retrieval System
63.112(e)(13)	Waste Emplacement/Retrieval System
63.131(b)	Waste Emplacement/Retrieval System
63.131(d)(3)	Waste Emplacement/Retrieval System
63.134(d)	Waste Emplacement/Retrieval System
63.111(a)(1)	Waste Handling Building Electrical System
63.112(e)(2)	Waste Handling Building Electrical System
63.112(e)(3)	Waste Handling Building Electrical System
63.112(e)(8)	Waste Handling Building Electrical System
63.112(e)(11)	Waste Handling Building Electrical System
63.112(e)(12)	Waste Handling Building Electrical System
63.112(e)(13)	Waste Handling Building Electrical System
63.21(c)(17)	Waste Handling Building System
63.111(a)(1)	Waste Handling Building System
63.111(a)(2)	Waste Handling Building System
63.111(b)(2)	Waste Handling Building System
63.112(e)(1)	Waste Handling Building System
63.112(e)(2)	Waste Handling Building System
63.112(e)(3)	Waste Handling Building System
63.112(e)(4)	Waste Handling Building System
63.112(e)(5)	Waste Handling Building System
63.112(e)(8)	Waste Handling Building System
63.112(e)(10)	Waste Handling Building System
63.112(e)(13)	Waste Handling Building System
63.111(a)(1)	Waste Handling Building Ventilation System
63.111(a)(2)	Waste Handling Building Ventilation System
63.111(b)(2)	Waste Handling Building Ventilation System
63.112(e)(1)	Waste Handling Building Ventilation System
63.112(e)(2)	Waste Handling Building Ventilation System
63.112(e)(3)	Waste Handling Building Ventilation System
63.112(e)(4)	Waste Handling Building Ventilation System
63.112(e)(8)	Waste Handling Building Ventilation System
63.112(e)(10)	Waste Handling Building Ventilation System
63.112(e)(11)	Waste Handling Building Ventilation System
63.112(e)(13)	Waste Handling Building Ventilation System
63.21(c)(17)	Waste Package Remediation System

Table 5-8. Allocation of Regulatory Requirements from 10 CFR 63 for MGR Design (Continued)

Regulatory Requirement	Fifth Level MGR Architecture
63.78	Waste Package Remediation System
63.111(a)(1)	Waste Package Remediation System
63.112(e)(8)	Waste Package Remediation System
63.112(e)(10)	Waste Package Remediation System
63.112(e)(13)	Waste Package Remediation System
63.21(c)(17)	Waste Treatment Building System
63.111(a)(1)	Waste Treatment Building System
63.112(e)(1)	Waste Treatment Building System
63.112(e)(2)	Waste Treatment Building System
63.112(e)(3)	Waste Treatment Building System
63.112(e)(4)	Waste Treatment Building System
63.112(e)(5)	Waste Treatment Building System
63.112(e)(8)	Waste Treatment Building System
63.112(e)(10)	Waste Treatment Building System
63.112(e)(13)	Waste Treatment Building System
63.111(a)(1)	Waste Treatment Building Ventilation System
63.112(e)(1)	Waste Treatment Building Ventilation System
63.112(e)(2)	Waste Treatment Building Ventilation System
63.112(e)(3)	Waste Treatment Building Ventilation System
63.112(e)(4)	Waste Treatment Building Ventilation System
63.112(e)(10)	Waste Treatment Building Ventilation System
63.112(e)(13)	Waste Treatment Building Ventilation System

6. CONTROLLED PROJECT ASSUMPTIONS

The CPAs are intended to provide a consistent program-wide basis for planning and conducting design activities, and to support some non-design activities such as performance assessment and environmental impact analysis. All of the CPAs in this section are considered to be part of the technical baseline. Discussions of each individual CPA are presented in this section and summarized in Table 6-1. Each assumption is documented on an Assumption Rationale Sheet in a format similar to that used in the *Controlled Design Assumptions Document* (CRWMS M&O 1998a). The assumption identifier and subject are given at the top of the sheet and followed by the statement of the assumption and the rationale for the assumption. The final portion of the Assumption Rationale Sheet identifies the:

- M&O organization(s) responsible for establishing and maintaining the assumption
- Applicable M&O organizations that will use or be impacted by the assumption
- Systems to which the assumption is allocated for potential applicability
- Other work products to which the assumption is allocated, if applicable

The allocations to systems are identified by system designators defined in the MGR Architecture (CRWMS M&O 1999i, Appendix A) and in Section 4.1 of this document. A listing of the system designators and their names is also provided in Appendix A of this document. Allocations to systems do not necessarily imply that criteria will be established in the corresponding SDDs. For example, the assumption may be an assumed design concept related to the system addressed in the respective SDD and to be described in Sections 2 through 4 of that document.

References to requirements from the MGR RD (CRWMS M&O 2000b) are given in the following format: MGR RD 3.3.G refers to the requirement established in 3.3.G of that requirements document.

Table 6-1 lists the controlled project assumptions documented on the assumption rationale sheets in this section. The listing includes the organizational responsibility and applicability allocations from part III of the assumption rationale sheets. The organizational codes are included in the list of acronyms and abbreviations.

Table 6-1. CPA Allocation

Identifier	Subject	Responsible Organization Note 1	User Organization Note 1	System Designator Note 2	Other Allocation
CPA 001	Site Generated Wastes	SED, SFD, ES&H	SFD, R&RSD	GST, SHZ, SRW	EIS
CPA 002	LLW Disposal at NTS	R&RSD	R&RSD, SFD, ES&H	SRW	EIS
CPA 003	Secondary Waste from Water that Contacts SNF or HLW	SFD	SFD, ES&H	HBS, PLS, SRW, TBS	EIS
CPA 004	Surface Facilities Location	SFD	SFD, SSFD	HBS, MSL, SCA, OMC, SED, SET, SFR, SFS, SSM, SVS, SWC, TBS, WES	EIS
CPA 005	Use of North Ramp for Waste Transport	SSFD	SFD, SSFD	MSL, OMC, SET, SFS, SSM, SVS, WES	EIS
CPA 006	Temporary Surface Facilities for Underground Construction	SFD, SSFD	SFD, SSFD	MHS, MSL, OMC, SED, SDT, SES, SSM	EIS
CPA 007	Remedial Processing of Canistered Waste Forms	SFD	SFD	ATS, CTS	EIS
CPA 008	Withdrawn in REV 00 DCN 01 (Substantiated by LADS decision for No Rod Consolidation)				
CPA 009	Withdrawn in REV 01 (replaced by blending inventory requirement)				
CPA 010	Withdrawn in REV 01 (replaced by blending inventory requirement)				
CPA 011	Parking Capacity for Loaded Casks	SED	SFD	CCT, MSL, SSG	EIS
CPA 012	Limited Cask Maintenance Capability	SED	SFD	ATS, CCT, CTS	EIS
CPA 013	Decontamination Concept	SFD, ES&H	SFD, SSFD, ES&H	CBS, HBS, MSL, SFS, TBS	MGR Concept of Operations, EIS
CPA 014	Source of Water	SED, SFD, ES&H	SFD	SWS	EIS
CPA 015	Telephone Communications	SED, SFD	SFD, ES&H	SSG, TCS	EIS
CPA 016	Withdrawn in REV 01 DCN 01				
CPA 017	Withdrawn in REV 01 DCN 01				
CPA 018	ALARA Cost-Benefit Analysis	ES&H, S&HD	SFD, SSFD, S&HD	ATS, BES, CBS, CCH, CCT, CMH, CTS, DCH, HBS, HBV, PCM, PLS, SET, SRW, SSM, SVS, TBS, WES, WPR	ALARA Program Documentation, EIS
CPA 019	Waste Package Shielding	WPD	SFD, SSFD, WPD, ES&H	CDC, DCH, DDC, EDC, HBS, NDC, SFS, UDC, VDC,	EIS

Table 6-1. CPA Allocation (Continued)

Identifier	Subject	Responsible Organization Note 1	User Organization Note 1	System Designator Note 2	Other Allocation
				WES, EDS	
CPA 020	Limitation on Human Entry in Emplacement Drifts Containing Waste Packages	SSFD, ES&H	SSFD	PCV, SSM, WES, PCM	EIS
CPA 021	Emplacement Drift Entrance Doors	SSFD	SSFD, ES&H	SFS, SVS	EIS
CPA 022	Retrieval	LD	SSFD, ES&H	WES	EIS
CPA 023	Modular Design and Construction Capability	SED	SFD, SSFD, ES&H	Will be allocated to most surface and subsurface systems	EIS
CPA 024	Underground Transport of Personnel, Supplies, and Excavated Rock	SSFD	SSFD, ES&H	BES, MHS, SET, SDT	EIS
CPA 025	Diesel Equipment Limitation	SSFD	SSFD, ES&H	BES, MHS, SCS, SDT, SED, SES, SET, SSM, SVS, WES	EIS
CPA 026	Subsurface Configuration for Water Drainage	SSFD	SSFD, ES&H	SFS, SWC	PA models, EIS
CPA 027	Applicability of Mine Safety and Health Administration Regulations	SED, S&HD, ES&H	SSFD	BES, GCS, MHS, PCM, MHS, SCA, OMC, SCS, SDT, SED, SES, SET, SFR, SFS, SSM, SVS, SWC, SWD, WES, EDS	EIS
CPA 028	Withdrawn in REV 00 DCN 01 (due to removal of backfill)				
CPA 029	Use of Disposability Interface Specification	SED	SFD, SSFD, WPD	ATS, CBS, CCH, CCT, CDC, CMH, CTS, DDC, EDC, HBS, NDC, SFS, UDC, VDC, EDS	EIS
CPA 030	Burnup Credit	WPD	WPD	CDC, UDC, VDC	EIS
CPA 031	Burnup Measurements Not Required	SED, WPD	SFD, WPD	ATS, CDC, CTS, UDC	EIS
CPA 032	Disposal Criticality Analysis Methodology	WPD	WPD	CDC, DDC, EDC, UDC, VDC	EIS
CPA 033	Neutron Absorbers	WPD	WPD	UDC	EIS
CPA 034	Withdrawn in REV 01 (replaced by waste type requirements)				
CPA 035	Withdrawn in REV 01 (replaced by a performance requirement)				
CPA 036	Criticality Control Period	WPD	SSFD, WPD	CDC, DDC, EDC, SFS, UDC, VDC, EDS	EIS
CPA 037	Credit for SNF Cladding	PAD, WPD	PAD, WPD	UDC, CDC	PA models, EIS
CPA 038	Transportation Mode/Route within	RT	SED, R&RSD,	N/A	EIS; Cost

Table 6-1. CPA Allocation (Continued)

Identifier	Subject	Responsible Organization Note 1	User Organization Note 1	System Designator Note 2	Other Allocation
	Nevada		ES&H		estimation
CPA 039	Enhanced Design Alternative II Design Definition for Performance Assessment Department, Waste Package Department, and Subsurface Facilities Department	SED	PAD, SED, ECD, WPD, SSFD, ES&H	N/A	PA models; Cost estimation; EIS
CPA-040	Bounding Water Percolation	AR&TP	SSFD, PAD, WPD	EDS	EIS

Notes 1: See Acronyms and Abbreviations for Responsible and User Organization definitions.

2: See Appendix A for System Designator identification.

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 001 – Site Generated Wastes

I. STATEMENT OF ASSUMPTION

Secondary site-generated wastes (radioactive low-level, hazardous, and mixed) will be transported to government-approved off-site facilities for disposal. Radioactive low-level waste (LLW) will be processed (including volume reduction) and packaged for off-site disposal, as designated in assumption CPA 002, and in compliance with the waste acceptance criteria for that disposal site and Department of Transportation shipping requirements. (As indicated in CPA 002, the MGR must account for 10 CFR 20.2001 requirements for disposal of LLW at a licensed disposal site or obtain NRC approval per 10 CFR 20.2002 prior to use of any non-licensed facility for disposal of LLW.) Used DPCs will be prepared for off-site recycling or disposal as LLW. Hazardous and mixed wastes will be collected and packaged for transport to Resource Conservation and Recovery Act-approved off-site treatment, storage, and disposal facilities. This activity will be limited to packaging required for transportation and acceptance of the hazardous and mixed waste at the disposal facility. (Some actions such as neutralization or compaction prior to shipment may be allowed without a Resource Conservation and Recovery Act permit under certain circumstances.) Strict measures will be taken to maintain separation of LLW and the materials that could become hazardous during HLW processing to preclude the formation of mixed waste. Temporary accumulations of site-generated wastes will be accommodated on-site to facilitate treatment of LLW and packaging of all waste types prior to transport to designated facilities. Off-site disposal and recycling options are to be assessed.

NOTE: This assumption is included to clarify the interpretation of MGR RD 3.3.G, because that requirement does not explicitly recognize differences in the handling of hazardous, low-level radioactive, and mixed wastes.

II. RATIONALE

A preliminary study of site-generated waste quantities and disposal options was completed in September 1997 and updated in February 1998 in *Site-Generated Waste Disposal Options* (CRWMS M&O 1998c). The report documented conclusions and rationale for the selected options, which provide the basis for the above assumption. Section 7 of the report summarizes the conclusions and recommendations for disposal of the site-generated wastes based on the evaluations of disposal options for LLW, hazardous waste, and mixed waste in Sections 4, 5, and 6, respectively.

Options for LLW disposal on-site and off-site had been evaluated. The availability of the LLW facility at the Nevada Test Site (NTS), as addressed in assumption CPA 002, would provide a relatively low-cost alternative that is particularly convenient for transportation. To adopt this recommendation from the preliminary study, the MGR must obtain NRC approval per 10 CFR 20.2002. The preliminary study also concluded that DPCs, which would otherwise represent a large amount of LLW to be disposed, should be assumed to be recyclable. The assumption allows for recycling of the DPCs but leaves the determination to Surface Facilities Department analysis.

Hazardous waste quantities were estimated in the preliminary study to be too small to justify permitting for treatment, storage, and disposal. Mixed waste quantities comprise a small fraction of the hazardous wastes. The Office of Civilian Radioactive Waste Management (OCRWM) policy excludes mixed waste from disposal at the MGR, as indicated in the Director's June 1995 Memorandum for the Secretary, *Information Only: Initiation of National Environmental Policy Act requirements for the potential repository at Yucca Mountain, Nevada* (Dreyfus 1995).

Disposal of municipal and construction wastes (nonradioactive, nonhazardous) is not addressed in this assumption.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Systems Engineering Department; Surface Facilities Department; Environmental, Safety and Health

User Organization(s): Surface Facilities Department; Radiological and Regional Studies Department

System allocations: GST, SHZ, SRW

Other allocations: Environmental Impact Statement (EIS)

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 002 – LLW Disposal at NTS

I. STATEMENT OF ASSUMPTION

The DOE NTS LLW disposal facilities will be made available for MGR generated LLW. This would be an off-site facility compatible with assumption CPA 001. It is assumed that NRC will approve disposal of the LLW from the MGR at the NTS facilities under 10 CFR 20.2002. The volume of LLW to be shipped to the disposal facility will be minimized through appropriate means at the MGR.

II. RATIONALE

As indicated in the rationale for assumption CPA 001, recommendations for site-generated waste disposal were provided in Section 7 of *Site-Generated Waste Disposal Options* (CRWMS M&O 1998c). The report recommended that arrangements be made to use the LLW facility at the NTS for the disposal of LLW from the repository. The NTS LLW site is an existing facility with known acceptance criteria and capacity to accommodate MGR LLW. However, an agreement would have to be reached between the Yucca Mountain Site Characterization Office (YMSCO) and the Nevada Operations Office before this assumption could be implemented, because the MGR is currently not listed among LLW producers eligible for disposing LLW at NTS (see Notes below).

Shipping LLW from MGR to NTS will avoid transportation on public roads.

Notes:

1) The MGR must account for 10 CFR 20.2001 requirements for disposal of LLW at a licensed disposal site or obtain NRC approval per 10 CFR 20.2002 prior to use of any non-licensed facility for disposal of LLW. Because the NTS LLW site is not licensed by NRC, the MGR must obtain NRC approval under 10 CFR 20.2002 to be in compliance with 10 CFR 20.2001.

2) MGR is currently not listed among LLW producers eligible for disposing LLW at NTS. Securing this listing must be accomplished. Ensuring NTS availability is necessary because NTS and state of Nevada are currently in litigation regarding the NTS-wide EIS. Any challenge that repository waste is "DOE-owned" waste should be identified and resolved at this time.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Radiological and Regional Studies Department

User Organization(s): Radiological and Regional Studies Department; Surface Facilities Department; Environmental, Safety, and Health

System allocations: SRW

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: -CPA 003 – Secondary Waste from Water that Contacts SNF or HLW

I. STATEMENT OF ASSUMPTION

Waste generated from pool water that contacts SNF or HLW will be processed in the Waste Handling Building for shipment to the off-site waste disposal facility addressed in assumptions CPA 001 and CPA 002 and not enter the Waste Treatment Building.

III. RATIONALE

The Waste Treatment Building will be designed primarily for contact operations involving LLW materials. The waste from the Fuel Pool Cleanup system will be processed and packaged within the Waste Handling Building and not be sent to the Waste Treatment Building. The fuel pool is the only system that can contact HLW or transuranics. The Fuel Pool Cleanup system will clean up the water, but it should not become HLW. The resin and filters from this system will remain LLW and be disposed of in a LLW disposal facility.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Surface Facilities Department

User Organization(s): Surface Facilities Department; Environmental, Safety, and Health

System allocations: HBS, PLS, SRW, TBS

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 004 – Surface Facilities Location

I. STATEMENT OF ASSUMPTION

The proposed repository waste handling and administrative surface facilities will be located adjacent to the North Portal. Administrative facilities will be located east of the operations facilities.

NOTE: This assumption is established jointly with CPA 005.

II. RATIONALE

This assumption establishes probable general siting of facilities based on performance objectives to permit specific facility siting criteria to proceed and is supported by:

- *Nevada Nuclear Waste Storage Investigations Project Site Characterization Plan Conceptual Design Report* (SNL 1987, Figure 4-5 and Sections 4.2.2.2 and 4.2.3.1) proposed the location of the central surface facilities at the entrance to the waste ramp portal. This location was determined by operational considerations, including the provision of short distances between the waste-handling facilities and the waste ramp over which the waste transporter must travel.

- Effort is underway to collect seismic data on the North Portal location proposed for waste handling facilities to support the establishment of seismic design criteria.

- *Exploratory Studies Facility Alternatives Study: Final Report*, Vol. 1: Executive Summary, Supporting Information and Study Conclusions (SNL 1991, Figure 5-30 and Table 7-1) recommended relocation of the waste and tuff ramps portals based on Option 30 findings.

- The Exploratory Studies Facility (ESF) surface facilities are presently located at the entrance to the North Portal, and site improvements for the ESF might be used for the proposed repository surface facilities.

- The South Portal has a steeper ramp grade compared to the North Portal ramp. In general, a steeper grade is less desirable for the waste ramp in which the heavy WPs will be transported, although the difference in grade between the South Ramp (2.62 percent) and the North Ramp (2.15 percent) is not considered to be a deciding factor in selecting the waste ramp and related surface facilities location. Grades of ramps are given on the drawing *Subsurface Repository VA Design Layout Plan* (CRWMS M&O 1997a).

- Prevailing winds were analyzed during Viability Assessment Design (*Engineering Design Climatology and Regional Meteorological Conditions Report* (CRWMS 1997b, Section 4.1.4.3 and Appendix B)), and the relative location between the Administrative and Nuclear facilities in the North Portal area considers the prevailing winds in the event of an accidental hazardous release.

Controlled Project Assumption
Assumption Rationale Sheet

This assumption is established in conjunction with assumption CPA 005 to transport waste via the ramp with its portal located near the waste handling surface facilities. The foregoing rationale is a combined rationale to support both of these related assumptions. These assumptions have been the basis for planning and design efforts during Advanced Conceptual Design and Viability Assessment Design and are reflected in design criteria for LA design. For example, environmental criteria that are impacted by the location assume that the facilities will be located near the North Portal.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Surface Facilities Department

User Organization(s): Surface Facilities Department; Subsurface Facilities Department

System allocations: HBS, MSL, SCA, OMC, SED, SET, SFR, SFS, SSM, SVS, SWC, TBS, WES

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 005 – Use of North Ramp for Waste Transport

I. STATEMENT OF ASSUMPTION

The North Ramp will be used for waste transport.

NOTE: This assumption is established jointly with CPA 004.

II. RATIONALE

This assumption is established in conjunction with assumption CPA 004 to locate the waste handling surface facilities near the portal to the ramp that is to be used for waste transport. The rationale given for CPA 004 is a combined rationale to support both of these related assumptions.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Subsurface Facilities Department

User Organization(s): Subsurface Facilities Department; Surface Facilities Department

System allocations: MSL, OMC, SET, SFS, SSM, SVS, WES

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 007 – Remedial Processing of Canistered Waste Forms

I. STATEMENT OF ASSUMPTION

The MGR shall have the capability to handle canistered waste forms that require remedial processing. This includes remediation due to inability to load waste into a disposal container in the canistered configuration. Such off-normal handling includes opening CSNF canisters, removing the waste form, discarding the canister, and repacking the waste form in a disposal container. Applicability for other waste forms will be assessed and resolved during LA design.

NOTE: This assumption provides interpretation of MGR RD 3.4.2.D which states that "The MGR shall have the capability to handle any canistered waste forms that require remedial processing. Such processing may include opening the canister, transferring the waste form, and resealing."

II. RATIONALE

This assumption is provided for clarification with regard to MGR RD 3.4.2.D. The assumption pertains to disposable waste canisters that are otherwise intended not to be opened. The requirement is derived in the MGR RD and is not directly imposed by the *Revised Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations (Revision 01, July 22, 1999), for Yucca Mountain, Nevada* (Dyer 1999), or the CRD (DOE 2000b).

Possible events and best remedial methodology will need to be investigated before operations and equipment can be defined. The design includes systems for handling and packaging CSNF assemblies in normal operations; off-normal handling of CSNF could be handled with the same equipment.

The implications and extent of applicability of a remedial processing requirement on various canistered DOE SNF, Naval SNF, and HLW are subject to differing interpretations that must be resolved during LA design to define the scope of impact on repository facilities.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Surface Facilities Department

User Organization(s): Surface Facilities Department

System allocations: ATS, CTS

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 008 – Withdrawn in REV 00 DCN 01

The assumption was withdrawn because it was substantiated by the LADS decision not to use rod consolidation. A corresponding, negatively-stated design criterion is not needed.

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 009 – Withdrawn in REV 01

This assumption was withdrawn due to the License Application Design Selection decision on lag storage. See design constraint 5.2.14.

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 010 – Withdrawn in REV 01.

This assumption was withdrawn due to the License Application Design Selection decision on lag storage. See design constraint 5.2.14.

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 011 – Parking Capacity for Loaded Casks

I. STATEMENT OF ASSUMPTION

The MGR will be capable of parking the entire fleet of transportation casks loaded with SNF and HLW if the ability to unload transportation casks is interrupted. The transportation cask fleet is assumed to be consistent with the cask fleet described in the "Basis for the VA and TSLCC Cost Estimate Operational Waste Stream" (CRWMS M&O 1998d, Table 7).

II. RATIONALE

A requirement similar to this assumption is expected to be proposed for inclusion in the CRD (DOE 2000b) based on preliminary results of a blending inventory analysis. The MGR must be able to park loaded shipping casks to accommodate receipt of shipping casks that are enroute, and it should support additional acceptance of waste if needed. The maximum that could be accepted before the reinstatement of the MGR ability to unload casks is the amount that can be carried by the fleet of shipping casks. After mitigation of the causes of an interruption in the capability to unload the casks, the MGR could proceed to unload the casks at the maximum rate permitted by the unloading capacity of the facility. During this unloading period, there would be no delays awaiting deliveries, and new deliveries would not begin until sufficient casks were unloaded and back in service.

The assumed transportation cask fleet is based on the estimated numbers of casks in the *Basis for the VA and TSLCC Cost Estimate Operational Waste Stream* (CRWMS M&O 1998d, Table 7).

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Systems Engineering Department

User Organization(s): Surface Facilities Department

System allocations: CCT, MSL, SSG

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 012 – Limited Cask Maintenance Capability

I. STATEMENT OF ASSUMPTION

The repository will not perform transportation cask maintenance, except for the incidental maintenance and decontamination needed to return the casks to the Regional Servicing Contractors or ship the unloaded casks off site to a Cask Maintenance Facility approved by the Nuclear Regulatory Commission or Agreement State.

NOTE: This assumption is included to clarify the interpretation of MGR RD 3.4.2.L which states: "MGR shall have the capability to perform minor transportation cask maintenance necessary to support cask receipt and return rates."

II. RATIONALE

The Regional Servicing Contractors, under contract to the DOE, are to be responsible for arranging and providing waste acceptance and transportation services to deliver the CSNF to a federal facility, which is the repository for the reference design case. This will include responsibility for providing, maintaining, and decontaminating the transportation casks in which the SNF will be received at the repository. This means that the Cask Maintenance Facility is a non-MGR facility and not to be designed as part of the repository. The interpretation of MGR RD 3.4.2.L, as provided in this assumption, is consistent with this concept and indicates that the minor maintenance capability is limited to that needed to return the casks to the Regional Servicing Contractors or ship the unloaded casks off site to an approved Cask Maintenance Facility.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Systems Engineering Department

User Organization(s): Surface Facilities Department

System allocations: CCT for cask maintenance; ATS and CTS for decontamination

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 013 – Decontamination Concept

I. STATEMENT OF ASSUMPTION

MGR design will provide means for controlling the spread of potential contamination and performing decontamination, consistent with applicable codes and standards, by selecting design features and decontamination operations that will comply with ALARA (as low as reasonably achievable) requirements and, to the extent practicable, minimize the effect on operations. MGR radiological, waste handling, and maintenance operations will be supported by equipment designed to decontaminate the handling equipment, waste containers, and personnel as near the source of the contamination as practicable. Portable or mobile decontamination equipment will be provided where appropriate to support area clean up, and for preliminary equipment decontamination for the purposes of safe handling to final decontamination. Major decontamination operations will be centralized where confinement and movement to the centralized facility is dictated by ALARA considerations. Decontamination equipment will be designed to collect and confine the contamination byproducts in a way that they can be safely transported or transferred for processing.

III. RATIONALE

This assumption defines a decontamination philosophy that uses decentralized decontamination facilities where it is considered to be more difficult to control the spread of contamination in moving the contaminated items. Where justified by ALARA analyses, it also accommodates a centralized approach to major decontamination operations in combination with preliminary localized decontamination, confinement, and transfer to the central facilities.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Surface Facilities Department; Environmental, Safety and Health

User Organization(s): Surface Facilities Department; Subsurface Facilities Department; Environmental, Safety and Health

System allocations: CBS, HBS, MSL, SFS, TBS

Other allocations: MGR Concept of Operations, EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 014 – Source of Water

STATEMENT OF ASSUMPTION

The MGR will connect with the existing NTS water supply system as the source of water for the repository. Treatment will be required to provide the potable water.

II. RATIONALE

Use the existing water supply system rather than drilling for a new ground water source.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Systems Engineering Department; Surface Facilities Department; Environmental, Safety, and Health

User Organization(s): Surface Facilities Department

System allocations: SWS

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 015 – Telephone Communications

I. STATEMENT OF ASSUMPTION

The MGR shall connect to the existing NTS telephone system.

II. RATIONALE

DOE NTS Standard Operating Procedure, NTS-SOP-5301, defines the responsibilities and interfaces for all aspects of telecommunications at the NTS. The assumption is consistent with current policy.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Systems Engineering Department; Surface Facilities Department

User Organization(s): Surface Facilities Department; Environmental, Safety, and Health

System allocations: SSG, TCS

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 016 – Withdrawn in REV 01 DCN 01

This assumption was withdrawn because compliance with the applicable provisions of *Standards for Protection Against Radiation* (10 CFR 20) is a primary regulatory requirement of the *Civilian Radioactive Waste Management System Requirements Document* (DOE 2000b, Section 3.1.1.B).

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 017 – Withdrawn in REV 01 DCN 01

This assumption was withdrawn because compliance with the applicable provisions of *Standards for Protection Against Radiation* (10 CFR 20) is a primary regulatory requirement of the *Civilian Radioactive Waste Management System Requirements Document* (DOE 2000b, Section 3.1.1.B).

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 018 – ALARA Cost-Benefit Analysis

I. STATEMENT OF ASSUMPTION

In evaluating design options to ensure that doses are ALARA, cost-benefit analysis will be conducted when there is a tradeoff between the dose reduction achieved and added cost to implement the corresponding option. The design of MGR systems, facilities, and processes will be developed and modified using an ALARA evaluation process that includes mandatory dose reduction measures be added up to the point where further reductions would cost more than:

- $5,000 (in 1995 dollars) per person-rem occupational dose averted over the life of the facility until closure
- $2,000 (in 1995 dollars) per person-rem public dose averted over the life of the facility until closure.

(The costs and the dose averted are measured over the life, and dollars are expressed on a present worth basis.)

NOTE: MGR systems, facilities, and processes are to be designed to ensure that doses are ALARA. Until such time as the ALARA program documentation has been completed, assumptions, including this one, are established to support implementation.

II. RATIONALE

The requirement for ALARA in design is contained in 10 CFR 20.1101(b) which states: "The licensee shall use, to the extent practicable, 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 is reasonably achievable (ALARA)." Guidance on the ALARA process is contained in several guidance documents including Regulatory Guides 8.8 and 8.10.

Cost benefit guidance is given in the guidance documents referenced above and in NUREG-1530, *Reassessment of NRC's Dollar Per Person-Rem Conversion Factor Policy* (NRC 1995), which states in section 8: "...the NRC proposes that $2,000 per person-rem be used for routine emission, accidental releases, and 10 CFR 20 ALARA programs." To the extent that occupational exposures involve labor cost considerations, these impacts would be addressed as a separate additive element in the value-impact analysis. The nuclear power industry has been using values between $7,500 and $15,000 per person-rem.

The only dollar value per person-rem that appears in regulations is found in 10 CFR 50, Appendix I, Section II.D, which states: "...the applicant shall include in the radwaste system all items of reasonably demonstrated technology that, when added to the system sequentially and in order of diminishing cost-benefit return, can for a favorable cost-benefit ratio effect reductions in dose to the population reasonably expected to be within 50 miles of the reactor. As an interim measure and until establishment and adoption of better values (or other appropriate criteria), the values $1000 per total body man-rem and $1000 per man-thyroid-rem (or such lesser values as may be demonstrated to be suitable in a particular case) shall be used in this cost-benefit analysis." Section 2 of NUREG-1530 discusses the historical developments including the establishment of this value published in 10 CFR 50 Appendix I in 1975.

This assumption adopts the value defined in NUREG-1530 for public dose averted, but assigns a higher value for occupational dose avoided.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Environmental, Safety and Health; Safety and Health Department

User Organization(s): Surface Facilities Department; Subsurface Facilities Department; Safety and Health Department

System allocations: ATS, BES, CBS, CCH, CCT, CMH, CTS, DCH, HBS, HBV, PCM, PLS, SET, SRW, SSM, SVS, TBS, WES, WPR

Other allocations: ALARA program documentation (when issued), EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 019 – Waste Package Shielding

I. STATEMENT OF ASSUMPTION

WP containment barriers will provide sufficient shielding for protection of WP materials from radiation enhanced corrosion.

Individual WPs will not provide any additional shielding for personnel protection.

Additional shielding for personnel protection will be provided on the subsurface and surface waste handling SSCs, including the WP transporter.

II. RATIONALE

Cost, size, and weight of individually shielded WPs would be excessive.

It will be more cost effective to meet ALARA requirements with shielding options rather than WP design.

Personnel radiation protection from individual WPs will be provided through the use of:

- Remote handling equipment in the assembly and emplacement areas
- A shielded WP transporter during emplacement operations
- Shielding and seals at the entrances to the emplacement drifts

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Waste Package Department

User Organization(s): Surface Facilities Department; Subsurface Facilities Department; Waste Package Department; Environmental, Safety, and Health

System allocations: CDC, DCH, DDC, EDC, HBS, NDC, SFS, UDC, VDC, WES, EDS

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 020 – Limitation on Human Entry in Emplacement Drifts Containing Waste Packages

I. STATEMENT OF ASSUMPTION

Under normal conditions, no human entry is planned in emplacement drifts while WPs are present. The waste emplacement, retrieval, and performance confirmation equipment may use robotics or remote control features to perform operations and monitoring within the emplacement drifts. Under off-normal conditions, human entry will be considered and protection (including radiation) to the workers will be provided.

II. RATIONALE

The current design is based on unshielded WPs in the emplacement drifts. Radiation from the unshielded WPs is too high to allow human entry into the emplacement drifts without supplemental protection. Operations will be carried out by remote mechanical methods. Human entry may be allowed for off-normal events if adequate protection is assured.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Subsurface Facilities Department; Environmental, Safety and Health

User Organization(s): Subsurface Facilities Department

System allocations: PCV, SSM, WES, PCM

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 021 – Emplacement Drift Entrance Doors

I. STATEMENT OF ASSUMPTION

Doors are required at entrances to emplacement drifts.

II. RATIONALE

Doors at entrances to emplacement drifts serve two purposes. They control access to the emplacement drifts and they provide control of ventilation through the drifts. They will also inherently provide some amount of radiological shielding.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Subsurface Facilities Department

User Organization(s): Subsurface Facilities Department; Environmental, Safety, and Health

System allocations: SFS, SVS

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 022 – Retrieval

I. STATEMENT OF ASSUMPTION

Proof of principle demonstrations of WP retrieval will be documented before license application through supplier performance data, and proof-of-principle testing will be conducted following license application.

II. RATIONALE

The *Retrievability Strategy Report* (CRWMS M&O 1998e) proposed updated retrieval strategy based on the conceptual design and WP design and analysis during Viability Assessment design. The proposed strategy recognized that:

> Under the current repository design and operational concept, the requirements for "proof of principle" and prototype tests to show that retrieval will be possible would be met by the tests required to ensure that WPs can be accessed and moved under normal and abnormal conditions during the operational period. No demonstration for retrieval is required. (CRWMS M&O 1998e, Table 8-3 and Section 8.1.3)

The strategy also stated:

> "To build an acceptable level of confidence that retrieval is possible, proof-of-principle demonstrations must be completed and documented before submittal of the License Application to receive and possess waste." (See reference to supporting note.) "Those components for which adequate demonstration cannot be provided through supplier performance data will be identified by a Test and Evaluation analysis and tested to provide reasonable assurance that the planned retrieval method will function under abnormal conditions." (CRWMS M&O 1998e, Table 8-3)
>
> A supporting note indicated that the *Civilian Radioactive Waste Management Program Plan*, as developed and revised by DOE, modifies its position on the development of the disposal system. A previous requirement for proof-of-principle prior to License Application was restated in the 1996 Program Plan revision as "License Application design ... will describe designs in enough detail to demonstrate repository safety and enable compliance reviews by the Nuclear Regulatory Commission." Since demonstration can be shown in several ways this statement implies that the proof-of-principle testing can be deferred to the post License Application timeframe (CRWMS M&O 1998e, Table 8-3 footnote). The 1998 Program Plan revision reiterated that the "design for the license application ... will describe designs in sufficient detail to demonstrate safety" (DOE 1998c, p. 23).

Controlled Project Assumption
Assumption Rationale Sheet

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Licensing Department

User Organization(s): Subsurface Facilities Department; Environmental, Safety, and Health

System allocations: WES

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 023 – Modular Design and Construction Capability

I. STATEMENT OF ASSUMPTION

The MGR will be designed in a manner that will permit modular design and/or construction in stages such that maximum annual funding requirements could be reduced. This will facilitate the start of operations at the repository after the initial construction stage and continuation of operations concurrently with subsequent construction stage. The amount of modular design or construction staging would be selected based on funding and schedule constraints.

II. RATIONALE

This assumption anticipates that one of the decisions will be to carry options that provide flexibility of the MGR to be constructed and operated in accordance with budget limitations and schedule constraints. This assumption also anticipates that design and staged construction of modules will provide an option for maintaining the waste acceptance schedule even if other actions, such as site recommendation and construction authorization, are delayed.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Systems Engineering Department

User Organization(s): Surface Facilities Department; Subsurface Facilities Department; Environmental, Safety, and Health

System allocations: (Will be allocated to most surface and subsurface systems.)

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 024 – Underground Transport of Personnel, Supplies, and Excavated Rock

I. STATEMENT OF ASSUMPTION

Rail in both the emplacement and development sides of the repository will be used for transporting underground supplies, equipment, and personnel to the extent practical. Excavated rock will be removed by conveyor belt or conveyor belt variation when practical.

II. RATIONALE

The assumed use of rail in the subsurface emplacement transportation system:

- Takes advantage of the rail system required to transport heavy WPs in the waste emplacement system
- Is well suited to in-drift emplacement mode
- Is highly suitable for remotely handled or automated operations

The assumed use of rail for the subsurface development transportation system is ideal for supplying tunnel boring machine operation. Both rail systems are compatible with repository subsurface gradient and ideal for transportation of people.

Use of a conveyor belt for transporting excavated rock (muck) reduces the underground transportation fleet required and reduces operating costs where excavated opening size and configuration makes use of a conveyor system practical.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Subsurface Facilities Department

User Organization(s): Subsurface Facilities Department; Environmental, Safety, and Health

System allocations: BES, MHS, SET, SDT

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 025 – Diesel Equipment Limitation

I. STATEMENT OF ASSUMPTION

The use of diesel powered equipment will not be allowed in the subsurface repository under normal conditions. Its use is not precluded, however, in off-normal events.

II. RATIONALE

The use of diesel engines underground produces emissions that could potentially have a negative impact on long-term performance. Diesel particulates (soot) and Oxides of Nitrogen are the chief constituents of concern. The *Determination of Importance Evaluation for the Subsurface Exploratory Studies Facility* (CRWMS M&O 1999k), and its accompanying *Waste Isolation Evaluation: Tracers, Fluids, and Materials and Excavation Methods for Use in the Package 2C Exploratory Studies Facility Construction* (CRWMS M&O 1995), contain preliminary evaluations on which early diesel work was based.

Diesel use has been allowed in the ESF on the basis that its use will not materially affect waste isolation because no potential emplacement areas are being excavated in the course of the construction of the ESF. However, it has been assumed by the repository design team that diesel use would not be acceptable for the construction and operation of the repository. This is based on the significantly larger total emissions that would result from construction and 100-year operations in the repository over that expected from construction and operations of the ESF, and the fact that repository airflow paths would include emplacement areas.

Information on this subject is available in *Use of NTS Surplus Diesel Locomotives in the Excavation and Operation of the North Ramp of the ESF* (CRWMS M&O 1994a) and *Diesel Emissions Expected From Deutz F8L413FW Engine During North Ramp Excavation*" (CRWMS M&O 1994b).

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Subsurface Facilities Department

User Organization(s): Subsurface Facilities Department; Environmental, Safety, and Health

System allocations: BES, MHS, SCS, SDT, SED, SES, SET, SSM, SVS, WES

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 026 – Subsurface Configuration for Water Drainage

I. STATEMENT OF ASSUMPTION

The repository subsurface layout will be configured for postclosure water drainage such that:

- Water entering the emplacement drifts can drain directly into the surrounding host rock without draining along the drift for collection in a centralized location (this assumption does not encompass general flooding of the facility).
- Drifting above the emplacement level will not have direct connection to an emplacement drift such that water entering the overlying drift could flow by gravity through a man-made opening into the underlying emplacement drifts.
- Drifting above the emplacement level will be configured to slope so that any water that enters the drift can flow, by gravity, away from the emplacement area.

The drainage patterns shown in drawing *Drainage Patterns VA Design Layout Plan* (CRWMS M&O 1997c) will require modification to accommodate the first bullet above.

II. RATIONALE

The rationale for the guidance stated above is to require the underground facility to aid in the isolation of wastes and the achievement of the postclosure performance requirements established in regulations. The assumptions above result in a facility which, to the extent practical, minimizes the opportunities for water to contact disposal containers after closure. Drifts above the emplacement horizon are restricted such that they must slope to allow any water entering them to flow away from the emplacement area. Drifts above the horizon are also constrained in that they must have no direct connection with emplacement drifts that could provide a gravity flow pathway from the overlying drift into the emplacement horizon.

It is not possible to preclude water contact with containers solely by the layout of the drifts, but the measures above help ensure that the layout does not allow water more than one chance to contact a container, and does not focus flow onto containers that otherwise may not have been reached.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O organization(s): Subsurface Facilities Department

User Organization(s): Subsurface Facilities Department; Environmental, Safety, and Health

System allocations: SFS, SWC

Other allocations: Performance Assessment models, EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 027 – Applicability of Mine Safety and Health Administration Regulations

I. STATEMENT OF ASSUMPTION

There is no implication that the Mine Safety and Health Administration has any enforcement authority over construction or operations of the MGR. Nevertheless, some regulations that implement the Federal Mine Safety and Health Act of 1977 (30 USC 801 et seq.) may be selectively applied as appropriate design criteria for subsurface facilities and equipment, or for those mining-related surface facilities and equipment specifically addressed therein.

II. RATIONALE

Background: The Occupational Safety and Health Administration standards and regulations contained in 29 CFR 1910 (Occupational Safety and Health Standards) and 29 CFR 1926 (Safety and Health Regulations for Construction), as applicable, apply to all repository facilities and equipment. This is not addressed in the assumption because it is a fact. MGR RD 3.1.E and 3.1.F impose these standards and regulations in 29 CFR 1910 and 29 CFR 1926.

Regulations that implement the Federal Mine Safety and Health Act of 1977 (30 USC 801 et seq.) do not directly apply to the repository. However, they may be selectively applied by DOE or its contractors as effective safety criteria without implying that the Mine Safety and Health Administration has any enforcement authority over construction or operations of the MGR. The applicability of any such provisions would be limited to subsurface facilities and equipment and to those mining-related surface facilities and equipment specifically addressed therein.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Systems Engineering Department; Safety & Health Department; Environmental, Safety and Health

User Organization(s): Subsurface Facilities Department

System allocations: BES, GCS, MHS, PCM, MHS, SCA, OMC, SCS, SDT, SED, SES, SET, SFR, SFS, SSM, SVS, SWC, SWD, WES, EDS

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 028 – Withdrawn in REV 00 DCN 01

The assumption was withdrawn due to the removal of backfill from the current design (Stroupe 2000).

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 029 – Use of Disposability Interface Specification

I. STATEMENT OF ASSUMPTION

The bounds on various waste properties defined in the *Monitored Geologic Repository Draft Disposability Interface Specification* (CRWMS M&O 1998f) will be used as criteria for MGR design until such time as the comparable information is captured in an integrated interface control document between the OCRWM Office of Acceptance, Transportation, and Integration (OATI) and the YMSCO.

II. RATIONALE

The *Monitored Geologic Repository Draft Disposability Interface Specification* (CRWMS M&O 1998f), which has been referred to as the DIS, was prepared to define the bounding values of key waste properties/characteristics that impact MGR design. It was based on the premise that if the wastes delivered to the MGR meet these bounding values, and the various design organizations use these same bounding values in MGR design activities, there is an appreciable level of system integration achieved.

A decision by DOE to consolidate all external interfaces with OCRWM into a single document (a revision of the *Waste Acceptance System Requirements Document* (DOE 1999b)) and key internal-OCRWM interfaces in a separate document (a new integrated interface control document), led to DOE directing the M&O not to publish the DIS. Instead, the information from the DIS will be incorporated first into the integrated interface control document between the OATI and YMSCO and then into Revision 4 of the *Waste Acceptance System Requirements Document*. Once the integrated OATI-to-YMSCO interface control document is issued, it will provide the design input currently addressed in the DIS and will supersede the DIS. Until issuance of this interface control document, the DIS provides the M&O's best available information for use as assumed MGR design criteria for the properties of the waste to be received.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Systems Engineering Department

User Organization(s): Surface Facilities Department; Subsurface Facilities Department; Waste Package Department

System allocations: ATS, CBS, CCH, CCT, CDC, CMH, CTS, DDC, EDC, HBS, NDC, SFS, UDC, VDC, EDS

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 030 – Burnup Credit

I. STATEMENT OF ASSUMPTION

Credit will be received for Principal Isotope burnup in disposal criticality evaluations of commercial light water reactor SNF. Burnup credit will also be received for Naval SNF.

II. RATIONALE

The use of burnup credit is a realistic method for determining the criticality potential of SNF over long periods of time, especially when evaluating criticality during the MGR postclosure phase. The assumption reflects the position presented in the *Disposal Criticality Analysis Methodology Topical Report* (YMP 1998, Section 2.3.3). NRC response to this topical report and any modifications in the report related to the position reflected in the assumption will be monitored for purposes of re-evaluation or substantiation of the assumption.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Waste Package Department

User Organization(s): Waste Package Department

System allocations: CDC, UDC, VDC

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 031 – Burnup Measurements Not Required

I. STATEMENT OF ASSUMPTION

Credit for burnup by analysis will be allowed based on records of the exposure history of the individual CSNF assemblies.

II. RATIONALE

The assumption reflects the position presented in Section 2.3.3 (p. 2-10) of the *Disposal Criticality Analysis Methodology Topical Report* (YMP 1998). NRC has not yet accepted this position. NRC response to this topical report and any modifications in the report related to the position reflected in the assumption will be monitored for purposes of re-evaluation or substantiation of the assumption. This assumption does not preclude the option of designing SNF burnup measurement capability for sampling or confirmation purposes.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Systems Engineering Department; Waste Package Department

User Organization(s): Waste Package Department; Surface Facilities Department

System allocations: ATS, CDC, CTS, UDC

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 032 – Disposal Criticality Analysis Methodology

I. STATEMENT OF ASSUMPTION

It is assumed that the disposal criticality analysis methodology as presented in the *Disposal Criticality Analysis Methodology Topical Report* (YMP 1998), with its use of risk-informed methodology and disposal burnup credit, will be accepted by the NRC for demonstrating that designs meet the disposal criticality control requirements.

II. RATIONALE

The use of burnup credit is a realistic method for determining the criticality potential of SNF over long periods of time, especially when evaluating criticality during the MGR postclosure phase. The risk-informed methodology allows designers to focus on the most important aspects of criticality analysis by assessing specific risks. The proposed rule 10 CFR 63 (Dyer 1999) also presented proposed criteria for the repository that is risk-informed and performance-based. NRC response to the topical report identified in the assumption and any modifications in this topical report related to the position reflected in the assumption will be monitored for purposes of re-evaluation or substantiation of the assumption.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Waste Package Department

User Organization(s): Waste Package Department

System allocations: CDC, DDC, EDC, UDC, VDC

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 033 – Neutron Absorbers

I. STATEMENT OF ASSUMPTION

Credit can be taken for the presence of neutron absorber material in/from criticality control panels and rods made of a material that will last a sufficiently long time in the projected range of repository environments for disposal criticality analyses. The sufficiency of a material lasting in the range of projected repository environments must be determined by detailed geochemistry evaluations.

II. RATIONALE

As indicated above, the sufficiency of a material lasting in the range of projected repository environments must be determined by detailed geochemistry evaluations. Current evaluations indicate varying degrees of corrosion for different types of steel. See Section 7.2.1 of *Second Waste Package Probabilistic Criticality Analysis: Generation and Evaluation of Internal Criticality Configurations* (CRWMS M&O 1996b, pp. 34-36).

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Waste Package Department

User Organization(s): Waste Package Department

System allocations: UDC

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 034 – Withdrawn in REV 01

The assumption was withdrawn because the specific types of waste that the MGR should be designed to accommodate are now specified as a performance requirement in the MGR RD 3.2.B.

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 035 – Withdrawn in REV 01

The assumption was withdrawn because the expected annual dose limit to the average member of the critical group is now specified as a performance requirement in the MGR RD 3.2.P.

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 036 – Criticality Control Period

I. STATEMENT OF ASSUMPTION

The Criticality Control Period lasts to at least the end of the 10,000-year period of regulatory concern addressed in the postclosure performance measure provided in 10 CFR 63 (Dyer 1999). Longer periods will also be considered in analyzing criticality control.

II. RATIONALE

The interim postclosure performance measure contains a 10,000 year time frame for controlling peak dose based on the regulatory compliance period in 10 CFR 63.113(b) (Dyer 1999). Time periods beyond 10,000 years will also be considered.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Waste Package Department

User Organization(s): Waste Package Department; Subsurface Facilities Department

System allocations: CDC, DDC, EDC, SFS, UDC, VDC, EDS

Other allocations: EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 037 – Credit for SNF Cladding

I. STATEMENT OF ASSUMPTION

Appropriate credit will be taken for SNF cladding in retarding the release of radionuclides based on analysis of cladding damage occurring in the repository.

II. RATIONALE

In its June 4, 1998 meeting, the Level 3 Change Control Board directed that the *Controlled Design Assumptions Document* be modified to indicate that credit will be taken for cladding. This was reflected in the modification of assumption EBDRD 3.7.1.2.B in REV 05 of the *Controlled Design Assumptions Document* (CRWMS M&O 1998a). The part of the assumption addressing credit for cladding is being carried forward in the CPA.

The nuclear industry has done research on zirconium since the early 1950s and found it to be highly corrosion resistant. Performance assessment modeling by the M&O has considered credit for cladding in retarding the release of radionuclides. After excluding certain cladding from any credit, Performance Assessment models the exposed surface area of fuel resulting from damages to cladding (including perforation, mechanical failures from rockfalls, and localized corrosion) after the failure of the disposal container. The performance assessment modeling will reflect a range of values for cladding damage, prior to its receipt at the repository, that is sufficiently large to accommodate fuel from early reactor cores (including BWRs from 1973-1975) with higher percentages of failed fuel. This range will also be expanded to include pins that are damaged but have not yet failed. There should be no requirements for fuel inspection on the part of the utilities to satisfy the modeling of cladding in performance assessment.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Waste Package Department; Performance Assessment Department

User Organization(s): Waste Package Department; Performance Assessment Department

System allocations: UDC, CDC

Other allocations: Performance Assessment models, EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 038 – Transportation Mode/Route Within Nevada

I. STATEMENT OF ASSUMPTION

SNF and HLW arriving in Nevada on mainline rail lines will be transported to the repository via rail. The five rail routes being considered are described in *Rail Alignments Analysis* (CRWMS M&O 1997d).

II. RATIONALE

The EIS will continue to evaluate heavy-haul truck transportation within the state of Nevada as an option in comparison to rail, as indicated in the Notice of Intent. The EIS will provide the necessary analysis for decision-makers to use to decide on mode and route. Rail in Nevada is used as the assumption because it provides a reasonable basis for design that could be readily modified to heavy-haul transportation, if necessary. The five routes being considered are: Caliente, Jean, Carlin, Valley Modified, and Caliente/Chalk Mountain.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Regional Transportation

User Organization(s): Radiological and Regional Studies Department (EIS); Systems Engineering Department; Environmental, Safety, and Health

System allocations: N/A

Other allocations: EIS; Cost estimation

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 039 – Enhanced Design Alternative II Design Definition for Performance Assessment Department, Waste Package Department, and Subsurface Facilities Department

I. STATEMENT OF ASSUMPTION

Performance assessment modeling will use the design constraints and applicable performance criteria in Section 5.0 of this PDD to define design concepts and parameters implementing EDA II. Performance assessment will assume that the design parameters are equal to values stated in these constraints and criteria as nominal or limiting values.

In addition, the Performance Assessment Department, the Waste Package Department, and the Subsurface Facilities Department will assume for SR that the:

- Invert ballast material is crushed tuff.
- Free-standing drip shield is of "mailbox" shape and with uninterrupted coverage for the entire length of the emplacement drift.
- Average heat output per WP for PWR CSNF at the time of emplacement will be 11.3 ± 0.5 kW (Stroupe 2000), and the average heat output per WP for all WPs at the time of emplacement will be 7.12 kW.

Postclosure performance of the repository will be evaluated for potential preclosure periods of approximately 50 years and approximately 125 years. Closure at 50 years will be assumed for determination of worst case performance uncertainty, and closure at 125 years will be assumed for determination of performance uncertainty for a worst cost case.

II. RATIONALE

The design constraints in Section 5.2 have been established as supplemental criteria for design in implementing EDA II. They have been established in a form that will serve to define the EDA II design solutions for which MGR performance is to be assessed. The backfill and invert ballast materials are natural granular materials that satisfy the design constraints. The drip shield shape and continuous coverage reflect an effective concept for installation of a free-standing drip shield that will reside between the WP and the backfill and not be in contact with the WP and will divert dripping water from contacting the WP.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O Organization(s): Systems Engineering Department

User Organization(s): Performance Assessment Department; Systems Engineering Department; Environmental Compliance Department; Waste Package Department; Subsurface Facilities Department; Environmental, Safety, and Health

System allocations: N/A

Other allocations: Performance Assessment models; Cost estimation; EIS

Controlled Project Assumption
Assumption Rationale Sheet

Assumption Identifier and Subject: CPA 040 – Bounding Water Percolation

I. STATEMENT OF ASSUMPTION

The amount of liquid water that percolates downward, and is potentially available to seep into the emplacement drift in the vicinity of one WP, can be estimated in several ways. The following assumptions provide design basis flow conditions. These flow rates are developed for the present day conditions (up to 100 years after initial emplacement of waste), near-term conditions (up to 300 years after initial emplacement), and long-term conditions (up to 20,000 years after initial emplacement). A separate estimate of flow for drainage design is provided. The assumptions are as follows:

Ambient Fully Mediated (steady and uniform) Flow: (on average, the engineered barrier system in the vicinity of one WP)

Present-day: 0.05 m^3/year

Near-term: 0.1 m^3/year

Long-term: 0.5 m^3/year

Ambient Steady Focused Flow: (on average, the engineered barrier system in the vicinity of a WP will be exposed to such a flow once every 40 years)

Present-day: 2 m^3 of water, occurring over one year

Near-term: 4 m^3 of water, occurring over one year

Long-term: 20 m^3 of water, occurring over one year

Ambient Episodic Focused Flow: (on average, the engineered barrier system in the vicinity of a WP will be exposed to such a flow once every 40 years)

Present-day: 2 m^3 of water, occurring over one week, one time in the year

Near-term: 4 m^3 of water, occurring over one week, one time in the year

Long-term: 20 m^3 of water, occurring over one week, one time in the year

Drainage flow:

Present-day: 0.2 m^3/m of drift occurring over one week, one time per year

Near-term: 0.4 m^3/m of drift occurring over one week, one time per year

Long-term: 2 m^3/m of drift occurring over one week, one time per year

II. RATIONALE

The unsaturated zone at Yucca Mountain is composed of a sequence of variably-welded and variably-fractured tuff units, distinguishable in terms of their average flow properties: in descending order from the surface, these include the Tiva Canyon welded (TCw) and the Paintbrush Tuff nonwelded (PTn) units, and the Topopah Spring welded (TSw) unit (proposed repository host rock). Water reaching the TSw unit percolates downward to it from the surface through the overlying units. The percolation flux in the TSw unit itself is difficult to determine. It cannot be measured directly and only inferred from indirect lines of evidence. The rock is highly heterogeneous and the nature of flow in the unsaturated zone is chaotic and nonlinear, making such inference extremely difficult. Nevertheless, studies to date provide information that can be used to estimate a reasonable bound to the flow conditions that might affect the engineered barrier system.

Net infiltration into the TCw unit of water precipitating onto the surface of Yucca Mountain provides an upper boundary condition for the percolation flux. Current evidence suggests that present-day net infiltration averages about 5 mm/year across the site (Flint et al. 1996, Summary). This evidence also suggests that the infiltration varies significantly across the site. Precipitation at the site is episodic so that net infiltration at any specific location is intermittent, with episodes of higher infiltration occurring in short-duration events over only a few days to a week in any given year. Some estimates suggest that infiltration flux, averaged over the site, could be as much as 10 to 20 mm in some years and negligible in other years, under present conditions (Flint et al. 1996, Summary). Because precipitation at the surface could increase in the future, net infiltration at the site could also increase.

Estimates from different lines of evidence suggest the percolation flux at the repository horizon presently averages on the order of 5 to 10 mm/year (Bodvarsson and Bandurraga 1996, Section 1.3.1). This range is consistent with the estimate of present-day net infiltration flux.

Like the net infiltration, the percolation at depth is likely to be variable in both space and time. The PTn unit may provide significant mediation of the flow; however, this has not yet been shown conclusively. Also, the possibility of spatial focusing of the flow as it proceeds downward, increasing the percolation flux in different locations at different times, cannot presently be precluded. It is reasonably conservative to assume that the average present-day percolation flux is the same as the average present-day infiltration rate, and that this flow could concentrate on different locations in the host rock.

This information suggests that the engineered barrier system should be designed to withstand percolation fluxes averaging on the order of 5 mm/year and ranging from near zero to as much as 30 mm/year in the wettest years, if present-day conditions were assumed to continue. Under warming trends over the next few hundred years, average flux could double, with a range of near zero to 60 mm/year. Under longer term changes (over the next 20,000 years), the average percolation flux could increase by a factor of ten (50 mm/year), with a range between near zero and 300 mm/year.

Present-day flux is likely to be variable in time with values in some years much different than in others. If the percolation flux reflects the characteristics of the infiltration at the surface, it could also be intermittent within the year, with episodes of duration totaling as much as a week. Increased flux over the next few hundred years and in the longer term may occur because of increased frequency of these episodes, because of the increased intensity in individual episodes, or because the nature of the episodes changes (i.e., episodes of precipitation dominated by rainfall changing to those dominated by snow fall). For the purpose of design, two cases should be considered: one in which the flow is steady in flowing years and one in which the flow is episodic within the flowing years, with durations lasting seven days in those years.

The above flux estimates can be used to derive conservative design basis flows for the engineered barrier system. For engineered barriers of a 10 m^2 cross-sectional area and for flow that is fully mediated such that the flux is uniform across the repository and constant in time, the average flow contacting the portion of the engineered barrier system associated with a single WP would be 0.05 m^3/year (5 mm/year x 10 m^2 = 0.05 m^3/year). However, if the flow focuses, a greater amount of water could intersect the engineered barrier system associated with a single WP. At an areal mass loading of 85 MTHM/acre, the average area of host rock allocated to each WP is about 400 m^2. If all of the flow occurring in that area was in fact concentrated, as much as 2 m^3 (5 mm/year x 400 m^2 = 2 m^3/year) could intersect the portion of the engineered barrier system associated with a single WP if that water all focused to that location. This flow could be constant in time or could be episodic, for example, with a duration of one week out of the year. Because the WP area is about 1/40 of the area collecting the flowing water, each engineered barrier system region associated with a WP should be exposed to focused flow about once every 40 years.

A greater design basis flow should be considered for an engineered barrier system designed for longer-term conditions. In the near-term case, the average annual exposure could be as much as 0.1 m^3/year (10 mm/year x 10 m^2 =0.1 m^3/year) and for focused flow 4m^3/year (10 mm/year x 400 m^2 = 4 m^3/year). For systems designed for long-term periods (on the order of 20,000 years), the design basis should consider an average flow of 0.5 m^3/year (50 mm/year x 10 m^2 = 0.5 m^3/year) and a focused flow of 20 m^3 of water per year (50 mm/year x 400 m^2 = 20 m^3/year).

The ambient flow values presented in this assumption are based on the average flux for that time period and a specific ambient condition. The year to year variation in annual flux can be from near zero to as much as six times the average value utilized in this assumption. Table 6-2 presents the range of low and high flow values that correspond to the year to year variations in flux values.

Table 6-2. Range of Ambient Flow Values

Flow Condition	Flow Values (m^3 / year)	
	Minimum	Maximum
Ambient Fully Mediated		
Present-day	near zero	0.3
Near-term	near zero	0.6
Long-term	near zero	3
Ambient Episodic Steady		
Present-day	near zero	12
Near-term	near zero	24
Long-term	near zero	120
Ambient Episodic Focused		
Present-day	near zero	12
Near-term	near zero	24
Long-term	near zero	120

The ambient flow calculations described above account for time- and space-averaged fluxes, the year to year variations of those fluxes (as shown in the "range" table), the long-term variation of those fluxes ("present-day," "near-term," and "long-term" cases), steady spatial focusing of the flux into a few fractures, and episodic spatial focusing of the flux into a few fractures. The variation not included is the spatial variation of average flux across the footprint. This spatial variation ranges from 0 mm/year for much of the area to over 80 mm/year for some areas (Flint et al. 1996, Summary). It is not known how the variation transfers to percolation flux at depth, because the PTn unit has properties that can mediate, divert, or focus the flow, depending on the behavior of the fractures.

The drainage system should be designed to withstand flows of water from the previously described episodes. For a 5.5-m wide drift, a drainage system designed for present-day conditions should be capable of handling wet year ephemeral flows amounting to as much as 0.2 m^3 of water per meter of drift (30 mm/year x 5.5 m drift width = 0.165 m^3/m, rounded to 0.2 m^3/m) occurring over periods totaling one week. This quantity should be increased by a factor of 2 for a system designed to last several hundred years and by a factor of 10 for one designed to be effective on the order of 20,000 years.

III. RESPONSIBILITY AND APPLICABILITY

Responsible M&O organization(s): Applied Research and Testing Programs

User Organization(s): Subsurface Facilities Department; Waste Package Department; Performance Assessment Department

System allocations: EDS

Other allocations: EIS

7. DESIGN BASIS VERIFICATION

This section will be prepared in a subsequent revision.

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8. REFERENCES

8.1 DOCUMENTS CITED

Bodvarsson, G.S. and Bandurraga, T.M., eds. 1996. *Development and Calibration of the Three-Dimensional Site-Scale Unsaturated Zone Model of Yucca Mountain, Nevada.* Berkeley, California: Lawrence Berkeley National Laboratory. ACC: MOL.19970211.0176.

CRWMS M&O [Civilian Radioactive Waste Management System Management and Operating Contractor] 1994a. *Use of NTS Surplus Diesel Locomotives in the Excavation and Operation of the North Ramp of the ESF.* BAB000000-01717-1700-00001 REV 0. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19941116.0096.

CRWMS M&O 1994b. *Diesel Emissions Expected From Deutz F8L413FW Engine During North Ramp Excavation.* BAB000000-01717-0200-00001 REV 0. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19971023.0255.

CRWMS M&O 1995. *Waste Isolation Evaluation: Tracers, Fluids, and Materials, and Excavation Methods for Use in the Package 2C Exploratory Studies Facility Construction.* BABE00000-01717-2200-00007 REV 04. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19950721.0172.

CRWMS M&O 1996a. Not used.

CRWMS M&O 1996b. *Second Waste Package Probabilistic Criticality Analysis: Generation and Evaluation of Internal Criticality Configurations.* BBA000000-01717-2200-00005 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19960924.0193.

CRWMS M&O 1997a. *Subsurface Repository VA Design Layout Plan.* BCAA00000-01717-2700-81024 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980408.0609.

CRWMS M&O 1997b. *Engineering Design Climatology and Regional Meteorological Conditions Report.* B00000000-01717-5707-00066 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980304.0028.

CRWMS M&O 1997c. *Drainage Patterns VA Design Layout Plan.* BCAA00000-01717-2700-81028 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19971210.0502.

CRWMS M&O 1997d. *Rail Alignments Analysis.* BCBI00000-01717-0200-00002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19971212.0486.

CRWMS M&O 1998a. *Controlled Design Assumptions Document.* B00000000-01717-4600-00032 REV 05. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980804.0481.

CRWMS M&O 1998b. *Repository Surface Design Site Layout Analysis.* BCB000000-01717-0200-00007 REV 02. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980410.0136.

CRWMS M&O 1998c. *Site-Generated Waste Disposal Options (System Study Report).* B00000000-01717-5705-00078 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980608.0646.

CRWMS M&O 1998d. *Basis for the VA and TSLCC Cost Estimate Operational Waste Stream.* A00000000-01717-1701-00002 REV 00. Vienna, Virginia: CRWMS M&O. ACC: MOV.19980622.0021.

CRWMS M&O 1998e. *Retrievability Strategy Report.* B00000000-01717-5705-00061. REV 01 DCN 1. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990201.0011.

CRWMS M&O 1998f. *Monitored Geologic Repository Draft Disposability Interface Specification.* B00000000-01717-4600-00108 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19981102.0001.

CRWMS M&O 1999a. Development of the MGR Project Description Document (WP# 16012023M2). Activity Evaluation, September 15, 1998. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990312.0388.

CRWMS M&O 1999b. Not used.

CRWMS M&O 1999c. *License Application Design Selection Report.* B00000000-01717-4600-00123 REV 01 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990908.0319.

CRWMS M&O 1999d. *Enhanced Design Alternative II Report.* B00000000-01717-5705-00131 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990712.0194.

CRWMS M&O 1999e. Not used

CRWMS M&O 1999f. Not used

CRWMS M&O 1999g. Not used.

CRWMS M&O 1999h. Not used.

CRWMS M&O 1999i. *Monitored Geologic Repository Architecture.* B00000000-01717-5700-00011 REV 03 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19991101.0211.

CRWMS M&O 1999j. *Monitored Geologic Repository Concept of Operations.* B00000000-01717-4200-00004 REV 03. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990916.0104.

CRWMS M&O 1999k. *Determination of Importance Evaluation for the Subsurface Exploratory Studies Facility.* BAB000000-01717-2200-00005 REV 07 ICN 03. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990728.0282.

CRWMS M&O 1999l. Not used.

CRWMS M&O 2000a. *Repository Safety Strategy: Plan to Prepare the Postclosure Safety Case to Support Yucca Mountain Site Recommendation and Licensing Considerations.* TDR-WIS-RL-000001 REV 03. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000119.0189.

CRWMS M&O 2000b. *Preliminary Draft Requirements from the Monitored Geologic Repository Requirements Document.* Input Transmittal RSO-RSO-99324.Tb. Las Vegas, Nevada: CRWMS M&O. MOL.20000228.0201.

CRWMS M&O 2000c. Not used.

CRWMS M&O 2000d. *Commercial and DOE Spent Nuclear Fuel Waste Stream.* Input Transmittal SUF-RSO-00032.T. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000328.0217.

CRWMS M&O 2000e. *Waste Package and DOE Canister Inventory.* Input Transmittal RSO-SSR-99360.T. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000202.0002.

DOE 1998a. Not used.

DOE 1998b. *Preliminary Design Concept for the Repository and Waste Package.* Volume 2 of *Viability Assessment of a Repository at Yucca Mountain.* DOE/RW-0508. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19981007.0029

DOE 1998c. *Civilian Radioactive Waste Management Program Plan.* DOE/RW-0504, Rev. 2. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: HQO.19980106.0002.

DOE 1998d. Not used.

DOE 1999a. Not used.

DOE 1999b. *Waste Acceptance System Requirements Document.* DOE/RW-0351, Rev. 03. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: HQO.19990226.0001.

DOE 2000a. *Quality Assurance Requirements and Description.* DOE/RW-0333P, Rev. 10. Washington D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20000427.0422.

DOE 2000b. *Civilian Radioactive Waste Management System Requirements Document.* DOE/RW-0406, Rev. 05 DCN 01. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: HQO.19990722.0001.

Dreyfus, D. A. 1995. "Information Only: Initiation of National Environmental Policy Act Requirements for the Potential Repository at Yucca Mountain, Nevada." Memorandum From D.A. Dreyfus (OCRWM) to The Secretary, Department of Energy, through C.B. Curtis, Under Secretary; June 22, 1995 ACC: HQO.19950627.0016.

Dyer, J.R. 1999. "Revised Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations (Revision 01, July 22, 1999), for Yucca Mountain, Nevada." Letter from Dr. J.R. Dyer (DOE/YMSCO) to Dr. D.R. Wilkins (CRWMS M&O), September 3, 1999, OL&RC:SB-1714, with enclosure, "Interim Guidance Pending Issuance of New NRC Regulations for Yucca Mountain (Revision 01)." ACC: MOL.19990910.0079.

Flint, A.L.; Hevesi, J.A.; and Flint, L.E. 1996. *Conceptual and Numerical Model of Infiltration for the Yucca Mountain Area, Nevada*. Milestone 3GUI623M. Denver, Colorado: U.S. Geological Survey. ACC: MOL.19970409.0087.

NRC 1995. *Reassessment of NRC's Dollar Per Person-Rem Conversion Factor Policy*. NUREG-1530. Washington, D.C.: NRC. TIC: 226409.

SNL [Sandia National Laboratories] 1987. "Nevada Nuclear Waste Storage Investigations Project." Chapters 4-9 of *Site Characterization Plan Conceptual Design Report*. SAND84-2641, Volume 2. Albuquerque, New Mexico: Sandia National Laboratories. ACC: NN1.19880902.0015.

SNL 1991. *Exploratory Studies Facility Alternatives Study Final Report*. SAND91-0025-1 and -2. Albuquerque, New Mexico: Sandia National Laboratories. ACC: MOL.19980319.0240.

Stroupe, E.P. 2000. *Approach to Implementing the Site Recommendation Design Baseline*. Interoffice correspondence from E.P. Stroup (CRWMS M&O) to Dr. D.R. Wilkins, January 26, 2000, LV.RSO.EPS.1/00-004, with attachment. ACC: MOL.20000214.0480.

Wilkins, D.R. and Heath, C.A. 1999. "Direction to Transition to Enhanced Design Alternative II." Letter from Dr. D.R. Wilkins (CRWMS M&O) and Dr. C.A. Heath (CRWMS M&O) to Distribution, June 15, 1999, LV.NS.JLY.06/99-026, with enclosures, "Strategy for Baselining EDA II Requirements" and "Guidelines for Implementation of EDA II." ACC: MOL.19990622.0126; MOL.19990622.0127; MOL.19990622.0128.

YMP 1998. *Disposal Criticality Analysis Methodology Topical Report*. YMP/TR-004Q, Rev. 0. Las Vegas, Nevada: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19990210.0236.

8.2 REGULATIONS, STANDARDS, AND ORDERS

10 CFR 20. Energy: Standards for Protection Against Radiation. Readily available.

10 CFR 50. Energy: Domestic Licensing of Production and Utilization Facilities. Readily available.

29 CFR 1910. Labor: Occupational Safety and Health Standards. Readily available.

29 CFR 1926. Labor: Safety And Health Regulations For Construction. Readily available.

Federal Mine Safety and Health Act of 1977. 30 USC 801 et seq. Readily available.

Nuclear Waste Policy Amendments Act of 1987. Public Law No. 100-203. 101 Stat. 1330. Readily available.

Regulatory Guide 8.8, Rev. 3. 1978. *Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations will be as Low as is Reasonably Achievable.* Washington, D.C.: U.S. Nuclear Regulatory Commission. Readily available.

Regulatory Guide 8.10, Rev. 1. 1975. *Operating Philosophy for Maintaining Occupational Radiation Exposure As Low As Is Reasonably Achievable.* Washington, D.C.: U.S. Nuclear Regulatory Commission. Readily Available.

Resource Conservation and Recovery Act of 1976. 42 USC 6901 et seq. Readily available.

8.3 PROCEDURES

AP-3.11Q, Rev. 0 ICN 1. *Technical Reports.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. Readily available.

NTS-SOP-5301. *Telecommunications.* Las Vegas, Nevada: U.S. Department of Energy. TIC: 242243

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APPENDIX A

SYSTEM DESIGNATORS

APPENDIX A

SYSTEM DESIGNATORS

The system designators are used to identify the Level-5 systems shown in the body of this document. Separate SDDs are to be developed for each of these systems

System Designator	System Name
ADS	Administration System
ATS	Assembly Transfer System
BES	Backfill Emplacement System
CBS	Carrier Preparation Building System
CCH	Carrier/Cask Handling System
CCT	Carrier/Cask Transport System
CDC	Canistered SNF Disposal Container
CMH	Carrier Preparation Building Materials Handling System
CTS	Canister Transfer System
DCH	Disposal Container Handling System
DDC	DHLW Disposal Container
EDC	DOE SNF Disposal Container
EDS	Emplacement Drift System
ERS	Emergency Response System
GCS	Ground Control System
GST	General Site Transportation System
HBE	Waste Handling Building Electrical System
HBF	Waste Handling Building Fire Protection System
HBS	Waste Handling Building System
HBV	Waste Handling Building Ventilation System
HSS	Health Safety System
MHS	Muck Handling System
MSL	MGR Site Layout
MSS	Maintenance & Supply System
NDC	Non-Fuel Components Disposal Container
OMC	Monitored Geologic Repository Operations Monitoring and Control System
OUS	Off-Site Utilities System
PCA	Performance Confirmation Data Acquisition/Monitoring System
PCM	Performance Confirmation Emplacement Drift Monitoring System
PCV	Performance Confirmation Waste Isolation Verification/Validation System
PLS	Pool Water Treatment & Cooling System
SCA	Subsurface Compressed Air System
SCS	Subsurface Closure & Seal System

System Designator	System Name
SDT	Subsurface Development Transportation System
SED	Subsurface Electrical Distribution System
SEM	Surface Environmental Monitoring System
SEP	Site Electrical Power System
SES	Subsurface Excavation System
SET	Subsurface Emplacement Transportation System
SFP	Site Fire Protection System
SFR	Subsurface Fire Protection System
SFS	Subsurface Facility System
SHZ	Site Generated Hazardous, Nonhazardous & Sanitary Waste Disposal System
SOS	Site Operations System
SRM	Site Radiological Monitoring System
SRW	Site Generated Radiological Waste Handling System
SSG	Safeguards and Security System
SSM	Subsurface Safety and Monitoring System
SVS	Subsurface Ventilation System
SWC	Subsurface Water Collection/Removal System
SWD	Subsurface Water Distribution System
SWS	Site Water System
TBS	Waste Treatment Building System
TCA	Site Compressed Air System
TCS	Site Communications System
TVS	Waste Treatment Building Ventilation System
UDC	Uncanistered SNF Disposal Container
VDC	Naval Spent Nuclear Fuel Disposal Container
WES	Waste Emplacement/Retrieval System
WPR	Waste Package Remediation System

APPENDIX B

GLOSSARY

APPENDIX B

GLOSSARY

Colloids–Small particles in the size range of 10^{-9} to 10^{-6} meters that are suspended in a solvent. Naturally occurring colloids in groundwater arise from clay minerals.

Constraint–A type of design basis, subject to the same demand for adherence as a requirement. Constraints are internally imposed by the M&O addressing design solution issues.

Criterion–A type of design basis, subject to the same demand for adherence as a requirement. Criteria are internally imposed by the M&O addressing performance related issues.

Full Inventory Case–The waste inventory listed in MGR RD 3.2.B (CRWMS M&O 2000b) plus additional HLW totaling 97,000 MTU.

Goal–A type of design basis; however, no demand for adherence to goals is imposed. Goals are created either internally or externally to the M&O and represent design attributes that the current design is aiming towards, which it may achieve through further refinement of the design.

Nominal–(from the Latin *nominalis*, of a name) "having the nature of." When used to establish parametric values, i.e., "a nominal value of 2," it means the designer can work within the range of values that could be considered as having the nature of the specified value, which will generally be determined by the last significant figure. For example, any value between 1.6 and 2.5 would have the nature of a nominal value of 2; any value between 2.46 and 2.55 would have the nature of a nominal value of 2.5; any value between 24.6 and 25.5 would have the nature of a nominal value of 25.

Requirement–A demand imposed on the repository. Requirements are imposed by entities outside the CRWMS M&O, including but not limited to regulatory bodies, federal/state lawmaking bodies, the U.S. Department of Energy, building codes, or government agencies.

Sorption–The binding, on a microscopic scale, of one substance to another, and includes both adsorption and absorption. In this document, the word is especially used for the sorption of dissolved radionuclides onto aquifer solids or waste package materials by means of close-range chemical or physical forces.

Truncated Site Recommendation (SR) Design Case–The waste inventory as calculated by multiplying the Full Inventory Case by the ratio of the CSNF in the 70,000 MTU (63,000 MTU) to the CSNF in the 97,000 MTU (83,800 MTU). This results in an identical proportion of waste and an identical linear heat rate as the Full Inventory Case.

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