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System Description of the Repository-Only System for the FY 1990 Systems Integration Program Studies

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July 1991

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SYSTEM DESCRIPTION OF THE REPOSITORY-ONLY
SYSTEM FOR THE FY 1990 SYSTEMS INTEGRATION
PROGRAM STUDIES

R. W. McKee
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SUMMARY

This document provides both functional and physical descriptions of a conceptual high-level waste management system defined as a Repository-Only System. Its purpose is to provide a basis for required system computer modeling and system studies initiated in FY 1990 under the Systems Integration Program of the U.S. Department of Energy's (DOE) Office of Civilian Radioactive Waste Management Office (OCRWM). The Aggregate Receipt Rate Study, initiated in FY 1990, is the specific system study that utilizes the information in this document.

The Repository-Only System is designed to accept 3000 MTU per year of spent fuel and 400 equivalent MTU per year of high-level wastes disposal in the geologic repository. The information used to develop these descriptions was taken from various OCRWM conceptual design studies, the most recent being a series referred to as the MRS System Studies (DOE 1989a). This system description was preceded by the preparation of a more comprehensive unpublished Modular Description that contained descriptive information in a modular format that could be used to assemble a large number of separate waste management system concepts. The system description presented here represents a refined version of information excerpted from the unpublished Modular Description for this specific system.

This document contains both functional descriptions of the processes in the waste management system and physical descriptions of the equipment and facilities necessary for performance of those processes. These descriptions contain the level of detail needed for the projected systems analysis studies. Three levels of increasing functional description detail identified as Level 0, 1, and a combined Level 2 and 3, and two levels of increasing physical description detail identified as Level 1 and 2 are provided.

The Repository-Only System contains all system components, from the waste storage facilities of the waste generators to the underground facilities for final disposal of the wastes. The major facilities in the system are the waste generator waste storage facilities, a repository

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facility that packages the wastes and then emplaces them in the geologic repository, and the transportation equipment and facilities for transporting the wastes between these major facilities.

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1.0 INTRODUCTION

This document provides both functional and physical descriptions of a conceptual high-level waste management system defined as a Repository-Only System. Its purpose is to provide a basis for required system computer modeling and system studies initiated in FY 1990 under the Systems Integration Program of the U.S. Department of Energy's (DOE) Office of Civilian Radioactive Waste Management Office (OCRWM). The Aggregate Receipt Rate Study, initiated in FY 1990, is the specific system study that utilizes the information in this document.

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The system descriptions are presented in three levels of increasing functional description detail identified as Level 0, 1, and a combined Level 2 and 3, and two levels of increasing physical description detail identified as Level 1 and 2. The functional description levels are defined as follows:

- Level 0 defines just the basic elements of the system and shows primary waste stream routings.
- Level 1 defines only the basic system functions and will generically apply to any waste types requiring repository disposal.

- The combined Level 2 and 3 defines additional functional details and operations required for each required Level 1 function. The Level 2 represents the lowest level of detail at which all of the system computer models can report results.

To provide the functional details needed for analyzing work crew and equipment resources that must serve multiple functions, some of the Level 2 functions are further subdivided into Level 3 functions. This Level 3 detail is included as a part of a combined Level 2 and 3 functional description.

The Level 1 physical description provides a general overall description of the conceptual facilities needed and the Level 2 physical description provides additional descriptive details primarily with respect to equipment needed to carry out each of the required functions.

Although a repository site has not yet been selected, the Nuclear Waste Policy Amendments Act of 1987 (the Amendments Act) has directed DOE to limit site characterization to the Yucca Mountain candidate site in Nevada. This site may or may not prove to be acceptable. However, since no other site is presently under consideration, for the purposes of this document and its related studies, the conceptual repository described herein is assumed to be located at the Yucca Mountain candidate site.

Figure 1.1 provides an overview Level 0 flow diagram showing the distinguishing features of this system. After the repository opens, all spent fuel is shipped directly from the nuclear power stations to the assumed repository at the Yucca Mountain candidate site in Nevada. Both defense and commercial high-level waste (DHLW and CHLW) are also shipped directly to the

FIGURE 1.1. Level 0 Diagram - Repository-Only System with Intact SNF Containerization at a Single-Phase Repository

repository. At the repository, intact spent fuel assemblies and DHLW and CHLW canisters are seal-welded into repository containers and sent to underground disposal.

The Level 1 Functional Description is presented in Section 2.0. A general-purpose universal Level 1 functional flow diagram (Figure 2.1) that can be used to describe a large number of different system configurations is used to illustrate the sequential relationships of the Level 1 functions. The functions that are applicable to this specific system are highlighted and other functions not applicable to this specific system are suppressed on the flow diagram.

The combined Level 2 and 3 functional description is presented in Section 3.0. This description consists of a Level 2 functional description, with Level 3 details added when needed, for each of the major system elements. A Level 2 and 3 functional flow diagram is presented at the end of the description of functions for each element to illustrate the relationships between the Level 2 and 3 functions within each element.

Section 4.0 contains a Level 1 and Level 2 physical description of the facilities and equipment needed for this case. The general contents are keyed to the functional activities described in Sections 2.0 and 3.0 so that persons performing operational and economic analyses can identify the equipment and facilities corresponding to each of the functions. Emphasis is placed on describing the facilities and equipment that have significant effects on differences in operational times and economics between alternative system designs.

Section 5.0 contains the references used in this report.

Three appendixes are provided. The alphanumeric symbols developed for identifying the wastes, drums, canisters, containers and casks in the waste management system are described in Appendix A. The symbolic system is designed to meet requirements for data organization and filing for an electronic data base known as the Systems Integration Database (SIDB) that is currently under development.^(a)

(a) Development of the SIDB was placed in standby status in FY 1991.

Appendix B contains descriptions of the facilities and equipment needed for system spent fuel throughput rates of 1,500, 4,500 and 6,000 MTU/yr, which represent the range of possible receipt rates being evaluated in the Aggregate Receipt Rate Study in addition to the reference 3000 MTU/yr rate described in the main text.

Appendix C contains the glossary of terms and definitions used in the report.

Because of the many potential types of wastes handled and the potential alternative methods for processing and reworking those wastes, by-pass and return paths generally are not shown on the figures in this document. The consideration of all potential by-pass and return paths would unreasonably complicate illustration of the general process flow.

Although the current system studies assume that only intact spent fuel assemblies will be received by the repository from the waste generators, it is possible that a more complex mixture of spent fuel forms will have to be accepted by DOE. These other waste forms include, for example, at-reactor canistered intact or consolidated spent fuel assemblies and drums or canisters of non-fuel-bearing reactor components or hardware from disassembled spent fuel. These other possible waste forms are identified on the functional flow diagrams and in the Section 4.0 tables. However, no details are provided for any special handling or processing that might be required for these wastes.

2.0 LEVEL 1 FUNCTIONAL DESCRIPTION

The major functions within the waste management system are presented in the Level 1 description in this section.

The Level 1 universal functional flow diagram (Figure 2.1) is presented at the end of this section for convenience in referencing textual descriptions. This universal flow diagram contains all functions that were identified in the MRS System Studies (DOE 1989a). Functions not applicable to this Repository-Only System are cross-hatched. In the text that follows this introduction, separate subsections for each system element contain brief descriptions of each function that apply to this specific case.

The descriptions in this document include all operational activities necessary for receipt, shipment, processing, surface storage and emplacement of the wastes, plus closure of the repository. Initial surface facility construction activities are not included in these descriptions. Also not included are the initial mining operations for shafts, ramps, and common area development that must be completed before waste emplacement functions can start. However, the continuing underground repository activities related to extension of ventilation drifts, common areas, and emplacement panels are included. These are functions that are carried out during the repository operating period and must be accounted for in modeling for cost, safety and operations analyses.

Two types of waste storage--primary storage and secondary storage--are included in the functional description and flow diagrams for the waste generator element. Primary storage represents the original principal storage facilities, for example, the spent fuel pools at a reactor site. Secondary storage represents supplemental storage, for example, the dry storage casks that may be needed and added later.

2.1 LEVEL 1 FUNCTIONAL DESCRIPTION FOR THE WASTE GENERATORS

<u>Functional Steps</u>	<u>Functional Description</u>
1.1	Primary Storage Operations The wastes are moved into the storage facility, stored in that facility, and moved within that facility as necessary for waste processing operations, storage operation, transfer to secondary storage and preparation for shipment.
1.3	Secondary Storage The wastes are stored in the secondary storage facilities and monitored to detect changes in the storage conditions.
1.4	Transport Cask Loading The empty cask is washed, inspected, moved to the process building, prepared for loading, loaded with waste, prepared for shipment, and moved to the holding area.
1.5	Transport Cask Unloading The full cask is washed, inspected, decontaminated, moved to the process building, prepared for unloading, unloaded, prepared for shipment, and moved to the holding area.
1.6	Transport Cask Receipt A cask is received at the waste generator, surveyed for radioactivity, inspected, and moved inside the facility perimeter fence to the cask and vehicle holding area.
1.7	Transport Cask Lag Storage The cask and vehicle are stored in the holding area until scheduled for loading, unloading or shipment.
1.8	Cask Preshipment Inspection and Servicing The cask and vehicle are inspected to determine if they are ready for shipment and repaired and serviced as needed.

2.2 LEVEL 1 FUNCTIONAL DESCRIPTION FOR TRANSPORTATION

Functional Steps	Functional Description
2.1	Inspection and Acceptance DOE and the commercial carrier inspect and accept the shipment.
2.2	Cask Shipment The shipment is transported by a dedicated train, (a) a rail/barge combination or a continuous truck shipment from the waste generator's site to the repository.
2.3	Major Cask Servicing The support services facility at the repository provides non-routine servicing, preventative maintenance, requalification license compliance tests and inspections, major repairs, and decontamination of both the transport casks and their associated railcars or truck-trailers. After this servicing, the casks are returned to service.

-
- (a) A dedicated train for this document is defined as a train containing only an engine, buffer cars, cask cars, and a caboose for the escort personnel. Also see Glossary.

2.3 LEVEL 1 FUNCTIONAL DESCRIPTION FOR THE GEOLOGIC REPOSITORY FACILITY

Functional Steps	Functional Description
4.1	Transport Cask Receipt A cask of waste is received at the repository, surveyed for radioactivity, inspected and moved inside the facility perimeter fence to the cask lag storage or to a process building.
4.2	Transport Cask Lag Storage The casks on vehicles are stored in the cask lag storage area until scheduled for unloading, loading or shipment offsite.
4.3	Cask Preshipment Inspection and Servicing After unloading, the empty cask and vehicle are inspected to determine if they are ready for shipment and repaired and serviced as needed.
4.4	Transport Cask Unloading Prior to unloading, the full cask and vehicle are moved into the process building, washed, inspected and decontaminated. The cask is then prepared for unloading, connected to a process cell and unloaded. The empty cask is then disconnected from the process cell, prepared for shipment, loaded onto the transport vehicle, and moved with the vehicle to the cask and vehicle holding area for lag storage prior to shipment. The empty cask may also be diverted for maintenance, decontamination, or recertification at the MRS support services facility. The empty casks are shipped to the waste generators or MRS as needed.
4.5	Waste Lag Storage The incoming waste may be placed in the waste lag storage in the process cell before further handling or processing.
4.6	Waste Processing Depending on the condition of the wastes and the scenario being evaluated, the wastes may be processed to prepare them for disposal. These processed materials and all other wastes are placed in containers, the container is inerted and lids are welded on the containers.
4.7	Container Vault Storage The filled containers are transported to the vault storage building and may be placed in the surface vault storage and stored until scheduled for emplacement.

2.3 LEVEL 1 FUNCTIONAL DESCRIPTION FOR THE GEOLOGIC REPOSITORY FACILITY (contd)

Functional Steps	Functional Description
4.11	Interface to Waste Emplacement When ready for emplacement, a container is placed on a waste transporter.
4.12	Waste Emplacement Operations The disposal containers are transferred to an underground emplacement area and emplaced in the boreholes. The repository performance is monitored during the caretaker period for 50 years after emplacement of the first container.
4.13	Performance Testing Periodically during the caretaker period, a representative sample of the emplaced containers is retrieved from the repository and tested in the performance confirmation building. The wastes in those containers are placed in new containers and returned to the underground repository.
4.14	Mining The underground facilities for disposal of the wastes are extended by excavation of the necessary tunnels, common areas, emplacement rooms, and boreholes followed by installation of the borehole liners and equipment. The mined rock is transported to the surface and stored until needed for the repository decommissioning.
4.15	Final Waste Isolation Following this caretaker phase, a closure and decommissioning plan will be initiated during which the repository will be closed by filling all underground excavations with crushed rock and closing all points of access to the underground (i.e., boreholes, shafts, and ramps) with seals designed to retain their integrity for thousands of years. The surface facilities will be decommissioned and permanent markers will be erected at the site.
4.16	Balance-of-Plant Operations and Support Balance-of-Plant activities such as water and sewage system operations, maintenance, and security functions are provided for both the process and facility operations.

FIGURE 2.1. Level 1 Functional Flow Diagram for the Repository-Only Waste Management System

3.0 LEVEL 2 AND 3 FUNCTIONAL DESCRIPTION

The Level 2 and 3 functional description in this section includes the functions and operations necessary to accomplish the major functions described in the Level 1 functional description. It is presented in three subsections, corresponding to the major system elements. A modified Level 1 functional flow diagram for the specific system element, corresponding to the applicable section of Figure 2.1, is presented at the beginning of each subsection. On these flow diagrams, the Level 1 functions for that element are highlighted and the Level 1 functions that do not apply are suppressed (i.e., cross-hatched). A complete combination Level 2 and 3 flow diagram for the corresponding element is presented at the end of each subsection. A brief narrative description is presented in functional numerical order in each subsection for each function shown on the combined Level 2 and 3 flow diagram.

Routine support activities necessary for operation of the system (e.g., maintenance, facility decontamination, low-level waste collection and disposal) are not included in the description. At Level 2 and 3, the emphasis is placed only on operations directly related to the wastes scheduled for disposal in the repository, on the waste canisters and containers, on the casks used to transport the wastes, and on mining activities that precede waste emplacement. No further breakdown of the Level 1 balance-of-plant functions at the repository is provided. This function includes such activities as utility services, fire protection, plant security, administration, etc., and is included as a function primarily to provide a functional location to store cost data in the Systems Integration Database (SIDB).

Some of the Level 2 functions are further subdivided into Level 3 functions. This additional functional detail was provided as a result of needs identified in engineering analyses concerned with the allocation of work crew and scarce equipment resources that must serve multiple functions. Whereas the Level 2 functions are identified with a two decimal number designation, the Level 3 functions have a three decimal number designation. On the functional flowsheets, the Level 3 functions are shown enclosed in a

larger box having a Level 2 designation. The distinction between Level 2 and Level 3 functions has been maintained for the purposes of organizing and storing data in the SIDB. The Level 2 functions represent the lowest level of detail at which all models can report results and the lowest level of detail that can be defined generically with respect to any waste type that might be processed through the DOE high-level waste management system, (e.g., consolidated spent fuel, activated metals, etc.) The Level 3 functions in this document apply specifically to intact spent fuel assemblies and DHLW/CHLW.

The cask handling functions described here include provision for removal and replacement of both an inner and an outer transport cask lid. Since these functional descriptions were prepared, new transport cask design concepts have become available that have only a single lid. Thus, the outer lid removal and replacement functions may no longer be needed.

3.1 LEVEL 2 AND 3 FUNCTIONAL DESCRIPTION FOR THE WASTE GENERATORS

The portions of the overall waste management system Level 1 functional flow diagram for the waste generators (Figure 2.1) that are included in this case are illustrated in the Level 1 flow diagram in Figure 3.1.

FIGURE 3.1. Level 1 Functional Flow Diagram for the Waste Generators

A description of each Level 2 and 3 function for this activity follows, and the combined Level 2 and 3 functional flow diagram for the waste generators is presented in Figure 3.2 at the end of this subsection.

<u>Functional Steps</u>	<u>Functional Description(a)</u>
1.1	<u>Primary Storage Operations</u>
1.1.1	Place Wastes in Primary Storage The wastes are moved from the primary source, the internal waste processing operations, the cask unloading operations, or temporary waste storage to the primary storage.
1.1.2	Primary Storage The wastes are stored and monitored in the primary storage facility, which is a water pool at power reactors, a dry vault at reprocessing plants, and either a pool or a vault at other waste generators.
1.1.3	Place Wastes in Temporary Storage The wastes are moved from the primary storage, the primary source, or cask unloading to a temporary storage location, which normally is a portion of the primary storage facility adjacent to a cask loading and unloading facility. (Not all waste generators have a temporary storage facility.)
1.3	<u>Secondary Storage</u>
1.3.1	Move Wastes to Secondary Storage
1.3.1.1	Prepare Transfer or Storage Cask for Loading The cask is moved to the vehicle loading area at the process building. The cask is upended, removed from the vehicle and placed on a service pad or cart, and a work platform is installed around it. The vehicle is moved out of the vehicle loading area and stored until needed. The outer lid of the cask is removed. A radiation survey is made. The inner lid bolts on storage casks are loosened, and most are removed. The cask is filled with water if the loading station is a pool. The work platform is removed and the cask is moved to the loading position. The inner lid is removed or the cask shield plug is opened. The interior of the cask and the lid seals are inspected, and defective seals are replaced.

<u>Functional Steps</u>	<u>Functional Description(a)</u>
1.3.1.2	Load Wastes into Transfer or Storage Cask The wastes are moved from the temporary waste storage facility to the transfer or storage cask as appropriate for the secondary storage design. The cask shield plug or inner lid is replaced.
1.3.1.3	Place Wastes in Secondary Storage The transfer or storage cask is moved from the cask loading station to a service pad. The cask is drained, decontaminated, and filled with an inert gas, as appropriate, the outer lid is installed and sealed, and the cask is inspected and picked up by a transporter. The cask is transported to the secondary storage facility where storage casks are placed on a storage pad and the wastes in transfer casks are transferred into the secondary storage facility.
1.3.2	Secondary Storage The wastes are stored and monitored in the secondary storage facility.
1.3.3	Remove Wastes from Secondary Storage
1.3.3.1	Move Wastes to Process Building A transporter and transfer cask or an empty transporter is moved to the secondary storage facility where a full storage cask is picked up. If a transfer cask is used, wastes in the secondary storage facility are transferred into the transfer cask. The loaded cask is then transported to the process building and placed on a service pad.
1.3.3.2	Remove Wastes from Cask The outer lids are removed and the inner lids or shield plugs are loosened. The cask is filled with water, as appropriate, and placed in the cask loading station. The inner shield plugs or lids are removed. The wastes are transferred from the cask to the temporary waste storage facility.

**Functional
Steps**
Functional Description(a)
1.3.3.3
Store Empty Storage/Transport Casks

The interior of the empty cask is inspected and the inner lids or shield plugs are replaced. The cask is moved to the service pad where it is drained and the outer lids are installed and sealed, as appropriate. The cask is decontaminated and placed on a transporter, moved to the empty cask storage facility and stored.

1.4
Transport Cask Loading
1.4.1
Prepare Transport Cask for Waste Loading

The cask is moved to the vehicle loading area by either a commercial driver or an onsite drive unit. The personnel barrier, impact limiters and cask tiedowns are removed from the cask. The cask is upended, removed from the vehicle and placed on a service pad or cart, and a work platform is installed around it. The vehicle is moved out of the vehicle loading area and stored until needed.

The outer lid of the cask is removed. A radiation survey is made. The inner lid bolts are loosened, and most are removed. The cask is filled with water if the loading station is a pool. The work platform is removed and the cask is moved to the loading position. The inner lid is removed and the interior of the cask and the lid seals are inspected. Defective seals are replaced.

1.4.2
Place Wastes in Cask. Replace Lid.

The waste is placed in the cask and the inner lid is replaced.

1.4.3
Prepare Full Cask for Shipment

The cask is moved to the service area and a work platform is placed around it. The cask is surveyed and decontaminated. As appropriate, the cask is drained and dried. The inner lid bolts are tightened. The cask is filled with an inert gas, a leak-test is made, the cask is sealed and the outer lid is installed. The work platform is removed, the cask is moved to the vehicle loading area and loaded on a vehicle.

The cask is placed on a railcar or truck trailer and a final radiation survey and decontamination is performed. Cask tiedowns, impact limiters and personnel barriers are installed, and a final inspection is made.

The vehicle is moved from the vehicle loading area to the cask and vehicle holding area.

**Functional
Steps (contd)****Functional Description(a)**

1.5**Transport Cask Unloading****1.5.1****Prepare Transport Cask for Waste Unloading**

The cask is moved to the vehicle loading area by either a commercial driver or an onsite drive unit. The personnel barrier, impact limiters and cask tiedowns are removed from the cask. The cask is upended, removed from the vehicle and placed on a service pad or cart, and a work platform is installed around it. The vehicle is moved out of the vehicle loading area and stored until needed.

The outer lid of the cask is removed. A radiation survey is made. The inner lid bolts are loosened, and most are removed. The cask is filled with water if the loading station is a pool. The work platform is removed and the cask is moved to the loading position. The inner lid is removed and the interior of the cask and the lid seals are inspected. Defective seals are replaced.

1.5.2**Remove Wastes from Cask. Replace Lid**

The waste is removed from the cask and placed in the temporary waste storage. The cask inner lid is replaced.

1.5.3**Prepare Empty Cask for Shipment**

The cask is moved to the service area and a work platform is placed around it. The cask is surveyed and decontaminated. As appropriate, the cask is drained and dried. The inner lid bolts are tightened. The cask is filled with an inert gas, a leak-test is made, the cask is sealed and the outer lid is installed. The work platform is removed, the cask is moved to the vehicle loading area and loaded on a vehicle.

The cask is placed on a railcar or truck trailer and a final radiation survey and decontamination is performed. Cask tiedowns, impact limiters and personnel barriers are installed, and a final inspection is made.

The vehicle is moved from the vehicle loading area to the cask and vehicle holding area.

1.6**Transport Cask Receipt****1.6.1****Empty Transport Cask Receipt**

Transport vehicles carrying empty transport casks are received at the waste source facility. A security

Functional Steps (contd)	Functional Description(a)
1.6.1 (contd)	inspection is made. The cask is moved to the washdown area, washed, surveyed for contamination, and moved to the vehicle holding area. The personnel barrier is retracted during the washing.
1.6.2	Full Transport Cask Receipt Transport vehicles carrying full transport casks are received at the waste source facility. A security inspection is made. The cask is moved to the washdown area, washed, surveyed for contamination, and moved to the vehicle holding area. The personnel barrier is retracted during the washing.
1.7	<u>Transport Cask Lag Storage</u>
1.7.1	Empty Transport Cask and Vehicle Holding Before being shipped or loaded with wastes, vehicles containing empty casks may be placed in an onsite dispatch holding area until shipment or loading with wastes is scheduled.
1.7.2	Full Transport Cask and Vehicle Holding Before being shipped or transferred to a process building for waste unloading, vehicles containing full casks may be placed in an onsite holding area until shipment or the scheduled waste unloading.
1.8	<u>Cask Preshipment Inspection and Servicing</u>
1.8.1	Empty Cask Preshipment Inspection and Servicing The casks and transport vehicles are inspected and serviced to assure proper conditions immediately prior to shipment.
1.8.2	Full Cask Preshipment Inspection and Servicing The casks and transport vehicles are inspected and serviced to assure proper conditions immediately prior to shipment.

-
- (a) These operations are expected to occur for both transport and storage transportation casks. The wastes may be stored in water pools or in dry vaults.

FIGURE 3.2. Combined Level 2 and 3 Functional Flow Diagram for the Waste Generators

3.2 LEVEL 2 AND 3 FUNCTIONAL DESCRIPTION FOR TRANSPORTATION

The Level 2 functional description for transportation includes both transportation of casks and the major cask servicing activities. No Level 3 functional details are currently required for this element.

3.2.1 Transportation of Casks

The portions of the overall waste management system Level 1 functional flow diagram (Figure 2.1) that are included in the cask transportation are illustrated in the Level 1 flow diagram in Figure 3.3.

FIGURE 3.3. Level 1 Functional Flow Diagram for Cask Transportation

A description of each Level 2 function for this activity follows, and the Level 2 functional flow diagram for this transportation activity is presented in Figure 3.4 at the end of this subsection.

<u>Functional Steps</u>	<u>Functional Description</u>
2.1	<u>Inspection and Acceptance</u>
2.1.1	DOE Acceptance of Shipment When a cask is ready for shipment, a radiological inspection is made. DOE inspects the shipment, accepts it and transfers it to the commercial carrier.
2.1.2	Commercial Carrier Accepts Cask and Vehicle The commercial carrier inspects the casks and vehicles to be certain that they are ready and safe for movement.
2.2	<u>Cask Shipment</u>
2.2.1	Truck Transport from Waste Generators The empty truck casks are transported to the waste generators. The trailer supporting the full cask is connected to a drive unit. The cask is transported to the destination as a continuous normal freight shipment. Travel will occur primarily on interstate highways.
2.2.2	Rail/Barge Transport from Waste Generators The empty rail casks are transported to the waste generators. The vehicles supporting the full casks are connected to a dedicated commercial train. The dedicated train hauls the cars to the destination or to a barge dock. If transported by barge, the train cars are loaded on the barge, the barge transports the cars to a dock near the destination and the cars are moved by a dedicated train to the destination.

Repository-Only Case

FIGURE 3.4. Level 2 Functional Flow Diagram for Cask Transportation

3.2.2 Major Cask Servicing

The major cask servicing facilities provide dispatching, maintenance, inspection and servicing for the waste management system transport casks. The portions of the overall waste management system Level 1 functional flow diagram (Figure 2.1) for the cask servicing are illustrated in the Level 1 flow diagram in Figure 3.5.

FIGURE 3.5. Level 1 Functional Flow Diagram for the Cask Servicing Facilities

A description of each Level 2 function for this activity follows, and the Level 2 functional flow diagram for this activity is presented in Figure 3.6 at the end of this subsection.

<u>Functional Steps</u>	<u>Functional Description</u>
2.3	Major Cask Servicing
2.3.1	Receive and Inspect Cask The cask/vehicle system arrives at the cask maintenance facility, is visually checked for damage and a radiological survey is performed.
2.3.2	Washdown Cask The cask and vehicle are thoroughly washed.
2.3.3	Decontaminate Cask A radiation survey is performed, and any cask whose interior is found to be excessively contaminated is decontaminated.
2.3.4	Repair Damaged Cask Damaged casks are repaired.
2.3.5	Test and Inspect Cask The casks are tested and inspected as needed for recertification.
2.3.6	Maintain and Repair Vehicle Routine maintenance checks, tests and maintenance are performed.
2.3.7	Release Authorization The cask system is released from the cask maintenance facility and sent to the dispatch area for reuse (dispatch area is shared with normal empty cask dispatching).

FIGURE 3.6. Level 2 Functional Flow Diagram for the Cask Servicing Facility

3.3 LEVEL 2 AND 3 FUNCTIONAL DESCRIPTION FOR THE REPOSITORY

The Level 2 and 3 functional description for the repository includes descriptions for the surface waste handling building (WHB) and the underground repository.

The surface WHB receives bare spent fuel assemblies from the waste generators. These are containerized and then emplaced in the repository. The repository portion of the overall waste management system Level 1 functional flow diagram (Figure 2.1) is illustrated in Figure 3.7.

4.0 Repository

FIGURE 3.7. Level 1 Functional Flow Diagram for the Repository

A description of each Level 2 and 3 function for this system element follows, and the Level 2 functional flow diagram for the repository is presented in Figure 3.8 at the end of this subsection.

Functional Steps	Functional Description
4.1	<p><u>Full Transport Cask Receipt</u></p> <p>When a cask arrives at the repository, a security inspection is made of the cask and transport vehicle and the bill of lading is reviewed to determine the cask contents. A survey of the cask and transport vehicle is taken for radiation and contamination. The transport vehicle is disconnected from the commercial drive unit and connected to an onsite drive unit.</p>
4.2	<p><u>Transport Cask Lag Storage</u></p>
4.2.1	<p><u>Full Cask and Vehicle Holding</u></p> <p>The full cask and vehicle may be stored in an onsite holding area if a problem is detected or until the scheduled unloading or shipment time.</p>
4.2.2	<p><u>Empty Cask and Vehicle Holding</u></p> <p>The empty cask and vehicle may be stored in an onsite holding area if a problem is detected or until the scheduled loading, or shipment time.</p>
4.3	<p><u>Cask Preshipment Inspection and Servicing</u></p> <p>The cask and vehicle are inspected to determine if they are ready for shipment and repaired and serviced as needed.</p>
4.4	<p><u>Transport Cask Unloading</u></p>
4.4.1	<p><u>Prepare Transport Cask for Unloading</u></p>
4.4.1.1	<p><u>Wash Cask</u></p> <p>The cask and vehicle are moved to the washdown area and washed. The personnel barrier is retracted during the washing.</p>
4.4.1.2	<p><u>Prepare Cask for Removal from Vehicle</u></p> <p>The cask and vehicle are moved to the receiving, inspection and shipping area where the impact limiters and tie-downs are removed from the cask. A contamination and radiation survey of the cask exterior is made and it is decontaminated as necessary. Damaged casks are diverted to the support services facilities (Step 2.3), if necessary, before unloading.</p>
4.4.1.3	<p><u>Unload Cask from Vehicle</u></p> <p>The cask is removed from the transport vehicle and placed on a cart. Restraints are installed. The cart and cask are moved to the cask handling, preparation and decontamination room. The vehicle remains parked at the dock.</p>

Functional Steps (contd)	Functional Description
4.4.1.4	Remove Cask Outer Lid The cask outer lid is removed.
4.4.1.5	Vent and Sample Gases. Loosen Inner Lid. The cask internal pressure is checked and vented to the ventilation system. The vent gas radioactivity is measured and appropriate precautions are adopted to reduce radiation exposure of personnel, if high radioactivity is measured. The fasteners on the cask inner lid are loosened.
4.4.1.6	Install Contamination Barrier Adapter The cask contamination barrier adapter is installed.
4.4.1.7	Move Cask to Unloading Room. Engage Shields. The cask is moved to the cask unloading room where it is positioned for the removal of the waste. The cask contamination barrier and the shadow shield are engaged.
4.4.1.8	Remove Cell Plugs and Cask Inner Lid The shield plugs are removed from the cask unloading cell entry port. The cask inner lid is removed.
4.4.2	Remove Contents of Cask The interior of the cask is inspected to determine the contents of the cask. The contents of the cask are removed. DOE re-verifies the cask contents.
4.4.3	Prepare Empty Transport Cask for Shipment
4.4.3.1	Inspect Cask Interior. Install Cask Inner Lid. Install Cell Port Plug. The cask is inspected to verify that it is clear of waste material. The inner lid is replaced. The cask unloading cell entry port plug is replaced.
4.4.3.2	Remove Shields and Move Cask to Preparation Room The cask contamination barrier and shadow shield are disengaged. The empty cask and cart are moved into the cask handling, preparation and decontamination room.
4.4.3.3	Decontamination Cask and Secure Inner Lid The contamination barrier adapter is removed. The cask is surveyed for contamination and decontaminated if necessary and the inner lid is secured.

<u>Functional Steps (contd)</u>	<u>Functional Description</u>
4.4.3.4	Install Cask Outer Lid The outer lid is replaced.
4.4.3.5	Load Cask on Transport Vehicle The cask is moved to the cask receiving, inspection and shipping area and loaded onto a transport vehicle. It might be transferred to the support services facilities for repairs, internal decontamination or recertification (Step 2.3).
4.4.3.6	Prepare Loaded Vehicle for Shipment The impact limiters, cask shipping restraints and personnel barriers are installed. Minor or routine maintenance is done.
4.4.4	Move Loaded Vehicle to Holding Area The loaded vehicle is moved to the empty cask holding area.
4.5	<u>Waste Lag Storage</u> After being unloaded, the fuel assemblies and other wastes are normally placed in the incoming lag storage in the cask unloading cell. Some wastes may be transferred directly to the process or testing activities.
4.6	<u>Waste Processing</u>
4.6.3	Load Wastes into Container The wastes are placed in a disposal container. The wastes may pass through the waste inspection station if inspection is necessary before placing in a container.
4.6.4	Prepare Wastes for Storage
4.6.4.1	Weld Lid to Container The container is backfilled with an inert gas and the lid is welded on.
4.6.4.2	Move Wastes to Weld Inspection Station The container is lifted out of the weld station and placed in the inspection station.
4.6.4.3	Inspect Weld The weld is inspected at the inspection station.
4.6.4.4	Move Wastes to Leak Test Station The container is lifted out of the inspection station and moved to the leak test station.

Functional Steps (contd)	Functional Description
4.6.4.5	Leak Test Container The container is tested for leaks at the leak test station.
4.6.4.6	Move Wastes to Decontamination and Transfer Station The container is lifted out of the leak test station and moved to the decontamination and transfer station.
4.6.4.7	Decontaminate Container The container is decontaminated in the decontamination chamber.
4.6.4.8	Move Container to Inspection Cell The container is move to the inspection cell by moving the decontamination chamber to that cell.
4.6.4.9	Survey Container The surface contamination on the container is determined by taking surface swabs and measuring the radioactivity collected by the swabs. If the radioactivity is above the permissible level, the container is decontaminated again.
4.6.4.10	Rework Defective Containers If the container tests defective, the lid is cut off and a new lid is welded on.
4.7	<u>Container Vault Storage</u>
4.7.1	Place Wastes in Vault Storage
4.7.1.1	Transfer Container to Transfer Cart The container is lifted out of the decontamination chamber and placed in a transfer cart.
4.7.1.2	Transfer Container to Vault Building The transfer cart carries the containers through the transfer tunnel to the vault building.
4.7.1.3	Place Container in Vault The container transfer machine lifts the container out of the transfer cart, transports it to the vault storage position and places it in that position.

Functional Steps (contd)	Functional Description
4.7.2	Store and Monitor Wastes in Vault Storage The container is stored in the vault storage position until scheduled for placement in the repository.
4.7.3	Remove Wastes from Vault Storage The container transfer machine lifts the container out of the vault storage position, transports it to the transfer bay and places it in a transfer cart.
4.11	<u>Interface to Waste Emplacement</u>
4.11.1	Load Container into Transporter
4.11.1.1	Prepare Transporter for Loading An empty transporter at the ramp portal or at the transporter holding area is moved to the vault building and parked in the transfer bay over a waste transfer port.
4.11.1.2	Load Transporter A container of waste is lifted out of the transfer cart and into the waste transporter.
4.12	<u>Waste Emplacement Operations</u>
4.12.1	Transport and Emplace Wastes
4.12.1.1	Move Transporter to Ramp Portal The loaded transporter is moved from the transfer bay in the vault building to the ramp portal.
4.12.1.2	Move Transporter to Disposal Area The container transporter is moved through the underground ramps and tunnels to the emplacement location, where a borehole has been prepared.
4.12.1.3	Emplace Container At the emplacement site, the cask is rotated to a vertical position or aligned horizontally with the borehole, depending on its emplacement orientation. The cask is connected to the borehole, the borehole shielding cover is opened for container insertion, and the container is deposited into the borehole. The shielding cover is closed.
4.12.1.4	Return Transporter to Surface Facility The transporter is released and moved to the surface facility.

Functional Steps	Functional Description
4.12.1.5	Seal Emplacement Borehole The shielding plug is installed in the borehole, the shielding cover is removed and the lock cover is installed on the borehole.
4.12.2	Monitor Emplaced Wastes The wastes are stored in the repository and monitored for 50 years after the initial emplacement.
4.12.3	Waste Removal A representative sample of the emplaced containers is removed from the repository and transported to the Performance Confirmation Building.
4.13	<u>Performance Testing</u> The containers and wastes transported to the Performance Confirmation Building are tested. The wastes are placed in a new container that is prepared for emplacement.
4.14	<u>Mining</u>
4.14.1	Excavation Operations
4.14.1.1	Extend Common Underground Passageways and Facilities The tunnels and support facility rooms are extended by use of conventional mining techniques.
4.14.1.2	Excavate Emplacement Drifts and Rooms The emplacement drifts and rooms are excavated by use of conventional mining techniques as needed for the waste emplacement.
4.14.2	Waste Emplacement Borehole Development
4.14.2.1	Drill Emplacement Boreholes The emplacement boreholes are drilled with conventional rock-boring machines.
4.14.2.2	Prepare Boreholes for Emplacement The borehole liners, other borehole equipment and shielding covers are installed.
4.14.3	Mined Rock Handling
4.14.3.1	Transport Rock to Surface The rock removed during excavation of the tunnels, emplacement rooms and boreholes is transported to the surface storage pile.

<u>Functional Steps (contd)</u>	<u>Functional Description</u>
4.14.3.2	<p>Store Rock The rock excavated from the tunnels, rooms and boreholes is stored until needed for backfilling.</p>
4.15	<p><u>Final Waste Isolation</u> After a decision has been made to store the wastes permanently in the repository, or after the wastes have been retrieved, the emplacement rooms and access drifts will be backfilled and sealed. Then the underground common facilities, tunnels, shafts, and ramps will be backfilled and sealed in that sequence. The surface facilities will be demolished and the surface will be restored to near natural conditions. Appropriate monuments will be installed to identify the nature and location of the stored material.</p>
4.16	<p><u>Balance-of-Plant Operations and Support</u> Balance-of-Plant activities such as water and sewage system operations, maintenance, and security functions are provided for both the process and facility operations.</p>

FIGURE 3.8. Level 2 and 3 Functional Flow Diagram for the Repository

4.0 PHYSICAL DESCRIPTIONS OF THE SYSTEM

A physical description is presented in this section for each of the system elements described in the Repository-Only System. The description for each element is presented first at Level 1 and then at Level 2. The Level 1 descriptions provide a general physical description of the facilities and equipment needed for the activities described in the Level 1 and 2 functional descriptions. The descriptions cover: 1) waste generator sites, 2) the transportation system between the system facilities, and, 3) the geologic repository.

The Level 2 physical descriptions contain facility and equipment descriptions consistent with the Level 2 and 3 functional descriptions. This includes descriptions of the waste materials handled, process equipment, facility operations, equipment capacities, and other facility characteristics. The combination of physical and functional descriptions is intended to provide sufficient descriptive information on the activities, facilities and equipment to provide a basis for comprehensive system model development and system engineering studies.

This Level 2 information is presented primarily as tables keyed to the functional steps in the functional description. The tables provide brief descriptions of the equipment and facilities supplemented by illustrations as appropriate.

Before describing the facilities it is useful to consider how the waste forms may transition from one form to another as they are processed through the system. For example, spent fuel assemblies (SFAs) may be shipped from a reactor as intact assemblies, as canistered intact but failed SFAs, or as consolidated and canistered fuel rods. In the latter case, additional canisters will be required for the hardware from the SFA disassembly. However, for the Aggregate Receipt Rate Study (ARRS), it is assumed that all spent fuel is delivered as intact assemblies. For this system description, all waste forms are sealed into a final disposal container at the repository. The contents of the final disposal container might range from only bare

intact SFAs to canistered SFAs nested inside another canister. For the present studies (ARRS), only containerized, bare intact SFAs are considered.

Because of the variety and different combinations of waste types, canisters, containers, and casks that may be used in the waste management system, an alpha-numeric symbolic system was developed to provide a short-hand representation method to identify the various possible combinations. This symbolic system is described in Appendix A, and the tables and figures in this section that identify various characteristics of these waste types, canisters, containers, and casks utilize this symbolic system.

The waste canisters and containers are designed such that the mobile surface contamination on the wastes cannot migrate from the wastes and contaminate equipment and facilities. The canisters also generally are designed to conform to the shape of the wastes and do not add significantly to the volume occupied by the wastes. The basic descriptions of the wastes, canisters and containers and the generic types of wastes placed in the canisters and containers are listed in Table 4.1. The waste forms to be considered in the current studies are indicated by an asterisk. Final container concepts are illustrated in Figure 4.1.

Because of the variety of waste forms to be accommodated (e.g., intact SFAs, consolidated SFAs, a variety of different PWR and BWR designs, spent fuel hardware wastes, miscellaneous and non-fuel-bearing wastes, etc.), a variety of canister and container sizes must be accommodated. In preparing the listing of wastes, canisters and containers in Table 4.1, it was assumed that the number of canisters and containers would be minimized by standardizing on a few basic canister and container sizes and by accommodating a variety of different-length waste forms in standard-length canisters and containers. (The final repository container is referred to as a "container." Other containers are referred to as canisters or drums.) Collectively, the canisters, containers and drums are referred to as receptacles.

TABLE 4.1. Descriptions of the Wastes and Receptacles Handled in the Waste Management System

Generic Waste Form	Outer Canister or Container Symbol ^(d)	Cross Section		Typical Lengths ^(a)		Contents ^(c)		
		Geometry ^(e)	Dimension ^(b) (in.)	Outer Item (in.)	Contents (in.)	Source	Waste	Symbol ^(d)
*Intact PWR SFA	None	Square	<9	160 to 177	--	PWR	PWR SFA	SFA_P
*Intact BWR SFA	None	Square	<6	170 to 177	--	BWR	BWR SFA	SFA_B
At-Reactor PWR Canister	AR9	Square	~9	180 max	160 to 177	PWR	PWR SFA	SFA_P
					155 to 167	PWR	PWR Fuel Rods	CON_P
					160 to 162	PWR	PWR SFA Hardware	NFB_P
					160 to 162	PWR	PWR GTC Wastes	GTC_P
At-Reactor BWR Canister	AR6	Square	~6	180 max	170 to 177	BWR	BWR SFA	SFA_B
					160 to 176	BWR	BWR Fuel Rods	CON_B
					160 to 168	BWR	BWR SFA Hardware	NFB_B
					160 to 168	BWR	BWR GTC Wastes	GTC_B
*HLW Canister	CRP	Circular	24	118	--	Commercial Reprocess- ing Plant	Commercial HLW	HLW_W
						Defense Reprocessing Plant	Defense HLW	HLW_D
						Commercial Reprocess- ing Plant	GTC Wastes	GTC_W
						Defense Reprocessing Plant	GTC Wastes	GTC_D
Other Facility ^(f) Canister	OU	TBD	TBD	TBD	TBD	Other Reactors ^(g) Other Facility	Fuel Assemblies GTC Wastes	SFA_O GTC_O
55-Gallon Drums	DRM	Circular	23	36	--	MRS	MRS GTC Wastes PWR SFA Hardware BWR SFA Hardware	GTC_M NFB_P NFB_P
*Repository Hybrid Container	Y28BP	Circular	28	188	160 to 177 170 to 177	PWR BWR	PWR SFA BWR SFA	SFA_P SFA_B
*Repository PWR Intact Fuel Container	Y28I4	Circular	28	188	160 to 177	PWR	PWR SFA	SFA_P
*Repository BWR Intact Fuel Container	Y28I10	Circular	28	188	170 to 177	BWR	BWR SFA	SFA_B

TABLE 4.1. (contd)

Generic Waste Form	Outer Canister or Container Symbol (d)	Cross Section		Typical Lengths (a)		Contents (c)		
		Geometry (e)	Dimension (b) (in.)	Outer Item (in.)	Contents (in.)	Source	Waste	Symbol (d)
Repository Canned PWR Container	Y2814	Circular	28	188	180	PWR	Canned PWR Fuel Rods	AR9_CON_P
					180	PWR	Canned PWR SFA Hardware	AR9_NFB_P
					180	PWR	Canned PWR GTC Wastes	AR9_GTC_P
					180	PWR	Canned PWR SFA	AR9_SFA_P
Repository Canned BWR Container	Y2819	Circular	28	188	180	BWR	Canned BWR Fuel Rods	AR6_CON_B
					180	BWR	Canned BWR SFA Hardware	AR6_NFB_B
					180	BWR	Canned BWR GTC Wastes	AR6_GTC_B
					180	BWR	Canned BWR SFA	AR6_SFA_B
*Repository HLW Container	Y26H	Circular	26	126	118	Commercial Reprocessing Plant	Canned Commercial HLW	CRP
					118	Defense Reprocessing Plant	Canned Defense HLW	CRP
					TBD	Commercial Reprocessing Plant	GTC Wastes (h)	GTC_W
					TBD	Defense Reprocessing Plant	GTC Wastes (h)	GTC_D
Repository Cylindrical Container	Y28C	Circular	28	188	180	MRS	Canned GTC Wastes	MDRM_GTC_M
					180	Repository	Canned GTC Wastes	RDRM_GTC_R
					TBD	Other Reactors	Canned Fuel Assemblies	OU_SFA_O
					TBD	Other Facilities	Canned GTC Wastes	OU_GTC_O

(a) Lengths accommodate most wastes, canisters and containers. Other lengths needed for a few exceptions.

(b) Approximate dimensions. Canister and container dimensions are selected such that they can be nested.

(c) Wastes listed are the basic waste form inserted into the canister or container identified in column 2. The symbol identifies any canisters that contained the waste prior to insertion into the canister or container identified in column 2. The symbol does not include the outer canister or container listed in the first two columns.

(d) See Appendix A for further explanation of symbols.

(e) See Figure 4.3 for contents of square cross section canister and Figure 4.1 for contents circular cross section container.

(f) Other facilities include possible not yet identified sources of waste that may require repository disposal.

(g) Other reactors include Peach Bottom 1 and Ft. St. Vrain HTGRs and various research and test reactors.

(h) Waste forms and quantities are uncertain for this reprocessing plant.

* Indicates waste forms of primary interest in the current studies.

FIGURE 4.1. Repository Disposal Containers

The dimensions of canisters and containers in Table 4.1 are illustrative and approximate, since designs have not been fixed. If a better match between contents and outer lengths is desired, a variety of canister and container lengths would be required.

The cross-section dimension of the final spent fuel containers is representative of current waste package concepts. However, other sizes may have to be considered to accommodate different waste loadings because of the characteristics of the SFAs as received at the repository. The SFA heat characteristics are a function of SFA exposure and age. These, in turn, are a function of the specific logistics and heat management scenario that is assumed. Further details of the repository container and container loadings are presented in Section 4.3.

Figure 4.2 illustrates the variety of the wastes, canisters, and containers in the waste management system for this case. The limited waste form assumptions for the current studies are indicated by the heavy line flow paths. The upper boxes represent the waste generators. The enclosed symbols are the symbols for the wastes that must be disposed of. The unenclosed symbols are the symbols for the canisters and containers in which the wastes are packaged. As an example, the SFA_P waste at the extreme upper left in Figure 4.2 is placed in an AR9_P canister at a PWR. The waste and canister are then shipped to the repository, where they are placed in a Y28I4 container. For details on the canister and container sizes, see Table 4.1.

Information included in the physical descriptions that follow is based on available conceptual design references. In situations where design information is incomplete or not available, the type of facility or equipment that appears to be needed is described and identified as preliminary. The physical descriptions are keyed to the functional step numbers presented in Sections 2.0 and 3.0.

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Note: Symbols in circles identify wastes before placement in canisters or containers.
 Symbols without circles identify canisters or containers.
 Only outer canisters and containers are identified. See Appendix A for definitions of symbols.

FIGURE 4.2. Wastes, Canisters, and Containers that May Require Disposal in the Repository-Only System

4.1 WASTE GENERATORS

The waste generator facilities and equipment are described as generic facilities that provide a general description of the typical waste generator facilities.

The wastes to be disposed of in the geologic repositories generally will originate from four sources: 1) nuclear reactor plants, 2) spent fuel reprocessing plants, 3) nuclear research and development facilities, and 4) miscellaneous sources. They include both private industry and government facilities. Prior to delivery to the waste management system, these wastes are expected to be stored in either of two types of facilities: pools or dry storage facilities. Although the design details for these hundreds of storage facilities will vary, the general shipment procedures and facility designs for each of these two basic types of storage facilities will be similar among the facilities of each type. Descriptions of the physical facilities for shipments of wastes from the waste generators are presented for only two generic facilities: 1) waste shipments from pools at nuclear power reactors, and 2) solidified high-level waste shipments from dry vaults. Descriptions of the shipment facilities for most sources are not expected to vary significantly from these generic descriptions except for dimensions of facilities and capacities of equipment.

The waste description and waste generator facility description information contained in this subsection was obtained primarily from DOE (1987a) and DOE (1987b). Only a brief generic description is presented for the facilities utilized at nuclear plants. This generic description illustrates the operations that interface with the waste management system. The information presented for the dry vault operations is conceptual and is based on Sandia (1987b) and Bechtel (1985).

4.1.1 Level 1 Physical Description

Spent Fuel Storage in Pools(a)

The primary wastes shipped from pools will be spent fuel assemblies (SFAs) stored in the spent fuel storage pools that are an integral part of the nuclear reactor buildings. The major waste shipment requirements for the reactor plant operators will be to provide for safe and efficient loading of transport casks and for the preparation of the loaded casks and their transport vehicles for shipment. Typical reactor plant wastes are described in Table 4.1. Typical reactor fuel assemblies are illustrated in Figure 4.3.

Waste shipments from reactor plants require use of three components: 1) the yard facilities for receiving and shipping trucks and train cars, 2) the reactor building facilities for preparing shipments of radioactive materials from the spent fuel pools, and 3) the yard facilities for secondary storage of spent fuel assemblies.

Figure 4.4 presents a generic plan view of the yard facilities used for waste shipments. The components involved in waste shipments include the railroad tracks and roads to the reactor building, the perimeter fence guardhouse, a washdown area where road dirt is washed off both the cask and the vehicle, the gate in the inner security fence, and parking areas for both railcars and trucks.

The reactor building facilities used for waste storage and shipments are illustrated in Figures 4.5 and 4.6. Figure 4.7 illustrates a storage pool. There are three general types of shipment facilities in the reactor building: 1) a vehicle loading area, 2) a cask service pad and 3) a cask loading pit. These facilities are illustrated in Figures 4.5 and 4.6 for a generic PWR plant. The facilities at a BWR plant are similar except that the service pad and spent fuel pool are at the elevation of the top of the reactor, up to 100 feet above the ground level. As a result the cask has to be lifted from the ground level to the service pad through a vertical passageway. Typical reactor plant facilities and equipment needed for the reactor plant functional

(a) Primary storage at reactor sites.

Typical PWR Fuel Assembly

Typical BWR Fuel Assembly

FIGURE 4.3. Typical LWR Fuel Assemblies

NOTE: Letters and numbers relate facility locations to descriptions in text and Tables 4.3 and 4.4.

LEGEND: Numbers in circles identify locations of functions.
Letters in squares identify waste processing areas.

FIGURE 4.4. Plan View of Generic Waste Generator Yard Facilities

activities are described below. The activities are described in the functional description section of this document. The locations of these activities in the reactor building are shown on Figures 4.4 to 4.6 as circles containing the functional activity numbers.

The vehicle loading area typically is a large hall with a parking area for either trucks or a single railroad car. The hall is serviced by a bridge crane with auxiliary hooks for handling lighter loads such as the cask lids.

NOTE: Letters and numbers relate facility locations to descriptions in Tables 4.3 and 4.4.

LEGEND: Numbers in circles identify locations of functions.
Letters in squares identify waste processing areas.

FIGURE 4.5. Elevation View of Generic PWR Spent Fuel Pool

NOTE: Letters and numbers relate facility locations to descriptions in Tables 4.3 and 4.4.

LEGEND: Numbers in circles identify locations of functions.
Letters in squares identify waste processing areas.

FIGURE 4.6. Plan View of Generic PWR Spent Fuel Pool

FIGURE 4.7. Water Pool for Storage of Spent Fuel at the Morris, Illinois, Facility (Courtesy of General Electric Company)

The cask service pad is a flat concrete floor area large enough for a cask standing on end. It has curbs and a sloping floor such that decontamination fluids drain into the plant radioactive waste system. It is serviced by the bridge crane identified above.

The cask loading pit is a deep water pool connected to or part of the fuel storage pool. It is large enough for a cask and deep enough that wastes in the pool can be placed in a cask standing on end without a significant increase in the radiation doses at the surface of the water. The pit is serviced by both the bridge crane described above and the spent fuel pool bridge crane.

Secondary Spent Fuel Storage

In those cases where a power reactor plant does not have sufficient room in its spent fuel pool for all wastes that must be stored before shipment, a secondary storage facility may be built in the plant yard. This secondary storage is often referred to simply as dry storage. The technology for dry storage has been demonstrated and several options are available. These include metal storage casks, concrete storage casks, horizontal concrete modules and modular concrete vaults. If substantial secondary storage requirements develop, it is anticipated that different storage options will be employed at different reactor sites. These alternatives are described and compared in some detail in DOE (1989b). In the preparation of the functional description, it was assumed that use of secondary storage will require use of either a transport cask for waste movements between the spent fuel pool and the secondary storage or a storage cask that is loaded in the pool and then placed in storage.

Solidified High-Level Wastes Stored in Dry Vaults

The major waste shipment equipment and facility requirements for plants shipping solidified high-level wastes (SHLW) parallel the requirements above for reactor plant operators.

Figure 4.8 illustrates a typical high-level waste canister. The solidified high-level waste is expected to be stored at the reprocessing plants that created the wastes. None of the shipping facilities at those plants

FIGURE 4.8. Savannah River Plant HLW Canister

S9106101.1

have been built. It is assumed that those wastes will be stored in dry vaults and shipped dry. (If pools are used, the shipping facilities and procedures probably would be the same as described above in Subsection 4.1.1 for pool shipments.) Figure 4.9 illustrates the general design of a dry vault.

The shipment facilities and procedures essentially are the same as for the reactor plants except for the attachment of the cask to the dry vault for loading. It is assumed that for this activity the cask is placed on a cask cart when it is moved to the cask preparation area. Then, after the cask has been prepared for loading, it is carried to the cask loading position by the cask cart and attached to a port in the floor of the room containing the stored waste (see Figure 4.10). The waste is loaded into the cask using a bridge crane in the waste storage vault. The cask is then carried by the cask cart back to the preparation area where it is prepared for shipment.

4.1.2 Level 2 Physical Description

The primary waste generators are the commercial nuclear power plants, the reprocessing plants, and the research reactors. In addition, there are a number of other sources of miscellaneous radioactive materials that may require disposal in the geologic repositories. Table 4.2 identifies the number of these sources. Tables 4.3 to 4.6 show equipment requirements for the Level 2 functions. Table 4.7 contains a description of the reactor plant spent fuel pool and spent fuel and cask handling crane characteristics.

FIGURE 4.9. Dry Vault Storage System

S9106101.2

NOTE: Letters and numbers relate facility locations to descriptions in Tables 4.5 and 4.6.

LEGEND: Numbers in circles identify locations of functions.
Letters in squares identify waste processing areas.

FIGURE 4.10. Typical Dry Vault Cask Loading Facilities

TABLE 4.2. Sources of Waste Requiring Disposal

Source	Number of Facilities
Nuclear Power Plants	118
Reprocessing Plants	4
Research Reactors(a)	104
Miscellaneous Waste Sources	TBD

(a) Includes Ft. St. Vrain and Peach Bottom 1.

TABLE 4.3. Major Waste Handling Equipment at Pool Storage Sites - Listed in Process Step Order^(a)

Function Reference Number	Equipment Title	Equipment Identification (b)	Function/Activity	Number of Units	Size or Capacity	Locations (Figures 4.4 to 4.6)
1.1	Fuel Handling Bridge Crane	4	Move SFAs in spent fuel pool	1	1 SFA	E
1.3.1.1	Cask Transporter	5	Move cask into vehicle loading area	1	150 ton	A
	Mobile Crane	6	Load cask onto transporter	1	150 ton	A
	Bridge Crane	2	Move cask to service pad	1	Main Hook (24 to 185 ton)	D
	Bridge Crane	2	Install service platform around cask	1	Auxiliary Hook (5 to 25 ton)	C
	Cask Service Platform	3	Support personnel working on cask top	1	1 to 5 ton	C
	Bridge Crane	2	Move cask outer lid to service pad	1	Auxiliary Hook (5 to 25 ton)	C
	Bridge Crane	2	Move service platform away from cask	1	Auxiliary Hook (5 to 25 ton)	C
	Bridge Crane	2	Move cask to loading area	1	Main Hook (24 to 185 ton)	C
	Bridge Crane	2	Move cask inner lid to service pad	1	Auxiliary Hook (5 to 25 ton)	C
1.3.1.2 + 1.4.2	Fuel Handling Bridge Crane	4	Load SFAs into cask	1	1 SFA	E to D
	Bridge Crane	2	Move cask inner lid to cask	1	Auxiliary Hook (5 to 25 ton)	C to D
1.3.1.3	Bridge Crane	2	Move cask to service pad	1	Main Hook (24 to 185 ton)	D to C
	Bridge Crane	2	Install service platform around cask	1	Auxiliary Hook (5 to 25 ton)	C
	Cask Service Platform	3	Support personnel working on cask	1	1 to 5 ton	C
	Bridge Crane	2	Move cask outer lid to cask	1	Auxiliary Hook (5 to 25 ton)	C
	Bridge Crane	2	Move service platform away from cask	1	Auxiliary Hook (5 to 25 ton)	C
	Bridge Crane	2	Move cask to vehicle loading area	1	Main Hook (24 to 185 ton)	C to B

Repository-Only Case

TABLE 4.3. (contd)

Function Reference Number	Equipment Title	Equipment Identification (b)	Function/Activity	Number of Units	Size or Capacity	Locations (Figures 4.4 to 4.6)
	Bridge Crane	2	Load cask onto transporter	1	Main Hook (24 to 185 ton)	B
	Cask Transporter	5	Move vehicle and cask to secondary storage area	1	150 ton	B to A
	Mobile Crane	6	Transfer cask from transporter to storage pad or support transfer cask during transfer of wastes into secondary storage	1	150 ton	A
1.3.3.1	Mobile Crane	6	Transfer storage cask from storage pad to transporter or support transfer cask during removal of wastes from secondary storage	1	150 ton	A
	Cask Transporter	5	Transport cask to vehicle loading area	1	150 ton	A to B
	Bridge Crane	2	Move cask to service pad	1	Main Hook (24 to 185 ton)	B to C
1.3.3.2	Bridge Crane	2	Install service platform around cask	1	Auxiliary Hook (5 to 25 ton)	C
	Cask Service Platform	3	Support personnel working on cask top	1	1 to 5 ton	C
	Bridge Crane	2	Move cask outer lid to service pad	1	Auxiliary Hook (5 to 25 ton)	C
	Bridge Crane	2	Move service platform away from cask	1	Auxiliary Hook (5 to 25 ton)	C
	Bridge Crane	2	Move cask to cask loading area	1	Main Hook (24 to 185 ton)	C to D
	Bridge Crane	2	Move cask inner lid to service pad	1	Auxiliary Hook (5 to 25 ton)	D to C
	Fuel Handling Bridge Crane	4	Transfer SFAs from cask to temporary storage	1	1 SFA	D to E
1.3.3.3	Bridge Crane	2	Move cask inner lid to cask	1	Auxiliary Hook (5 to 25 ton)	C to D
	Bridge Crane	2	Move cask to service pad	1	Main Hook (24 to 185 ton)	D to C

Repository-Only Case

TABLE 4.3. (contd)

Function Reference Number	Equipment Title	Equipment Identification (b)	Function/Activity	Number of Units	Size or Capacity	Locations (Figures 4.4 to 4.6)
1.3.3.3	Bridge Crane	2	Install service platform around cask	1	Auxiliary Hook (5 to 25 ton)	C
	Bridge Crane	2	Move cask outer lid to cask	1	Auxiliary Hook (5 to 25 ton)	C
	Bridge Crane	2	Move service platform away from cask	1	Auxiliary Hook (5 to 25 ton)	C
	Bridge Crane	2	Move cask to vehicle loading area	1	Main Hook (24 to 185 ton)	C to B
	Bridge Crane	2	Load cask onto transporter	1	Main Hook (24 to 185 ton)	B
	Onsite Drive Unit	1	Move vehicle and cask from vehicle loading area to storage facility	1	10 Railcars	B to A
1.4.1 + 1.5.1	Onsite Drive Unit	1	Move vehicles carrying casks into vehicle loading area	1	10 Railcars	A to B
	Bridge Crane	2	Remove impact limiters and cask tiedowns	1	Auxiliary Hook (5 to 25 ton)	B
	Bridge Crane	2	Move cask to service pad	1	Main Hook (24 to 185 ton)	B to C
	Bridge Crane	2	Install service platform around cask	1	Auxiliary Hook (5 to 25 ton)	C
	Cask Service Platform	3	Support personnel working on cask top	1	1 to 5 ton	C
	Onsite Drive Unit	1	Move vehicle without cask to parking area	1	10 Railcars	B to A
	Bridge Crane	2	Move cask outer lid to service pad	1	Auxiliary Hook (5 to 25 ton)	C
	Bridge Crane	2	Move service platform away from cask	1	Auxiliary Hook (5 to 25 ton)	C
	Bridge Crane	2	Move cask to cask loading area	1	Main Hook (24 to 185 ton)	C to D
	Bridge Crane	2	Move cask inner lid to service pad	1	Auxiliary Hook (5 to 25 ton)	D to C

Repository-Only Case

TABLE 4.3. (contd)

Function Reference Number	Equipment Title	Equipment Identification (b)	Function/Activity	Number of Units	Size or Capacity	Locations (Figures 4.4 to 4.6)
1.4.3	Bridge Crane	2	Move cask to service pad	1	Main Hook (24 to 185 ton)	D to C
1.5.3	Bridge Crane	2	Install service platform around cask (5 to 25 ton)	1	Auxiliary Hook	C
	Cask Service Platform	3	Support personnel working on cask	1	1 to 5 ton	C
	Onsite Drive Unit	1	Move vehicle into cask loading area	1	10 Railcars	A to B
	Bridge Crane	2	Move cask outer lid to cask	1	Auxiliary Hook (5 to 25 ton)	C
	Bridge Crane	2	Move service platform away from cask	1	Auxiliary Hook (5 to 25 ton)	C
	Bridge Crane	2	Move cask to vehicle loading area	1	Main Hook (24 to 185 ton)	C to B
	Bridge Crane	2	Load cask onto vehicle	1	Main Hook (24 to 185 ton)	B
	Bridge Crane	2	Install tiedowns and impact limiters	1	Auxiliary Hook (5 to 25 ton)	B
	Onsite Drive Unit	1	Move vehicle and cask out of vehicle loading area	1	10 Railcars	B to A
1.5.2	Fuel Handling Bridge Crane	4	Remove waste from cask and place in storage	1	1 SFA	D to E
	Bridge Crane	2	Move cask inner lid to cask	1	Auxiliary Hook (5 to 25 ton)	C to D
1.6	Onsite Drive Unit	1	Move vehicles carrying casks from outer guardhouse to washdown area and on to vehicle storage area	1	10 Railcars	A
1.8	Onsite Drive Unit	1	Move vehicle and cask to onsite dispatch area	1	10 Railcars	A

(a) Because the type of secondary storage has not been selected, this table contains the equipment needed for three potential types of storage (S/T casks, concrete casks and concrete storage modules). The equipment used in equipment analyses will have to be selected after the storage type is selected.

(b) Equipment identification included as an aid to equipment cost and utilization studies.

TABLE 4.4. Major Waste Handling Equipment at Pool Storage Sites - Listed by Equipment Item^(a)

Equipment Title	Equipment Identification (b)	Function Reference Number	Function/Activity	Number of Units	Size or Capacity	Locations (Figures 4.4 to 4.6)
Onsite Drive Unit	1	1.4.1	Move vehicles carrying casks into vehicle loading area	1	10 Railcars	A to B
		1.4.1	Move vehicle without cask to parking area			B to A
		1.4.3	Move vehicle into cask loading area			A to B
		1.3.3.3	Move vehicle and cask from vehicle loading area to storage facility			B to A
		1.5.1	Move vehicles carrying casks into vehicle loading area			A to B
		1.5.1	Move vehicle without cask to parking area			B to A
		1.5.3	Move vehicle into cask loading area			A to B
		1.4.3	Move vehicle and cask out of vehicle loading area			B to A
		1.5.3	Move vehicle and cask out of vehicle loading area			B to A
		1.6	Move vehicles carrying casks from outer guardhouse to washdown area and on to vehicle storage area			A
		1.8	Move vehicle and cask to onsite dispatch area			A
Bridge Crane	2	1.3.1.1	Install service platform around cask	1	Auxiliary Hook (5 to 25 ton)	C
		1.3.1.1	Move cask outer lid to service pad			C
		1.3.1.1	Move service platform away from cask			C
		1.3.1.1	Move cask inner lid to service pad			C
		1.3.1.2	Move cask inner lid to cask			C to D
		1.4.2	Move cask inner lid to cask			C to D
		1.3.1.3	Install service platform around cask			C
		1.3.1.3	Move cask outer lid to cask			C

TABLE 4.4. (contd)

<u>Equipment Title</u>	<u>Equipment (a) Identification</u>	<u>Function Reference Number</u>	<u>Function/Activity</u>	<u>Number of Units</u>	<u>Size or Capacity</u>	<u>Locations (Figures 4.4 to 4.6)</u>
Bridge Crane (contd)	2	1.3.1.3	Move service platform away from cask		Auxiliary Hook (5 to 25 ton)	C
		1.3.3.2	Install service platform around cask			C
		1.3.3.2	Move cask outer lid to service pad			C
		1.3.3.2	Move service platform away from cask			C
		1.3.3.2	Move cask inner lid to service pad			D to C
		1.3.3.3	Move cask inner lid to cask			C to D
		1.4.3	Install service platform around cask			C
		1.4.3	Move cask outer lid to cask			C
		1.4.3	Move service platform away from cask			C
		1.4.1	Remove impact limiters and cask tiedowns			B
		1.4.1	Install service platform around cask			C
		1.4.1	Move cask outer lid to service pad			C
		1.4.1	Move service platform away from cask			C
		1.4.1	Move cask inner lid to service pad			D to C
		1.5.2	Move cask inner lid to cask			C to D
		1.3.3.3	Install service platform around cask			C
		1.3.3.3	Move cask outer lid to cask			C
		1.3.3.3	Move service platform away from cask			C
		1.4.3	Install tiedowns and impact limiters			B
		1.5.1	Remove impact limiters and cask tiedowns			B
		1.5.1	Install service platform around cask			C
		1.5.1	Move cask outer lid to service pad			C

TABLE 4.4. (contd)

<u>Equipment Title</u>	<u>Equipment (a) Identification</u>	<u>Function Reference Number</u>	<u>Function/Activity</u>	<u>Number of Units</u>	<u>Size or Capacity</u>	<u>Locations (Figures 4.4 to 4.6)</u>
Bridge Crane (contd)	2	1.5.1	Move service platform away from cask		Auxiliary Hook (5 to 25 ton)	C
		1.5.1	Move cask inner lid to service pad			D to C
		1.5.3	Install service platform around cask			C
		1.5.3	Move cask outer lid to cask			C
		1.5.3	Move service platform away from cask			C
		1.5.3	Install tiedowns and impact limiters			B
		1.3.1.1	Move cask to service pad	1	Main Hook (24 to 185 ton)	D
		1.3.1.1	Move cask to loading area			C
		1.3.1.3	Move cask to service pad			D to C
		1.3.1.3	Move cask to vehicle loading area			C to B
		1.3.1.3	Load cask onto transporter			B
		1.3.3.1	Move cask to service pad			B to C
		1.3.3.2	Move cask to cask loading area			C to D
		1.3.1.3	Move cask to service pad			D to C
		1.4.3	Move cask to vehicle loading area			C to B
		1.3.1.3	Load cask onto transporter			
		1.4.1	Move cask to service pad			B to C
		1.4.1	Move cask to cask loading area			C to D
		1.4.3	Move cask to service pad			D to C
		1.3.3.3	Move cask to vehicle loading area			C to B

TABLE 4.4. (contd)

<u>Equipment Title</u>	<u>Equipment Identification (a)</u>	<u>Function Reference Number</u>	<u>Function/Activity</u>	<u>Number of Units</u>	<u>Size or Capacity</u>	<u>Locations (Figures 4.4 to 4.6)</u>
Bridge Crane (contd)	2	1.3.3.3	Load cask onto transporter			B
		1.4.3	Load cask onto vehicle			B
		1.5.1	Move cask to service pad			B to C
		1.5.1	Move cask to cask loading area			C to D
		1.5.3	Move cask to service pad			D to C
		1.5.3	Move cask to vehicle loading area			C to B
		1.5.3	Load cask onto vehicle			B
Cask Service Platform	3	1.3.1.1	Support personnel working on cask	1	1 to 5 ton	C
		1.3.1.3	Support personnel working on cask			C
		1.3.3.2	Support personnel working on cask			C
		1.4.1	Support personnel working on cask			C
		1.4.3	Support personnel working on cask			C
		1.5.1	Support personnel working on cask			C
		1.5.3	Support personnel working on cask			C
Fuel Handling Bridge Crane	4	1.1	Move SFAs in spent fuel pool	1	1 SFA	E
		1.3.1.2	Load SFAs into cask			E to D
		1.5.2	Remove wastes from cask and place in storage			D to E
		1.4.2	Load SFAs into cask			E to D
		1.3.3.2	Transfer SFAs from cask to temporary storage			D to E

TABLE 4.4. (contd)

Equipment Title	Equipment Identification (a)	Function Reference Number	Function/Activity	Number of Units	Size or Capacity	Locations (Figures 4.4 to 4.6)
Cask Transporter	5	1.3.1.1	Move cask into vehicle loading area	1	150 ton	A
		1.3.1.3	Move vehicle and cask to secondary storage area			B to A
		1.3.3.1	Transport cask to vehicle loading area			A to B
Mobile Crane	6	1.3.1.1	Load cask onto transporter	1	150 ton	A
		1.3.1.3	Transfer cask from transporter to storage pad or support transfer cask during transfer of wastes into secondary storage			A
		1.3.3.1	Transfer storage cask from storage pad to transporter or support transfer cask during removal of wastes from secondary storage			A

- (a) Because the type of secondary storage has not been selected, this table contains the equipment needed for three potential types of storage (S/T casks, concrete casks and concrete storage modules). The equipment used in equipment analyses will have to be selected after the storage type is selected.
- (b) Equipment identification included as an aid to equipment cost and utilization studies.

TABLE 4.5. Major Waste Handling Equipment at Dry-Vault Storage Sites - Listed in Process Step Order

Function Reference Number	Equipment Title	Equipment Identification (a)	Function/Activity	Number of Units	Size or Capacity	Location (Figure 4.10)
1.1	Hot Cell Bridge Crane	5	Move canisters in dry vault	1	25 ton	E
1.4.1	Onsite Drive Unit	1	Move vehicles carrying casks into vehicle loading area	1	10 Railcars	B
	Bridge Crane	2	Remove impact limiters and cask tiedowns	1	Auxiliary Hook (25 ton)	B
	Cask Cart	3	Support cask	2	150 ton	C
	Bridge Crane	2	Move cask to cask cart	1	Main Hook (200 ton)	B to C
	Cask Service Platform	4	Support personnel working on cask top	1	5 ton	C
	Onsite Drive Unit	1	Move vehicle without cask to parking area	1	10 Railcars	B
	Bridge Crane	2	Move cask outer lid to service pad	1	Auxiliary Hook (25 ton)	C
	Cask Cart	3	Move cask to cask loading area	2	150 ton	C to D
	Cask Contamination Barrier	6	Installed to prevent spread of contamination	4	1 Cask	D
	Hot Cell Bridge Crane	5	Move hot cell port plug and cask inner lid to storage areas	1	25 ton	D
1.4.2	Hot Cell Bridge Crane	5	Load canisters into cask	1	25 ton	E to D
	Hot Cell Bridge Crane	5	Move cask inner lid to cask. Install hot cell port plug	1	25 ton	D
	Cask Cart	3	Support cask	2	150 ton	D

TABLE 4.5. (contd)

Function Reference Number	Equipment Title	Equipment Identification (a)	Function/Activity	Number of Units	Size or Capacity	Location (Figure 4.10)
1.4.3	Cask Contamination Barrier	6	Disconnected from cask	4	1 Cask	D
	Cask Cart	3	Move cask to service pad	1	150 ton	D to C
	Cask Service Platform	4	Support personnel working on cask top	1	5 ton	C
	Onsite Drive Unit	1	Move vehicle into vehicle loading area	1	10 Railcars	B
	Bridge Crane	2	Move cask outer lid to cask	1	Auxiliary Hook (25 ton)	C
	Bridge Crane	2	Move cask to vehicle loading area	1	Main Hook (200 ton)	C to B
	Bridge Crane	2	Load cask onto vehicle	1	Main Hook (200 ton)	B
	Bridge Crane	2	Install tiedowns and impact limiters	1	Auxiliary Hook (25 ton)	B
	Onsite Drive Unit	1	Move vehicle and cask out of vehicle loading area to holding area	1	10 Railcars	B
1.6	Onsite Drive Unit	1	Move vehicles carrying casks from outer guardhouse to washdown area and on to vehicle storage area	1	10 Railcars	--
1.8	Onsite Drive Unit	1	Move vehicle and cask to onsite dispatch area	1	10 Railcars	--

(a) Equipment identification included as an aid to equipment cost and utilization studies.

TABLE 4.6. Major Waste Handling Equipment at Dry-Vault Storage Sites - Listed by Equipment Item

<u>Equipment Title</u>	<u>Equipment Identification (a)</u>	<u>Function Reference Number</u>	<u>Function/Activity</u>	<u>Number of Units</u>	<u>Size or Capacity</u>	<u>Location (Figure 4.10)</u>
Onsite Drive Unit	1	1.4.1	Move vehicles carrying casks into vehicle loading area			B
		1.4.1	Move vehicle without cask to parking area			B
		1.4.3	Move vehicle into vehicle loading area			B
		1.4.3	Move vehicle and cask out of vehicle loading area to holding area			B
		1.6	Move vehicles carrying casks from outer guardhouse to washdown area and on to vehicle storage area	1	10 Railcars	--
		1.8	Move vehicle and cask to onsite dispatch area			--
Bridge Crane	2	1.4.1	Remove impact limiters and cask tiedowns	1	Auxiliary Hook (25 ton)	B
		1.4.1	Move cask outer lid to service pad			C
		1.4.3	Move cask outer lid to cask			C
		1.4.3	Install tiedowns and impact limiters			B
		1.4.1	Move cask to cask cart	1	Main Hook (200 ton)	B to C
		1.4.3	Move cask to vehicle loading area			C to B
		1.4.3	Load cask onto vehicle			B
Cask Cart	3	1.4.1	Support cask	2	150 ton	C
		1.4.1	Move cask to cask loading area			C to D
		1.4.2	Support cask			D
		1.4.3	Move cask to service pad			D to C
Cask Service Platform	4	1.4.1	Support personnel working on cask top	1	5 ton	C
		1.4.3	Support personnel working on cask top			C

TABLE 4.6. (contd)

<u>Equipment Title</u>	<u>Equipment Identification (a)</u>	<u>Function Reference Number</u>	<u>Function/Activity</u>	<u>Number of Units</u>	<u>Size or Capacity</u>	<u>Location (Figure 4.10)</u>
Hot Cell Bridge Crane	5	1.1	Move canisters in dry vault	1	25 ton	E
		1.4.1	Move hot cell port plug and cask inner lid to storage areas			D
		1.4.2	Move cask inner lid to cask. Install hot cell port plug			D
		1.4.2	Load canisters into cask			E to D
Cask Contamination Barrier	6	1.4.1	Installed to prevent spread of contamination	4	1 Cask	D
		1.4.3	Disconnected from cask			D

(a) Equipment identification included as an aid to equipment cost and utilization studies.

TABLE 4.7. Reactor Plant Spent Fuel Pool and Shipping Capability Descriptions(a)

ID	STATE	REACTOR	REACTOR TYPE	POOL SHARING	POOL MAXIMUM CAPACITY (ASSEMBLIES)	REACTOR FULL CORE RESERVE (ASSEMBLIES)	CANISTERS OF FUEL IN POOL (AS OF 12-88)	--- CRANE NAMEPLATE RATING (TONS)	CAPACITY --- CURRENT DERATED CAP. (TONS)	SHIPPING MODE ASSUMED POSSIBLE	CURRENT FUEL TYPE
0101	AL	FARLEY 1	PWR	NO	1407	157	1	125		RAIL	WE17JWST
0102	AL	FARLEY 2	PWR	NO	1407	157		125		RAIL	WE17JWST
0301	AZ	PALO VERDE 1	PWR	NO	1329	241		150		RAIL	CE180CS8
0302	AZ	PALO VERDE 2	PWR	NO	1329	241	1	150		RAIL	CE180CS8
0303	AZ	PALO VERDE 3	PWR	NO	1329	241		150		RAIL	CE160
0401	AR	ARK NUCLEAR 1	PWR	NO	968	177		100	100	RAIL	0W15K0MB
0402	AR	ARK NUCLEAR 2	PWR	NO	988	177	1	100	100	RAIL	CE18NCS0
0501	MD	CALVERT CLF 1	PWR	YES	1830	217	2	150		TRUCK	CE14TCST
0502	MD	CALVERT CLF 2	PWR	YES	0	217		150		TRUCK	CE14TCST
0601	MA	PILGRIM 1	BWR	NO	2320	500		100		TRUCK	GE08LG81
0701	NC	BRUNSWICK 1	BWR	NO	1003	560		125		TRUCK	GE08LG72
0702	NC	BRUNSWICK 2	BWR	NO	1039	560		125		TRUCK	GE08LG72
0703	NC	HARRIS 1	PWR	NO	1032	157		150		TRUCK	WE17J
0705	SC	ROBINSON 2	PWR	NO	544	157	1	125		TRUCK	EX15JWE
0711	NC	BRUNSWICK 1 PWR	PWR	NO	100	0		125		TRUCK	CARETAKR
0712	NC	BRUNSWICK 2 PWR	PWR	NO	144	0		125		TRUCK	CARETAKR
0713	NC	HARRIS 1 BWR POOL	BWR	NO	968	0		150		TRUCK	CARETAKR
0901	OH	PERRY 1	BWR	NO	4020	740		125	125	RAIL	GE08L
0902	OH	PERRY 2	BWR	NO	9999	740		0		RAIL	CN 8+
1001	IL	BRAIDWOOD 1	PWR	YES	1013	193		125	15	RAIL	WE17JWOF
1002	IL	BRAIDWOOD 2	PWR	YES	0	193		125	15	RAIL	WE17J
1003	IL	BYRON 1	PWR	YES	2064	193	1	125		RAIL	WE17JWOF
1004	IL	BYRON 2	PWR	YES	0	193		125		RAIL	WE17JWOF
1005	IL	DRESDEN 1	BWR	NO	720	464		75		TRUCK	EX06EEG0
1006	IL	DRESDEN 2	BWR	NO	3537	724		125		RAIL	EX08LEG3
1007	IL	DRESDEN 3	BWR	NO	3537	724	2	125		RAIL	EX08LEG3
1008	IL	LASALLE CTY 1	BWR	YES	8140	704		125		RAIL	GE08LG52
1009	IL	LASALLE CTY 2	BWR	YES	0	704		125		RAIL	GE08LG72
1010	IL	QUAD CITIES 1	BWR	YES	7551	724	2	125		RAIL	GE08LG71
1011	IL	QUAD CITIES 2	BWR	YES	0	724		125		RAIL	GE08LG71
1012	IL	ZION 1	PWR	YES	2079	193		125		RAIL	WE15JWOF
1013	IL	ZION 2	PWR	YES	0	193		125		RAIL	WE15JWOF
1101	NY	INDIAN PT 1	PWR	NO	750	120		75	75	TRUCK	WE14FWIP
1102	NY	INDIAN PT 2	PWR	NO	900	193		40	40	TRUCK	WE16JWZZ
1201	WI	BIG ROCK 1	BWR	NO	441	84	7	75	24	TRUCK	EX11AEBR
1204	WI	PALISADES	PWR	NO	892	204	0	100		TRUCK	EX15NEPR
1301	WI	LACROSSE	BWR	NO	440	72		50		TRUCK	EX10CEAC
1402	WI	ENRICO FERMI2	BWR	NO	2383	704		125		RAIL	GE08L
1501	SC	CATAWBA 1	PWR	NO	2615	193		125	125	RAIL	WE17JWOF
1502	SC	CATAWBA 2	PWR	NO	2615	193		125	125	RAIL	WE17J
1504	NC	MCGUIRE 1	PWR	NO	1449	193	2	125	125	RAIL	WE17JWOF
1505	NC	MCGUIRE 2	PWR	NO	1437	193	1	125	125	RAIL	WE17JWOF
1508	SC	OCONEE 1	PWR	YES	1312	177	3	100	100	TRUCK	0W15K0BZ
1507	SC	OCONEE 2	PWR	YES	0	177		125	125	TRUCK	0W15K0BZ

TABLE 4.7. (contd)

ID	STATE	REACTOR	REACTOR TYPE	POOL SHARING	POOL MAXIMUM CAPACITY (ASSEMBLIES)	REACTOR FULL CORE RESERVE (ASSEMBLIES)	CANISTERS OF FUEL IN POOL (AS OF 12-88)	--- CRANE NAMEPLATE RATING (TONS)	CAPACITY --- CURRENT DERATED CAP. (TONS)	SHIPPING MODE ASSUMED POSSIBLE	CURRENT FUEL TYPE
1508	SC	OCONEE 3	PWR	NO	825	177		100	100	TRUCK	BN16K80Z
1601	PA	BEAVER VALLEY 1	PWR	NO	833	157	1	130	125	RAIL	WE17JWST
1602	PA	BEAVER VALLEY 2	PWR	NO	1088	157		125		RAIL	WE17J
1701	FL	CRYSTAL RVR 3	PWR	NO	842	177		120		TRUCK	BN16KBW0
1801	FL	ST LUCIE 1	PWR	NO	1708	217		105	25	TRUCK	EX14TECE
1802	FL	ST LUCIE 2	PWR	NO	1584	217		150	100	TRUCK	CE16NCSL
1803	FL	TURKEY PT 3	PWR	YES	1378	167	1	105	25	TRUCK	WE15JWZZ
1804	FL	TURKEY PT 4	PWR	YES	814	167		105	25	TRUCK	WE16JWZZ
1901	PA	3 MILE ISL 1	PWR	NO	752	177		110		RAIL	BN16KBW0
1903	NJ	OYSTER CRK 1	BWR	NO	2800	560	17	100		TRUCK	EX08LEG3
2001	GA	HATCH 1	BWR	YES	5790	560	4	125		RAIL	GE08LG72
2002	GA	HATCH 2	BWR	YES	0	560		125		RAIL	GE08LG72
2003	GA	VOGTLE 1	PWR	YES	2388	193		125		RAIL	WE17JWST
2004	GA	VOGTLE 2	PWR	YES	0	193		125		RAIL	WE17J
2101	LA	RVR BEND 1	BWR	NO	3172	824		125		RAIL	GE08LG72
2201	TX	SOUTH TEXAS 1	PWR	NO	1969	193		150		RAIL	WE17P
2202	TX	SOUTH TEXAS 2	PWR	NO	1969	193		150		RAIL	WE17P
2301	IL	CLINTON 1	BWR	NO	2872	624		125		RAIL	GE08L
2401	IA	DUANE ARNOLD	BWR	NO	2050	368		100	100	TRUCK	GE08LG02
2501	KS	WOLF CREEK 1	PWR	NO	1340	193		150		RAIL	WE17JWST
2501	NY	SHOREHAM	BWR	NO	2885	560		125	126	TRUCK	GE08LG02
2701	LA	WATERFORD 3	PWR	NO	1088	217	1	125		RAIL	CE16NCS0
2801	ME	MAINE YANKEE	PWR	NO	1476	217	4	125		RAIL	EX14TECE
2901	MS	GRAND GULF 1	BWR	NO	3931	800		150		TRUCK	GE08LG02
3001	NE	COOPER STN	BWR	NO	2368	548		100		TRUCK	GE08LG02
3101	NY	NINE MILE PT1	BWR	NO	2778	532		125		RAIL	GE08LG01
3102	NY	NINE MILE PT2	BWR	NO	4049	764		125		RAIL	GE08L
3201	CT	MILLSTONE 1	BWR	NO	2184	680		110		TRUCK	GE08LG71
3202	CT	MILLSTONE 2	PWR	NO	1112	217	4	100		RAIL	WE14TMC
3203	CT	MILLSTONE 3	PWR	NO	1838	193		125		RAIL	WE17JWST
3301	MN	MONTICELLO	BWR	NO	2237	484		85		TRUCK	GE08LG01
3302	MN	PRAIRIE ISL 1	PWR	YES	1388	121	20	125		RAIL	EX14JETR
3303	MN	PRAIRIE ISL 2	PWR	YES	0	121		125		RAIL	EX14JETR
3401	NE	FORT CALHOUN	PWR	NO	729	133		75		TRUCK	EX14TEFC
3501	CA	DIABLO CANYON 1	PWR	NO	1324	193		125		TRUCK	WE17JWST
3502	CA	DIABLO CANYON 2	PWR	NO	1324	193		125		TRUCK	WE17JWST
3503	CA	HUMBOLDT BAY	BWR	NO	488	184	1	75		TRUCK	EX06DEGH
3601	PA	SUSQUEHANNA 1	BWR	YES	5660	784	1	125		RAIL	GE08LG02
3602	PA	SUSQUEHANNA 2	BWR	YES	0	784		125		RAIL	GE08LG02
3701	PA	LIMERICK 1	BWR	YES	4080	784		125	110	RAIL	GE08LG72
3702	PA	LIMERICK 2	BWR	YES	0	784		125	110	RAIL	GE08L
3704	PA	PEACHBOTTL0W 2	BWR	NO	3814	764	2	125	110	TRUCK	GE08LG72
3705	PA	PEACHBOTTL0W 3	BWR	NO	3819	764	1	125	110	TRUCK	GE08LG02
3801	OR	TROJAN	PWR	NO	1408	193		125		RAIL	WE17JWST
3901	NY	FITZPATRICK	BWR	NO	2854	560		125		RAIL	GE08LG72

TABLE 4.7. (contd)

ID	STATE	REACTOR	REACTOR TYPE	POOL SHARING	POOL MAXIMUM CAPACITY (ASSEMBLIES)	REACTOR FULL CORE RESERVE (ASSEMBLIES)	CANISTERS OF FUEL IN POOL (AS OF 12-88)	--- CRANE CAPACITY --- NAMEPLATE RATING (TONS)	CURRENT DERATED CAP. (TONS)	SHIPPING MODE ASSUMED POSSIBLE	CURRENT FUEL TYPE
3902	NY	INDIAN PT	3	PWR	NO	1346	193	0		TRUCK	WE16JWOF
4201	NJ	HOPE CREEK		BWR	NO	3978	784	150		TRUCK	GE08LG72
4202	NJ	SALEM	1	PWR	NO	1170	193	110		TRUCK	WE17JWST
4203	NJ	SALEM	2	PWR	NO	1170	193	110		TRUCK	WE17JWST
4401	NY	GINNA		PWR	NO	1010	121	40	32	TRUCK	WE14JWOF
4501	CA	RANCHO SECO	1	PWR	NO	1000	177	105		TRUCK	BN16KBWB
4601	SC	SUMMER	1	PWR	NO	1276	167	125		RAIL	WE17JWST
4701	CA	SAN ONOFRE	1	PWR	YES	210	167	116	100	TRUCK	WE14FWSS
4702	CA	SAN ONOFRE	2	PWR	YES	800	217	126		RAIL	CE18NCSD
4703	CA	SAN ONOFRE	3	PWR	YES	800	217	126		RAIL	CE18NCSD
4801	AL	BELLEFONTE	1	PWR	NO	1050	206	150		RAIL	BN15K
4802	AL	BELLEFONTE	2	PWR	NO	1050	206	150		RAIL	BN15K
4803	AL	BROWNS FERRY1		BWR	YES	6942	784	125		TRUCK	GE08LG82
4804	AL	BROWNS FERRY2		BWR	YES	0	784	125		TRUCK	GE08LG82
4805	AL	BROWNS FERRY3		BWR	NO	3471	784	125		TRUCK	GE08LG82
4808	TN	SEQUOYAH	1	PWR	YES	1381	193	125		RAIL	WE17JWST
4809	TN	SEQUOYAH	2	PWR	YES	0	193	125		RAIL	WE17JWST
4810	TN	WATTS BAR	1	PWR	YES	1294	193	125		RAIL	WE17J
4811	TN	WATTS BAR	2	PWR	YES	0	193	125		RAIL	WE17J
4901	TX	COMANCHE PK	1	PWR	YES	3302	193	130	130	TRUCK	WE17J
4902	TX	COMANCHE PK	2	PWR	YES	0	193	130	130	TRUCK	WE17J
5001	OH	DAVIS-BESSE	1	PWR	NO	736	177	140		RAIL	BN16KBWB
5101	MO	CALLAWAY	1	PWR	NO	1340	193	150		TRUCK	WE17JWST
5201	VA	NORTH ANNA	1	PWR	YES	1737	167	125	125	RAIL	WE17JWST
5202	VA	NORTH ANNA	2	PWR	YES	0	167	125	125	RAIL	WE17JWST
5203	VA	SURRY	1	PWR	YES	1044	167	125	125	TRUCK	WE14JWST
5204	VA	SURRY	2	PWR	YES	0	167	125	125	TRUCK	WE15JWZS
5301	WA	WNP-1		PWR	NO	9999	999	0		RAIL	GN17+
5302	WA	WASH NUCLEAR2		BWR	NO	2058	784	125		TRUCK	GE08LG82
5401	WI	POINT BEACH	1	PWR	YES	1307	121	125		TRUCK	WE14JWOF
5402	WI	POINT BEACH	2	PWR	YES	0	121	125		TRUCK	WE14JWOF
5501	WI	KENAUWEE		PWR	NO	990	121	125		TRUCK	EX14JEME
5601	MA	YANKEE-ROWE	1	PWR	NO	721	76	76		TRUCK	CE18DCYR
5701	CT	HADDAM NECK		PWR	NO	1168	167	100		TRUCK	BN16GBWB
5801	MI	COOK	1	PWR	YES	2048	193	150	150	RAIL	WE15JWOF
5802	MI	COOK	2	PWR	YES	0	193	150	150	RAIL	EX17JEME
5901	NH	SEABROOK	1	PWR	NO	1238	193	125		RAIL	WE17J
6001	VT	VT YANKEE	1	BWR	NO	2070	368	110		RAIL	GE08LG82
6101	NY	WEST VALLEY-B		BWR	NO	802	0	100	100	RAIL	CARETAKR
6102	NY	WEST VALLEY-P		PWR	NO	802	0	100	100	RAIL	CARETAKR
6501	IL	MORRIS-BWR		BWR	NO	3775	0	125	125	RAIL	CARETAKR
6502	IL	MORRIS-PWR		PWR	NO	1060	0	125	125	RAIL	CARETAKR

Repository-Only Case

(a) Information provided by ORNL based on CY-1988 RW-859 Nuclear Fuel Data and other sources.

4.2 WASTE TRANSPORTATION

The transportation of the wastes between the DOE waste management facilities requires two general types of activities: cask transportation between the facilities and cask servicing.

4.2.1 Cask Transportation

The transportation activities move waste transport casks between the waste generators and the repository. The major requirements of these transportation activities will be to:

- provide transport casks appropriately designed for loading and unloading at the waste generators and repository, ready decontamination after submersion in wet storage facilities, satisfaction of regulatory requirements for routine radiation doses and accident resistance, and low system costs
- deliver empty casks to the waste generators
- transport casks in a safe, economically efficient manner that provides minimum adverse impacts on the general public and transport employees.

These requirements provide the reference basis for this physical description of the cask transportation activities.

4.2.1.1 Level 1 Physical Description

Cask transportation from the waste generators requires three activities:

- inspection and acceptance (Function 2.1)
- transportation over railroads and waterways (Function 2.2)
- transportation over highways (Function 2.2).

Facilities and equipment required for each of these transportation activities are discussed below. A central cask fleet dispatching center in the support services building at the repository will control cask scheduling.

The information in this subsection was obtained primarily from DOE (1987a), Sandia (1983), Wooden (1986), and 40 CFR 173.

Function 2.1 - Inspection and Acceptance. The inspection and acceptance of the transport casks occurs at the vehicle dispatch areas on the waste generator's property and the DOE facilities. These are a railroad track and/or a truck parking area inside the facility perimeter fence so that the casks have normal facility security surveillance. The truck parking area has to have a capacity of only one truck. The railroad vehicle parking area, on the other hand, must have sufficient capacity for at least three cask cars at reactor sites or five cars at repository sites. However, this parking area may be distributed among several locations if a single location with ample capacity is not available.

The tools and equipment for the inspection consist only of hand-held wrenches, pry bars and radiation monitors for determining the integrity of the personnel barriers, tightness of bolts, and the radiation fields.

Function 2.2.1 - Truck Transport from Waste Generators. A truck cask on a truck trailer may be either a legal weight truck (LWT) cask (less than 80,000 pounds for cask and truck) or an overweight truck (OWT) cask that requires a special permit to travel.

A truck shipment starts at the dispatch area near the perimeter fence of the waste generator. The shipment uses the connecting first-class highway to an interstate highway, interstate highways to the turnoff interchange to the destination, and a first-class connecting highway to the destination. Intermediate stops are made at truck stops for refueling, driver meals, and periodic check-in phone calls to the dispatch center, and at state inspection stations for inspections and check-in phone calls.

Generally, the transport route avoids high population areas when this can be done on first-class highways without excessive extra travel distance.

The empty casks are returned to the waste generators as normal non-radioactive freight shipments.

Function 2.2.2 - Rail/Barge Transport from Waste Generators. A rail cask on a railroad car may be a commercial-weight cask (e.g., less than 110 tons) or an overweight cask (110 to 150 tons). Commercial-weight shipments (defined as total car plus cask weight of less than 263,000 pounds) can

travel at normal freight-train speeds and as part of a normal freight train. Overweight cars must travel at lower speeds and only on tracks with adequate strength.

A rail shipment starts at the dispatch area near the perimeter fence of the waste generators. The shipment then proceeds over the connecting railroads to a main-line railroad and then over main-line railroads to the destination. During the shipment, short stops are made at classification terminals for crew changes, refueling, engine changes, and car inspections. Generally, because the shipments are by dedicated trains, no switch engines are needed at the classification terminals.

The spent fuel and HLW shipments are planned to be dedicated shipments. Such shipments are expected to consist of an engine, one to three cask cars from reactor sites and five cask cars from reprocessing plant sites, two to six buffer cars, several cars for non-fuel wastes and a caboose. One buffer car is placed between the engine and the cask cars containing fuel, between adjacent cask cars and between the cask cars and the caboose.

A waterway shipment will be initiated as a truck or rail shipment from the dispatch area at the origin facility. The vehicle will carry the cask to a barge dock and will be loaded onto the barge. Because of the large capacity of barges, several casks will be shipped on one barge.

The barge will then transport the casks over canals, rivers, lakes and oceans to a barge dock as close as possible to the destination. The casks will be transported from the barge dock to the destination as truck or rail shipments.

The empty casks will be returned to the waste generators as normal non-radioactive truck or railcar freight shipments.

4.2.1.2 Level 2 Physical Description

The waste shipments will have three general configurations:

1. Truck casks on truck trailers (Functional step 2.2.1). A shipment consists of a tractor and a trailer carrying one cask.

2. Rail casks on railcars (Functional step 2.2.2). A shipment consists of an engine, cask cars, buffer cars between the cask cars, and a caboose.
3. Intermodal transport of casks on trucks, railcars and barges (Functional steps 2.2.1 and 2.2.2). A shipment consists of many shipments to and from the barges as described above, a tugboat and a barge loaded with many casks.

As shown in Table 4.2, the wastes will originate from several hundred different sources scattered throughout the country. They will be transported primarily over interstate highways and mainline railroads plus barge routes between those sources and the repository. The method selected for transport of specific shipments will depend on several variables such as the ability of the waste generator shipment facilities to handle rail and truck casks, the availability of barge transport at a lower cost than for railroad transport, and the effects of weather conditions on the available transport routes.

The general characteristics of the transport casks are listed in Table 4.8. Typical casks are illustrated in Figure 4.11.

The designs of these casks are based on the regulatory radiation dose maxima for the system design basis of PWR fuel exposed to 35,000 MWd/t and cooled for 5 years after discharge. Since most fuel shipped will have other characteristics (designs, cooling, etc.), analyses to determine radiation doses should be based on radiation fields expected for the material in the casks. The wastes that may be shipped in each type of cask are listed in Table 4.9.

The transportation distances and times from the waste generators to the candidate repository site are presented in Table 4.10. Except for connections at the origins, the routes are either mainline railroads or interstate highways. The connections to the repository are expected to be either first-class railroads or highways.

TABLE 4.8. Typical Waste Transport Cask Descriptions

Cask Type	Cask ^(c) Symbol	Cask Weight (tons) ^(a)		Cask Exterior Dimensions ^(b) (in.)		Capacity ^(b)				
		Empty	Loaded	Length	Diameter	Intact PWR SFAS	Intact BWR SFAS	Consolidated PWR	Consolidated BWR	HLW Canisters
Rail/Barge	RC100	80	102	235	85	21	52	42 ^(d)	104 ^(d)	n.a. ^(e)
Legalweight Truck (BWR)	TC28B	26	28	225	44	--	9	--	9 ^(f)	n.a.
Legalweight Truck (PWR)	TC28P	26	28	215	44	4	--	4	--	n.a.
Overweight Truck	TC40	36	40	215	51	5	12	6	14	n.a.
Storage/Transportation	RC125ST	95	125	235	72	24	61	48 ^(d)	122 ^(d)	n.a.
HLW Truck	TC25HLW	23	26	151	46	n.a.	n.a.	n.a.	n.a.	1
HLW Rail - Defense	RC100HLW	88	100	151	106	n.a.	n.a.	n.a.	n.a.	5
HLW Rail - MRS	RC150HLW	133	150	151	106	n.a.	n.a.	n.a.	n.a.	7
MRS Rail ^(g)	RC150MRS	112	150	208	76	34	80	56	140	n.a.
Long Rail	RC100L	87	108	260	69	18	42	36 ^(d)	84 ^(d)	n.a.

(a) Cask weights and dimensions obtained from DOE (1990a), DOE (1990b) or estimated by use of information in DOE (1987a). Cask empty weight includes the sealed empty cask, impact limiters and any ancillary equipment. Cask loaded weight includes the loaded cask, impact limiters and any ancillary equipment.

(b) Capacities obtained from DOE (1990a), DOE (1990b) or estimated by use of information in DOE (1987a). Consolidation assumed to double the number of fuel pins shipped in the volume occupied by an intact SFA.

(c) See Appendix A for explanation of symbols.

(d) Capacity may be limited by crane capacities at the waste generators.

(e) Not applicable.

(f) Cask capacity limited by total permissible cask weight.

(g) Cask also used to transport 4 cages or canisters of SFA hardware or 4 containers of spent fuel containing 12 intact PWR, 24 intact BWR, 24 consolidated PWR or 72 consolidated BWR SFAs, or 7 canisters of HLW.

FIGURE 4.11. Typical Transport Cask Designs

TABLE 4.9. Potential Contents in Transport Casks

Waste Forms and Canister or Container(b)	Transport Casks(a)							
	RC100	RC100L	RC125ST	TC25	TC40	RC150MRS	RC100HLW	TC25HLW
AR6_CON_B	X		X	X	X	X		
AR6_GTC_B	X		X	X	X	X		
AR6_NFB_B	X		X	X	X	X		
AR6_SFA_B	X		X	X	X	X		
AR9_CON_P	X	X	X	X	X	X		
AR9_GTC_P	X	X	X	X	X	X		
AR9_NFB_P	X	X	X	X	X	X		
AR9_SFA_P	X	X	X	X	X	X		
CRP_GTC_D							X	X
CRP_GTC_W							X	X
CRP_HLW_D(c)							X	X
CRP_HLW_W(c)							X	X
M6_SFA_B						X		
MDRM_GTC_M						X		
MU_GTC_M						X		
OFU_GTC_O	X	X		X	X			
OFU_SFA_O	X	X		X	X			
SFA_B(c)	X		X	X	X	X		
SFA_P(c)	X	X	X	X	X	X		

- (a) Cask baskets are assumed to correspond to geometry of wastes and canisters. More than one type of waste form may be placed in a cask for a specific shipment.
- (b) Canister lengths are typical lengths. Other lengths could be used with or without spacers to prevent movement of contents inside the canister. See Appendix A for explanation of symbols.
- (c) Indicates principal concern of current studies.

TABLE 4.10. Transportation Distances for Waste Shipments

INIS ID	Shipment Origin	Transport Distances (miles)			
		MRS		Candidate Repository Site	
		Highway	Railroad	Highway	Railroad
1901	3 Mile Island 1	413	387	2666	2815
401	Arkansas Nuclear 1	1155	1227	1744	2067
402	Arkansas Nuclear 2	1155	1227	1744	2067
1601	Beaver Valley 1	418	478	2347	2572
1602	Beaver Valley 2	418	478	2347	2572
1201	Big Rock Point	908	1033	2391	2481
1001	Braidwood 1	828	908	1902	2061
1002	Braidwood 2	828	908	1902	2061
4803	Browns Ferry 1	804	929	2279	2365
4804	Browns Ferry 2	804	929	2279	2365
4805	Browns Ferry 3	804	929	2279	2365
701	Brunswick 1	520	663	2836	3033
711	Brunswick 1 PWR Pool	520	663	2836	3033
702	Brunswick 2	520	663	2836	3033
712	Brunswick 2 PWR Pool	520	663	2836	3033
1003	Byron 1	894	947	1862	2095
1004	Byron 2	894	947	1862	2095
5101	Callaway 1	1001	1179	1807	1834
501	Calvert Cliffs 1	457	422	2714	2967
502	Calvert Cliffs 2	457	422	2714	2967
1501	Catawba 1	531	586	2628	2819
1502	Catawba 2	531	586	2628	2819
2301	Clinton	867	1001	1927	2077
4901	Comanche Peak 1	1442	1929	1747	1694
4902	Comanche Peak 2	1442	1929	1747	1694
5801	Cook 1	770	876	1985	2078
5802	Cook 2	770	876	1985	2078
3001	Cooper Station	1253	1473	1516	1620
1701	Crystal River 3	1044	1159	2837	3009
5001	Davis-Besse 1	552	617	2186	2387
3501	Diablo Canyon 1	2922	3200	546	687
3502	Diablo Canyon 2	2922	3200	546	687
1005	Dresden 1	826	894	1900	2003
1006	Dresden 2	826	894	1900	2003
1007	Dresden 3	826	894	1900	2003
2401	Duane Arnold	1041	1082	1721	1794
1402	Enrico Fermi 2	590	662	2179	2363
101	Farley 1	969	1024	2533	2956
102	Farley 2	969	1024	2533	2956
3901	Fitzpatrick	446	542	2622	2805
3401	Fort Calhoun	1262	1321	1458	1531
4101	Fort St. Vrain	TBD	TBD	897	1114
4401	Ginna	430	444	2533	2752
2901	Grand Gulf 1	1089	1123	2080	2419
5701	Haddam Neck	564	682	2809	3104
7003	Hanford Reservation	2771	3000	----	1302

TABLE 4.10. (contd)

INIS ID	Shipment Origin	Transport Distances (miles)			
		MRS		Candidate Repository Site	
		Highway	Railroad	Highway	Railroad
703	Harris 1	450	678	2732	2962
713	Harris 1 BWR Pool	450	678	2732	2962
2001	Hatch 1	761	872	2619	2899
2002	Hatch 2	761	872	2619	2899
4201	Hope Creek	475	537	2755	2947
3503	Humboldt Bay	3327	3314	1003	1158
7002	Idaho Chemical Proc. Plant	2358	2454	----	756
1101	Indian Point 1	510	600	2728	3022
1102	Indian Point 2	510	600	2728	3022
3902	Indian Point 3	510	600	2728	3022
5501	Kewaunee	1004	1085	2098	2214
1301	La Crosse	1124	1108	1944	2094
1008	LaSalle City 1	845	920	1875	2046
1009	LaSalle City 2	845	920	1875	2046
3701	Limerick 1	486	449	2755	2881
3702	Limerick 2	486	449	2755	2881
2801	Maine Yankee	766	897	3029	3243
1504	McGuire 1	527	714	2597	2882
1505	McGuire 2	527	714	2597	2882
3201	Milestone 1	591	794	2813	3115
3202	Milestone 2	591	794	2813	3115
3203	Milestone 3	591	794	2813	3115
3301	Monticello	1250	1303	1863	1933
6601	Morris BWR Pool	828	892	1902	2001
6602	Morris PWR Pool	828	892	1902	2001
3101	Nine Mile Point 1	447	541	2623	2804
3102	Nine Mile Point 2	447	541	2623	2804
5201	North Anna 1	426	479	2741	2789
5202	North Anna 2	426	479	2741	2789
1506	Oconee 1	628	739	2536	2769
1507	Oconee 2	628	739	2536	2769
1508	Oconee 3	628	739	2536	2769
1903	Oyster Creek 1	516	573	2791	3030
1204	Palisades	763	906	2014	2108
301	Palo Verde 1	2376	2599	607	696
302	Palo Verde 2	2376	2599	607	696
303	Palo Verde 3	2376	2599	607	696
3704	Peach Bottom 2	431	406	2713	2860
3705	Peach Bottom 3	431	406	2713	2860
901	Perry 1	459	579	2290	2453
601	Pilgrim 1	651	781	2922	3203
5401	Point Beach 1	1000	1017	2094	2146
5402	Point Beach 2	1000	1017	2094	2146
3302	Prairie Island 1	1233	1248	1858	1894
3303	Prairie Island 2	1233	1248	1858	1894
1010	Quad Cities 1	951	1078	1770	2012

TABLE 4.10. (contd)

INIS ID	Shipment Origin	Transport Distances (miles)			
		MRS		Candidate Repository Site	
		Highway	Railroad	Highway	Railroad
1011	Quad Cities 2	951	1078	1770	2012
4501	Rancho Seco	2882	3334	680	821
2101	River Bend 1	1191	1296	2134	2676
705	Robinson 2	530	658	2681	2865
4202	Salem 1	475	543	2755	2953
4203	Salem 2	475	543	2755	2953
4701	San Onofre 1	2684	3112	415	455
4702	San Onofre 2	2684	3112	415	455
4703	San Onofre 3	2684	3112	415	455
7001	Savannah River Plant	624	735	----	2763
5901	Seabrook	661	800	2924	3146
4808	Sequoyah 1	735	723	2318	2537
4809	Sequoyah 2	735	723	2318	2537
2201	South Texas 1	1534	1607	1862	2613
2202	South Texas 2	1534	1607	1862	2613
1801	St. Lucie 1	1025	1192	2957	3116
1802	St. Lucie 2	1025	1192	2957	3116
4601	Summer 1	566	709	2600	2779
5203	Surry 1	463	600	2843	2891
5204	Surry 2	463	600	2843	2891
3601	Susquehanna 1	434	420	2565	2880
3602	Susquehanna 2	434	420	2565	2880
3801	Trojan	2948	3093	1328	1476
1803	Turkey Point 3	1171	1481	3103	3340
1804	Turkey Point 4	1171	1481	3103	3340
6001	Vermont Yankee 1	595	667	2848	3089
2003	Vogtle 1	650	739	2606	2934
2004	Vogtle 2	650	739	2606	2934
5302	Washington Nuclear 2	2786	3008	1166	1310
2701	Waterford 3	1146	1293	2200	2611
4810	Watts Bar 1	685	688	2368	2502
4811	Watts Bar 2	685	688	2368	2502
6401	West Valley BWR Pool	430	499	2452	2652
6402	West Valley PWR Pool	430	499	2452	2652
2501	Wolf Creek 1	1242	1333	1669	1766
5601	Yankee Rowe 1	632	622	2885	2968
----	Yucca Mountain, Nevada	----	2886	----	----
1012	Zion 1	861	894	1955	2023
1013	Zion 2	861	894	1955	2023

Source: Generic MRS distances derived from route-specific data provided by Geographic Data Systems Section, Computing and Telecommunication Division, Oak Ridge National Laboratory (ORNL), August 1988. Route-specific distances to Yucca Mountain, Nevada, also provided by ORNL, February 1988.

Table 4.11 lists the general characteristics of truck shipments (Functional step 2.2.1). Table 4.12 lists the general characteristics of dedicated rail shipments of loaded casks (Functional step 2.2.2). Table 4.13 lists the general characteristics of barge shipments (Functional step 2.2.2). The general characteristics of rail shipments of empty casks are listed in Table 4.14.

4.2.2 Cask Servicing

The major requirement for this activity will be to:

- maintain all waste management system transport casks and vehicles in satisfactory condition such that there is no significant reduction in the safety and efficiency of the transportation systems because of cask or vehicle deterioration.

The cask servicing facilities provide major maintenance, decontamination, inspection and testing of the transport casks and associated transport vehicles. Scheduling and control of these activities and of cask dispatching will occur at the central cask fleet dispatching center in the support services buildings at the repository.

The transport casks and vehicles will be serviced in a support services facility solely for that purpose. Figures 4.12 and 4.13 present a cut-away perspective and a plan view of the facility, respectively. Table 4.15 lists the process areas in that facility, the functions of those areas, the internal dimensions, and location keys that indicate where on Figure 4.13 the various process areas are located in that building. The major process equipment needed for the fleet servicing facility is listed in Table 4.16.

Casks and vehicles will be moved to and from that facility by the onsite drive vehicles that service the process buildings.

The information in this subsection was obtained primarily from DOE (1987b), Sandia (1987a) and AGNS (1980).

TABLE 4.11. General Characteristics of Truck Transport of Loaded Casks

	<u>Legal Weight Trucks</u>	<u>Overweight Trucks</u>
Transport mode	Single truck with trailer	Single truck with trailer
Total shipment weight	80,000 lb	110,000 lb
General transport methods	Continuous trip with short intermediate stops	Continuous trip with short intermediate stops routed to avoid states that prohibit night travel
Average speed while moving	40 mph	40 mph
Stop frequency		
Refueling	500 miles	500 miles
Food and rest	Every 6 to 7 hours	Every 6 to 7 hours
Communication stops	Every 2 hours	Every 2 hours
Inspection stops	Each state line	Each state line
Average	2 hours	2 hours
Daily travel	900 miles	900 miles

TABLE 4.12. General Characteristics of Rail Transport of Loaded Casks

	<u>Normal Weight Shipments</u>	<u>Overweight Shipments</u>
Transport mode	Dedicated train	Dedicated train
Number of casks per train	Variable(a)	Variable(a)
Total car and cask weight	<263,000 lb	380,000 lb
General transport method	Continuous trip with intermediate stops	Continuous trip with intermediate stops
Average speed	27 mph	27 mph
Stop frequency	150 miles	150 miles

- (a) Number of casks per train varies because: 1) a shipment from a reactor plant will contain all fuel expected to be shipped during 1 year and 2) shipments from the MRS to the repository will contain 5 cars of spent fuel plus a variable number of cars of hardware. Shipments from reprocessing plants will contain 5 cars of HLW.

TABLE 4.13. General Characteristics of Barge Transport of Loaded Casks

Transport mode	Dedicated barge
Number of casks per barge	10 to 50
General transport method	Continuous trip with intermediate stops
Average trip speed	2 mph
Stop frequency	Infrequent

TABLE 4.14. General Characteristics of Rail Transport of Empty Casks

Transport mode	Normal freight shipments
Total shipment weight	240,000 lb
General transport method	Normal freight shipment
Average speed	22 mph
Stop frequency	150 mi

FIGURE 4.12. Fleet Servicing Facility

Note: Letters in squares identify process areas listed in Table 4.15.

FIGURE 4.13. Plan View of Integrated Fleet Service Facility

TABLE 4.15. Support Services Facility Process Room Dimensions

<u>Process Room</u>	<u>Approximate Dimension (feet)</u>			<u>Location Symbol (a)</u>
	<u>Length</u>	<u>Width</u>	<u>Height</u>	
Cask and Vehicle Washdown	105	46	27	A
Cask Unloading	70	68	50	B
Test and Inspection	102	68	27	C
Test and Repair	71	68	50	D
Cask and Insert Cleaning	70	42	29	E
Transfer Hall	49	42	50	F

(a) Letter symbol indicates location on Figure 4.13.

TABLE 4.16. Major Process Equipment in Fleet Servicing Facility

<u>Equipment Title</u>	<u>Equipment Identification</u>	<u>Function/Activity</u>	<u>Number of Units</u>	<u>Size or Capacity</u>
Cask Pit Covers	1	Provide shielding and ventilation control on cask pits	20	1 pit
Bridge Crane	2	Move casks between servicing stations	1	150/ 30 ton
Jib Cranes	3	Move cask lids and inserts	4	--
Storage Bay Crane	4	Move cask tiedowns and impact limiters between railcars and storage area	1	15 ton
Insert Service Crane	5	Move cask inserts between service stations	1	10 ton
Test Bay Crane	6	Move test equipment	1	15 ton
Cask Service Cart	7	Support and move cask service equipment	1	--

4.3 REPOSITORY

The conceptual repository is in a tuff formation at the Yucca Mountain candidate site in Nevada. It will provide waste preparation, emplacement, and final geologic disposal. The major requirements of this facility will be to:

- receive spent nuclear fuel from nuclear power generating facilities and high-level waste from reprocessing plants
- process and package spent fuel and other wastes as needed for final disposal
- safely emplace no more than 70,000 MTU of spent fuel and other wastes
- continuously monitor and manage spent fuel and wastes during the repository caretaker period
- remove selected disposal containers from the repository for Performance Confirmation Testing during a 50-year emplacement and caretaker period
- retrieve all wastes in the event some disqualifying feature is found in the repository within 50 years of the time when waste emplacement operations are initiated
- close the repository for safe final disposal of the wastes by backfilling and sealing of the underground facilities and decommissioning the surface facilities.

These requirements provide the reference basis for this physical description of a tuff repository.

The Yucca Mountain candidate site is in Nye County, Nevada, on and adjacent to the southwest portion of the DOE's Nevada Test Site, about 100 miles northwest of Las Vegas (see Figure 4.14).

There are three general types of facilities at the conceptual repository: 1) the support facilities, 2) the waste receiving, handling and temporary storage facilities, and 3) the underground disposal facilities. A

FIGURE 4.14. Location of Yucca Mountain Candidate Repository Site in Southern Nevada

conceptual perspective view of these facilities is shown in Figure 4.15. The general characteristics of these facilities and their alternatives are described here.

The descriptions in this subsection are based on information from Bechtel (1985), DOE (1988b), and Weston (1989).

Figure 4.16 presents a conceptual plan view of the repository surface facilities, including the Waste Handling Building (WHB) and the required support facilities. Table 4.17 lists the primary support facilities and states their purposes and typical floor areas. Their locations are keyed to Figure 4.16.

4.3.1 Level 1 Physical Description

The primary purposes of the repository are to receive 3000 MTU per year of intact fuel and 400 MTU per year of HLW, unload these wastes from the transport casks, place them in repository containers, and then emplace them in their final disposal location in the underground facilities.

The Waste Handling Building

The primary purposes of the Waste Handling Building (WHB) are to receive loaded transport casks, unload the wastes from these casks, place the wastes in containers and seal these containers. Figure 4.17 presents a conceptual process flow diagram for this WHB that illustrates its primary functions. Figures 4.18 and 4.19 present simplified floor plans for the main floor and basement for the building.

The general process areas are the receiving, inspection and shipping area, the cask preparation area, two cask unloading hot cells, two inspection cells, two container transfer tunnels, and the surface storage vault. The two unloading hot cells contain seven cask unloading ports (two in one cell for HLW and five in the other cell for intact fuel). Table 4.18 lists the approximate process area dimensions and location keys that indicate where (on Figures 4.18 and 4.19) the various functions are located in the WHB.

The WHB contains a number of support facilities necessary for safe and efficient performance of its operations. These support facilities and their location keys are listed in Table 4.19.

FIGURE 4.15. Conceptual Tuff Repository Perspective View

LEGEND: Letters in diamonds identify facilities listed in Table 4.17.

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FIGURE 4.16. Conceptual Plan View of Repository Central Surface Facilities

TABLE 4.17. Tuff Repository Primary Support Facilities

Facility Title	Facility Purpose	Approximate Area (ft ²) (a)	Location Symbol (b)
Waste Receiving and Inspection Area	Receive waste shipments, store shipments, wash casks and vehicles (Functions 5.1 and 5.2)	600,000	L
Waste Treatment Building	Prepare site-generated radioactive wastes for shipment offsite	21,000	M
Decontamination Building	Decontaminate and repair radioactive equipment	5,400	N
Performance Confirmation Building	Determine condition of wastes removed from repository	24,000	O
Electrical Substation and Emergency Generators	Supply electricity during normal and emergency conditions	14,000	P
Fire Station	House fire department personnel and equipment	5,000	Q
Medical Facilities	Provide routine and emergency medical activities	6,400	R
Underground Personnel Building	Provide changerooms and supervisory offices for underground personnel	15,000	S
Mock-Up Building	Train personnel on mock-ups of repository equipment and facilities	6,300	T
Administration	House repository administrative activities	32,000	U

TABLE 4.17. (contd)

<u>Facility Title</u>	<u>Facility Purpose</u>	<u>Approximate Area (ft²) (a)</u>	<u>Location Symbol (b)</u>
Training Auditorium	Auditorium for personnel training and other activities requiring a large auditorium	1,000	V
Food Service	Cafeteria	5,400	W
Computer Building	House repository computers	5,400	X
Central Warehouse	Warehouse materials	51,000	Y
Shops	Maintenance activities	24,000	Z

(a) Typical areas for the repository that both consolidate spent fuel and containerize all wastes. Some of these facilities will be smaller for repositories that do not consolidate and/or do not containerize wastes.

(b) Locations on Figure 4.16.

FIGURE 4.17. Conceptual Process Flow Diagram for the WHB

Repository-Only Case

NOTE: Letters and numbers relate facility locations to descriptions in Tables 4.18, 4.19, and 4.21.

Shaded portion will not be included in final design.

LEGEND: Numbers in circles identify locations of functions.

Letters in squares identify waste processing areas.

Letters in diamonds identify building support facilities.

FIGURE 4.18. General Plan View of the WHB Main Floor

NOTE: Letters and numbers relate facility locations to descriptions in Tables 4.18, 4.19, and 4.21.

Shaded portion will not be included in final design.

LEGEND: Numbers in circles identify locations of functions.

Letters in squares identify waste processing areas.

Letters in diamonds identify building support facilities.

FIGURE 4.19. General Plan View of the WHB Basement

TABLE 4.18. WHB Process Room Dimensions

Process Room	Approximate Dimension (feet)			Location Symbol (a)
	Length	Width	Height	
Air Control Vestibule	386	68	25	A
Receiving and Shipping Area	386	88	75(b)	B
Cask Preparation Area	386	25	100	C
Cask Unloading Rooms	154(c)	55	40	D
Cask Unloading Hot Cell	139	40	40	E
	+			
	326			
Inspection Cell	42	34	40	F
	+			
	64			
Waste Transfer Tunnel	137	23	23	I
Surface Storage Vault	286	34	40	J

(a) Letter symbol indicates location on Figures 4.18 and 4.19.

(b) Height of main hall. Airlocks at outer ends are only 25 feet high.

(c) Total length of all rooms.

TABLE 4.19. WHB Process Support Facilities

Facility	Function	Location Key(a)	
		Building Floor	Symbol
Material Receiving	Receive and store nonradioactive material	1	J
Operations Support	Operating gallery, weld power supply	1	O
Maintenance	Maintenance shops and storage	Basement	P
Air Conditioning and Exhaust Treatment	Air purification, distribution	2	R
Personnel Annex	Administrative offices, change rooms, training facilities, auditorium	1	S
Container Storage and Transfer	Store clean empty container and transfer to waste transfer tunnel	1	T

(a) Symbol indicates location on Figures 4.18 and 4.19.

The WHB facilities needed for each of the repository functional activities are described in the following subsections. The activities are described in the functional description section of this document. The locations of these activities in the WHB are shown in Figures 4.18 and 4.19 as circles containing the functional activity numbers.

Function 4.1 - Transport Cask Receipt. Cask receipt occurs at the waste receiving and inspection area where the railroad lines enter the facility (area L in Figure 4.16).

Function 4.2 - Transport Cask Lag Storage. Lag storage of the casks occurs on one of the railcar parking lines at the waste receiving and inspection area (area L in Figure 4.16).

Function 4.3 - Empty Cask Preshipment Inspection and Servicing. These activities occur in the cask and vehicle holding areas described above for Function 4.2.

Function 4.4 - Cask Unloading. The cask receiving facilities in the WHB are illustrated in Figure 4.20 and the general location is shown in Figure 4.18. The casks are received at the receiving, inspection and shipping area. This area has facilities and equipment in five separate receiving bays for receiving trucks and railroad cars transporting loaded casks, removing those casks from those vehicles, placing the casks on transfer carts and reversing these procedures for placing casks back onto the vehicles.

This large unshielded receiving and shipping area contains railroad tracks, extending the full length of the area. Large doors near the center of each receiving bay, in combination with the doors at the entrance, create airlocks at the outer ends so that vehicles can enter and leave without compromising the controlled ventilation system. Overhead bridge cranes have capacity for lifting the transport casks and transporting them to the transfer carts in the cask preparation area at the side of the receiving and shipping area.

Cask unloading occurs in the cask preparation area, the cask transfer tunnels and the cask unloading hot cells (see Figures 4.17 and 4.20). The unloading facilities have equipment for transporting the casks from the

FIGURE 4.20. Typical WHB Cask Receiving Facilities

preparation area to rooms under the cask unloading cells, preparing the casks for unloading, connecting the casks to the cask unloading cells, and reversing those processes to return the casks to the cask preparation area. With the casks sitting in rooms under the cask unloading cells, the contents are lifted out of the casks through ports in the room ceilings into the cells by the unloading cell bridge cranes.

The cask preparation area and cask transfer tunnels have a set of cart tracks for each unloading port in the unloading cells and a transfer cart for each set of tracks. Ventilation doors separate the cask preparation area from the cask transfer tunnels, and shadow shields attached to the roof of

the transfer tunnels can be lowered to provide radiation shielding between the open unloading cell entry ports and the cask preparation area. The preparation room contains moveable work platforms for personnel working on the cask tops. Jib cranes in the cask preparation area are used for removing and replacing the cask outer lids, and robots are used for routine operations such as loosening and tightening bolts.

The cask unloading hot cells have overhead bridge cranes that remove and replace the hot cell port plugs, remove and replace the cask inner lids, lift the wastes out of the casks and transport the wastes inside the cells. The cells also are equipped for storage of the waste materials, inspecting containers, cutting lids off containers, welding lids on containers and placing the containers on transfer carts in a transfer tunnel to the surface storage vault area.

The routine empty cask preparation for shipment occurs in the cask preparation area described above and uses the same equipment as is used for cask receipt and unloading. The preparation area also has a cask decontamination area for cleaning casks.

Function 4.5 - Waste Lag Storage. The cask unloading cell lag storage is illustrated in Figure 4.21 and the location is shown in Figure 4.18. The facilities are of modular construction with capacity for one shipment of waste.

Function 4.6 - Waste Processing. The unloading and inspection hot cells contain several processing stations such as leak-test stations, welding stations, weld inspection stations, canister inspection stations, container inspection stations, container decontamination stations and fuel inspection stations. These are listed below in Section 4.3.2. This equipment has not been designed.

Representative containers are illustrated in Figure 4.1.

Function 4.7 - Container Vault Storage. A separate surface storage vault provides lag storage between the hot cell operations and the waste emplacement. The wastes are transported from the inspection hot cells to the vault by transfer carts in the waste transfer tunnels. A shielded transfer

FIGURE 4.21. Cask Unloading Cell Lag Storage

machine transfers the wastes between the transfer carts, the vault storage areas, and the out-transfer station, where the canisters of waste are loaded into the waste transporter cask (see Figure 4.17).

Function 4.11 - Interface to Waste Emplacement. The interface activities provide transfer of containers of waste between the vault storage transfer bay and the waste transporters. The vault storage building contains transfer bays where the wastes are transferred between the container transfer tunnel, the vaults, and the waste transporter (see Figure 4.17).

The Repository Underground Facilities

The purposes of the underground facilities are to transport containerized wastes to the emplacement locations, emplace the wastes, store the wastes without significant releases to the environment, and remove or retrieve the wastes if necessary for transport to the surface before the repository is closed.

The underground facilities, based on a vertical borehole emplacement concept, are illustrated in Figures 4.15, 4.22 and 4.23. The primary facilities are the waste ramp, the tuff ramp, the main drifts, the several personnel and ventilation shafts, the emplacement drifts, and the underground

FIGURE 4.22. Plan View of Repository Underground Facilities

FIGURE 4.23. Repository Underground Mining Activities

support facilities. The repository facilities needed for each of the underground functional activities are described in the following subsections. The activities are described in the functional description section of this document. Except for specific activities carried out at the out-transfer station in the WHB, the road connecting the station to the waste ramp, and the tuff pile near the adit for the tuff ramp, these activities are carried out throughout the underground facilities.

Function 4.12 - Waste Emplacement Operations. Emplacement facilities and equipment are illustrated in Figures 4.15, and 4.22 to 4.29. The facilities needed for emplacement are the out-transfer station at the WHB surface storage vault, the roads connecting the out-transfer station to the underground waste ramp, the underground waste ramp, the main drifts, the panel access drifts, the emplacement drifts and the boreholes. The waste transporter carries the waste from the surface storage vault through the ramp and drifts to the borehole and places it in the borehole.

Figure 4.24 illustrates a vertical borehole. The vertical boreholes are long enough for only one canister of waste and are only partially lined near the top to provide support for the shield plug and shielding closure and to prevent rock from falling on the canisters.

Figure 4.25 illustrates the waste transporter in the transport mode and in the emplacement mode when the transporter is connected to a borehole in the emplacement drift. Figure 4.26 illustrates the preparation of a vertical borehole prior to waste emplacement. Figure 4.27 illustrates transfer of a container from the surface storage vault to the underground borehole. Figure 4.28 illustrates emplacement of the container in a vertical borehole and return of the empty transporter to the surface. Figure 4.29 illustrates closure of a vertical borehole by insertion of a plug, removal of the closure, and installation of the cover.

If the wastes are removed from the boreholes, the same facilities and equipment will be used for removing the wastes but operating in reverse order.

FIGURE 4.24. Conceptual Design of Vertical Borehole

Repository-Only Case

FIGURE 4.25. Waste Transporter

FIGURE 4.26. Borehole Preparation

FIGURE 4.27. Container Transfer to Underground Borehole

FIGURE 4.28. Emplacement of Container in Borehole

FIGURE 4.29. Closure of Borehole

During the caretaker period, the shafts, ramps, drifts and underground support facilities remain in operation to permit surveillance of the repository performance.

Function 4.13 - Performance Testing. Performance testing during the caretaker period will use all of the equipment and facilities described above for periodic removal, transport to and from the examination facility, and re-emplacment of selected waste containers. The mining equipment also may be used if some of the boreholes become unusable because of testing after removal of the wastes. In addition, the performance testing uses the surface performance confirmation building and associated equipment.

Function 4.14 - Mining. The underground facilities are excavated using tunnel-boring machines for long straight runs and drill-and-blast mining for short runs or drifts that are not circular in cross-section. Roof bolting will be installed as needed.

The shafts, ramps and common areas will be developed during the initial construction of the repository. Then, after the start of operations, the ventilation drifts, common areas, and emplacement panels will be extended as necessary for emplacement of the wastes.

The current reference waste emplacement concept calls for vertical boreholes in the floor of the emplacement rooms (drifts). The vertical emplacement boreholes will be drilled by a two-pass procedure. First, a pilot hole will be drilled and then the hole will be reamed to final diameter. The excavated tuff will be transported to the surface by a combination of load/haul/dump units and conveyors.

An alternative borehole emplacement concept, under consideration but not described here, is based on **horizontal borehole emplacement** in the sides of drifts.

Function 4.15 - Final Waste Isolation. After the caretaker period closure of the repository will use the same rock transfer equipment as was used for conveying the rock out of the underground facilities. In addition, rock grading and crushing equipment will be used at the surface for preparing rock of the proper size for the closure, and mechanical and pneumatic compactors

will be used for placing fill in the drifts. Drift, shaft and ramp seals will be made with normal concrete placement equipment and procedures.

4.3.2 Level 2 Physical Description

The Waste Handling Building

The Waste Handling Building (WHB) is scheduled to receive and handle 3000 MTU of intact spent fuel assembly wastes from the reactors and 400 MTU equivalent of HLW per year. It will operate 24 hours per day, 5 days per week and 250 days per year for all primary functions (unloading shipments, processing wastes, and loading waste transporters). Shipments will be accepted 7 days per week, 365 days per year.

Table 4.20 contains general descriptions of the waste packages handled by this WHB.

The major process equipment needed for the WHB is listed in Table 4.21. This table contains the functional description reference numbers, equipment titles, equipment functions, number of equipment items, equipment size or capacity, and location information. The equipment is listed in this table by functional description reference number. Table 4.22 lists the information in Table 4.21 by equipment item to show the number of functions for which each equipment item is used.

The Repository Underground Facilities

The tuff repository is scheduled to emplace 3000 MTU of spent fuel wastes directly from reactors and 400 MTU equivalent of HLW per year. It will operate 24 hours per day, 5 days per week and 250 days per year for emplacing wastes.

Table 4.23 provides general characteristics of the repository underground facilities. This information consists primarily of a list of facilities and general characteristics (areas, general design, functions, etc.).

The major process equipment needed for the underground activities is listed in Table 4.24. This table contains the functional description reference numbers, equipment titles, equipment functions, number of equipment items, equipment size or capacity, and location information. The equipment is listed in that table by functional description reference number.

Repository-Only Case

TABLE 4.20. Wastes Handled at the Repository WHB(a)

Facility Location	Location Symbol ^(b)	Contents	Contents Symbol ^(c)	Canister and/or Contents Symbol ^(c)	Wastes Considered in Current Studies
Cask Unloading Area and Cask Unloading Cell Input	A to E (from reactors)	One PWR SFA	SFA_P	SFA_P	x
		One BWR SFA	SFA_B	SFA_B	x
		Rods from SFAs	CON_P CON_B	AR9_CON_P AR6_CON_B	
		Hardware from consolidated SFAs	NFB_P NFB_B	AR9_NFB_P AR6_NFB_B	
		Miscellaneous wastes	GTC_P GTC_B	AR9_GTC_P AR6_GTC_B	
		Canistered SFAs	SFA_P SFA_B	AR9_SFA_P AR6_SFA_B	
	A to E (from other facilities)	Other reactor SFAs	SFA_O	OU_SFA_O	
		Other facility miscellaneous wastes	GTC_O	OU_GTC_O	
	A to E (from reprocessing plants)	Commercial HLW (West Valley)	HLW_W	CRP_HLW_W	x
		Defense HLW	HLW_D	CRP_HLW_D	x
Cask Unloading Cell to Repository	E	PWR SFAs	SFA_P	Y28BP_SFA_BP Y2814_SFA_P	x x
		BWR SFAs	SFA_B	Y28BP_SFA_BP Y28110_SFA_B	x x
		Rods from SFAs consolidated at-reactor	CON_P CON_B	Y2814_AR9CON_P Y2819_AR6CON_B	
		Hardware from SFAs consolidated at-reactor	NFB_P NFB_B	Y2814_AR9NFB_P Y2819_AR6NFB_B	
		Miscellaneous at-reactor wastes	GTC_P	Y2814_AR9GTC_P Y2819_AR6GTC_B	
		At-reactor canistered SFAs	SFA_P SFA_B SFA_O	Y2814_ARSFA_P Y2819_AR6SFA_B Y28C_OUSFA_O	
		Miscellaneous wastes from MRS	GTC_M GTC_M	Y28C_MCDRMGTC_M Y28C_MCGTC_M	
		Miscellaneous repository wastes	GTC_R	Y28C_GTC_R	
		Miscellaneous wastes from other facilities	GTC_O	Y28C_OGTC_O	
		West Valley HLW	HLW_W	Y26C_CRPHLW_W	x
		Defense HLW	HLW_D	Y26C_CRPHLW_D	x

(a) See Table 4.1 for description of wastes.

(b) Locations on Figures 4.18 and 4.19, which show the related process functions.

(c) See Appendix A for explanation of symbols.

TABLE 4.21. Major Waste Handling Equipment for the WHB - Listed in Process Step Order

Function Reference Number	Equipment Title	Equipment Identification (a)	Function/Activity	Number of Units	Size or Capacity	Equipment Locations (b)
4.1	Onsite Drive Unit	37	Connect to train cars	2	8 Railcars	L
4.2.1	Onsite Drive Unit	37	Move train cars to holding area	2	8 Railcars	L
4.2.2	Car Puller	1	Move vehicles in waste handling building	3	10,000 lb	A,B
	Onsite Drive Unit	37	Move casks and cars to dispatch holding area	2	8 Railcars	A to L
	Onsite Drive Unit	37	Make up shipment train	2	8 Railcars	L
4.4.1.1	Onsite Drive Unit	37	Move casks and cars to washdown area	2	8 Railcars	L to A
4.4.1.2	Car Puller	1	Move vehicles inside waste handling building	3	10,000 lb	A,B
	Airlock Bridge Crane	2	Remove impact limiters tiedowns and personnel barriers, perform radiological surveys	2	5 ton	A
4.4.1.3	Bridge Crane	3	Move casks from vehicles to cask carts	2	200 ton	B to C
	Cask Cart	4	Receive cask	7	200 ton	C
4.4.1.4	Cask Service Platform	5	Support personnel during work on cask tops	7	--	C
	Jib Crane	6	Move cask outer lid to service pad	3	10 ton	C
	Floor-Mounted Robot	7	Remote work on cask tops	3	1 ton	C
4.4.1.5	Floor-Mounted Robot	7	Remote work on cask tops	3	1 ton	C
4.4.1.6	Cask Contamination Barrier Adaptor	8	Installed to provide connection between cask top and cask contamination barrier	30	1 cask	C
	Jib Crane	6	Install contamination barrier adaptor	3	10 ton	C
4.4.1.7	Cask Cart	4	Move cask to unloading room	7	200 ton	C to D
	Cask Contamination Barrier	9	Installed to provide connection between cask top and process cell port	7	1 Cask	D

TABLE 4.21. (contd)

Function Reference Number	Equipment Title	Equipment Identification (a)	Function/Activity	Number of Units	Size or Capacity	Equipment Locations (b)
4.4.1.8	Cask Unloading Cell Shield Plug	10	Provide shielding in cask unloading cell port. Removed to permit cask unloading	7	1 Port	E
	Cask Shadow Shield	11	Installed to shield preparation area when cask unloading cell port plug is out	7	--	D
	Cask Unloading Cell Bridge Crane	12	Remove cask unloading cell port plugs, remove cask inner lid	3	20 ton	E
4.4.2	Cask Shadow Shield	11	Shields preparation area when cask unloading cell port plug is out	7	--	D
	Lag Storage Covers	13	Ventilation cover on lag storage, removed and replaced during waste transfers into storage	18	--	E
	Cask Unloading Cell Bridge Crane	12	Remove and replace lag storage covers, inspect and remove cask contents and transfer contents to lag storage or next process step	3	20 ton	E
4.4.3.1	Cask Unloading Cell Bridge Crane	12	Inspect cask interior, replace cask inner lid and cask unloading cell port plugs	3	20 ton	E
	Cask Unloading Cell Shield Plug	10	Installed to provide shielding in cask unloading cell port	7	1 Port	E
4.4.3.2	Cask Contamination Barrier	9	Removed to eliminate connection between cask top and cask unloading cell port	7	1 Cask	D
	Cask Shadow Shield	11	Retracted to permit cask movement	7	--	D
	Cask Cart	4	Move cask to preparation room	7	200 ton	D to C
4.4.3.3	Cask Service Platform	5	Support personnel during work on cask tops	7	--	C
	Jib Crane	6	Remove contamination barrier adaptor	3	10 ton	C

TABLE 4.21. (contd)

Function Reference Number	Equipment Title	Equipment Identification (a)	Function/Activity	Number of Units	Size or Capacity	Equipment Locations (b)
4.4.3.3	Cask Contamination Barrier Adaptor	8	Removed from cask	30	1 Cask	C
	Floor Mounted Robot	7	Remote work on cask tops	3	1 ton	C
	Decontamination Station	14	Decontaminate cask	2	1 Cask	C
	Bridge Crane	3	Move cask to decontamination station	3	200 ton	C
4.4.3.4	Floor Mounted Robot	7	Remote work on cask top	3	1 ton	C
	Jib Crane	6	Move cask outer lid to cask	3	10 ton	C
4.4.3.5	Bridge Crane	3	Move cask to transport vehicle	2	200 ton	C to B
	Onsite Drive Unit	37	Move casks and cars to support services facilities	2	8 Railcars	A
4.4.3.6	Airlock Bridge Crane	2	Install impact limiters and cask tiedowns	2	5 ton	A
	Car Puller	1	Move vehicles in waste handling buildings	3	10,000 lb.	A,B
4.4.4	Onsite Drive Unit	37	Move loaded vehicle to holding area	2	8 Railcars	A to L
4.5	Lag Storage Covers	13	Remove and replace when wastes are moved out of lag storage	18	--	E
	Cask Unloading Cell Bridge Crane	12	Remove and replace lag storage covers, move waste in and out of lag storage	3	20 ton	E
4.6.3	Cask Unloading Cell Bridge Crane	12	Move clean containers to weld station, move waste to weld station	3	20 ton	E
	Container Supply System	21	Move clean containers into unloading hot cell	3	1 Container	E
	Lag Storage Covers	13	Removed and replaced for waste removal from storage	18	--	E

TABLE 4.21. (contd)

Function Reference Number	Equipment Title	Equipment Identification (a)	Function/Activity	Number of Units	Size or Capacity	Equipment Locations (b)
4.82	4.6.4.1 Container Lid Supply System	23	Supply and handle container lids in cells	3	1 Lid	E
	Welding Module	24	Weld lids on containers	3	1 Container	E
	Master Slave Manipulator	25	Equipment operation and maintenance	7	TBD	E
	4.6.4.2 Cask Unloading Cell Bridge Crane	12	Move container to weld inspection station	3	20 ton	E
	4.6.4.3 Weld Inspection System	27	Inspect welds	3	1 Container	E
	4.6.4.4 Cask Unloading Cell Bridge Crane	12	Move container to leak test station	3	20 ton	E
	4.6.4.5 Leak-Test Station	28	Leak-test containers	3	1 Container	E
	4.6.4.6 Cask Unloading Cell Bridge Crane	12	Move container to decontamination chamber	3	20 ton	E
	4.6.4.7 Decontamination Chamber	26	Decontaminate containers	3	1 Container	E
	4.6.4.8 Decontamination Chambers	26	Move wastes to inspection cell	3	1 Container	E to F
	4.6.4.9 Decontamination Chambers	26	Rotate container during swabbing	3	1 Container	F
	4.6.4.10 Cask Unloading Cell Bridge Crane	12	Move container between process stations	3	20 ton	E
	Master Slave Manipulators	25	Equipment operation and maintenance	7	TBD	E
	Welding Module	24	Repair defective welds	3	1 Container	E
	4.7.1.1 Inspection Cell Bridge Crane	31	Transfer containers to transfer carts	2	5 ton	F
	Transfer Cart	33	Receive containers	4	12.5 MT	F

TABLE 4.21. (contd)

Function Reference Number	Equipment Title	Equipment Identification (a)	Function/Activity	Number of Units	Size or Capacity	Equipment (b) Locations
4.7.1.2	Transfer Cart	33	Move containers from inspection cell to waste package storage vault	4	12.5 MT	F to I
4.7.1.3	Surface Storage Vault Entrance Port Plugs	34	Removed and replaced to permit waste transfers	7	1 Port	J
	Container Transfer Machine	35	Remove and replace storage vault area port plugs, move containers between container transfer carts and storage positions	2	1 Container	J
	Vault Storage Position plugs	36	Removed and replaced to permit waste transfers	270	1 Port	J
4.7.3	Surface Storage Vault Entrance Port Plugs	34	Removed and replaced to permit waste transfers	4	1 Port	J
	Container Transfer Machine	35	Remove and replace storage vault area port plugs, move containers between storage positions and container transfer carts	2	1 Container	J
	Vault Storage Position plugs	36	Removed and replaced to permit waste transfers	270	1 Port	J

(a) Equipment identification included as an aid to equipment cost and utilization studies.

(b) Letters are locations on Figures 4.16, 4.18, and 4.19.

TABLE 4.22. Major Waste Handling Equipment for the WHB - Listed by Equipment Item

Equipment Title	Equipment Identification (a)	Function Reference Number	Function/Activity	Number of Units	Size or Capacity	Equipment Locations (b)
Car Puller	1	4.2.2	Move vehicles in waste handling building	3	10,000 lb	A,B
		4.4.1.2	Move vehicles inside waste handling building			A,B
		4.4.3.6	Move vehicles in waste handling buildings			A,B
Airlock Bridge Crane	2	4.4.1.2	Remove impact limiters tiedowns and personnel barriers, perform radiological surveys	2	5 ton	A
		4.4.3.6	Install impact limiters and cask tiedowns			A
Bridge Crane	3	4.4.1.3	Move casks from vehicles to cask carts	2	200 ton	B to C
		4.4.3.3	Move cask to decontamination station			C
		4.4.3.5	Move cask to transport vehicle			C to B
Cask Cart	4	4.4.1.3	Receive cask	7	200 ton	C
		4.4.1.7	Move cask to unloading room			C to D
		4.4.3.2	Move cask to preparation room			D to C
Cask Service Platform	5	4.4.1.4	Support personnel during work on cask tops	7	--	C
		4.4.3.3	Support personnel during work on cask tops			C
Jib Crane	6	4.4.1.4	Move cask outer lid to service pad	3	10 ton	C
		4.4.1.6	Install contamination barrier adaptor			C
		4.4.3.3	Remove contamination barrier adaptor			C
		4.4.3.4	Move cask outer lid to cask			C

TABLE 4.22. (contd)

<u>Equipment Title</u>	<u>Equipment Identification (a)</u>	<u>Function Reference Number</u>	<u>Function/Activity</u>	<u>Number of Units</u>	<u>Size or Capacity</u>	<u>Equipment Locations (b)</u>
Floor-Mounted Robot	7	4.4.1.4	Remote work on cask tops	3	1 ton	C
		4.4.1.5	Remote work on cask tops			C
		4.4.3.3	Remote work on cask tops			C
		4.4.3.4	Remote work on cask tops			C
Cask Contamination Barrier Adaptor	8	4.4.1.6	Installed to provide connection between cask top and cask contamination barrier	30	1 cask	C
		4.4.3.3	Removed from cask			C
Cask Contamination Barrier	9	4.4.1.7	Installed to provide connection between cask top and process cell port	5	1 Cask	D
		4.4.3.2	Removed to eliminate connection between cask top and cask unloading cell port			D
Cask Unloading Cell Shield Plug	10	4.4.1.8	Provide shielding in cask unloading cell port. Removed to permit cask unloading	7	1 Port	E
		4.4.3.1	Installed to provide shielding in cask unloading cell port			E
Cask Shadow Shield	11	4.4.1.8	Installed to shield preparation area when cask unloading cell port plug is out	7	--	D
		4.4.2	Shields preparation area when cask unloading cell port plug is out			D
		4.4.3.2	Retracted to permit cask movement			D
Cask Unloading Cell Bridge Crane	12	4.4.1.8	Remove cask unloading cell port plugs, remove cask inner lid	3	20 ton	E
		4.4.2	Remove and replace lag storage covers, inspect and remove cask contents and transfer contents to lag storage or next process step			E

TABLE 4.22. (contd)

<u>Equipment Title</u>	<u>Equipment Identification (a)</u>	<u>Function Reference Number</u>	<u>Function/Activity</u>	<u>Number of Units</u>	<u>Size or Capacity</u>	<u>Equipment Locations (b)</u>
Cask Unloading Cell Bridge Crane (contd)	12	4.4.3.1	Inspect cask interior, replace cask inner lid and cask unloading cell port plugs	3	20 ton	E
		4.5	Remove and replace lag storage covers, move waste in and out of lag storage			E
		4.6.3	Move clean containers to weld station, move waste to weld station			E
		4.6.4.2	Move container to weld inspection station			E
		4.6.4.4	Move container to leak test station			E
		4.6.4.6	Move container to decontamination chamber			E
		4.6.4.10	Move container between process stations			F
Lag Storage Covers	13	4.4.2	Ventilation cover on lag storage, removed and replaced during waste transfers into storage	18	--	E
		4.5	Remove and replace when wastes are moved out of lag storage			E
		4.6.3	Removed and replaced for waste removal from storage			E
Decontamination Station	14	4.4.3.3	Decontaminate cask	2	1 Cask	C
Container Supply System	21	4.6.3	Move clean containers into unloading hot cell	3	1 Container	E
Container Lid Supply System	23	4.6.4.1	Supply and handle container lids in cells	3	1 Lid	E
Welding Module	24	4.6.4.1	Weld lids on containers	3	1 Container	E
		4.6.4.10	Repair defective welds			E

TABLE 4.22. (contd)

<u>Equipment Title</u>	<u>Equipment Identification (a)</u>	<u>Function Reference Number</u>	<u>Function/Activity</u>	<u>Number of Units</u>	<u>Size or Capacity</u>	<u>Equipment Locations (b)</u>
Master Slave Manipulator	25	4.6.4.1	Equipment operation and maintenance	7	TBD	E
		4.6.4.10	Equipment operation and maintenance			E
Decontamination Chamber	26	4.6.4.7	Decontaminate containers	3	1 Container	E
		4.6.4.8	Move wastes to inspection cell			E to F
		4.6.4.9	Rotate container during swabbing			F
Weld Inspection System	27	4.6.4.3	Inspect welds	3	1 Container	E
Leak-Test Station	28	4.6.4.5	Leak-test containers	3	1 Container	E
Inspection Cell Bridge Crane	31	4.7.1.1	Transfer containers to transfer carts	2	5 ton	F
Transfer Cart	33	4.7.1.1	Receive containers	4	12.5 MT	F
		4.7.1.2	Move containers from inspection cell to waste package storage vault			F to I
Surface Storage Vault Entrance Port Plugs	34	4.7.1.3	Removed and replaced to permit waste transfers	4	1 Port	J
		4.7.3	Removed and replaced to permit waste transfers			J
Container Transfer Machine	35	4.7.1.3	Remove and replace storage vault area port plugs, move containers between container transfer carts and storage positions	2	1 Container	J
		4.7.3	Remove and replace storage vault area port plugs, move containers between storage positions and container transfer carts			J

TABLE 4.22. (contd)

<u>Equipment Title</u>	<u>Equipment Identification (a)</u>	<u>Function Reference Number</u>	<u>Function/Activity</u>	<u>Number of Units</u>	<u>Size or Capacity</u>	<u>Equipment Locations (b)</u>
Vault Storage Position plugs	36	4.7.1.3	Removed and replaced to permit waste transfers	270	1 Port	J
		4.7.3	Removed and replaced to permit waste transfers			J
Onsite Drive Unit	37	4.1	Connect to train cars	2	8 Railcars	L
		4.2.1	Move train cars to holding area			L
		4.2.2	Move casks and cars to dispatch holding area			A to L
		4.2.2	Make up shipment train			L
		4.4.1.1	Move casks and cars to washdown area			L to A
		4.4.3.5	Move casks and cars to support services facilities			A
		4.4.4	Move loaded vehicle to holding area			A to L

(a) Equipment identification included as an aid to equipment cost and utilization studies.

(b) Letters are locations on Figures 4.16, 4.18, and 4.19.

TABLE 4.23. Repository Underground Excavations for Vertical Borehole Storage

Facility Title	Number	Function/Activity	Geometry	Approximate Internal Dimensions (ft)					
				Vertical Boreholes			Horizontal Boreholes		
				Width	Height	Length	Width	Height	Length
Waste Ramp	1	Transport waste to and from repository. Ventilation for emplacement area	Inverted U	21	16	6,603	19	13.67	6,603
Tuff Ramp	1	Transport tuff to and from repository. Ventilation exhaust for development area	Inverted U	24	21	4,627	20	16	4,627
Men-and-Materials Shaft	1	Personnel and materials transportation utility route. Ventilation exhaust for emplacement area	Round	20	20	1,090	20	20	1,090
Emplacement Area Exhaust Shaft	1	Ventilation exhaust for emplacement area	Round	20	20	1,030	20	20	1,030
Exploratory Shaft 1	1	Ventilation intake for emplacement area	Round	12	12	1,480	12	12	1,480
Exploratory Shaft 2	1	Ventilation intake for emplacement area	Round	6	6	1,020	6	6	1,020
Waste Main	1	Waste transport ventilation intake for emplacement area. Transport of wastes	Round	24	21.5	9,120	20	15.25	9,120
Tuff Main	1	Tuff transport. Ventilation exhaust for development area	Inverted U	24	18.5	9,120	24	18.5	9,120
Service Main	1	Personnel access to development area. Ventilation intake to development area	Inverted U	24	14.5	9,120	24	14.5	9,120
Panel Access Drifts		Access to emplacement drifts	Inverted U	24	13.5	85,350	20	13.5	85,350
Emplacement Drifts		Access to emplacement boreholes	Inverted U	15	21.5	401,480	22	12.5	75,260
Perimeter Drift	1	Ventilation exhaust for emplacement area	Round	22	20.83	26,550	22	20.83	26,550
Midpanel Drift		Ventilation control for emplacement panels	Round	15	13.5	37,750	--	--	0
Shop Areas		Maintenance, administration and personnel facilities for underground operations	Inverted U	25	Varies	2,400	25	Varies	2,400

TABLE 4.24. Major Process Equipment for Waste Emplacement at the Repository - Listed in Process Step Order

Function Reference Number	Equipment Title	Equipment Identification (a)	Function/Activity	Number of Units	Size or Capacity	Locations (Figure Number)
4.11.1.1	Waste Transporter	58	Connected to vault entrance port, transporter gate opened	TBD	1 container	4.18
	Surface Storage Vault Entrance Port Plugs	34	Removed to permit waste transfers	5	1 port	4.18
4.11.1.2	Waste Transporter	58	Lifts wastes out of transfer cart and loads it into transporter	TBD	1 container	4.18
	Surface Storage Vault Entrance Port Plugs	34	Replaced to provide shielding	5	1 port	4.18
4.12.1.1	Waste Transporter	58	Transport waste to waste ramp	TBD	1 Container	4.25
4.12.1.2	Waste Transporter	58	Transport waste to underground borehole	TBD	1 Container	4.27
4.12.1.3	Waste Transporter	58	Insert container into borehole	TBD	1 Container	4.28
	Temporary Borehole Shield Closure	56	Opened and closed during container placement in boreholes	TBD	1 Borehole	4.26, 4.27
4.12.1.4	Waste Transporter	58	Moved to waste handling building, performance confirmation building or holding area	TBD	1 Container	4.15, 4.20
4.12.1.5	Borehole Forklift	57	Transport borehole equipment	TBD		4.27
	Shield Plug	59	Provide shielding in boreholes	1 per Borehole	1 Borehole	4.29
	Shield Plug Installer	60	Install shield plugs in boreholes	TBD	1 Plug	4.29
	Temporary Borehole Shield Closure	56	Removed from borehole	TBD	1 Borehole	4.27
	Borehole Cover	61	Installed on borehole to provide borehole seal	1 per Borehole	1 Borehole	4.24

TABLE 4.24. (contd)

Function Reference Number	Equipment Title	Equipment Identification (a)	Function/Activity	Number of Units	Size or Capacity	Locations (Figure Number)
4.12.3	Borehole Cover	61	Removed and later replaced to permit access to borehole	1 per Borehole	1 Borehole	4.24
	Temporary Borehole Shield Closure	56	Installed to permit access to borehole during waste removal, then removed	1 per Borehole	1 Borehole	4.27
	Borehole Forklift	57	Transport borehole equipment	TBD		4.27
	Shield Plug Installer	60	Removes and later replaces shield plugs	TBD	1 Plug	4.27
	Shield Plug	59	Removed to permit access to wastes	TBD	1 Borehole	4.27
	Waste Transporter	58	Retrieves waste containers. Transports them to performance confirmation building.	TBD	1 Container	4.15, 4.22
4.14.1.1	25-ft-Diameter Tunnel-Boring Machine	38	Excavate tunnels and rooms	1	25 ft	4.15, 4.22
	23-ft-Diameter Tunnel-Boring Machine	39	Excavate tunnels and rooms	1	23 ft	4.15, 4.22
	Conveyor Belt System	40	Excavate tunnels and rooms	1		4.15, 4.22
	Conveyor Belt System	41	Excavate tunnels and rooms	2		4.22, 4.23
	Concrete Truck	42	Carry concrete for paving tunnels and rooms	3	5 yd ³	4.15, 4.22
	Concrete-Paving Spreader	43	Pave tunnels and rooms	2		4.15, 4.22
	Feeder/Breaker	44	Excavate tunnels and rooms	4		4.15, 4.22
	Drill Jumbo	45	Excavate tunnels and rooms	4	2 Boom	4.15, 4.22
	Anfo-Loading Truck	46	Excavate tunnels and rooms	4		4.15, 4.22
	Load/Haul/Dump Unit	47	Excavate tunnels and rooms	4	5 yd ³	4.15, 4.22
	Roof-Bolting Machine	48	Construct tunnels and rooms	5	3 Boom	4.15, 4.22, 4.23
	Scaling Machine	49	Construct tunnels and rooms	4	1 Pick	4.15, 4.22, 4.23
	Shotcrete Truck	50	Line tunnels and rooms	5		4.15, 4.22, 4.23

TABLE 4.24. (contd)

Function Reference Number	Equipment Title	Equipment Identification (a)	Function/Activity	Number of Units	Size or Capacity	Locations (Figure Number)
4.92	4.14.1.2 Concrete Truck	42	Line emplacement drifts and rooms	3	5 yd ³	4.23
	Feeder/Breaker	44	Excavate emplacement drifts and rooms	4		4.23
	Drill Jumbo	45	Excavate emplacement drifts and rooms	4	2 Boom	4.23
	Anfo-Loading Truck	46	Excavate emplacement drifts and rooms	4		4.23
	Load/Haul/Dump Unit	47	Excavate emplacement drifts and rooms	4	5 yd ³	4.23
	Roof-Bolting Machine	48	Excavate emplacement drifts and rooms	5	3 Boom	4.23
	Scaling Machine	49	Excavate emplacement drifts and rooms	4	1 Pick	4.23
	Shotcrete Truck	50	Line emplacement drifts and rooms	3		4.23
	Conveyor Belt System	51	Excavate emplacement drifts and rooms	10		4.23
	4.14.2.1 Pilot Hole Drill	52	Drill pilot holes for vertical boreholes	5	11 in.	4.23
	Reamer Drill	53	Ream vertical boreholes to final diameter	7	29 in.	4.23
	Load/Haul/Dump Unit	47	Convey tuff to conveyors	10	5 yd ³	4.23
	Conveyor Belt System	40	Excavate boreholes	1		4.23
	Conveyor Belt System	41	Excavate boreholes	2		4.23
	Conveyor Belt System	51	Convey tuff to tuff main	10		4.23
	4.14.2.2 Support Plate	54	Supports waste container in vertical boreholes	1 per borehole	1 Borehole	4.24
	Vertical Borehole Liner to prevent rock fall	55 borehole	Line upper portion of vertical boreholes	1 per	36 in.	4.24
	Temporary Borehole Shield Closure	56	Provide shielding during waste emplacement in boreholes	TBD	1 Borehole	4.26, 4.27
	Borehole Forklift	57	Transport borehole equipment	TBD		4.26, 4.27
	4.14.3.1 Conveyor Belt System	51	Convey tuff to tuff main	10		4.23
	Conveyor Belt System	41	Convey tuff through tuff main	2		4.22, 4.23
	Conveyor Belt System	40	Convey tuff up tuff ramp	1		4.15, 4.22

TABLE 4.24. (contd)

Function Reference Number	Equipment Title	Equipment Identification (a)	Function/Activity	Number of Units	Size or Capacity	Locations (Figure Number)
4.15	Rock Excavator	62	Excavate tuff in tuff pile	1		4.15
	Conveyor Belt	63	Convey excavated tuff to grinding equipment	1		4.15
	Grinding Equipment	64	Grind tuff	1		4.15
	Sorting Equipment	65	Sort ground tuff by size	1		4.15
	Conveyor Belt System	40	Convey tuff to underground facilities	1		4.15
	Conveyor Belt System	41	Convey tuff to underground facilities	1		4.15, 4.22
	Conveyor Belt System	51	Convey tuff in emplacement drifts	10		4.23
	Load/Haul/Dump Unit	47	Convey tuff underground	TBD	5 yd ³	4.15
	Bulldozers	66	Move tuff underground	TBD		4.15
	Pneumatic Backfillers	67	Emplace tuff underground	TBD		4.15
	Vibratory Rollers	68	Compact tuff underground	TBD		4.15
	Concrete Truck	42	Carry concrete for seal work	2	5 yd ³	4.15
	Bulldozers	66	Demolish structures and level site	TBD		4.15
	Trucks	69	Transport waste materials to disposal pit	TBD		4.15
	Excavators	70	Excavate disposal pits	TBD		4.15
	Drill Jumbo	45	Drill concrete for demolition	TBD	2 Boom	4.15
	Rippers	71	Destroy roads and other surface structures	TBD		4.15
	Load/Haul/Dump Unit	47	Transport waste materials and load into trucks	TBD	5 yd ³	4.15

(a) Equipment identification included as an aid to equipment cost and utilization studies.

Table 4.25 lists the information in Table 4.24 by equipment item to show the number of functions for which each equipment item is used.

Table 4.26 lists general design characteristics of the repository.

TABLE 4.25. Major Process Equipment for Waste Emplacement at the Repository - Listed by Equipment Item

<u>Equipment Title</u>	<u>Equipment (a) Identification</u>	<u>Function Reference Number</u>	<u>Function/Activity</u>	<u>Number of Units</u>	<u>Size or Capacity</u>	<u>Locations (Figure Number)</u>
Surface Storage Vault Entrance Port Plugs	34	4.11.1.1	Removed to permit waste transfers	5	1 port	4.18
		4.2.8	Replaced to provide shielding			4.18
		4.2.8	Replaced to provide shielding	5	1 port	4.18
25-ft-Diameter Tunnel- Boring Machine	38	4.14.1.1	Excavate tunnels and rooms	1	25 ft	4.15, 4.22
23-ft-Diameter Tunnel- Boring Machine	39	4.14.1.1	Excavate tunnels and rooms	1	23 ft	4.15, 4.22
Conveyor Belt System	40	4.14.1.1	Excavate tunnels and rooms	1		4.15, 4.22
		4.14.2.1	Excavate boreholes	1		4.23
		4.14.3.1	Convey tuff up tuff ramp	1		4.15, 4.22
		4.15	Convey tuff to underground facilities	1		4.15
Conveyor Belt System	41	4.14.1.1	Excavate tunnels and rooms	2		4.22, 4.23
		4.14.2.1	Excavate boreholes	2		4.23
		4.14.3.1	Convey tuff through tuff main	2		4.22, 4.23
		4.15	Convey tuff to underground facilities	1		4.15, 4.22
Concrete Truck	42	4.14.1.1	Carry concrete for paving tunnels and rooms	3	5 yd ³	4.15, 4.22
		4.14.1.2	Line emplacement drifts and rooms	3	5 yd ³	4.23
		4.15	Carry concrete for seal work	2	5 yd ³	4.15
Concrete-Paving Spreader	43	4.14.1.1	Pave tunnels and rooms	2		4.15, 4.22
Feeder/Breaker	44	4.14.1.1	Excavate tunnels and rooms	4		4.15, 4.22
		4.14.1.2	Excavate emplacement drifts and rooms	4		4.23
Drill Jumbo	45	4.14.1.1	Excavate tunnels and rooms	4	2 Boom	4.15, 4.22
		4.14.1.2	Excavate emplacement drifts and rooms	4	2 Boom	4.23

TABLE 4.25. (contd)

<u>Equipment Title</u>	<u>Equipment (a) Identification</u>	<u>Function Reference Number</u>	<u>Function/Activity</u>	<u>Number of Units</u>	<u>Size or Capacity</u>	<u>Locations (Figure Number)</u>
Drill Jumbo (contd)	45	4.15	Drill concrete for demolition	TBD	2 Boom	4.15
Anfo-Loading Truck	46	4.14.1.1	Excavate tunnels and rooms	4		4.15, 4.22
		4.14.1.2	Excavate emplacement drifts and rooms	4		4.23
Load/Haul/Dump Unit	47	4.14.1.1	Excavate tunnels and rooms	4	5 yd ³	4.15, 4.22
		4.14.1.2	Excavate emplacement drifts and rooms	4	5 yd ³	4.23
		4.14.2.1	Convey tuff to conveyors	10	5 yd ³	4.23
		4.15	Convey tuff underground	TBD	5 yd ³	4.15
		4.15	Transport waste materials and load into trucks	TBD	5 yd ³	4.15
Roof-Bolting Machine	48	4.14.1.1	Construct tunnels and rooms	5	3 Boom	4.15, 4.22, 4.23
		4.14.1.2	Excavate emplacement drifts and rooms	5	3 Boom	4.23
Scaling Machine	49	4.14.1.1	Construct tunnels and rooms	4	1 Pick	4.15, 4.22, 4.23
		4.14.1.2	Excavate emplacement drifts and rooms	4	1 Pick	4.23
Shotcrete Truck	50	4.14.1.1	Line tunnels and rooms	5		4.15, 4.22, 4.23
		4.14.1.2	Line emplacement drifts and rooms	3		4.23
Conveyor Belt System	51	4.14.1.2	Excavate emplacement drifts and rooms	10		4.23
		4.14.2.1	Convey tuff to tuff main	10		4.23
		4.14.3.1	Convey tuff to tuff main	10		4.23
		4.15	Convey tuff in emplacement drifts	10		4.23
Pilot Hole Drill	52	4.14.2.1	Drill pilot holes for vertical boreholes	5	11 in.	4.23
Reamer Drill	53	4.14.2.1	Ream vertical boreholes to final diameter	7	29 in.	4.23
Support Plate	54	4.14.2.2	Supports waste container in vertical boreholes	1 per borehole	1 Borehole	4.24
Vertical Borehole Liner	55	4.14.2.2	Line upper portion of vertical boreholes to prevent rock fall borehole	1 per	36 in.	4.24

TABLE 4.25. (contd)

Equipment Title	Equipment (a) Identification	Function Reference Number	Function/Activity	Number of Units	Size or Capacity	Locations (Figure Number)
Temporary Borehole Shield Closure	56	4.12.1.3	Opened and closed during container placement in boreholes	TBD	1 Borehole	4.26, 4.27
		4.12.1.5	Removed from borehole	TBD	1 Borehole	4.27
		4.12.3	Installed to permit access to borehole during waste removal, then removed	1 per Borehole	1 Borehole	4.27
		4.14.2.2	Provide shielding during waste emplacement in boreholes	TBD	1 Borehole	4.26, 4.27
Borehole Forklift	57	4.12.1.5	Transport borehole equipment	TBD		4.27
		4.12.3	Transport borehole equipment	TBD		4.27
		4.14.2.2	Transport borehole equipment	TBD		4.26, 4.27
Waste Transporter	58	4.11.1.1	Connected to vault entrance port, transporter gate opened	TBD	1 container	4.18
		4.11.1.2	Lifts wastes out of transfer cart and loads it into transporter	TBD	1 container	4.18
		4.12.1.1	Transport waste to waste ramp	TBD	1 Container	4.25
		4.12.1.2	Transport waste to underground borehole	TBD	1 Container	4.27
		4.12.1.3	Insert container into borehole	TBD	1 Container	4.28
		4.12.1.4	Moved to waste handling building, performance confirmation building or holding area	TBD	1 Container	4.15, 4.22
		4.12.3	Retrieves waste containers. Transports them to performance confirmation building.	TBD	1 Container	4.15, 4.22
Shield Plug	59	4.12.1.5	Provide shielding in boreholes	1 per Borehole	1 Borehole	4.29
		4.12.3	Removed to permit access to wastes	TBD	1 Borehole	4.27
Shield Plug Installer	60	4.12.1.5	Install shield plugs in boreholes	TBD	1 Plug	4.29
		4.12.3	Removes and later replaces shield plugs	TBD	1 Plug	4.27

TABLE 4.25. (contd)

<u>Equipment Title</u>	<u>Equipment (a) Identification</u>	<u>Function Reference Number</u>	<u>Function/Activity</u>	<u>Number of Units</u>	<u>Size or Capacity</u>	<u>Locations (Figure Number)</u>
Borehole Cover	61	4.12.1.5	Installed on borehole to provide borehole seal	1 per Borehole	1 Borehole	4.24
		4.12.3	Removed and later replaced to permit access to borehole	1 per Borehole	1 Borehole	4.24
Rock Excavator	62	4.15	Excavate tuff in tuff pile	1		4.15
Conveyor Belt	63	4.15	Convey excavated tuff to grinding equipment	1		4.15
Grinding Equipment	64	4.15	Grind tuff	1		4.15
Sorting Equipment	65	4.15	Sort ground tuff by size	1		4.15
Bulldozers	66	4.15	Move tuff underground	TBD		4.15
		4.15	Demolish structures and level site	TBD		4.15
Pneumatic Backfillers	67	4.15	Emplace tuff underground	TBD		4.15
Vibratory Rollers	68	4.15	Compact tuff underground	TBD		4.15
Trucks	69	4.15	Transport waste materials to disposal pit	TBD		4.15
Excavators	70	4.15	Excavate disposal pits	TBD		4.15
Rippers	71	4.15	Destroy roads and other surface structures	TBD		4.15

(a) Equipment identification included as an aid to equipment cost and utilization studies.

TABLE 4.26. Reference Repository Characteristics and Data

Reference emplacement configuration:	Vertical boreholes
Number of waste packages per borehole:	1
Reference thermal loading:	3.5 kW/package
Reference areal thermal load:	55.6 kW/acre ^(a)
Reference repository capacity:	70,000 MTU
Typical rock mining	
Total rock mining:	15,600,000 tons
Common area mining:	528,000 tons
Mining per package of intact fuel:	313 tons
Mining per package of consolidated fuel:	626 tons
Backfill fraction	0.76
Typical annual package emplacements:	
Intact fuel	1510
Consolidated fuel	0
Hardware	0
HLW	<u>800</u>
Total	2310

(a) Maximum for 10-yr-old PWR fuel. The limit for 10-yr-old BWR fuel is 50.3 kW/acre.

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APPENDIX A

ALPHANUMERIC SYMBOLS FOR IDENTIFICATION OF WASTE RECEPTACLES AND RADIOACTIVE WASTE MATERIALS

APPENDIX A

ALPHANUMERIC SYMBOLS FOR IDENTIFICATION OF WASTE RECEPTACLES AND RADIOACTIVE WASTE MATERIALS

The alphanumeric symbol system presented in this document has been developed to provide a standardized shorthand symbolic representation method for use in identifying the wastes, drums, canisters, containers and casks handled by the waste management system.

Because of the variety of waste types, canisters, containers and casks expected to be handled in the system, this unique identification system has been established to facilitate analyses and aid proper identification of the wastes, canisters, containers and casks during the analyses. Not all of the combinations of wastes, canisters and containers will necessarily be utilized in the deployed system. However, the ones not to be used cannot yet be identified and system modeling should consider all possibilities.

This appendix describes the symbols and the proposed uses for them. The symbols can be used for five purposes:

- a. to identify waste materials
- b. to identify waste receptacles (drums, canisters or containers)
- c. to identify the receptacles, plus the contained waste material
- d. to identify transportation and/or storage casks and any contained wastes
- e. to identify drywells, storage casks or vaults and contents.

These uses are described sequentially in the following sections.

A.1 IDENTIFICATION OF WASTE MATERIALS

Symbols that identify waste materials consist of a lead group of letters that defines the type of waste and a following group of letters that defines the source facility for the waste.

The lead three letter symbols are:

CON for consolidated SFA pins
 GTC for greater than class C waste other than non-fuel bearing components
 HLW for solidified high-level waste (in canisters)
 LLW for classes A, B and C wastes
 NFB for non-fuel bearing components
 SFA for spent fuel assemblies.

The following groups of letters for the sources are:

B for BWR
 BP for a combination of BWR and PWR
 D for defense
 M for Monitored Retrievable Storage
 O for other facility
 P for PWR
 R for repository
 W for West Valley

The resultant typical waste symbols include:

<u>Waste Description</u>	<u>Symbols</u>
Intact PWR SFA	SFA_P
Intact BWR SFA	SFA_B
A combination of intact BWR and PWR SFAs	SFA_BP
Other reactor intact SFA	SFA_O
Consolidated PWR fuel pins	CON_P
Consolidated BWR fuel pins	CON_B
PWR SFA NFBC	NFB_P
BWR SFA NFBC	NFB_B
PWR greater than class C wastes	GTC_P
BWR greater than class C wastes	GTC_B
Other facility greater than class C wastes	GTC_O
MRS greater than class C wastes	GTC_M
Repository greater than class C wastes	GTC_R
West Valley solidified high-level wastes	HLW_W
Defense solidified high-level wastes	HLW_D
West Valley reprocessing plant greater than class C wastes	GTC_W
Defense reprocessing plant greater than class C wastes	GTC_D
MRS class A, B and C wastes	LLW_M
Repository class A, B, and C wastes	LLW_R

A.2 IDENTIFICATION OF WASTE RECEPTACLES AND THE CONTAINED RADIOACTIVE WASTE MATERIALS

Symbols used in the identification of waste receptacles and the contained radioactive waste materials are described in the following subsections.

A.2.1 Identification of Waste Receptacles (Drums, Canisters, and Containers)

Symbols that identify a receptacle are read from left to right:

- a. The lead letters identify the basic design of the receptacle and in most cases infer a source:

AR means a power reactor plant canister

CAG means a cage for 55-gallon drums

CRP means a chemical reprocessing plant canister (either defense or West Valley)

DRM means a 55-gallon drum

OF means other facility canister

M means Monitored Retrievable Storage canister

Y means the Yucca Mountain candidate repository site container.

- b. The remainder of the symbol describes the general design of the receptacle. Definitions of the receptacle description symbols are presented in Table A.1, together with examples of typical contents for each receptacle. The receptacles are assumed to have the lengths defined in that table. Spacers may be used to fill the empty portion of the receptacle if the contents are shorter than the receptacle. Any of the symbols in the table may be added to the above lead group symbols to define a specific design. As an example, a YRBP lead group would mean a repository container designed to hold a mix of 4 BWR and 3 PWR fuel assemblies. Also, two of the receptacles definition symbols may be added to the lead symbol to obtain full definition of the receptacle. As an

TABLE A.1. Definition of Receptacle Description Symbols

Symbol	Storage Space Cross Section	Standard External Lengths (in.)			Typical Contents
		Reactor or Reprocessing Plant Canisters	MRS Canisters	Repository Containers	
6	6-in. square	180	--(a)	--(a)	1 BWR fuel assembly
9	9-in. square	180	--	--	1 PWR fuel assembly ^(b)
*26	26-in. D.D. container with 25 1/4-in. I.D.	--	--	126	HLW canister
*28	28-in. D.D. container with 27-1/4-in. I.D.	--	--	188	SFAs including insert or 26-in O.D. canister or 4 to 5 drums
C	A 26-in. O.D. cylindrical canister	--	--	188	Shredded metals or 4 to 5 drums
DRM	A 55-gallon drum	36	--	--	Shredded metals in drums
*H	A 24-in. O.D. canister with 23-1/4-in. I.D.	118	--	--	HLW
*BP	An insert with four - 6 x 6-in. and three - 9 x 9-in. spaces	--	--	188	4 intact BWR and 3 intact PWR fuel assemblies ^(b)
I4	An insert with four - 9 x 9-in. spaces	--	--	188	4 intact or canned PWR fuel assemblies ^(b)
I9	An insert with nine - 6 x 6-in. spaces	--	--	188	9 canned BWR assemblies
I10	An insert with ten - 6 x 6-in. spaces	--	--	188	10 intact BWR assemblies
U	Undefined ^(c)	TBD	TBD	TBD	Wastes yet to be defined

(a) Dashes mean that no canister or container in this category is used in this system concept.

(b) Excludes South Texas reactor fuel, which will need about 20-inch-longer canisters or containers.

(c) If the wastes can be placed in one of the other canisters or containers, that receptacle probably would be used.

* Indicates receptacles of primary interest in the current studies.

example, Y26I6 means a 26-inch outer diameter repository container containing an I6 insert with 6 openings that are 6 inches square for holding 6 PWR spent fuel assemblies.

The external lengths for the canisters and containers were obtained by assuming that the canisters are about 6 inches longer than the longest contained material and that the repository containers are about 8 inches longer than the longest canister or waste expected to be placed in the containers.

A.2.2 Identification of Waste Receptacles Plus the Contained Radioactive Waste Material

A symbol that identifies a single receptacle plus the contents is obtained by identifying the receptacle and then the waste material. The first group of letters identifies the receptacle as described above. The rest of the alphanumeric symbol identifies the contained waste material.

The symbol for the contents is separated from the symbol for the outer receptacle by an underscore line. There also is one underscore line in the symbol for the contents. That second underscore line is placed immediately before the last letter or letters that identify the source for the wastes.

If there is more than one receptacle, plus the waste nested in one or two canisters, the receptacles are identified in sequence starting with the outer one. The final letters identify the contents. The receptacle designs are identified as described above by the identification of the contents.

As an example, a 28-inch-diameter repository container containing a reactor canister that contains consolidated BWR fuel pins would be:

Y28I9_AR6CON_B

In this example, the container and canister are designed for BWR fuel assemblies, that design being identified by the B in the third group of symbols and the I9 in the first group of symbols.

A.3 IDENTIFICATION OF TRANSPORTATION CASKS AND CONTENTS

Symbols that identify transport casks have only one group of letters. The first two letters are RC for rail casks or TC for truck casks. The number that follows is the nominal cask weight in tons. The final letters identify characteristics of the casks as follows:

HLW	High-level wastes
L	Longer than normal spent fuel casks
M	MRS to repository cask
ST	Storage/transportation cask
P	PWR spent fuel
B	BWR spent fuel

As an example, TC25HLW identifies a 25-ton truck cask for transporting HLW canisters.

The cask and contents are identified by adding the symbol for the contents to the symbol for the cask. As an example, RC100_AR9CON_P means a 100-ton rail/barge cask containing PWR canisters originating at a reactor and containing consolidated PWR fuel rods.

A.4 IDENTIFICATION OF STORAGE FACILITIES AND THE CONTAINED RADIOACTIVE WASTE MATERIALS

Symbols that identify storage facilities at the MRS start with a symbol for the type of storage facility--drywell (MDW), storage cask (MSC) or vault (MV)--in the first group and have a second group that identifies the type material stored in the cask facility. The second group of symbols may be:

B	for BWR SFAs
O	for other reactor SFAs
P	for PWR SFAs
R	for repository containers
GTC	for greater than class C wastes
HLW	for high-level wastes
NFB	for non-fuel bearing components

As an example, MSC_P identifies a storage cask at the MRS for storing 9-inch-square canisters for PWR SFAs.

The drywell, cask or vault and contents are identified by adding the symbol for the contents to the drywell, cask or vault symbol. As an example, MSC_AR9CON_P means a storage cask at the MRS containing canisters originating at a reactor site that contain consolidated PWR fuel rods.

A.5 SUMMARIZED SYMBOLS

The following list summarizes all of the definitions that are used for either the single letters or groups of letters in the symbols.

B	BWR
C	Cylindrical
D	Defense
H	HLW
L	Long
M	Monitored Retrievable Storage
O	Other Facility (other than BWRs, PWRs, MRS, Chemical Reprocessing Plants and Repository)
P	PWR
R	Repository
U	Receptacle of Unknown Geometry
V	Vault
W	West Valley
AR	At-Reactor
BP	A combination of BWR and PWR fuel assemblies
DW	Drywell
I6	6 BWR fuel assemblies
I9	9 BWR fuel assemblies
I10	10 BWR fuel assemblies
I3	3 PWR fuel assemblies
I4	4 PWR fuel assemblies
OU	Other Facility
RC	Rail Cask
SC	Storage Cask

ST	Storage/Transportation
TC	Truck Cask
Y	Yucca Mountain Candidate Repository Site Container
CAG	Drum storage cage
CON	Consolidated SFA Pins
CRP	Chemical Reprocessing Plant
DRM	55-Gallon Drum
GTC	Greater than class C wastes
HLW	Solidified High-Level Waste
LLW	Low-Level Wastes (classes A, B and C)
NFB	Non-Fuel Bearing Components
SFA	Spent Fuel Assemblies

APPENDIX B

SYSTEM CHARACTERISTICS FOR ALTERNATIVE SYSTEM THROUGHPUT RATES

APPENDIX B

SYSTEM CHARACTERISTICS FOR ALTERNATIVE SYSTEM THROUGHPUT RATES

This appendix presents a description of the facilities and equipment that would change if the system were designed for an HLW throughput at 400 MTU/yr plus spent fuel throughput rates of 1500, 4500 or 6000 MTU/yr instead of the base case spent fuel rate of 3000 MTU/yr. Only the sizes of the facilities and the number of equipment items are included here because it is assumed that the functions performed by the system and the general designs of the facilities would not change if the throughput rates were changed. Also, the capacities of specific equipment items (e.g., shipping casks, welding modules, etc.) are assumed to be the same regardless of the throughput rates.

The primary changes in the system description for the various throughput rates are the changes in the sizes of the WHB and associated surface storage vaults at the repository. The sizes of these facilities and the number of process equipment items in these facilities are essentially proportional to the throughput rates. The length and waste handling capacities of the spent fuel unloading cell and the surface storage vaults are essentially proportional to the throughput rate. These changes are illustrated by Table B.1 below.

The general designs of the WHBs for the 1500, 4500 and 6000 MTU/yr throughput rates are illustrated by Figures B.1 to B.6 (three versions of Figures 4.18 and 4.19). The general process area dimensions for these WHB designs are presented below in Table B.2 (corresponding to Table 4.18 of the text.)

The changes in design of the WHB and the surface storage vaults also result in changes in the number of equipment items in those buildings. The number of equipment items needed for each of the throughput rates is listed below in Tables B.3 and B.4 (corresponding to Tables 4.21 and 4.22).

TABLE B.1. WHB Characteristics for Various System Throughput Rates

	Number Items and Capacities for Various Throughput Rates			
	<u>1500 MTU/yr</u>	<u>3000 MTU/yr^(a)</u>	<u>4500 MTU/yr</u>	<u>6000 MTU/yr</u>
Entry Bays	5	7	10	12
Cask Unloading Ports	5	7	10	12
Unloading Hot Cells	2	2	2	2
Inspection Hot Cells	2	2	3	3
Transfer Tunnels	2	2	3	3
Storage Vaults	1	2	3	4
Total Storage Vaults Capacity (MTU) ^(b)	190	375	560	750

(a) Base case rate.

(b) 6 weeks capacity.

FIGURE B.1. General Plan View of WHB Main Floor for 1,500 MTU/yr Throughput Without an MRS (corresponds to Figure 4.18)

FIGURE B.2. General Plan View of WHB Basement for 1,500 MTU/yr Throughput Without an MRS (corresponds to Figure 4.19)

FIGURE B.3. General Plan View of WHB Main Floor for 4,500 MTU/yr Throughput Without an MRS (corresponds to Figure 4.18)

FIGURE B.4. General Plan View of WHB Basement for 4,500 MTU/yr Throughput Without an MRS (corresponds to Figure 4.19)

FIGURE B.5. General Plan View of WHB Main Floor for 6,000 MTU/yr Throughput Without an MRS (corresponds to Figure 4.18)

FIGURE B.6. General Plan View of WHB Basement for 6,000 MTU/yr Throughput Without an MRS (corresponds to Figure 4.19)

TABLE 8.2. WHB Process Room Dimensions

Process Room	Location Symbol ^(b)	Height	Approximate Dimensions (feet)							
			Base Case ^(a)		1500 MTU/yr		4500 MTU/yr		6000 MTU/yr	
			Length	Width	Length	Width	Length	Width	Length	Width
Air Control Vestibule	A	25	386	68	312	68	506	68	604	68
Receiving and Shipping Areas	B	75	386	88	312	88	506	88	604	88
Cask Preparation Areas	C	100	386	25	312	25	506	25	604	25
Cask Unloading Rooms ^(c)	D	40	154	40	110	40	220	40	264	40
Cask Unloading Hot Cells	E	40	139	40	139	40	139	40	139	40
			+ 326		+ 209		+ 446		+ 544	
Inspection Cells	F	40	42	34	42	34	42,	34	42,	34
			+ 64		+ 64		64, 42		64, 64	
Waste Transfer Tunnels	I	23	137	23	137	23	137	23	137	23
Surface Storage Vaults	J	40	286	34	143	63	143	63	286	63
							+ 286		+ 286	

(a) Corresponds to Table 4.18.

(b) Letter symbol indicates location (letter in square) on Figure 4.18.

(c) Total length of all rooms.

TABLE B.3. Major Waste Handling Equipment for the WHB - Listed in Process Step Order

Function Reference Number	Equipment Title	Equipment Identification	Function/Activity	Number of Units				Size or Capacity	Equipment ^(a) Locations
				1500 MTU/yr	3000 MTU/yr	4500 MTU/yr	6000 MTU/yr		
4.1	Onsite Drive Unit	37	Connect to train cars	2	2	2	2	8 Railcars	L
4.2.1	Onsite Drive Unit	37	Move train cars to holding area	2	2	2	2	8 Railcars	L
4.2.2	Car Puller	1	Move vehicle in waste handling building	3	3	5	6	10,000 lb	A,B
	Onsite Drive Unit	37	Move casks and cars to dispatch holding area	2	2	2	2	8 Railcars	A to L
	Onsite Drive Unit	37	Make up shipment train	2	2	2	2	8 Railcars	L
4.4.1.1	Onsite Drive Unit	37	Move casks and cars to washdown area	2	2	2	2	8 Railcars	L to A
4.4.1.2	Car Puller	1	Move vehicles inside waste handling building	3	3	5	6	10,000 lb	A,B
	Airlock Bridge Crane	2	Remove impact limiters tiedowns and personnel barriers, perform radiological surveys	2	2	3	3	5 ton	A
4.4.1.3	Bridge Crane	3	Move casks from vehicles to cask carts	2	3	3	4	200 ton	B to C
	Cask Cart	4	Receive cask	5	7	10	12	200 ton	C
4.4.1.4	Cask Service Platform	5	Support personnel during work on cask tops	5	7	10	12	--	C
	Jib Crane	6	Move cask outer lid to service pad	3	4	6	7	10 ton	C
	Floor-Mounted Robot	7	Remote work on cask tops	3	4	6	7	1 ton	C
4.4.1.5	Floor-Mounted Robot	7	Remote work on cask tops	3	4	6	7	1 ton	C
4.4.1.6	Cask Contamination Barrier Adaptor	8	Installed to provide connection between cask top and cask contamination barrier	22	30	42	50	1 cask	C
	Jib Crane	6	Install contamination barrier adaptor	3	4	6	7	10 ton	C

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TABLE B.3. (contd)

Function Reference Number	Equipment Title	Equipment Identification	Function/Activity	Number of Units				Size or Capacity	Equipment ^(a) Locations
				1500 MTU/yr	3000 MTU/yr	4500 MTU/yr	6000 MTU/yr		
4.4.1.7	Cask Cart	4	Move cask to unloading room	5	7	10	12	200 ton	C to D
	Cask Contamination Barrier	9	Installed to provide connection between cask top and process cell port.	5	7	10	12	1 Cask	D
4.4.1.8	Cask Unloading Cell Shield Plug	10	Provide shielding in cask unloading cell port. Removed to permit cask unloading.	5	7	10	12	1 Port	E
	Cask Shadow Shield	11	Installed to shield preparation area when cask unloading cell port plug is out	5	7	10	12	--	D
	Cask Unloading Cell Bridge Crane	12	Remove cask unloading cell port plugs, remove cask inner lid	3	3	4	5	20 ton	E
4.4.2	Cask Shadow Shield	11	Shield preparation area when cask unloading cell port plug is out	5	7	10	12	--	D
	Lag Storage Covers	13	Ventilation cover on lag storage, removed and replaced during waste transfers into storage	12	18	24	30	--	E
	Cask Unloading Cell Bridge Crane	12	Remove and replace lag storage covers, inspect and remove cask contents and transfer contents to lag storage or next process step	3	3	4	5	20 ton	E
4.4.3.1	Cask Unloading Cell Bridge Crane	12	Inspect cask interior, replace cask inner lid and cask unloading cell port plugs	3	3	4	5	20 ton	E
	Cask Unloading Cell Shield Plug	10	Installed to provide shielding in cask unloading cell port	5	7	10	12	1 Port	E
4.4.3.2	Cask Contamination Barrier	9	Removed to eliminate connection between cask top and cask unloading cell port	5	7	10	12	1 Cask	D
	Cask Shadow Shield	11	Retracted to permit cask movement	5	7	10	12	--	D
	Cask Cart	4	Move cask to preparation room	5	7	10	12	200 ton	D to C

TABLE B.3. (contd)

Function Reference Number	Equipment Title	Equipment Identification	Function/Activity	Number of Units				Size or Capacity	Equipment ^(a) Locations
				1500 MTU/yr	3000 MTU/yr	4500 MTU/yr	6000 MTU/yr		
4.4.3.3	Cask Service Platform	5	Support personnel during work on cask tops	5	7	10	12	--	C
	Jib Crane	6	Remove contamination barrier adaptor	3	4	6	7	10 ton	C
	Cask Contamination Barrier Adaptor	8	Removed from cask	22	30	42	50	1 Cask	C
	Floor Mounted Robot	7	Remote work on cask tops	3	4	6	7	1 ton	C
	Decontamination Station	14	Decontaminate cask	1	2	3	3	1 Cask	C
	Bridge Crane	3	Move cask to decontamination station	2	3	3	4	200 ton	C
4.4.3.4	Floor Mounted Robot	7	Remote work on cask top	3	4	6	7	1 ton	C
	Jib Crane	6	Move cask outer lid to cask	3	4	6	7	10 ton	C
4.4.3.5	Bridge Crane	3	Move cask to transport vehicle	2	3	3	4	200 ton	C to B
	Onsite Drive Unit	37	Move casks and cars to support services facilities	2	2	2	2	8 Railcars	A
4.4.3.6	Airlock Bridge Crane	2	Install impact limiters and cask tiedowns	2	2	3	3	5 ton	A
	Car Puller	1	Move vehicles in waste handling buildings	3	3	5	6	10,000 lb.	A,B
4.4.4	Onsite Drive Unit	37	Move loaded vehicle to holding area	2	2	2	2	8 Railcars	A to L
4.5	Lag Storage Covers	13	Remove and replace when wastes are moved out of lag storage	12	18	24	30	--	E
	Cask Unloading Cell Bridge Crane	12	Remove and replace lag storage covers, move waste in and out of lag storage	3	3	4	5	20 ton	E
4.6.3	Cask Unloading Cell Bridge Crane	12	Move clean containers to weld station, move waste to weld station	3	3	4	5	20 ton	E

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TABLE B.3. (contd)

Function Reference Number	Equipment Title	Equipment Identification	Function/Activity	Number of Units				Size or Capacity	Equipment ^(a) Locations
				1500 MTU/yr	3000 MTU/yr	4500 MTU/yr	6000 MTU/yr		
	Container Supply System	21	Move clean containers into unloading hot cell	2	3	4	5	1 Container	E
	Lag Storage Covers	13	Removed and replaced for waste removal from storage	12	18	24	30	--	E
4.6.4.1	Container Lid Supply System	23	Supply and handle container lids in cells	2	3	4	5	1 Lid	E
	Welding Module	24	Weld lids on containers	2	3	4	5	1 Container	E
	Master Slave Manipulator	25	Equipment operation and maintenance	4	5	7	8	TBD	E
4.6.4.2	Cask Unloading Cell Bridge Crane	12	Move container to weld inspection station	3	3	4	5	20 ton	E
4.6.4.3	Weld Inspection System	27	Inspect welds	2	3	4	5	1 Container	E
4.6.4.4	Cask Unloading Cell Bridge Crane	12	Move container to leak test station	3	3	4	5	20 ton	E
4.6.4.5	Leak-Test Station	28	Leak-test containers	2	3	4	5	1 Container	E
4.6.4.6	Cask Unloading Cell Bridge Crane	12	Move container to decontamination chamber	3	3	4	5	20 ton	E
4.6.4.7	Decontamination Chambers	26	Decontaminate containers	2	3	4	5	1 Container	E
4.6.4.8	Decontamination Chambers	26	Move wastes to inspection cell	2	3	4	5	1 Container	E to F
4.6.4.9	Decontamination Chambers	26	Rotate container during swabbing	2	3	4	5	1 Container	F
4.6.4.10	Cask Unloading Cell Bridge Crane	12	Move container between process stations	3	3	4	5	20 ton	E
	Master Slave Manipulators	25	Equipment operation and maintenance	4	5	7	8	TBD	E
	Welding Module	24	Repair defective welds	2	3	4	5	1 Container	E

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TABLE B.3. (contd)

Function Reference Number	Equipment Title	Equipment Identification	Function/Activity	Number of Units				Size or Capacity	Equipment ^(a) Locations
				1500 MTU/yr	3000 MTU/yr	4500 MTU/yr	6000 MTU/yr		
B.14	4.7.1.1 Inspection Cell Bridge Crane	31	Transfer containers to transfer carts	2	3	4	5	5 ton	F
	Transfer Cart	33	Receive containers	4	4	6	6	12.5 MT	F
	4.7.1.2 Transfer Cart	33	Move containers from inspection cell to waste package storage vault	4	4	6	6	12.5 MT	F to I
	4.7.1.3 Surface Storage Vault Entrance Port Plugs	34	Removed and replaced to permit waste transfers	2	4	6	6	1 Port	J
	Container Transfer Machine	35	Remove and replace storage vault area port plugs, move containers between container carts and storage positions	1	2	3	4	1 Container	J
	Vault Storage Posi- tion plugs	36	Removed and replaced to permit waste transfers	135	270	405	540	1 Port	J
	4.7.3 Surface Storage Vault Entrance Port Plugs	34	Removed and replaced to permit waste transfers	2	4	6	6	1 Port	J
	Container Transfer Machine	35	Remove and replace storage vault area port plugs, move containers between container carts and storage positions	1	2	3	4	1 Container	J
	Vault Storage Posi- tion plugs	36	Removed and replaced to permit waste transfers	135	270	405	540	1 Port	J

(a) Equipment identification included as an aid to equipment cost and utilization studies.

(b) Figures 4.16, 4.18, and B.1 to B.6.

TABLE B.4. Major Waste Handling Equipment for the WHB - Listed by Equipment Item

Equipment Title	Equipment Identification	Function Reference Number	Function/Activity	Number of Units				Size or Capacity	Equipment ^(a) Locations
				1500 MTU/yr	3000 MTU/yr	4500 MTU/yr	6000 MTU/yr		
Car Puller	1	4.2.2	Move vehicle in waste handling building	3	3	5	6	10,000 lb	A,B
		4.4.1.2	Move vehicles inside waste handling building						A,B
		4.4.3.6	Move vehicles in waste handling buildings						A,B
Airlock Bridge Crane	2	4.4.1.2	Remove impact limiters tiedowns and personnel barriers, perform radiological surveys	2	2	3	3	5 ton	A
		4.4.3.6	Install impact limiters and cask tiedowns						A
Bridge Crane	3	4.4.1.3	Move casks from vehicles to cask carts	2	3	3	4	200 ton	B to C
		4.4.3.3	Move cask to decontamination station						C
		4.4.3.5	Move cask to transport vehicle						C to B
Cask Cart	4	4.4.1.3	Receive cask and move to cask handling room	5	7	10	12	200 ton	C
		4.4.1.7	Move cask to unloading room						C to D
		4.4.3.2	Move cask to preparation room						D to C
Cask Service Platform	5	4.4.1.4	Support personnel during work on cask tops	5	7	10	12	--	C
		4.4.3.3	Support personnel during work on cask tops						C
Jib Crane	6	4.4.1.4	Move cask outer lid to service pad	3	4	6	7	10 ton	C
		4.4.1.6	Install contamination barrier						C
		4.4.3.3	Remove contamination barrier						C
		4.4.3.4	Move cask outer lid to cask						C

TABLE B.4. (contd)

Equipment Title	Equipment Identification	Function Reference Number	Function/Activity	Number of Units				Size or Capacity	Equipment ^(a) Locations
				1500 MTU/yr	3000 MTU/yr	4500 MTU/yr	6000 MTU/yr		
Floor-Mounted Robot	7	4.4.1.4	Remote work on cask tops	3	4	6	7	1 ton	C
		4.4.1.5	Remote work on cask tops						C
		4.4.3.3	Remote work on cask tops						C
		4.4.3.4	Remote work on cask top						C
Cask Contamination Barrier Adaptor	8	4.4.1.6	Installed to provide connection between cask top and cask contamination barrier	22	30	42	50	1 Cask	C
		4.4.3.3	Removed from cask						C
Cask Contamination Barrier	9	4.4.1.7	Installed to provide connection between cask top and process cell port	5	7	10	12	1 Cask	D
		4.4.3.2	Removed to eliminate connection between cask top and cask unloading cell port						D
Cask Unloading Cell Shield Plug	10	4.4.1.8	Provide shielding in cask unloading cell port. Removed to permit cask unloading	5	7	10	12	1 Port	E
		4.4.3.1	Installed to provide shielding in cask unloading cell port						E
Cask Shadow Shield	11	4.4.1.8	Installed to shield preparation area when cask unloading cell port plug is out	5	7	10	12	--	D
		4.4.2	Shields preparation area when cask unloading cell port plug is out						D
		4.4.3.2	Retracted to permit cask movement						D
Cask Unloading Cell Bridge Crane	12	4.4.1.8	Remove cask unloading cell port plugs, remove cask inner lid	3	3	4	5	20 ton	E
		4.4.2	Remove and replace lag storage covers, inspect and remove cask contents and transfer contents to lag storage or next process step						E

TABLE B.4. (contd)

Equipment Title	Equipment Identification	Function Reference Number	Function/Activity	Number of Units				Size or Capacity	Equipment ^(a) Locations
				1500 MTU/yr	3000 MTU/yr	4500 MTU/yr	6000 MTU/yr		
Cask Unloading Cell Bridge Crane	12	4.4.3.1	Inspect cask interior, replace cask inner lid and cask unloading cell port plugs	3	3	4	5	20 ton	E
		4.5	Remove and replace lag storage covers, move waste in and out of lag storage						E
		4.6.3	Move clean containers to weld station, move waste to weld station						E
		4.6.4.2	Move container to weld inspection station						E
		4.6.4.4	Move container to leak test station						E
		4.6.4.6	Move container to decontamination chamber						E
		4.6.4.10	Move container between process stations						F
Lag Storage Covers	13	4.4.2	Ventilation cover on lag storage, removed and replaced during waste transfers into storage	12	18	24	30	--	E
		4.5	Remove and replace when wastes are moved out of lag storage						E
		4.6.3	Removed and replaced for waste removal from storage						E
Decontamination Station	14	4.4.3.3	Decontaminate cask	1	2	3	3	1 Cask	C
Container Supply System	21	4.6.3	Move clean containers into unloading hot cell	2	3	4	5	1 Container	E
Container Lid Supply System	23	4.6.4.1	Supply and handle container lids in cells	2	3	4	5	1 Lid	E

TABLE B.4. (contd)

Equipment Title	Equipment Identification	Function Reference Number	Function/Activity	Number of Units				Size or Capacity	Equipment ^(a) Locations
				1500 MTU/yr	3000 MTU/yr	4500 MTU/yr	6000 MTU/yr		
B.18	Welding Module	24	4.6.4.1 Weld lids on containers	2	3	4	5	1 Container	E
			4.6.4.10 Repair defective welds						E
	Master Slave Manipulator	25	4.6.4.1 Equipment operation and maintenance	4	5	7	8	TBD	E
			4.6.4.10 Equipment operation and maintenance						E
	Decontamination Chamber	26	4.6.4.7 Decontaminate containers	2	3	4	5	1 Container	E
			4.6.4.8 Move wastes to inspection cell						E to F
			4.6.4.9 Rotate container during swabbing						F
	Weld Inspection System	27	4.6.4.3 Inspect welds	2	3	4	5	1 Container	E
	Leak-Test Station	28	4.6.4.5 Leak-test containers	2	3	4	5	1 Container	E
	Inspection Cell Bridge Crane	31	4.7.1.1 Transfer containers to transfer carts	2	3	4	5	5 ton	F
	Transfer Cart	33	4.7.1.1 Receive containers	4	4	6	8	12.5 MT	F
			4.7.1.2 Move containers from inspection cell to waste package storage vault						F to I
	Surface Storage Vault Entrance Port Plugs	34	4.7.1.3 Removed and replaced to permit waste transfers	2	4	6	8	1 Port	J
			4.7.3 Removed and replaced to permit waste transfers						J
	Container Transfer Machine	35	4.7.1.3 Remove and replace storage vault area port plugs, move containers between container transfer carts and storage positions	1	2	3	4	1 Container	J

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TABLE B.4. (contd)

Equipment Title	Equipment Identification	Function Reference Number	Function/Activity	Number of Units				Size or Capacity	Equipment ^(a) Locations
				1500 MTU/yr	3000 MTU/yr	4500 MTU/yr	6000 MTU/yr		
Container Transfer Machine	35	4.7.3	Remove and replace storage vault area port plugs, move containers between storage positions and container transfer carts	1	2	3	4	1 Container	J
Vault Storage Position plugs	36	4.7.1.3	Removed and replaced to permit waste transfers	135	270	405	540	1 Port	J
		4.7.3	Removed and replaced to permit waste transfers						J
Onsite Drive Unit	37	4.1	Connect to train cars	2	2	2	2	8 Railcars	L
		4.2.1	Move train cars to holding area						L
		4.2.2	Move casks and cars to dispatch holding area						A to L
		4.2.2	Make up shipment train						L
		4.4.1.1	Move casks and cars to support services facilities						L to A
		4.4.3.5	Move casks and cars to waste handling building						A
		4.4.4	Move loaded vehicle to holding area						A to L

(a) Equipment identification included as an aid to equipment cost and utilization studies.

(b) Figures 4.16 and 4.18, and 8.1 to 8.6.

APPENDIX C

GLOSSARY

APPENDIX C

GLOSSARY

ARRS	Aggregate Receipt Rate Study
Backfill	1) The fill placed in the excavated areas of the underground facility, shafts, or ramps. Backfill materials may be either excavated tuff or other earthen materials. 2) The material or process used to refill an excavation.
Borehole	A hole made with a drill, auger, or other tools for exploring strata in search of minerals, supplying water for blasting, emplacing waste, proving the position of old workings or faults, or releasing accumulations of gas or water. Boreholes include core holes, dry-well-monitoring holes, waste emplacement boreholes, and test holes for geophysical or ground-water characterization.
Emplacement Borehole cover	A cylindrical metallic cap placed on the end of a vertical or horizontal borehole after the waste containers and shielding plug have been emplaced to limit access, to identify borehole contents, and to prevent the accumulation of debris (vertical borehole). The borehole cover does not serve a shielding or containment function.
Borehole liner	See "emplacement borehole liner."
Cage	A structure that supports several drums stacked vertically.
Canistering	Placing material in a metal canister and welding on a lid. Usually the canister is filled with an inert gas before the lid is welded on.
Canister	As used in this document, a canister is the initial metal receptacle in which solid radioactive waste is placed for transport to the repository. The canister is not intended to meet the 300- to 1,000-yr containment requirement of 10 CFR 60.113(a)(1)(ii)(A).
Caretaker period	A period of time after emplacement of a waste container in a repository, but before the waste is either retrieved from the repository or the waste is permanently entombed by filling and sealing the tunnels, shafts, and ramps necessary for retrieving that waste. It corresponds to the retrievability period.

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Cask	A receptacle that holds one or more fuel assemblies, canisters, or disposal containers and provides shielding for highly radioactive materials during transportation or storage.
Cask transfer cart	A rail-mounted motorized vehicle located in the cask transfer areas of the waste-handling buildings.
Certification	Demonstration that a cask meets the NRC requirements for a transport cask.
Closure	1) Final backfilling of the remaining open operational areas of the repository underground facility and boreholes after the termination of waste emplacement, culminating in the sealing of the shafts. 2) Any lid, door, etc. used to seal a container, borehole or room.
Commercial high-level waste	High-level radioactive waste generated in private industrial and other nongovernment facilities.
Consolidation	The operation performed on spent fuel assemblies during which the upper and lower fuel assembly tie plates are removed, the assembly spacer grids and any other assembly structural members are removed, and the fuel rods are collected and formed into a closely packed bundle for insertion into a canister or container. The nonfuel structural members of the fuel assemblies are reduced in volume and placed in canisters or containers for shipment and disposal.
Containerization	Placing wastes in a container that is designed to assist in attaining long-term waste form integrity in a geologic repository.
Container (disposal container or waste container)	The metal barrier portion of the waste package that is placed around the waste form. The container meets the 300- to 1,000-yr containment requirement of 10 CFR 60.113(A)(1)(ii)(A).
Contamination barrier	A cylindrical mechanism that connects the top of a cask standing on its bottom end to a port in the ceiling above the cask. This mechanism minimizes air exchange between the room containing the cask and the room connected to the top of the cask.
Contamination barrier adaptor	A round metallic plate with a hole in the center the size of the hole at the top of an open cask. The plate is placed on the top of the cask to assist in making up the contamination barrier between the top of the cask and the ceiling above the cask.

Conventional mining	Drill-and-blast mining.
Decommissioning	The permanent removal from service and demolition of surface facilities and components in accordance with regulatory requirements and environmental policies.
Decontamination	The removal of unwanted material (especially radioactive material) from the surface of, or from within, a component.
Dedicated train	A train that transports a shipment from the origin to the destination without switching of the freight cars between trains. There may be multiple origins and destinations clustered near the two ends of a long shipment.
Defense high-level waste (DHLW)	High-level radioactive waste generated by activities related to the national defense program, including the manufacture of nuclear weapons, the operation of naval reactors, and research and development at weapons laboratories.
Disposal	The emplacement in a repository of high-level radioactive waste, spent nuclear fuel, or other highly radioactive material with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste.
Drift	Horizontal, or nearly horizontal, mined passageway.
Drill-and-blast mining	A method of mining in which holes are drilled into the rock and then loaded with explosives. The blast from the explosives breaks the rock so that the rock can be removed. The underground opening is expanded by repeated drilling and blasting.
Emplacement	The act of placing waste containers in prepared positions in the repository. The method of waste emplacement assumed here is based on emplacement of a single waste container in a shallow vertical borehole in the floor of the emplacement drift.
Emplacement borehole liner	A sleeve placed in a vertical or horizontal borehole to prevent sloughed rock from interfering with the emplacement or removal of waste packages. The liner does not serve a shielding or containment function. The liner runs the complete length of horizontal boreholes, but, in vertical boreholes, extends only from the mouth of the borehole to just below the shoulder of the emplaced waste container.

Emplacement drift	A drift in which waste emplacement boreholes are located.
Emplacement horizon	The specific geologic stratum, or portion thereof, in which waste will be emplaced below the earth's surface. A portion of the Topopah Spring Member of the Paintbrush Tuff is currently the target emplacement horizon at the Yucca Mountain candidate site.
End fittings (of spent fuel assemblies)	Part of the mechanical support structure of fuel assemblies.
First-class railroad	A railroad with rails of sufficient strength and radii of curvature to permit operation of loaded freight trains at normal maximum speeds.
Fuel assembly	A single mechanical unit consisting of a number of fuel rods held together by a mechanical support structure designed to maintain proper spacing of the fuel rods and facilitate their handling.
Fuel assembly hardware	The non-fuel-bearing mechanical support structure and component of a fuel assembly that is excess waste left after consolidation.
Fuel rod	A long, slender, cylindrical tube (usually made of stainless steel or Zircaloy) containing nuclear fuel in the form of uranium oxide fuel pellets. Also called "fuel pin."
Functional description	A description of the activities or operations in a flow diagram. The level of the description corresponds to the level of the flow diagram.
Geologic repository	A system for the disposal of radioactive wastes in excavated geologic media. A geologic repository includes 1) the geologic repository operations area and 2) the portion of the geologic setting that provides isolation of the radioactive waste and is located within the controlled area.
High-level radioactive waste	As used in this document, the solidified highly radioactive material resulting from the reprocessing of spent nuclear fuel that contains fission products in sufficient concentrations; and other highly radioactive material that the NRC, consistent with existing law, determines by rule to require permanent isolation.
Impact limiter	A structure that reduces damage to the cask or its contents by impact during accidents.

Inner lid	This lid seals the inner cask cavity and contains the inner cask atmosphere-sampling ports.
Intact SFA	An LWR fuel assembly that has no defects that would make consolidation undesirable.
Intermodal transport	Transport of casks between facilities by use of two types of transport (truck, rail or barge) during a shipment.
Lag storage	Any storage area where process materials can be stored between process activities.
Level 0 flow diagram	A diagram showing the general flow of materials between the major facilities of a system.
Level 1 flow diagram	A diagram showing the general flow of materials through the principal activities in each of the facilities and activities shown in a Level 0 flow diagram.
Level 2 flow diagram	A diagram showing the general flow of materials through the principal operations in each of the principal activities in a Level 1 flow diagram.
LWR	Light water reactor
Low-level waste (radioactive)	Radioactive material that is neither high-level waste, spent nuclear fuel, transuranic waste, or by-product material as defined in Section 11e(2) of the Atomic Energy Act of 1954.
Outer lid	The secondary containment seal for the cask (the inner lid is the primary seal). The outer lid may contain a port for sampling the atmosphere in the cavity between the inner and outer lids.
Overpack	Any receptacle, wrapper, box, or other structure that becomes an integral part of a radioactive waste package and is used to enclose a waste container for purposes of providing additional protection or for meeting the requirements of an acceptance or isolation criterion for a specific site. An overpack is often used to encase a damaged or contaminated waste package for which repair or decontamination is impractical.
Personnel barrier	A structure on a cask transport vehicle that prevents human contact with the cask.
Physical description	A description of the facilities and equipment needed for accomplishing the activities or operations described in a functional description. The level of the description corresponds to the level of the functional description.

Primary storage	Original storage facilities, e.g., spent fuel storage pool at a reactor.
Retrievability period	The time during which emplaced waste is capable of being retrieved. For design purposes, this period begins with emplacement of the first waste and ends 50 years thereafter at the end of the caretaker period.
Retrieval	The act of intentionally removing radioactive waste from the underground location at which the waste had been previously emplaced for disposal.
RHTRU	Remotely Handled Transuranium Wastes
SFA	Spent Fuel Assembly
SHLW	Solidified High-Level Waste
SNF	Spent nuclear fuel
Secondary storage	Supplemental storage, e.g., dry storage casks at a reactor site.
Shadow shield	A movable radiation shield placed between a radiation source and an area occupied by workers.
Single-Phase Facility	A facility that is built in its entirety before waste handling activities begin. This contrasts to multiple-phase facilities at which waste handling activities begin as soon as construction of a part of the facility is completed even though construction of other parts of the facility is not completed.
Storage cask	A cask that can be used for storing radioactive materials onsite but is not certified for transporting radioactive materials offsite.
S/T Cask	A cask licensed for both storage and transportation of wastes.
Three-Phase Facility	A facility built in three phases. As each phase is completed, that portion of the facility begins operating.
Transfer cask	A cask for transporting radioactive materials onsite. It is not certified by the NRC for transporting radioactive materials offsite.
Transport cask	A cask certified by the NRC for transporting radioactive materials offsite.

Tuff	A compacted pyroclastic deposit of volcanic ash and dust that contains rock and mineral fragments incorporated during eruption or transport.
Two-Phase Facility	A facility built in two phases. As each phase is completed, that portion of the facility begins operating.
Waste	As used in this document, high-level radioactive waste, spent fuel or other material requiring geologic disposal.
West Valley Reprocessing Plant	The West Valley Spent Fuel Reprocessing Plant is the only commercial reprocessing plant ever to operate in the U.S. It is located at West Valley, New York, and was shut down in 1971. A large inventory of liquid HLW remains, which when solidified as a borosilicate glass, will be sent to the repository for disposal.

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