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Civilian Radioactive Waste Management System
Management and Operating Contractor

CONCEPT OF OPERATIONS FOR THE MULTI-PURPOSE CANISTER SYSTEM

Revision 1

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Prepared for:

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EXECUTIVE SUMMARY

PURPOSE

The purpose of the Concept of Operations is to define the operations and parameters that were used in evaluating the Multi-Purpose Canister (MPC) system and the reference scenario against which the MPC system is compared. This concept of operations provides continuity and consistency in the development and analysis of the various elements of the MPC system and serves as the framework around which all related systems analyses are developed. These systems analyses, in turn, provide guidance in developing conceptual designs of the MPC and its transportation and storage modes, as well as MPC-related design considerations for the transfer facilities at the Monitored Retrievable Storage (MRS) Facility, the Mined Geologic Disposal System (MGDS) surface and subsurface facilities, and the On-Site Transfer and Storage (OSTS) System. Adherence to this concept of operations helps ensure that the MPC system evaluation results in an MPC system in which each element is designed and integrated for the benefit of the overall system.

The concept of operations consists of three components: 1) operational descriptions of the reference scenario and the MPC system; 2) system parameters which define the Civilian Radioactive Waste Management System (CRWMS) and their assigned values for the purpose of analysis in the MPC Conceptual Design Phase work; and 3) transportation modal capability, based on each facility's cask handling capabilities and transportation infrastructure (this is a detailed breakout of one of the parameters, and determines the degree to which large casks or MPCs are used in this analysis).

Scenarios are developed for the MPC system and the reference scenario, and evaluated on a consistent basis, in order to provide supporting data for a decision on whether to implement the MPC in the CRWMS.

OPERATIONAL DESCRIPTION

The operational description of the reference scenario and the MPC system describes the loading and movement of the MPC through the CRWMS, summarized according to system element. Common to the scenarios are a total acceptance of 86,155 metric tons of initial uranium (MTU) of spent nuclear fuel (SNF) based on 1992 Energy Information Administration projections for no new reactor orders, and waste acceptance allocation and selection based on oldest fuel first (OFF). The scenarios assume a generic western MRS and no western strategy. The first MGDS will emplace 63,000 MTU of SNF and 7000 MTU equivalent of high level waste (HLW) from reprocessing spent fuel. The second MGDS will emplace the remainder of the SNF and HLW.

Utilities

Reference scenario--Spent fuel will be stored in the pools at the facilities until it is picked up or placed in at-reactor dry storage. Facilities requiring dry storage will load and store non-transportable multiple element sealed canisters (MESCs).

MPC system--Spent fuel will be stored in the pools at the facilities until it is picked up or placed in at-reactor storage. Facilities requiring dry storage will load and store rail-sized MPCs. Facilities that cannot handle rail-sized MPCs are assumed, for the purposes of analysis, to load small non-transportable MESCs for dry storage.

Waste Acceptance

Reference scenario--Spent fuel will be loaded into transportation casks in the pools at the facilities. MESCs used for on-site storage must be returned to the pool and opened, and the spent fuel must be transferred to a transportation cask at the time spent fuel is picked up.

MPC system--MPCs in transportation casks will be loaded in the facility pools. Some facilities will load MPCs using an on-site transfer cask in the pool and then transfer the sealed MPC from the transfer cask to a transportation cask outside of the pool. MPCs used for on-site storage will be transferred directly from storage to the transportation cask for shipment without going back through the pool. Facilities that cannot handle MPCs will ship uncanistered SNF by legal weight truck (LWT) casks to the MRS.

Transportation

Reference scenario--Loaded rail and LWT transportation casks with uncanistered SNF will be shipped by rail or truck to the MRS.

MPC system--The loaded MPC in its transportation cask will be transported to the MRS by rail. Truck shipments will be used to move uncanistered SNF in LWT casks to the MRS.

Both systems--Barge and heavy-haul truck will be used as needed to move rail-sized casks to the nearest rail line. Dedicated trains will be used to move rail casks from the facilities to the MRS, and from the MRS to the first MGDS. All shipments from facilities to the first MGDS will be via the MRS. Shipments from facilities to the second MGDS will go directly to the MGDS using both rail and truck shipments.

MRS

Reference scenario--Spent fuel assemblies that will be stored at the MRS will be transferred from rail and truck transportation casks into the storage mode inside transfer cells. Arriving truck casks with spent fuel not intended for storage will be unloaded in transfer cells, and the spent fuel assemblies will be transferred to rail transportation casks for shipment to the MGDS (passthrough). Arriving rail casks with spent fuel not intended for storage will be placed directly on trains for shipment to the MGDS (flowthrough).

MPC system--Arriving truck casks will be unloaded in transfer cells and the spent fuel assemblies transferred to MPCs for storage or for shipment to the MGDS (passthrough). Arriving rail MPCs will either be transferred from the transportation cask to the storage mode in a clean, shielded transfer room, or will be placed directly on trains for shipment to the MGDS (flowthrough).

MGDS

Reference scenario--Spent fuel assemblies will be transferred from the transportation casks to the waste packages in transfer cells, and the waste packages will be emplaced in the underground repository.

MPC system--Sealed MPCs will be transferred from the transportation casks to the waste packages in clean, shielded transfer rooms, and the waste packages will be emplaced in the underground repository. At the second MGDS, uncanistered SNF will arrive from truck facilities in LWT casks and will be emplaced in reference scenario waste packages, and sealed MPCs will arrive from rail facilities and will be emplaced in MPC waste packages.

SYSTEM PARAMETERS

A set of parameters was identified that defines the system design and operations of the CRWMS; these were assigned values for the reference scenario and the MPC system in accordance with existing program documents, current program planning, and anticipated MPC requirements.

The reference scenario used for comparison to the MPC system is consistent with the Reference System Description (RSD) Document in all ways with the following exceptions:

the reference scenario considers loading operations and at-reactor dry storage at utilities, which is not considered in the RSD;

the reference scenario considers all SNF and HLW projected to be produced; the RSD only considers the first 63,000 MTU of SNF and 7000 MTU of HLW;

the reference scenario includes a second MGDS to accommodate SNF and HLW beyond the first 70,000 MTU; the RSD considers only the first MGDS;

the reference scenario includes an MRS that begins operation in 2000 in accordance with the most recent MRS Major System Acquisition (MSA) schedule analysis; the RSD includes an MRS that begins operation in 1998; and

the reference scenario uses a large in-drift emplaced waste package; the RSD uses a small borehole-emplaced waste package with the large in-drift emplaced waste package as an alternative.

MODAL CAPABILITIES

Potential transportation modal capabilities at the facilities were evaluated, reflecting current and potentially enhanced handling capabilities and transportation infrastructure. A base case modal capability was identified for each facility which will serve as the modal capability assumption for both the reference scenario and the MPC system for the MPC Conceptual Design Phase work. Based on common cask handling and transportation infrastructure capabilities, a potential family of transportation casks and MPCs was identified, with projected PWR/BWR assembly capacities based on existing and anticipated cask technology and preliminary MPC design concepts:

Cask/MPC	Capacity	
25-ton truck cask	4 PWR/ 9 BWR	
75-ton rail cask	12 PWR/ 24 BWR	
100-ton rail cask	21 PWR/ 37 BWR	
75-ton MPC	12 PWR/ 24 BWR	(nominally 75 tons loaded weight, MPC in transportation cask)
125-ton MPC	21 PWR/ 40 BWR	(nominally 115 tons loaded weight, MPC in transportation cask)

In addition, an on-site MPC transfer cask was conceptualized that would allow 32 facilities with crane capacity limited to 100 tons to handle the "125-ton" MPC, and then transfer the MPC to the 125-ton rail cask out of the pool. The on-site transfer cask will weigh less than the MPC transportation cask such that the hook weight of the loaded MPC in the transfer cask is less than 100 tons. The shielding provided by the on-site transfer cask will be sufficient for on-site use, but would not meet transportation requirements.

The number of facilities that are assumed to ship each size of cask or MPC for the basic modal capability is summarized as:

Reference Scenario	Number of Facilities
Truck cask	19
75-ton rail cask	14
100-ton rail cask	88

MPC System	Number of Facilities
Truck cask	19
75-ton rail MPC	14
125-ton rail MPC	88

The basic modal capability was developed into implementation scenarios for the MPC Conceptual Design Phase work, and evaluated for both the reference scenario and the MPC system for the purpose of comparison. Section 4 provides details on the modal capabilities for each facility, including required additional operations such as use of an on-site transfer cask, barge and heavy-haul truck.

In order to provide a conservative approach to the comparison between the reference scenario and the MPC system, both systems are evaluated with some facilities shipping by truck cask. Cask-to-cask transfer of uncanistered spent fuel assemblies is one means by which some of the truck facilities could be upgraded to ship rail transportation casks (with MPCs). Conceptual design work is in progress on a cask-to-cask transfer facility as part of the OSTS that could be used to reduce the use of truck shipments and maximize the use of MPCs in the CRWMS.

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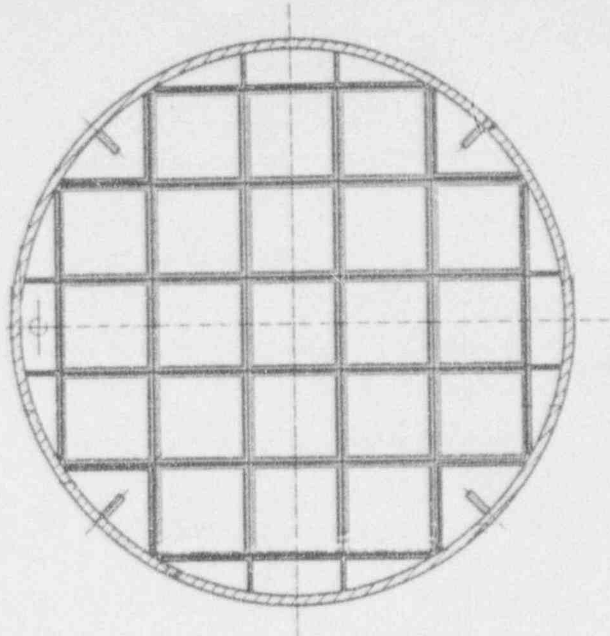
1. INTRODUCTION

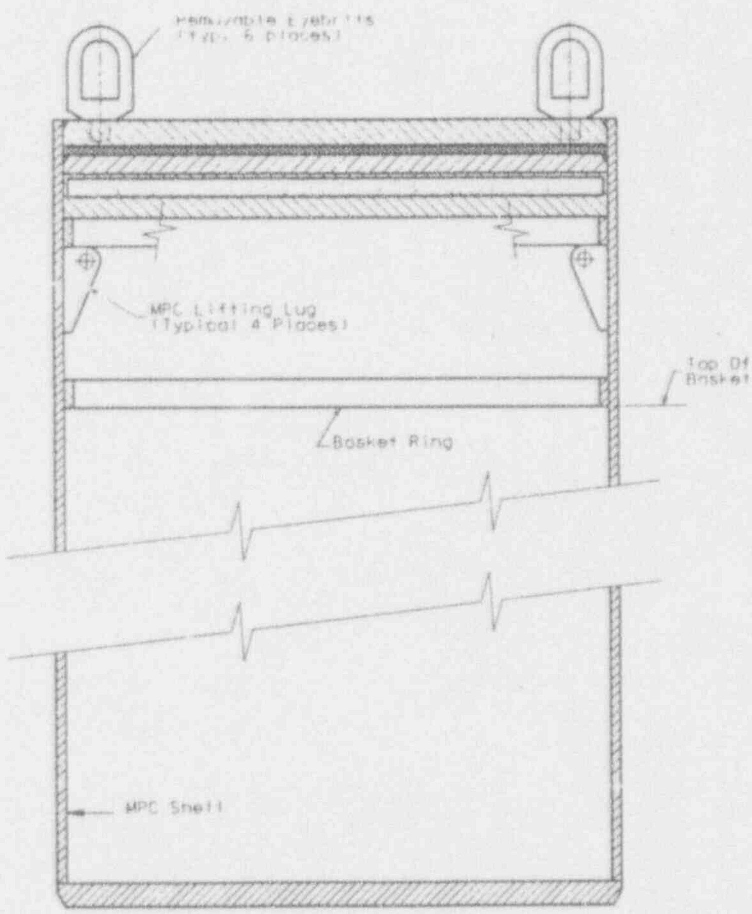
The Office of Civilian Radioactive Waste Management (OCRWM) of the U.S. Department of Energy is considering the use of the Multi-Purpose Canister (MPC) system to handle spent nuclear fuel throughout the Civilian Radioactive Waste Management System (CRWMS). MPCs are sealed, metallic canisters maintaining multiple spent fuel assemblies in a dry, inert environment and overpacked separately and uniquely for the various system elements of storage, transportation, and geologic disposal. A preliminary conceptual design of an MPC is shown in Figure 1-1.

A preliminary evaluation of MPCs, completed in January 1993 (Ref 1), concluded that the use of MPCs in the CRWMS is feasible, and that MPCs appear to offer a number of advantages over the system as it is currently envisioned (termed the "reference system"). As a result of this initial finding of feasibility, the program's Management and Operating (M&O) Contractor was directed to conduct conceptual design work and a series of system studies to develop the MPC concept sufficiently for OCRWM to make a decision regarding MPC implementation in the CRWMS.

A concept of operations is required for continuity and consistency among the conceptual design work and associated system studies. The concept of operations develops a method by which the MPC can be implemented in the system, given the various constraints of the system elements. This method was developed in the form of a scenario based on the extent of large and moderate-sized MPC use in the system. A similar scenario was developed as a reference scenario, in order to provide a basis for comparison and supporting data for decisions regarding MPC implementation in the CRWMS.



125-Ton 21 PWR CONFIGURATION



SECTION of MPC

Figure 1-1. Conceptual Design of Multi-Purpose Canister

2. OPERATIONAL DESCRIPTION

The movement of spent nuclear fuel (SNF) through the reference scenario and the MPC system are described in operational detail for use in the MPC Conceptual Design Phase. The Utilities subsections address utility functions specifically related to at-reactor dry storage, whereas the Waste Acceptance subsections address functions related to loading and sealing of MPCs and pick up of SNF into the CRWMS.

2.1 GENERAL

Between 1998 and 2000, utilities will be responsible for SNF storage. MPCs will be available for at-reactor dry storage beginning in 1998. SNF will be picked up from the facilities and accepted into the CRWMS beginning in the year 2000. From 2000 to 2010, all SNF will be transported to the MRS and placed in storage. When the MGDS begins receiving SNF in 2010, the MRS will commence passthrough/flowthrough operations--arriving rail casks/MPCs will be placed directly on dedicated trains for shipment to the MGDS (flowthrough), while LWT casks will be unloaded and the SNF placed in rail transportation casks/MPCs for shipment to the MGDS (passthrough). Starting in 2015, 7000 MTU equivalent of high level waste (HLW) from spent fuel reprocessing will be shipped by rail from storage sites directly to the MGDS, where the canisters of HLW will be emplaced in waste packages similar to those containing the SNF.

Once 63,000 MTU of SNF and 7000 MTU equivalent of HLW have been emplaced in the first MGDS, the remaining SNF and HLW will be shipped to the second MGDS for emplacement. Spent fuel will be shipped from the facilities directly to the second MGDS, and the MRS will be decommissioned. All facilities with sufficient handling capability will ship rail transportation casks/MPCs to the second MGDS. Facilities without sufficient handling capability will ship SNF to the second MGDS in LWT transportation casks. At the MGDS, the uncanistered SNF assemblies will be transferred to a waste package and emplaced in the underground repository. Table 2-1 summarizes the movement of SNF and HLW through the CRWMS.

Based on the *Reference System Description* (RSD--Ref 2), the MPC Conceptual Design Phase analyses were conducted with an MRS included in the system. A scenario without an MRS is considered in the document *Programmatic Risk and Contingency Analysis for the Multi-Purpose Canister System* (Ref 3).

2.2 REFERENCE SCENARIO

In the reference scenario, SNF will be stored in spent fuel pools at the facilities until it is picked up into the CRWMS. At the time of waste acceptance, uncanistered SNF assemblies will be loaded in transportation casks in the spent fuel pools at the facilities. The facilities will load either rail casks or truck casks, depending on handling capabilities. The transportation casks will be shipped to the MRS, where SNF arriving in rail casks will either be transferred into storage casks or placed on trains for shipment to the MGDS; SNF arriving at the MRS in truck casks will either be transferred to storage casks before being placed in storage or to rail casks before continuing on to the MGDS. At the MGDS, the casks will be unloaded, and the SNF assemblies will be transferred to waste packages, which will be emplaced in the underground repository.

Table 2-1. SNF and HLW Movement in the CRWMS (MTU)

	Picked up from Reactors	Into MRS Storage	Inventory at MRS	From MRS/ Emplaced in 1st MGDS	Emplaced in 2nd MGDS	HLW 1st MGDS	HLW 2nd MGDS
2000	900	900	900	0	0	0	0
2001	900	900	1800	0	0	0	0
2002	900	900	2700	0	0	0	0
2003	900	900	3600	0	0	0	0
2004	900	900	4500	0	0	0	0
2005	900	900	5400	0	0	0	0
2006	900	900	6300	0	0	0	0
2007	900	900	7200	0	0	0	0
2008	900	900	8100	0	0	0	0
2009	900	900	9000	0	0	0	0
2010	1400	1100	10100	300	0	0	0
2011	2000	1400	11500	600	0	0	0
2012	2600	1400	12900	1200	0	0	0
2013	3000	1000	13900	2000	0	0	0
2014	3000	0	13900	3000	0	0	0
2015	3000	0	13900	3000	0	372	0
2016	3000	0	13900	3000	0	372	0
2017	3000	0	13900	3000	0	372	0
2018	3000	0	13900	3000	0	372	0
2019	3000	0	13900	3000	0	372	0
2020	3000	0	13900	3000	0	372	0
2021	3000	0	13900	3000	0	372	0
2022	3000	0	13900	3000	0	372	0
2023	3000	0	13900	3000	0	372	0
2024	3000	0	13900	3000	0	372	0
2025	3000	0	13900	3000	0	372	0
2026	3000	0	13900	3000	0	372	0
2027	3000	0	13900	3000	0	372	0
2028	3000	0	13900	3000	0	372	0
2029	0	-3000	10900	3000	0	372	0
2030	0	-3000	7900	3000	0	372	0
2031	0	-3000	4900	3000	0	363	0
2032	0	-3000	1900	3000	0	363	0
2033	0	-1900	0	1900	0	322	0
2034	2500	0	0	0	2500	0	500
2035	3000	0	0	0	3000	0	500
2036	3000	0	0	0	3000	0	500
2037	3000	0	0	0	3000	0	500
2038	3000	0	0	0	3000	0	500
2039	3000	0	0	0	3000	0	500
2040	3000	0	0	0	3000	0	500
2041	2655	0	0	0	2655	0	470.5
Total	**86155**	**N/A**	**N/A**	**63000**	**23155**	**7000**	**3970.5**

2.2.1 Utilities

As the spent fuel is discharged from the reactors, it will be placed in racks in the spent fuel pools for storage until it is picked up by the CRWMS. Facilities that run out of storage space in their pools will load SNF into non-transportable MESCs for on-site dry storage. Facilities with sufficient handling capabilities will load large MESCs (24P/52B), while those that cannot handle large MESCs will load small MESCs (7P/17B). The MESCs will be loaded inside a transfer cask in the facility pool and transferred to an on-site concrete cask for storage. The loading of a MESC will be similar to the loading of an MPC, which is described in Section 2.3.

2.2.2 Waste Acceptance

At the time of waste acceptance, the transportation cask will be moved inside the fuel handling building, filled with water, and lowered into the spent fuel pool using an appropriate handling yoke with the fuel handling building crane. Spent fuel assemblies will be removed from the storage rack and placed in the transportation cask. The serial number of each fuel assembly will be verified in the process. If the large PWR cask is being loaded, the burnup of the SNF will also be verified. When all fuel slots in the cask have been filled, the lid will be set in place on top of the cask, and the cask will be lifted clear of the pool water and set to the side of the pool. Cask lid bolting will be completed, and the cask will be vacuum dried and filled with an inert gas. The access port will be sealed, and the cask exterior will be decontaminated. The cask will then be prepared for shipment to the MRS. MESCs used for on-site storage must be returned to the spent fuel pool and opened, and the SNF in the MESC must be unloaded into the pool storage racks and then transferred to a transportation cask. The loading of a legal weight truck cask is illustrated in Figure 2-1.

Two sizes of rail cask will be used to accommodate the majority of facilities; 88 facilities will load and ship 100-ton rail casks and 14 facilities will load and ship 75-ton rail casks. For conservatism, legal weight truck casks (25 tons) will be used at the 19 facilities that cannot handle the rail casks. The weights listed are nominal crane hook weights, including SNF, water, transportation cask with lid, and lifting yoke.

2.2.3 Transportation

Once picked up into the CRWMS, the loaded transportation cask will be shipped to the MRS by legal weight truck or dedicated train. At many facilities, the use of barge and/or heavy-haul truck will enable the use of the largest cask possible. Heavy-haul will be used at 49 facilities. Off-site heavy-haul truck will be used to transport rail casks from 9 facilities to off-site rail. On-site heavy-haul truck will be used to transport rail casks from 22 facilities to rail at the site boundary. On-site heavy-haul truck will be used to transport rail casks from 18 facilities to barge for transport to off-site rail. All shipments from the MRS to the MGDS will be by dedicated train. Truck and rail shipments from the facilities to the second MGDS will not go through the MRS.

2.2.4 MRS

Upon arrival at the MRS, transportation casks containing spent fuel scheduled for storage will be washed down if necessary, moved into the Transfer Facility, and inspected. Shipment-related

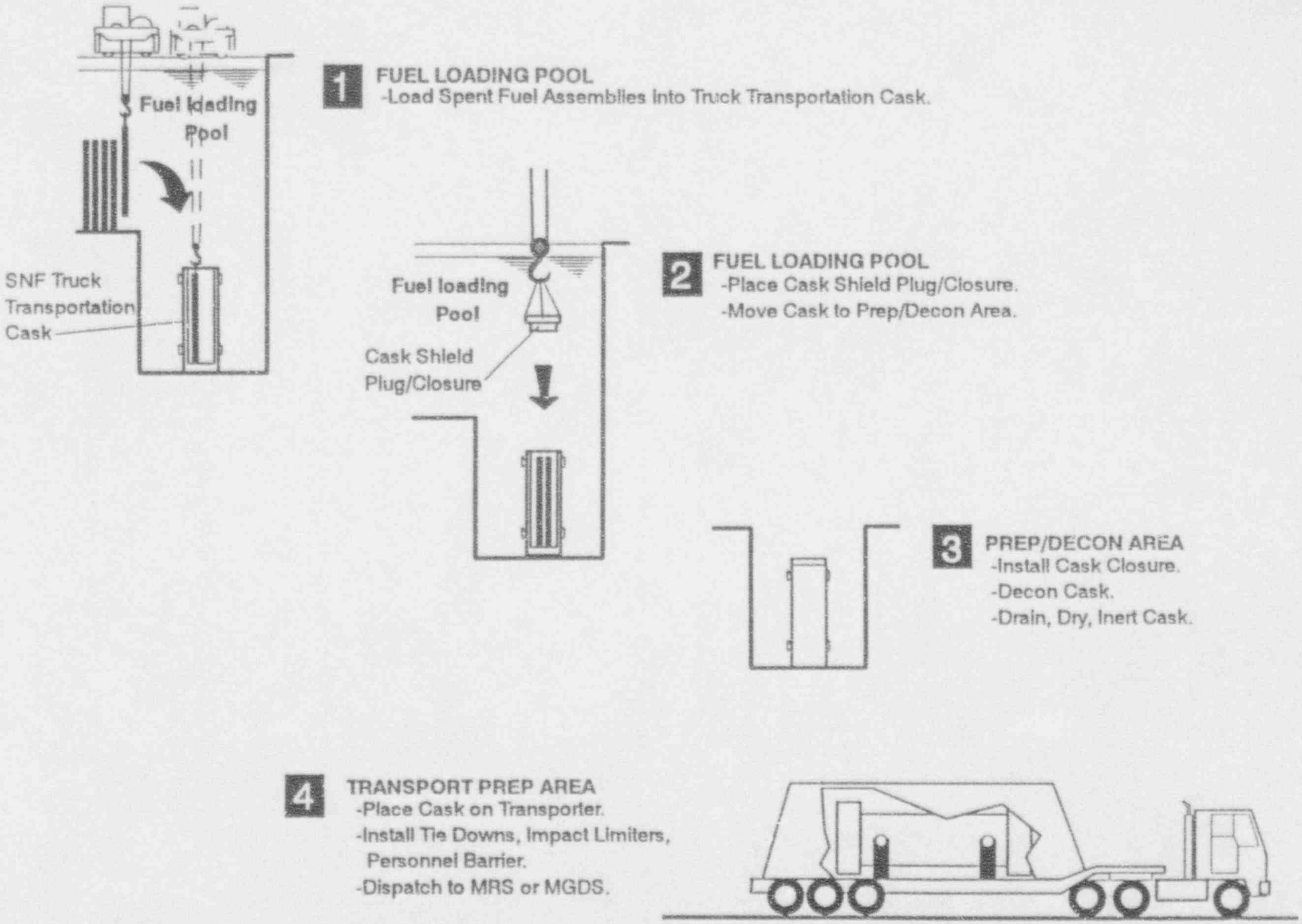


Figure 2-1. Loading SNF into a Legal Weight Truck Cask

hardware will be removed (impact limiters, tie downs, etc), and the cask will be transferred from the rail or truck to an on-site carrier. The cask will then be moved to the cask preparation area and prepared for unloading. Gases in the cask interior will be sampled, and, if the cask has both an inner and an outer lid, the outer lid will be unbolted and removed. If the cask has a bolted inner lid, the bolts will be loosened. The cask will be fitted with a port cell adapter, moved into position under the port of the transfer cell, and mated to the inload port. From the transfer cell, a crane with appropriate grapples will remove the cask's inner lid and set it in a lay down area in the cell. A crane with a different grapple will lift a spent fuel assembly from the transportation cask into the transfer cell, and the serial number of the fuel assembly will be recorded. The crane will then move the fuel assembly across the transfer cell and lower it into the storage cask, situated below the outload port. The spent fuel assembly transfer process will be repeated until the storage cask is full. At that time, the storage cask lid will be set in place and sealed, and the storage cask will be moved to the storage area. The transfer of spent fuel from storage to transportation casks for shipment to the MGDS will be the reverse process.

Arriving truck casks with spent fuel not intended for storage will be unloaded in transfer cells and the spent fuel assemblies transferred to rail transportation casks for shipment to the MGDS (passthrough). The process is similar to the loading of a storage cask, as described above. Arriving rail casks with spent fuel not intended for storage will not move through the Transfer Facility, but will be placed directly on trains for shipment to the MGDS (flowthrough).

The Cask Maintenance Facility (CMF) will be integrated with the MRS to support maintenance activities for the fleet of shipping casks. Major repairs and maintenance tasks performed on transportation casks in the CMF would include decontaminating cask interiors, changing cask baskets, performing periodic maintenance, and repairing damaged casks.

2.2.5 MGDS

Upon arrival at the MGDS, the cask will be transferred from the off-site carrier to an on-site carrier, washed if necessary, and moved into the Waste Handling Building (WHB). The first MGDS will receive rail casks with SNF from the MRS and HLW from current storage sites. The second MGDS will receive both truck and rail casks directly from the facilities. Spent fuel assemblies will be transferred from transportation casks to waste packages via transfer cells in the WHB. The cask handling and waste package loading processes are similar to the loading of a storage cask at the MRS, as described above. When the waste package is fully loaded, it will be moved to the welding station, and full-penetration welds will be performed on both the inner corrosion-resistance lid and the outer corrosion-allowance lid of the waste package. The sealed waste package will then be moved to the surface vault for transfer to the underground transporter.

The shielded transporter will move the waste package to the disposal horizon via the waste emplacement ramp. In order to provide cost traceability to the program baseline while providing comparability with the MPC, the MGDS for the reference scenario will be evaluated with a small, borehole-emplaced waste package and a large, drift-emplaced waste package. For the case of the small borehole waste package, emplacement will be in vertical boreholes in the floor of the emplacement panels or drifts. For borehole emplacement, the waste package must be transferred from the transporter to an emplacement vehicle designed to insert the package into the borehole. For the case of large waste packages, in-drift emplacement will be used, and it will be assumed that the transport vehicle will also perform the emplacement function All handling of the waste packages will be performed from shielded vehicles, as the disposal package will not be shielded sufficiently to allow contact handling.

To provide traceability in the cost analysis, the borehole waste package case will consider two variants, the first of which is the *Site Characterization Plan* (SCP--Ref 4) design, based on drill and blast mining, a vertical Exploratory Shaft Facility, and borehole emplacement panels. The second variant is a modification of the SCP design reflecting the results of the ESF Alternatives Study, and is based on the use of tunnel boring machines (TBMs), the Exploratory Studies Facility (ESF) which is currently under construction, and borehole emplacement drifts. The large waste package case reflects the on-going Emplacement Mode System Study by the MGDS Systems Analysis department, and is based on the use of TBMs, current ESF design, and in-drift emplacement of large waste packages in emplacement drifts.

2.3 MPC SYSTEM

In the MPC system, SNF will be stored in pools at the facilities. Facilities that run out of pool storage space will load MPCs for on-site dry storage (if they can accommodate MPCs). At the time of waste acceptance, SNF assemblies will be loaded into MPCs in transportation casks in the spent fuel pools. The MPCs in transportation casks will be shipped to the MRS, where the MPCs will either be transferred to a storage mode or placed on a train for shipment to the MGDS. Facilities that cannot handle MPCs will ship uncanistered SNF in LWT casks to the MRS, where the SNF will be transferred to MPCs and placed in storage or shipped to the MGDS by rail. At the MGDS, the MPCs will be placed in disposal containers, which will be emplaced in the underground repository. The following subsections describe the process in greater detail.

2.3.1 Utilities

This section describes the use of MPCs for at-reactor dry storage. The empty MPC will be placed in an on-site transfer cask with the lid of both the MPC and the transfer cask removed. The annular gap between the MPC and transfer cask will be filled with de-ionized water and sealed with a temporary seal to prevent pool water from coming in contact with the clean outer surface of the MPC. The transfer cask containing the MPC will then be filled with water and lowered into the pool using an appropriate handling yoke with the fuel handling building crane. A spent fuel assembly will be lifted partway out of the spent fuel storage rack and its burnup verified using a burnup verification device. This process will be repeated for each fuel assembly loaded into the MPC. According to handling capabilities, facilities will load 125-ton MPCs, 75-ton MPCs, or small non-transportable MESCs for on-site storage (which will require returning to the spent fuel pool to transfer the spent fuel to LWT transportation casks when the SNF is picked up into the CRWMS). The use of non-transportable MESCs is assumed for the purposes of analysis.

When all fuel slots in the MPC have been filled, the end shield plug will be set in place, and the transfer cask/MPC will be lifted clear of the water. The water level inside the MPC will be lowered to the level of the shield plug. The inner lid will be set in place on top of the shield plug and a partial-penetration weld will be performed. This weld will then undergo non-destructive evaluation. A honeycomb steel spacer will be set on top of this, and the outer lid will be placed on top of the steel spacer and welded with a partial-penetration weld. The weld on the outer lid will then undergo non-destructive evaluation similar to the inner lid. The MPC will be vacuum dried and filled with an inert gas, the access port will be sealed, and the gap seal and de-ionized water will be removed from the annular gap between the MPC and the transfer cask. The lid will then be bolted on the transfer cask, and the transfer cask will be removed from the pool, decontaminated, and placed on an on-site transporter or heavy-haul truck.

The MPC in its transfer cask will then be transported to the at-reactor storage facility, where the MPC will be transferred to its storage mode and the lid or door of the storage mode will be closed and tack welded, as appropriate, for security. The loading and handling of an MPC for on-site storage is shown in Figure 2-2.

2.3.2 Waste Acceptance

The loading and sealing operations of MPCs for acceptance into the CRWMS directly from the spent fuel pool will be similar to the loading and sealing of MPCs for at-reactor dry storage (Section 2.3.1), except that the MPC will be in a transportation cask, where possible, rather than an on-site transfer cask. This procedure is shown in Figure 2-3. Once the MPC is welded and the de-ionized water and seal are removed from the annular gap, the transportation cask will be bolted closed, the exterior of the cask will be decontaminated, and the cask will be loaded onto a skid or carriage to be picked up into the CRWMS.

For MPCs in dry storage at the time the MPC is to be picked up into the CRWMS, the closure will be removed from the storage mode door or lid, and the MPC will be transferred from the storage mode to the transportation cask, either directly, or using a transfer system. The lid will be bolted on the transportation cask, which will then be accepted into the CRWMS. This procedure is shown in Figure 2-4.

Two sizes of MPC will be used to accommodate the majority of facilities; 88 facilities will load and ship 125-ton MPCs (115-ton nominal crane hook weight, including MPC plus shield plug, SNF, water, transportation cask without lid, and lifting yoke) and 14 facilities will load and ship 75-ton MPCs. Legal weight truck casks (25 tons) will be used at 19 facilities that cannot handle the 125-ton or 75-ton MPCs.

Of the 88 facilities that will ship 125-ton MPCs, 32 facilities have handling capabilities limited to 100 tons. These facilities will load 125-ton MPCs in the spent fuel pools in on-site transfer casks and transfer the MPCs to transportation casks using the OSTS. This procedure is shown in Figure 2-5.

2.3.3 Transportation

The loaded MPC in its transportation cask will be transported to the MRS by rail. A conceptual sketch of the MPC in its transportation cask is shown in Figure 2-6. For facilities with rail access to the fuel handling building, the MPC in its cask will be placed directly on the rail car using the fuel handling building crane. At many sites, barge and/or heavy-haul truck will be used to enable the use of the large MPC. Off-site heavy-haul will be used to transport MPCs in transportation casks from 9 facilities to off-site rail. On-site heavy-haul will be used to transport

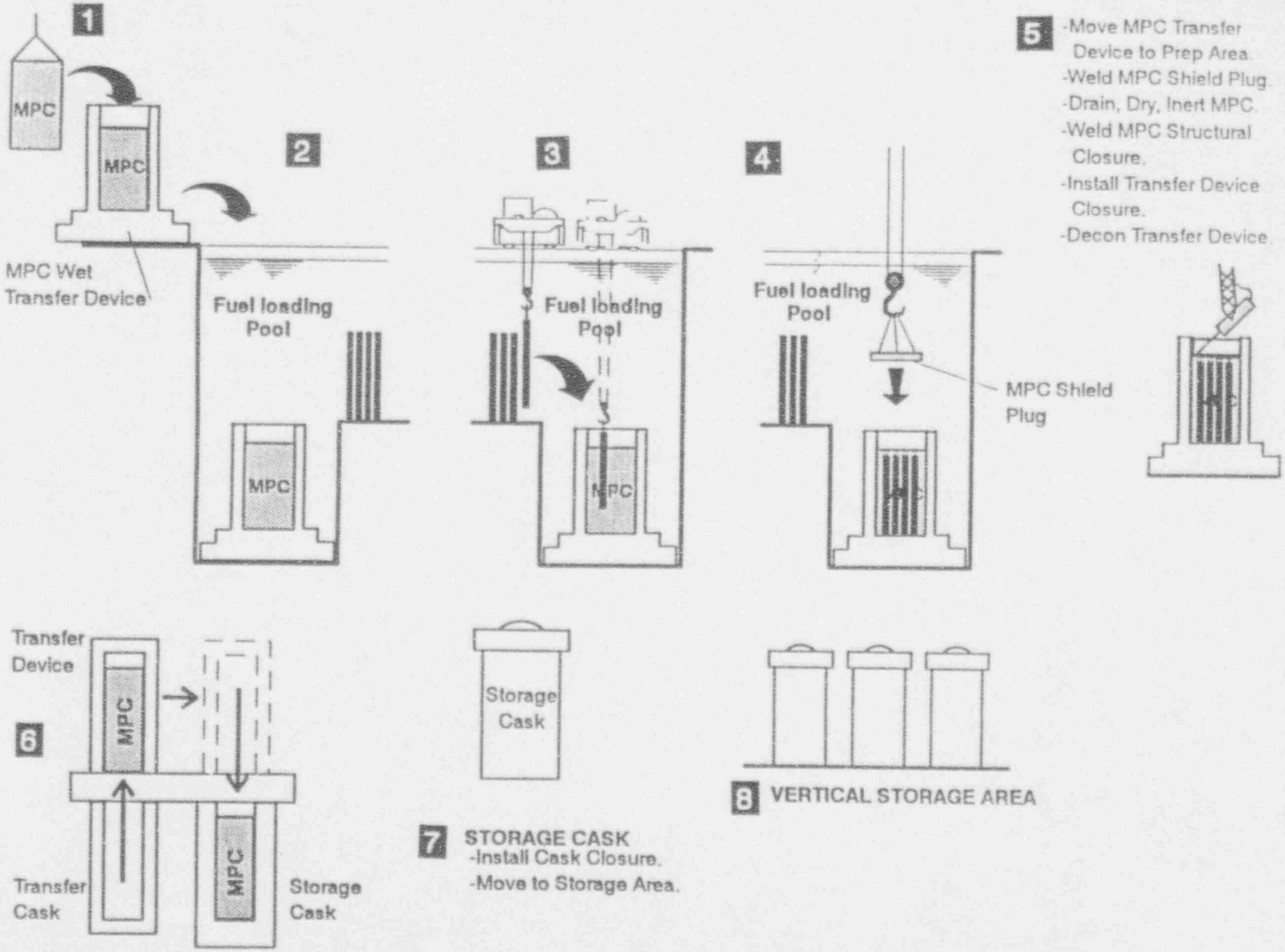


Figure 2-2. Loading and Handling of MPC for On-Site Storage

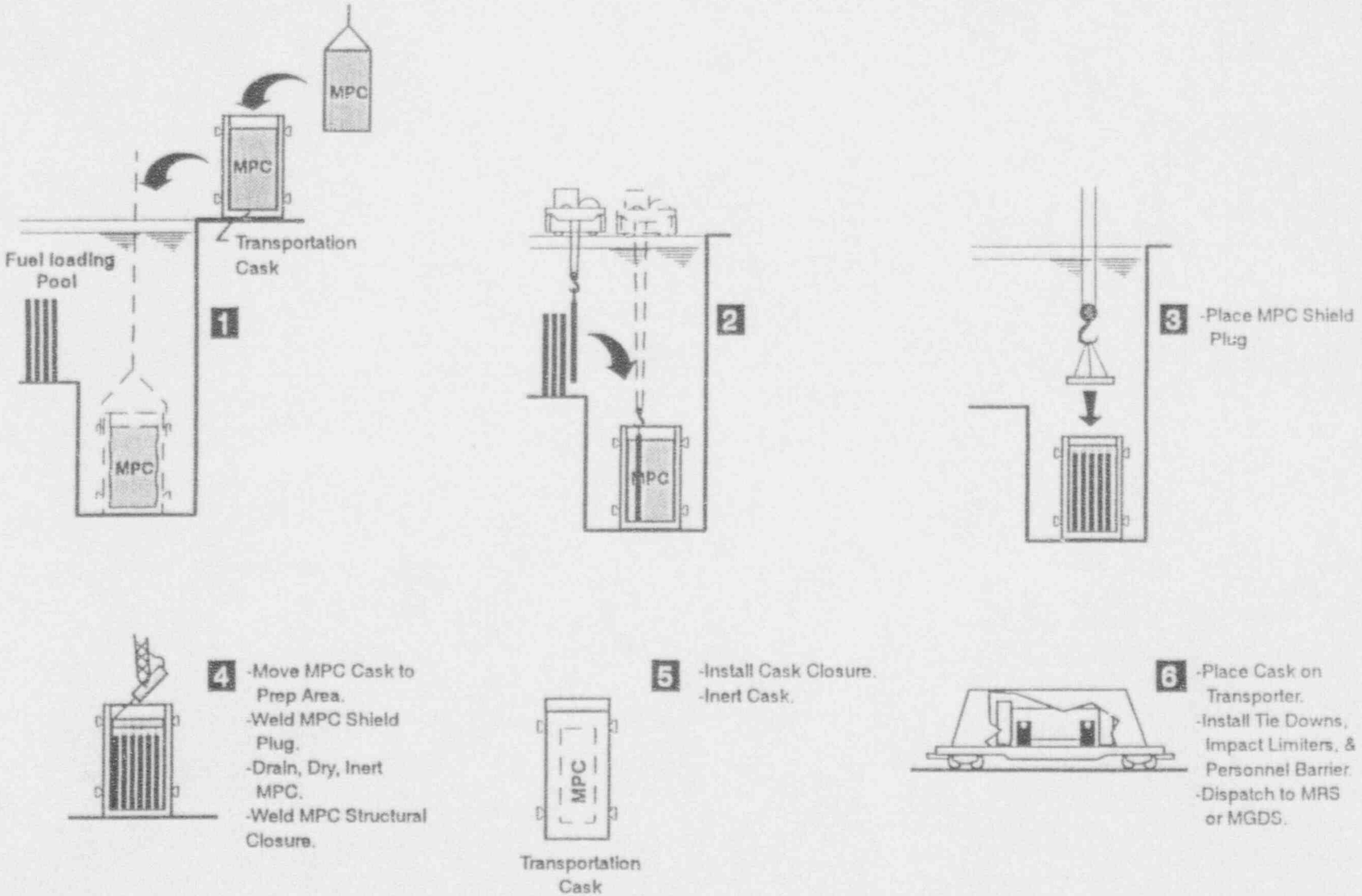


Figure 2-3. Loading and Handling of MPC for Off-Site Shipment

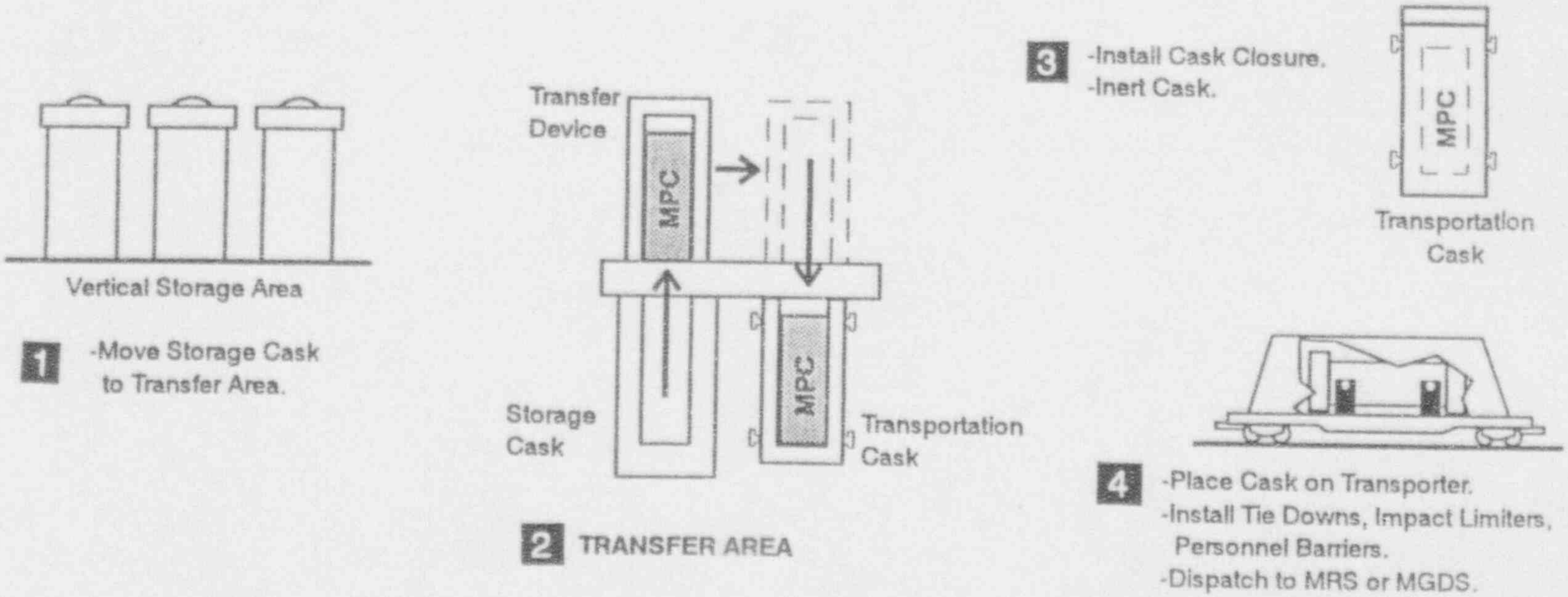


Figure 2-4. Removal of MPC from On-Site Storage for Transportation

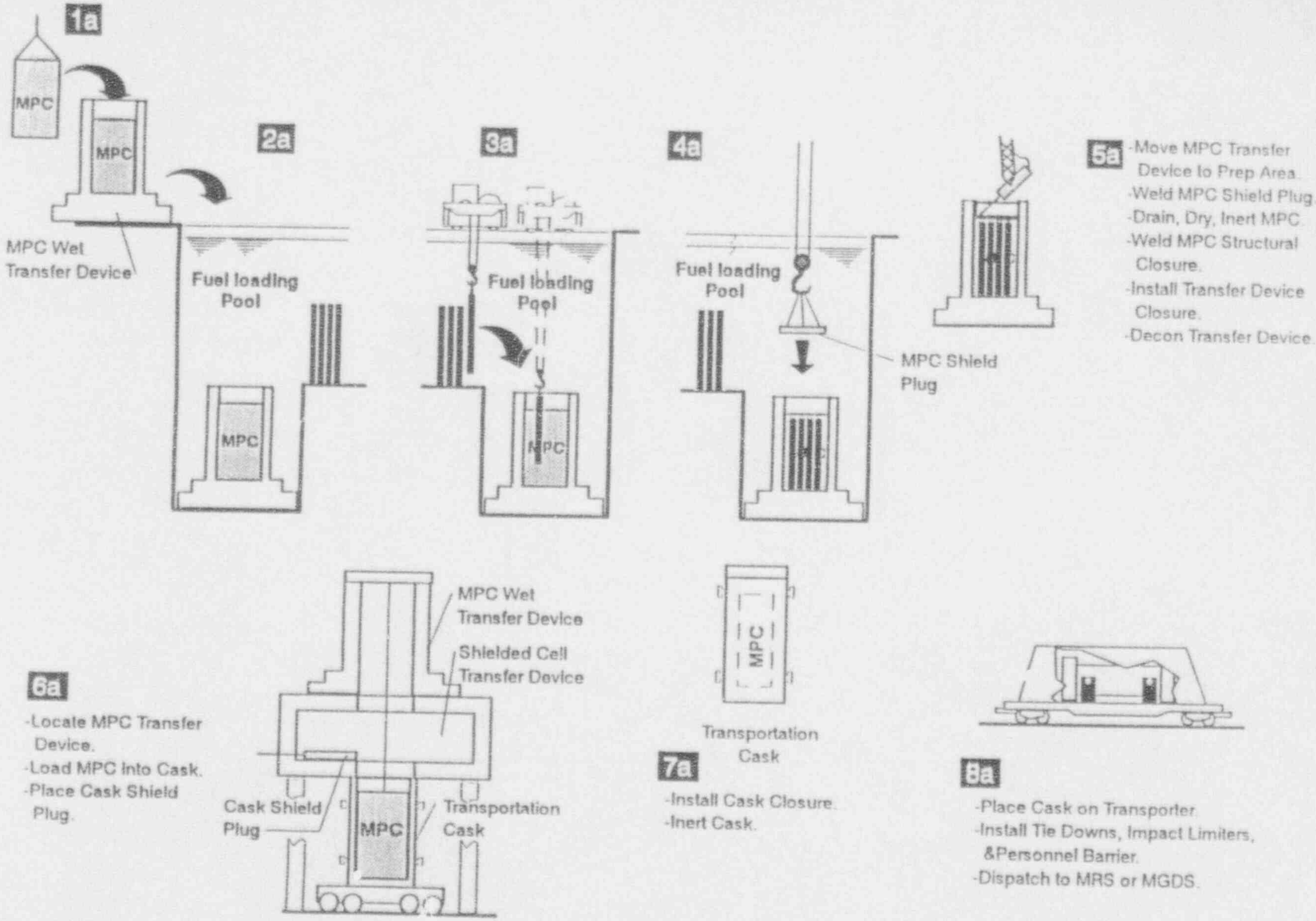


Figure 2-5. Loading and Handling of MPC for Transportation via On-Site Transfer Cask

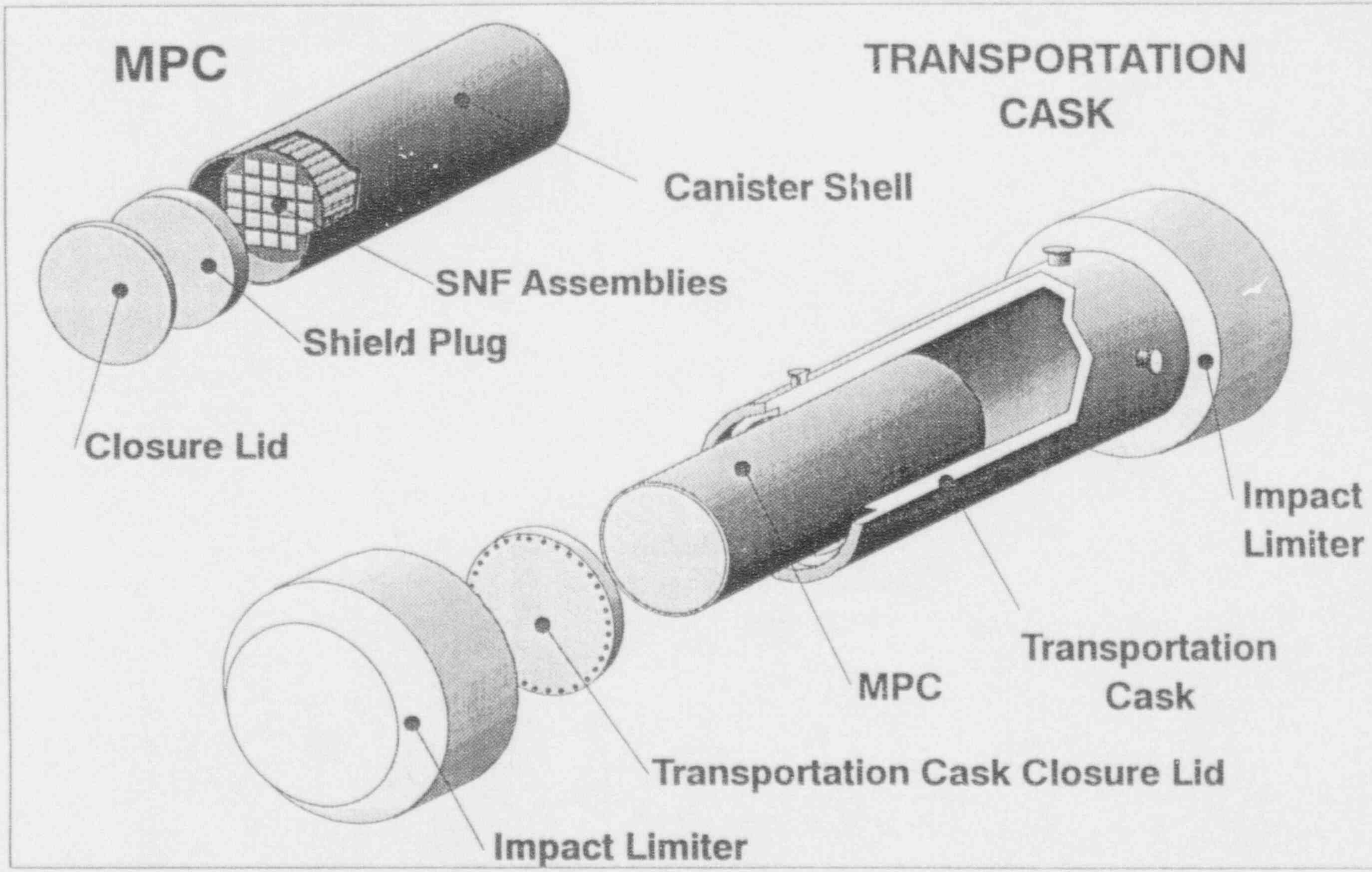


Figure 2-6. MPC and MPC Transportation Cask

MPCs in transportation casks from 22 facilities to rail at the site boundary. On-site heavy-haul truck will be used to transport MPCs in transportation casks from 18 facilities to barge for transport to off-site rail. All shipments from the MRS to the MGDS will be by dedicated train. Truck and rail shipments from the facilities to the second MGDS will not go through the MRS.

2.3.4 MRS

When a loaded MPC arrives at the MRS, it will be placed either in storage or on a dedicated train for shipment to the MGDS (flowthrough). An MPC going into storage will be transferred from its transportation cask to its storage mode inside a transfer room that will be used only for handling clean, sealed MPCs. The lid will be placed on the storage mode, and it will be moved outside to the storage area. Figure 2-7 shows a potential MRS storage mode concept. The transportation cask will be inspected and any required maintenance will be performed at the CMF before it is shipped with an empty MPC to the next facility.

Truck casks arriving at the MRS from facilities that cannot handle an MPC will be placed inside a bare fuel transfer cell, and the individual fuel assemblies will be transferred from the transportation cask to an MPC. When the MPC is fully loaded, it will be sealed and the lid will be decontaminated. During the loading operation, the MPC will either be in its storage mode or in a transportation cask, depending on whether the MPC will be placed in storage at the MRS or placed on a dedicated train for shipment to the MGDS (passthrough). The unloaded bare fuel transportation cask will be decontaminated and inspected, and any required maintenance will be performed at the CMF before it is shipped to the next facility.

When the MPC is retrieved from storage at the MRS, the storage mode will be returned to the clean transfer room, and the MPC will be transferred from the storage mode to a transportation cask, which will be placed on a dedicated train for shipment to the MGDS. If the need were identified, the MRS would have the ability to access the interior of the MPCs before or after the storage period.

The CMF will be integrated with the MRS for the MPC system and will perform the same functions as the CMF in the reference scenario. However, all rail transportation casks in the MPC system will be used to transport clean, sealed MPCs, which will substantially reduce the amount of decontamination required and will simplify facilities and operations at the CMF. Maintenance of LWT casks for the MPC system will be identical to that for the reference scenario.

2.3.5 MGDS

At the MGDS, the MPC will be transferred from its transportation cask to a disposal container inside a transfer room, and the container will be sealed with full-penetration welds on both the inner corrosion-resistance lid and the outer corrosion-allowance lid. The waste package (i.e., MPC in its disposal container) will be moved into the underground repository using a shielded transporter and will be emplaced using in-drift emplacement. The design and operation of the MGDS in the MPC system will be similar to the MGDS in the large waste package case of the reference scenario (Section 2.2.5) with the exception that all routine handling will be of clean, sealed MPCs rather than uncanistered SNF. A transfer cell will be available at the first MGDS

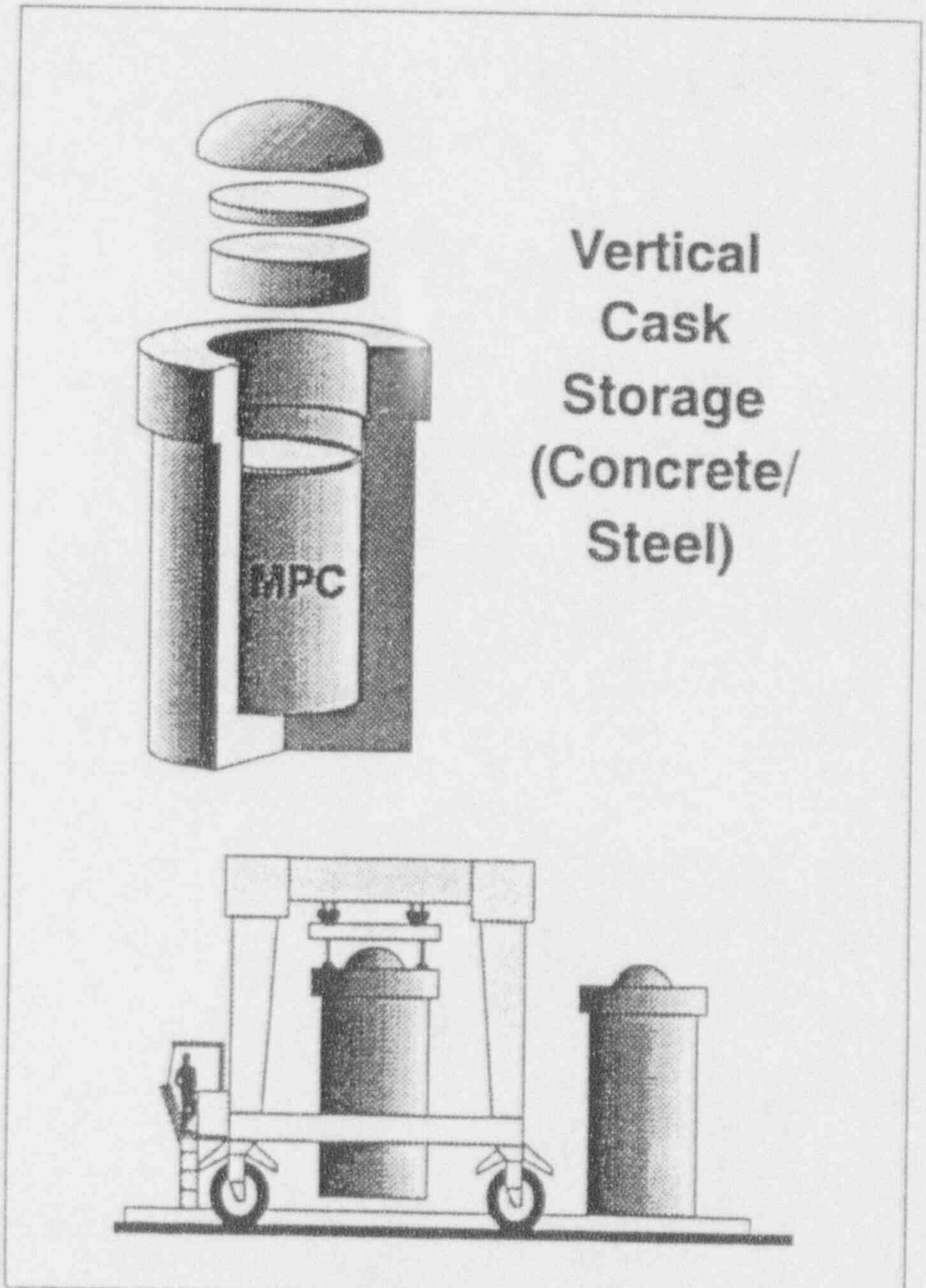


Figure 2-7. Potential MRS Storage Mode for MPC

for recovery from off-normal conditions, such as a damaged MPC, which would require that uncanistered SNF assemblies be transferred to a separate waste package for emplacement. If the need were identified, the MGDS would have the ability to add filler to the MPCs prior to emplacement.

For the second MGDS, some uncanistered fuel will arrive at the MGDS in LWT transportation casks. In these cases, the fuel assemblies will be transferred inside bare fuel transfer cells into large waste packages similar to those in the large waste package case of the reference scenario, and the waste packages will be decontaminated as needed, before being moved to the underground repository for in-drift emplacement.

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3. DEFINITION OF SYSTEM PARAMETERS

A set of system parameters was identified which defines the overall design and operations of the CRWMS; these parameters were assigned values for the reference scenario and MPC system in accordance with existing program documents, current program planning, and anticipated MPC requirements. The parameters and assigned values are described below, listed according to the appropriate system element.

3.1 UTILITIES

At-Reactor Storage Strategy
The reference scenario will use non-transportable multi-element sealed canisters (MESCs) in Dry Vertical Concrete Casks (DVCCs) for dry storage at operating reactors that have exceeded the capacity of their spent fuel pools. This assumption is based on using a low-cost option for operating reactor dry storage in the reference scenario. The MPC system will use MPCs in their storage modes for dry storage at operating reactors that can handle MPCs and have exceeded the capacity of their spent fuel pools. For the purposes of analysis, it is assumed that MPCs will be available for dry storage beginning in 1998. It is also assumed that facilities requiring dry storage prior to 1998 will use non-transportable MESCs. Reactors that cannot handle large casks (75 tons or greater) in the MPC system are assumed, for purposes of analysis, to use small non-transportable MESCs (7P/17B) for on-site storage.

In the case of shutdown reactors, the reference scenario will leave all SNF in the storage pools until it is picked up. For reactors that will ship the SNF in MPCs, all remaining fuel is assumed to be removed from the pools five years after shutdown and sealed in MPCs, which are placed in MPC storage modes. Truck facilities will leave all SNF in the pools until it is picked up.

SNF Discharge Projections
Both scenarios have been evaluated using the 1992 Energy Information Administration (EIA) projections for total SNF discharges as presented in Reference 3. The projection totals 86,155 MTU of SNF, which assumes a 40-year life for all reactors currently operating or under construction, and no new reactors being ordered.

3.2 WASTE ACCEPTANCE

Fuel Acceptance Strategy
Both scenarios have been evaluated for the acceptance of 86,155 MTU of SNF and 11,000 MTU equivalent of HLW (based on the Oak Ridge National Laboratory Integrated Database for 1992) (Ref 5). Allocation rights for waste acceptance and selection for both scenarios have been based on oldest fuel first (OFF), with pickup of SNF in dry storage deferred until a facility's pool is empty. The assumption of OFF for selection has been used due to the unavailability of thermal and radiation derating data for the MPC designs being developed in the MPC Conceptual Design Phase work. As these data become available, follow-on analyses will consider the impact of selection of youngest fuel first, aged at least 5 years (YFF5) and 10 years (YFF10).

Dry Storage/Transportation Interface

At the time that SNF is picked up into the CRWMS from reactors using dry storage in the reference scenario, and for "truck" facilities in the MPC system, the non-transportable MESCs will be returned to the spent fuel pool once the fuel in the pool has been picked up. The MESCs will be opened in the spent fuel pool, and the SNF returned to the storage racks, from which it will be transferred to a transportation cask. In the MPC system, the sealed MPC will be transferred from its storage mode into its transportation cask without going back through the spent fuel pool. Spent fuel placed in dry storage in MESCs prior to 1998 in the MPC system will be unloaded from the MESCs and transferred to MPCs in the spent fuel pools at the time the SNF is picked up into the CRWMS.

Non-Standard Fuel Strategy

Both scenarios treat non-standard fuel as standard fuel for the purpose of analysis in the MPC Conceptual Design Phase work. Non-standard fuel and non-fuel components have been shown (Ref 6) to have a relatively minor impact on the CRWMS, and are not perceived to be a discriminator between the reference scenario and the MPC system. This includes items such as SNF from the South Texas PWRs which is longer than standard fuel, and will require extended length designs in both the reference scenario and the MPC system.

Other Waste Type Strategy

Other waste types, such as fuel from the Fort St. Vrain high temperature gas cooled reactor and research reactors, and the damaged Three Mile Island Unit 2 core were not considered in the scenarios.

3.3 TRANSPORTATION

Family of Casks/Canisters

The reference scenario uses three sizes of transportation cask: 100-ton rail cask, with a capacity of 21 PWR assemblies or 37 BWR assemblies (based on the latest *Reference Transportation Data and Assumptions (RTDA) Report*--Ref 7); 75-ton rail cask, with a capacity of 12 PWR assemblies or 24 BWR assemblies; and 25-ton legal weight truck (LWT) cask, with a capacity of 4 PWR assemblies or 9 BWR assemblies. For dry storage at the facilities, the reference scenario uses large non-transportable MESCs with a capacity of 24 PWR assemblies or 52 BWR assemblies at facilities with large cask handling capabilities, and small non-transportable MESCs with a capacity of 7 PWR assemblies or 17 BWR assemblies at those facilities limited to small cask handling.

The MPC system uses two sizes of MPC with associated transportation casks, an on-site transfer cask for the large MPC, and one size of LWT cask for uncanistered SNF. The 125-ton MPC (115-ton nominal crane hook weight, including MPC plus shield plug, SNF, water, transportation cask without lid, and lifting yoke) will have a capacity of 21 PWR assemblies or 40 BWR assemblies. The 75-ton MPC will have a capacity of 12 PWR assemblies or 24 BWR assemblies. The MPC system will use a 25-ton LWT cask for uncanistered SNF, with a capacity of 4 PWR assemblies or 9 BWR assemblies to accommodate the facilities that do not have the capability to handle the rail-sized MPCs. The MPC system will also use on-site transfer casks for moving the 125-ton and 75-ton MPCs into and out of storage. The transfer cask for the 125-ton MPC will also be used to transfer the sealed MPC to its transportation cask out of the pool at some facilities; the nominal crane hook weight of the loaded MPC/transfer cask will be equal to or below 100 tons.

Modal Capability
Facility cask handling capabilities and transportation infrastructure were analyzed to identify the most plausible modal capability for the handling and transportation of MPCs and transportation casks. Section 4 presents the modal capabilities of each facility in greater detail. The number of facilities shipping each size of cask or MPC is summarized as follows:

Reference Scenario	Number of Facilities
Truck cask	19
75-ton rail cask	14
100-ton rail cask	88

MPC System	Number of Facilities
Truck cask	19
75-ton rail MPC	14
125-ton rail MPC	88

Use of Intermodal Transfer
Both scenarios employ barge and heavy-haul truck to move MPCs from the facility fuel handling buildings to rail facilities at sites that can handle MPCs but do not have rail access. Heavy-haul truck shipments will be transferred to rail at the nearest rail facility. Barge shipments are assumed to terminate at the nearest rail-accessible port, in accordance with current Interline transportation model assumptions. LWT casks will be shipped by legal weight truck from the facilities to the MRS; LWT casks will not undergo intermodal transfer.

Use of Western Strategy
Both scenarios assume no use of a western strategy (i.e., facilities located in the western United States bypassing the MRS and shipping SNF directly to a western MGDS after the MGDS begins operations).

Transportation Routing and Mileage
Both scenarios are based on the Highway and Interline transportation models and associated databases, similar to the Throughput Study report recently produced by the M&O (Ref 8).

Throughput Rate
Both scenarios are based on a system ramp-up throughput rate of 900 MTU per year before the first MGDS opens, and a throughput rate of 3000 MTU per year during first MGDS steady-state operations (Table 2-1). The second MGDS will operate at 3000 MTU per year.

Cask Maintenance Facility
Both scenarios are based on the Cask Maintenance Facility (CMF) being integrated with the MRS while the first MGDS is in operation, and with the second MGDS once the MRS and first MGDS cease to receive SNF or HLW and the MRS is decommissioned.

3.4 MRS

Number of MRSs
Both scenarios are based on a single MRS in the system. The inclusion of an MRS in the system is based on the RSD (Ref 2). A scenario without an MRS is considered in the document *Programmatic Risk and Contingency Analysis for the Multi-Purpose Canister System* (Ref 3).

Location of MRS
The location of the MRS for both scenarios is generic western.

Start Date of MRS
Both scenarios are based on a 2000 start date of the MRS, based on the most recent MRS Major System Acquisition (MSA) schedule analysis.

Capacity
The maximum allowable amount of SNF stored at the MRS for both scenarios is 10,000 MTU prior to the commencement of emplacement at the MGDS and 15,000 MTU thereafter.

Storage Technology
The reference scenario will utilize dry vertical concrete casks (DVCCs) for the storage of uncanistered SNF at the MRS; the DVCC will have a capacity of 28 PWR assemblies or 56 BWR assemblies, consistent with the MRS Conceptual Design Report. The MPC system will use DVCCs for the storage of 75-ton and 125-ton MPCs.

Operational Concept
The MRS will handle uncanistered SNF in the reference scenario; in the MPC system, it will handle both MPCs and uncanistered fuel.

3.5 MGDS

Number of MGDSs
Both scenarios have been evaluated with two MGDSs. This was necessary to accommodate the acceptance of all 86,155 MTU of SNF while conforming to the legislated maximum emplacement of 63,000 MTU of SNF plus 7,000 MTU equivalent of HLW in the first repository until such time as a second repository is in operation [NWPA Section 114(d)].

Locations
The first MGDS is assumed to be located at Yucca Mountain, Nevada for the purpose of analyses in the MPC Conceptual Design Phase work. The second MGDS is assumed to be located at a generic western site.

MGDS Start Dates
The first MGDS will begin receiving SNF in 2010 for both scenarios. The second MGDS will begin receiving SNF in 2034, after receipt of SNF and HLW at the first MGDS is complete (70,000 MTU).

Amount of SNF/HLW Accepted
Both scenarios are based on the first MGDS emplacing 63,000 MTU of SNF and 7000 MTU equivalent of HLW, and the second MGDS emplacing the remaining 23,155 MTU of SNF and 4000 MTU of HLW.

MGDS Surface Storage
Both scenarios are based on minimal lag storage and no interim storage at the MGDS.

Waste Package Design
The waste package for the small, borehole waste package case of the reference scenario will be the unconsolidated, uncanistered SNF waste package design, with a capacity of 3P+4B as specified in the 1989 Total System Life Cycle Cost (TSLCC) analysis (Ref 9), based on the Repository-Specific Rod Consolidation study, Ref 10). For years in which the ratio of P/B assemblies does not result in an integral number of mixed P/B waste packages, the capacity of the small borehole waste package will be 4 PWR assemblies or 10 BWR assemblies. The material of construction will be stainless steel, in accordance with the 1989 TSLCC. The waste package for the large, in-drift case of the reference scenario will be similar to the 125-ton MPC, but will not be designed or licensed for transportation. For the purpose of analysis, the large, in-drift waste package will be constructed of Alloy 825 for corrosion resistance and mild steel for corrosion allowance.

The waste package for the MPC system will be the MPC (75- or 125-ton) in its disposal container. The disposal container will be constructed of Alloy 825 for corrosion resistance and mild steel for corrosion allowance, based on using stainless steel for the base case MPC material.

Emplacement Mode
The reference scenario was evaluated for both borehole emplacement of small waste packages in accordance with the SCP and in-drift emplacement of large waste packages similar to an MPC. The MPC system will employ in-drift emplacement.

Areal Power Density
Both scenarios was based on areal power density in the repository of 57 kW/acre in accordance with the SCP. Areal power density represents the thermal output (in kilowatts) of the emplaced waste per unit area (in acres) of the underground repository.

MGDS Operational Concept
For the first MGDS, the reference scenario was based on the MGDS handling unconsolidated, uncanistered fuel assemblies. The MPC system was based on the first MGDS handling MPCs only; however, the MGDS was designed with the ability to handle uncanistered fuel in the event of an off-normal event.

For the second MGDS, the reference scenario was based on the MGDS handling unconsolidated, uncanistered fuel assemblies. The MPC system was based on the second MGDS handling MPCs, as well as intact, uncanistered fuel assemblies from "truck" facilities.

HLW Operational Strategy
High level waste (HLW) from SNF reprocessing at civilian and defense sites will be stored at current locations until it is shipped to the MGDS beginning in 2015. All HLW will be shipped to the MGDS by rail in transportation casks with a capacity of five HLW canisters each. The reference scenario borehole waste package will contain one HLW canister; the large, reference scenario in-drift waste package and the MPC system in-drift disposal container will each contain four HLW canisters.

The system parameters and assigned values for both the reference system and MPC system are summarized and presented in Table 3-1.

Table 3-1. Definition of System Parameters for MPC Conceptual Design Phase Work

PARAMETER	REFERENCE	MPC
UTILITIES		
At-Reactor Storage Strategy		
--Operating reactor dry storage	Non-transportable MESC in dry vertical concrete cask.	MPC in storage mode. Small MESC for "truck" facilities.
--Shutdown reactor storage	Leave all SNF in pool until pickup.	Place all SNF into MPC storage after five years, except truck sites, which keep pool open.
SNF Discharge Projections	EIA 1992 no new orders.	EIA 1992 no new orders.
WASTE ACCEPTANCE		
Fuel Acceptance Strategy		
--Amount	86,155 MTU SNF + 11,000 MTU HLW	86,155 MTU SNF + 11,000 MTU HLW
--Allocation	Oldest fuel first (OFF)	OFF
--Selection	OFF (dry storage deferred).	OFF (dry storage deferred).
Dry Storage/Transportation Interface	SNF removed from large and small non-transportable MESCs in the spent fuel pool and loaded in transportation casks.	MPC transferred from storage mode into transportation cask without returning to the pool. For "truck" facilities, SNF removed from small non-transportable MESCs in the spent fuel pool and loaded in truck transportation casks.
Non-Standard Fuel Strategy	Treat as standard fuel for analysis.	Treat as standard fuel for analysis.

PARAMETER	REFERENCE	MPC
Other Waste Type Strategy	Not considered--HTGR, research reactors, TMI-2.	Not considered--HTGR, research reactors, TMI-2.
TRANSPORTATION		
Family of Casks/Canisters		
--Derating	No.	No.
--Burnup credit	Yes.	Yes.
--Capacity	LWT 4P / 9B 75-ton 12P / 24B 100-ton 21P / 37B	LWT bare fuel 4P / 9B 75-ton MPC 12P / 24B 125-ton MPC 21P / 40B 100 ton on-site transfer cask.
	At-reactor dry storage: Large MESC 24P / 52B Small MESC 7P / 17B	At-reactor dry storage: 75-ton MPC 12P / 24B 125-ton MPC 21P / 40B Small MESC 7P / 17B.
Modal Capability		
--Handling capability & --Infrastructure	19 Truck cask facilities 14 75-ton cask facilities 88 100-ton cask facilities.	19 Truck cask facilities 14 75-ton MPC facilities 88 125-ton MPC facilities.
Use of Intermodal Transfer		
--LWT to rail	No.	No.
--Heavy-haul truck to rail	Yes.	Yes.
--Heavy-haul truck to barge to rail	Yes.	Yes.
Use of Western Strategy	No.	No.
Transportation Routing and Mileage	Based on Highway/Interline.	Based on Highway/Interline.

PARAMETER	REFERENCE	MPC
Throughput Rate	3000 MTU/yr with ramp-up.	3000 MTU/yr with ramp-up.
Cask Maintenance Facility	At MRS for first MGDS; At second MGDS.	At MRS for first MGDS; At second MGDS.
MRS		
Number of MRSs	1.	1.
Location of MRS	Generic western.	Generic western.
Start Date of MRS	2000.	2000.
Maximum Capacity	10,000 MTU prior to 2010; 15,000 MTU thereafter.	10,000 MTU prior to 2010; 15,000 MTU thereafter.
MRS Storage Technology	DVCC for uncanistered fuel. (28P / 56B).	DVCC for MPC.
MRS Operational Concept		
--Bare fuel vs canisters	Uncanistered fuel.	MPCs plus uncanistered fuel from "truck" facilities.
--Passthrough/flowthrough	Passthrough/flowthrough, no blending.	Passthrough/flowthrough, no blending.
MGDS		
Number of MGDSs	2.	2.
Locations	1--Yucca Mtn; 2--Generic western.	1--Yucca Mtn; 2--Generic western.
MGDS Start Dates	First--2010; Second--2034 (Table 2-1).	First--2010; Second--2034 (Table 2-1).

PARAMETER	REFERENCE	MPC
Amount of SNF/HLW Accepted at Each MGDS	1--63,000 MTU SNF + 7000 MTU HLW; 2--remainder.	1--63,000 MTU SNF + 7000 MTU HLW; 2--remainder.
MGDS Surface Storage		
--Lag storage	Minimal lag storage.	Minimal lag storage.
--Interim storage	No interim storage.	No interim storage.
Waste Package Design		
--Capacity	Borehole: 3P + 4B; stainless steel	75-ton MPC 12P / 24B
--Materials	In-drift: 21P / 40B; Alloy 825/mild steel.	125-ton MPC 21P / 40B Alloy 825/mild steel (for stainless steel MPC).
Emplacement Mode	Borehole, in-drift.	In-drift.
Areal Power Density	SCP 57 kW/acre.	SCP 57 kW/acre.
MGDS Operational Concept **--Uncanistered fuel vs canisters**	Uncanistered fuel.	1st MGDS: MPCs only; 2nd MGDS: MPCs plus uncanistered fuel from "truck" facilities.
HLW Operational Strategy	Store at sites until picked up. Begin pick up in 2015. 5 canisters per transportation cask. Transportation by rail only. 1 canister per borehole waste package; 4 canisters per in-drift waste package.	Store at sites until picked up. Begin pick up in 2015. 5 canisters per transportation cask. Transportation by rail only. 4 canisters per in-drift waste package.

Table 3-1. Definition of System Parameters for MPC Conceptual Design Phase Work (continued)

PARAMETER	REFERENCE	MPC
HLW Operational Strategy	Store at sites until picked up. Begin pick up in 2015. 5 canisters per transportation cask. Transportation by rail only. 1 canister per borehole waste package; 4 canisters per in-drift waste package.	Store at sites until picked up. Begin pick up in 2015. 5 canisters per transportation cask. Transportation by rail only. 4 canisters per in-drift waste package.

3.6 COMPARISON OF REFERENCE SCENARIO WITH REFERENCE SYSTEM DESCRIPTION

The *Reference System Description* (Ref 2) has been written to provide a top-level description of the CRWMS reference system. The RSD is based on technical baseline design documents and system descriptions extracted from the system requirements documents. In areas where physical and operational descriptions are not formally documented as a baseline, the RSD includes characteristics judged likely to be included in future baseline documentation. As such, the RSD provides a basis of comparison in the conduct of systems studies. The reference scenario developed in the MPC Concept of Operations is in close accord with the RSD, with the exception of areas in which current program thinking has developed beyond that in the RSD. Differences between the reference scenario and the RSD are as follows:

The RSD does not address the electric utilities that own the SNF. Since the MPC could be used for at-reactor dry storage, it is necessary to address the utilities in the Concept of Operations.

The RSD considers only the first 63,000 MTU of SNF and 7000 MTU of HLW that will be emplaced in the first MGDS. In order to evaluate total system costs and the costs associated with SNF storage at the reactors in the MPC Conceptual Design Phase work, it is necessary to consider the total projected volume of SNF and HLW that will be accepted into the CRWMS.

The RSD is based on the commencement in 1998 of shipments of SNF from the facilities to the MRS. The Concept of Operations lists the date as 2000, based on the most recent MRS MSA schedule analysis. The RSD utilizes lower capacity Phase 1 casks from 1998 to 2002. Based on the 2000 MRS start date and MRS MSA analysis predicting availability of higher capacity Initiative I casks as early as 1998, the Concept of Operations assumes the use of Initiative I casks in 2000. This assumption provides for a fair comparison between the reference scenario and the MPC system, which is not burdened with lower capacity designs in the early years.

The RSD describes the 26" diameter borehole MGDS waste package as described in the MGDS Site Characterization Plan, with a capacity of 6P / 18B (consolidated rods) or 3P / 6B (intact assemblies). The Concept of Operations reference scenario considers the 28" diameter borehole waste package as described in the TSLCC, which serves as the program cost baseline for the CRWMS. This waste package has a capacity of 3P+4B intact assemblies (or 4P / 10B for years in which the ratio of P/B assemblies does not result in an integral number of mixed P/B waste packages). In order to provide a fair comparison with the large, in-drift MPC, the Concept of Operations reference scenario also considers a conceptual large, in-drift waste package with capacity identical to the MPC, but which is not designed or licensed for transportation. The large in-drift waste package is included as an alternative in the RSD.

4. SPECIFICATION OF TRANSPORTATION MODAL CAPABILITIES

A set of transportation modal capabilities for all the facilities was developed (Ref 11), based on extensive analysis by the M&O of data from the utilities' annual RW-859 submissions, the Facility Interface Capability Assessment (Ref 12), and the Site Modal System Study (Ref 13). The modal capability assumptions were reviewed by the utilities and modified (Ref 14) based on utility input specific to the MPC Conceptual Design Phase work. The updated base modal case from Reference 14 is used in the MPC Conceptual Design Phase work. System- and facility-specific details of the base case are presented.

In order to provide a conservative approach to the comparison between the reference scenario and the MPC system, both systems are evaluated with some facilities shipping by truck cask. Cask-to-cask transfer of uncanistered spent fuel assemblies is one means by which some of the truck facilities could be upgraded to ship rail transportation casks (with MPCs). Conceptual design work is in progress on a cask-to-cask transfer facility that could be used reduce the use of truck shipments and maximize the use of MPCs in the CRWMS.

4.1 BASE CASE MODAL CAPABILITIES

The base case represents the most plausible modal capabilities at the commencement of waste acceptance, based on some facility modifications, administrative upgrades, and extensive use of heavy-haul truck and barge. "Facility" is defined here as an individual nuclear power reactor or independent spent fuel storage installation (ISFSI). There are 121 facilities in total, with modal capability as follows:

Reference Scenario

19	facilities with truck cask capability only
10	facilities with 75-ton rail cask capability without heavy-haul truck or barge
4	facilities with 75-ton rail cask using heavy-haul truck
43	facilities with 100-ton rail cask capability without heavy-haul truck or barge
27	facilities with 100-ton rail cask using heavy-haul truck
18	facilities with 100-ton rail cask using heavy-haul truck and barge
Total	121 facilities

MPC System

19	facilities with truck cask capability only
10	facilities with 75-ton MPC capability without heavy-haul truck or barge
4	facilities with 75-ton MPC using heavy-haul truck
33	facilities with 125-ton MPC capability without on-site transfer cask, heavy-haul, or barge
16	facilities with 125-ton MPC using heavy-haul truck
7	facilities with 125-ton MPC using heavy-haul truck and barge truck
10	facilities with 125-ton MPC using on-site transfer cask
11	facilities with 125-ton MPC using on-site transfer cask with heavy-haul truck
11	facilities with 125-ton MPC using on-site transfer cask with heavy-haul truck and barge
Total	121 facilities.

The number of facilities shipping each size of cask or MPC is summarized in Table 4-1. Details on the facility-specific modal capabilities assumed for the base case for the MPC Conceptual Design Phase work follow in Table 4-2, which shows the reactor type (BWR--B or PWR--P), projected number of assemblies to be picked up based on total acceptance of 86,155 MTU, size of cask or MPC that will be loaded, and any special operations needed to move the cask or MPC to its primary mode of transportation, such as on-site transfer cask (TX), heavy-haul truck (HH), or barge (BG). Barge (BG) shipment includes the use of on-site heavy-haul truck in all cases.

Table 4-1. Summary of Modal Capabilities

CASK/MPC SIZE	NUMBER OF FACILITIES
Reference	
Truck cask	19
75-ton rail cask	14
100-ton rail cask	88
MPC	
Truck cask	19
75-ton rail MPC	14
125-ton rail MPC	88

Table 4-2. Details of Modal Capabilities

Facility	Rx Type	Assy	Shipment Mode
Arkansas Nuclear 1	P	1455	Ref-100 / MPC-125 TX
Arkansas Nuclear 2	P	1765	Ref-100 / MPC-125 TX
Beaver Valley 1	P	1581	Ref-100 / MPC-125
Beaver Valley 2	P	1593	Ref-100 / MPC-125
Big Rock Point	B	540	Truck
Braidwood 1	P	2189	Ref-100 / MPC-125
Braidwood 2	P	1951	Ref-100 / MPC-125
Brown's Ferry 1	B	3737	Ref-100 / MPC-125 TX BG
Brown's Ferry 2	B	4629	Ref-100 / MPC-125 TX BG
Brown's Ferry 3	B	3554	Ref-100 / MPC-125 TX BG
Brunswick 1 (from H B Robinson)	B P	3361 160	Ref-75 / MPC-75

Table 4-2. Details of Modal Capabilities (continued)

Facility	Rx Type	Assy	Shipment Mode
Brunswick 2 (from H.B. Robinson)	B P	3211 144	Ref-75 / MPC-75
Byron 1	P	2223	Ref-100 / MPC-125
Byron 2	P	2132	Ref-100 / MPC-125
Callaway	P	2275	Ref-100 / MPC-125 HH
Calvert Cliffs 1	P	1746	Ref-100 / MPC-125 BG
Calvert Cliffs 2	P	1813	Ref-100 / MPC-125 BG
Catawba 1	P	1981	Ref-100 / MPC-125 HH
Catawba 2	P	1854	Ref-100 / MPC-125 HH
Clinton	B	4268	Ref-100 / MPC-125 TX HH
Comanche Peak 1	P	1851	Ref-100 / MPC-125 HH
Comanche Peak 2	P	2135	Ref-100 / MPC-125 HH
D.C. Cook 1	P	1947	Ref-100 / MPC-125 TX HH
D.C. Cook 2	P	1807	Ref-100 / MPC-125 TX HH
Cooper Station	B	3099	Ref-75 / MPC-75
Crystal River	P	1219	Truck
Davis Besse	P	1173	Ref-100 / MPC-125
Diablo Canyon 1	P	1946	Ref-100 / MPC-125 TX BG
Diablo Canyon 2	P	2012	Ref-100 / MPC-125 TX BG
Dresden 1	B	683	Ref-75 / MPC-75 Transfer to 2 & 3
Dresden 2	B	4263	Ref-75 / MPC-75
Dresden 3	B	4391	Ref-75 / MPC-75

Table 4-2. Details of Modal Capabilities (continued)

Facility	Rx Type	Assy	Shipment Mode
Duane Arnold	B	2826	Ref-100 / MPC-125 TX
Enrico Fermi	B	4343	Ref-100 / MPC-125 TX BG
Farley 1	P	1640	Ref-100 / MPC-125 HH
Farley 2	P	1678	Ref-100 / MPC-125 HH
Fitzpatrick	B	4248	Truck
Fort Calhoun	P	1150	Truck
Ginna	P	1263	Truck
Grand Gulf	B	7431	Ref-100 / MPC-125 BG
H.B. Robinson	P	989	Ref-75 / MPC-75
Haddam Neck	P	1319	Truck
Harris (from Brunswick)	P B	1607 413	Ref-100 / MPC-125
Hatch 1	B	4756	Ref-100 / MPC-125
Hatch 2	B	4531	Ref-100 / MPC-125
Hope Creek	B	6666	Ref-100 / MPC-125 BG
Humboldt Bay	B	390	Truck
Indian Point 1	P	160	Truck
Indian Point 2	P	1526	Truck
Indian Point 3	P	1431	Truck
Kewaunee	P	1456	Ref-100 / MPC-125 TX HH
LaCrosse	B	333	Truck
LaSalle 1	B	5226	Ref-100 / MPC-125
LaSalle 2	B	5479	Ref-100 / MPC-125
Limerick 1	B	5730	Ref-100 / MPC-125 TX HH
Limerick 2	B	5129	Ref-100 / MPC-125 TX HH

Table 4-2. Details of Modal Capabilities (continued)

Facility	Rx Type	Assy	Shipment Mode
Maine Yankee	P	2138	Ref-100 / MPC-125
McGuire 1	P	2130	Ref-100 / MPC-125 TX
McGuire 2	P	2298	Ref-100 / MPC-125 TX
Millstone 1	B	4227	Ref-75 / MPC-75 HH
Millstone 2	P	1858	Ref-75 / MPC-75 HH
Millstone 3	P	1691	Ref-100 / MPC-125 TX HH
Monticello	B	2389	Truck
Morris	B P	2865 352	Ref-100 / MPC-125
Nine Mile Pt 1	B	3186	Ref-100 / MPC-125 TX
Nine Mile Pt 2	B	4213	Ref-100 / MPC-125 TX HH
North Anna 1	P	1572	Ref-100 / MPC-125
North Anna 2	P	1699	Ref-100 / MPC-125
Oconee 1	P	1559	Ref-100 / MPC-125 TX HH
Oconee 2	P	1549	Ref-100 / MPC-125 TX HH
Oconee 3	P	1536	Ref-100 / MPC-125 TX HH
Oyster Creek	B	3408	Ref-100 / MPC-125 TX BG
Palisades	P	1519	Truck
Palo Verde 1	P	1795	Ref-100 / MPC-125
Palo Verde 2	P	2232	Ref-100 / MPC-125
Palo Verde 3	P	2222	Ref-100 / MPC-125
Peach Bottom 2	B	4648	Truck
Peach Bottom 3	B	4882	Truck
Perry 1	B	6137	Ref-100 / MPC-125
Pilgrim	B	3005	Truck

Table 4-2. Details of Modal Capabilities (continued)

Facility	Rx Type	Assy	Shipment Mode
Point Beach 1	P	1241	Ref-100 / MPC-125 HH
Point Beach 2	P	1183	Ref-100 / MPC-125 HH
Prairie Island 1	P	1332	Ref-100 / MPC-125 TX
Prairie Island 2	P	1358	Ref-100 / MPC-125 TX
Quad Cities 1	B	4672	Ref-75 / MPC-75
Quad Cities 2	B	4744	Ref-75 / MPC-75
Rancho Seco	P	493	Ref-100 / MPC-125
River Bend	B	5135	Ref-100 / MPC-125 HH
Salem 1	P	1666	Ref-100 / MPC-125 TX BG
Salem 2	P	1646	Ref-100 / MPC-125 TX BG
San Onofre 1	P	256	Ref-100 / MPC-125 Transfer to 2
San Onofre 2	P	2483	Ref-100 / MPC-125
San Onofre 3	P	2440	Ref-100 / MPC-125
Seabrook	P	1779	Ref-100 / MPC-125 HH
Sequoyah 1	P	1595	Ref-100 / MPC-125
Sequoyah 2	P	1595	Ref-100 / MPC-125
Shoreham	B	560	Ref-100 / MPC-125 HH
South Texas 1	P	1349	Ref-100 / MPC-125 HH
South Texas 2	P	1318	Ref-100 / MPC-125 HH
St. Lucie 1	P	2073	Truck
St. Lucie 2	P	1967	Ref-100 / MPC-125 BG
Summer	P	1598	Ref-100 / MPC-125
Surry 1	P	1363	Ref-100 / MPC-125 BG

Table 4-2. Details of Modal Capabilities (continued)

Facility	Rx Type	Assy	Shipment Mode
Surry 2	P	1264	Ref-100 / MPC-125 BG
Susquehanna 1	B	6216	Ref-100 / MPC-125
Susquehanna 2	B	6096	Ref-100 / MPC-125
Three Mile Island 1	P	1304	Ref-75 / MPC-75
Trojan	P	1420	Ref-100 / MPC-125 HH
Turkey Point 3	P	1189	Ref-100 / MPC-125 TX BG
Turkey Point 4	P	1094	Ref-100 / MPC-125 TX BG
Vermont Yankee	B	3811	Truck
Vogtle 1	P	1981	Ref-75 / MPC-75 HH
Vogtle 2	P	1899	Ref-75 / MPC-75 HH
Washington Nuc 2	B	5063	Ref-100 / MPC-125 HH
Waterford 3	P	2066	Ref-100 / MPC-125
Watts Bar 1	P	1642	Ref-100 / MPC-125
Watts Bar 2	P	1587	Ref-100 / MPC-125
Wolf Creek	P	2041	Ref-100 / MPC-125
Yankee Rowe	P	533	Truck
Zion 1	P	1689	Ref-100 / MPC-125 TX
Zion 2	P	1824	Ref-100 / MPC-125 TX

Notes:

BG = Barge
HH = Heavy-haul truck
TX = 125-ton MPC loaded via on-site MPC transfer cask

The numbers of assemblies listed for each facility in Table 4-2 provide an estimate of total SNF discharge projections from the Waste Stream Management (WSM) computer data base as of July 9, 1993. The quantities reflect some intra-utility transfer of spent fuel between spent fuel pools and are subject to change.

The following SNF inventories do not appear in Table 4-2: Hanford (5P, 2B), Idaho National Engineering Laboratory (93P, 4B), Vallecitos (1), West Valley (40P, 85B). All would ship 125-ton MPCs with the exception of Vallecitos, which would ship by truck.

5. SUMMARY

The scenarios developed for the reference scenario and the MPC system have been evaluated and compared against each other in order to provide supporting data for OCRWM's decision on MPC implementation in the CRWMS. These scenarios provide a consistent and continuous foundation for the various segments of the MPC Conceptual Design Phase work

The scenarios employ the most plausible modal capability/large cask utilization at the commencement of waste acceptance operations, given current capabilities and potential enhancements to handling capabilities and transportation infrastructure.

This concept of operations is a refinement of procedures developed in previous systems analyses and serves as a guiding document for follow-on studies.

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APPENDIX A

LIST OF ACRONYMS

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APPENDIX A

LIST OF ACRONYMS

BWR	Boiling water reactor
CDR	Conceptual Design Report
CMF	Cask Maintenance Facility
CRWMS	Civilian Radioactive Waste Management System
D&E	Development and evaluation
DVCC	Dry vertical concrete cask
E&C	Engineering and construction
ECM	Engineering Cost Model
EIA	Energy Information Administration
FPC	Final procurement and construction
HLW	High level waste
HTGR	High temperature gas-cooled reactor
ISFSI	Independent spent fuel storage installation
LWT	Legal weight truck
M&I	Management and integration
M&O	Management and Operating
MESC	Multiple element sealed canister
MGDS	Mined Geologic Disposal System
MPC	Multi-Purpose Canister
MRS	Monitored Retrievable Storage
MSA	Major system acquisition
MTU	Metric tons of (initial) uranium
NWPA	Nuclear Waste Policy Act
OCC	Operations Control Center
OFF	Oldest fuel first
OSTS	On-Site Transfer and Storage
PWR	Pressurized water reactor
QAP	Quality Administrative Procedure
RSD	Reference System Description
SCP	Site Characterization Plan
SNF	Spent nuclear fuel
SS	Stainless steel
TBM	Tunnel boring machine
TMI	Three Mile Island
TSLCC	Total System Life Cycle Cost
WHB	Waste handling building
WSM	Waste Stream Model

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