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Multi-Purpose Canister System Evaluation

A Systems Engineering Approach

September 1994

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EXECUTIVE SUMMARY

This report summarizes Department of Energy (DOE) efforts to investigate various container systems for handling, transporting, storing, and disposing of spent nuclear fuel (SNF) assemblies in the Civilian Radioactive Waste Management System (CRWMS). The primary goal of DOE's investigations was to select a container technology that could handle the vast majority of commercial SNF at a reasonable cost, while ensuring the safety of the public and protecting the environment. Several alternative cask and canister concepts were evaluated for SNF assembly packaging to determine the most suitable concept. Of these alternatives, the multi-purpose canister (MPC) system was determined to be the most suitable. Based on the results of these evaluations, the decision was made to proceed with design and certification of the MPC system. A decision to fabricate and deploy MPCs will be made after further studies and preparation of an environmental impact statement.

APPROACH

A systems engineering approach was used to evaluate concepts that would provide for packaging of multiple SNF assemblies. The systems evaluated included the dual-purpose transportable storage cask (TSC), the multi-purpose unit (MPU), and the MPC. All alternatives were evaluated in relation to an individual SNF assembly handling system that provides for handling individual, uncanistered SNF assemblies throughout the storage and transportation phases of CRWMS operations. Design input parameters were developed for each system such that the alternatives could be evaluated on a consistent basis. Evaluations of the alternatives considered the following measures of effectiveness: health and safety, environmental impacts, life cycle cost, schedule, technical feasibility, regulatory issues, and stakeholder acceptance.

Systems engineering methods were used to develop the alternatives to the extent necessary to evaluate them against the measures of effectiveness. Systems engineering provided the mechanism to thoroughly investigate the ability of each alternative to meet all CRWMS requirements. This approach began by performing functional analyses, defining overall system requirements, and developing a CRWMS concept for handling SNF. Operating concepts and interface requirements were then defined and allocated to elements within each alternative to ensure proper integration with the overall system concept. Using these operating concepts and requirements, conceptual designs were developed for each alternative. With the conceptual designs completed, system studies and analyses were performed to evaluate each alternative and select the preferred system.

Operational concepts were developed for Purchaser site activities, transportation activities, operations at the monitored retrievable storage (MRS) facility, and operations at the repository or mined geological disposal system (MGDS). (Note that, for the purposes of this report, Purchasers are defined as nuclear utilities and other sources of SNF that will participate in the CRWMS). Logistics requirements were defined to establish SNF throughput criteria for the various elements of the CRWMS. Purchaser SNF handling capabilities were reviewed and itemized, including transportation and cask handling capabilities. The effects of not providing an MRS facility were also considered in developing operational concepts and logistics requirements.

Conceptual designs were developed for major portions of each alternative to provide the basis for performing evaluations with respect to each measure of effectiveness. During the evaluation process, it became evident that the MPC system was the most suitable alternative because it provides the triple-purpose function of SNF assembly transportation, storage, and disposal at a significantly reduced cost as compared to other alternatives, and at a cost comparable to the individual SNF assembly handling system. In order to provide a better basis for evaluating the MPC system, detailed conceptual designs were produced for the following portions of this system: multi-purpose canisters, Purchaser on-site SNF transfer and storage components, MPC transportation casks, and MRS facility. Effects of MGDS requirements on the design of MPCs were evaluated in detail to ensure the MPC system would be compatible with the MGDS design as currently envisioned.

CONCEPTUAL DESIGNS

In the conceptual design of the MPC system, two sizes of MPCs were developed to provide a basis for evaluation: a large, 125-ton MPC and a small, 75-ton MPC. The large MPC holds either 21 pressurized water reactor (PWR) SNF assemblies or 40 boiling water reactor (BWR) SNF assemblies. The small MPC holds either 12 PWR SNF assemblies or 24 BWR SNF assemblies. In the design of the large PWR MPC, credit has been taken for burnup of the SNF assemblies. The SNF assemblies remain in the sealed MPCs throughout all storage, transportation, and disposal activities. Separate overpacks are provided for both shielding and containing the MPCs. At the MGDS, MPCs are transferred from transportation casks to disposal containers to form waste packages for emplacement in the repository.

Efforts are underway to find ways to utilize MPCs at as many Purchaser facilities as possible and to minimize the number of facilities that have to ship individual, uncanistered SNF assemblies in truck casks. The MPC system may include a bare SNF transfer system that would allow many Purchaser facilities to accommodate MPCs that otherwise could not because of lifting restrictions, transportation limitations, or other reasons. The bare SNF transfer system would allow MPCs to be loaded using special transfer casks that would transfer SNF assemblies into MPCs in transportation casks outside of a Purchaser's spent fuel pool.

In the conceptual design of the TSC system, two sizes of TSC metal casks were investigated, a 100-ton metal cask and a 75-ton metal cask. These sizes were selected to provide the same handling capability among facilities as provided by the MPC system and, therefore, the same basis of comparison. The large TSC metal cask holds either 21 PWR SNF assemblies or 40 BWR SNF assemblies, and the small TSC metal cask holds either 12 PWR or 24 BWR SNF assemblies. A TSC canister system was also investigated, which includes a dual-purpose canister that is removable from the overpack. SNF assemblies are loaded into dual-purpose TSCs for storage and transportation. Once the TSC is shipped to the MGDS, the individual SNF assemblies are transferred from the TSC into a separate waste package for disposal. Several commercial applications of the TSC metal cask system are currently being developed.

The MPU is a universal cask designed for storage, transportation, and disposal. No additional overpacks are required, except for a neutron shield used during transportation. Two sizes of MPUs were investigated for the MPU system, a 125-ton cask and a 90-ton cask. As with the

TSCs, these sizes of MPUs were selected to provide an equivalent basis of comparison with the MPC system. The large MPU contains either 21 PWR SNF assemblies or 40 BWR SNF assemblies; the small MPU contains either 12 PWR or 24 BWR SNF assemblies.

The individual SNF assembly handling system provides for transporting and storing uncanistered SNF assemblies and later transferring the assemblies to waste packages for disposal at the MGDS. This system was updated using revised transportation assumptions from the previously developed version that served as the baseline for CRWMS design prior to the decision to proceed with the MPC system. The updated individual SNF assembly handling system provided a reference for comparing and evaluating the MPC, TSC, and MPU system alternatives.

In the conceptual design of all alternatives, the following Purchaser facility transportation capabilities can be accommodated: large containers are assumed to be transported in rail transportation casks at 88 facilities, small containers are assumed to be transported in rail transportation casks at 14 facilities, and individual, uncanistered SNF assemblies are assumed to be transported in truck casks at 19 facilities. All alternatives make use of large containers to the maximum extent possible to reduce the number of shipments and containers.

EVALUATION RESULTS

Health and safety radiological impacts of each alternative are summarized in Table ES-1. Radiological routine exposures listed in the table are those expected for normal facility operations and transportation activities over the life of the system. Radiological incident exposures are those that can be anticipated from SNF handling and transportation accidents. Although design of the systems attempts to preclude such accidents, occurrence of some events has been conservatively assumed. Exposures estimated for transportation activities are separated from those estimated for facility activities to show the low values expected during routine transportation that could potentially affect the public. As indicated in the table, the individual SNF assembly handling system has the lowest routine exposure for facility operations. All alternatives have exposures within regulatory limits and are virtually equivalent with regard to transportation and incident impacts.

Table ES-1 Health and Safety Radiological Impacts of Alternatives With an MRS
(Total Program Exposures in Person-Rem)

System Impact Area	MPC System	TSC System	MPU System	Individual SNF Assembly Handling System
Radiological Routine				
· Facilities	56,980	43,820	53,920	42,080
· Transportation	1,450	1,450	1,450	1,450
Radiological Incident				
· Facilities	0.04	0.08	0.04	0.1
· Transportation	430	430	430	430

Preliminary evaluations indicated that environmental impacts are essentially equivalent for all alternatives and are within regulatory limits. Each of the alternatives results in a significant reduction of low-level radioactive waste generation compared to the individual SNF assembly handling system.

All alternatives were compared to the individual SNF assembly handling system to evaluate overall life cycle cost (LCC) differences between the systems. Table ES-2 provides a summary of this comparison. Costs for the CRWMS and Purchasers have been included to determine overall cost savings or increases associated with each option. With an MRS, the MPC system provides a total cost savings of $550 million as compared to the individual SNF assembly handling system. This cost savings is relatively small compared to total system costs. Primary contributors to cost savings with the MPC system are the advantages offered by using one canister for containing SNF assemblies throughout all CRWMS activities, simplification of SNF assembly handling facilities, and the ability to shutdown reactor spent fuel pools earlier than otherwise would be possible. The TSC and MPU systems cost $4.3 and $3.24 billion more, respectively, than the individual SNF assembly handling system. Without an MRS, the MPC system would provide $605 million in savings as compared to the individual SNF assembly handling system without an MRS; however, by not providing an MRS, CRWMS acceptance of SNF is delayed and Purchaser costs for constructing on-site dry storage facilities increase. Similar results are expected for the TSC system and the MPU system without an MRS facility. Therefore, a decision on which alternative to select is independent of whether or not an MRS is provided.

Table ES-2 Total System Life Cycle Cost Differences
(Millions of 1993 Dollars)

Cost Item	With MRS			No MRS
	MPC System	TSC System	MPU System	MPC System
CRWMS				
Containers	+ 5,074	+8,180	+12,600	+4,570
Waste Acceptance Equipment	+27	0	+31	+27
Transportation	-229	-2	-513	-282
MRS/CMF	-370	-885	-938	-36
First/Second MGDS	-3,002	0	-5,030	-2,602
Total Cost Difference for CRWMS	**+1,500**	**+7,293**	**+6,150**	**+1,677**
Purchasers				
Waste Acceptance Operations	+94	-3	+101	+94
Purchaser Site Storage	-2,144	-2,990	-3,010	-2,376
Total Cost Difference for Purchasers	**-2,050**	**-2,993**	**-2,909**	**-2,282**
Total System Cost Difference	**-550**	**+4,300**	**+3,241**	**-605**

Note: Table entries show differences in LCC between the alternative systems and the individual SNF assembly handling system. Negative entries indicate a savings with the alternative.

The individual SNF assembly handling system includes transportation and storage technologies that are currently available and that could be placed into operation by 1998; however, with the absence of an MRS facility, a variety of dry storage technologies might be used, complicating the waste acceptance process and potentially increasing system costs. Uncertainties in the availability of an MRS site make the schedule for waste acceptance in the individual SNF assembly handling system indeterminate. The MPC, TSC, and MPU systems can introduce standardization, ensure overall system compatibility, and provide storage without an MRS facility.

The TSC system is the closest alternative to receiving NRC licensing approval and should be available by 1998. There are some licensing issues that would have to be resolved with regard to transporting TSCs after long-term storage. The MPC system is similar to technologies currently in licensing review and, as such, has a reasonable probability of being available by 1998. Technology with licensing precedent is used in the conceptual design of the MPC, with the exception of the capability to transport the MPC after long-term storage and inclusion of the MPC as part of the disposal waste package. Use of burnup credit in the design of the large PWR MPC must also be resolved to ensure licensing of the entire MPC system. The MPU system technology is not part of a current licensing initiative; and, therefore, it is doubtful that the MPU could be available in 1998. Technical issues with regard to transportation of MPUs and use of the MPU as a waste package for disposal at the MGDS present licensing challenges for the MPU system.

Stakeholders have indicated they believe the MPC, TSC, and MPU system alternatives offer significant advantages over the individual SNF assembly handling system. These advantages result from the use of standardized containers for packaging SNF assemblies and minimization of SNF assembly handling. The triple-purpose function of the MPC and MPU systems offers the most integrated approach for SNF management by allowing for one-time packaging of SNF assemblies for all phases of transportation, storage, and disposal. Several stakeholder groups have endorsed the MPC system as the preferred method for SNF management in the CRWMS.

Additional studies of the MPC system and various operating contingencies were performed once it became clear that it would be the recommended alternative. These studies indicate that the system has flexibility to accommodate a variety of different operating scenarios.

CONCLUSIONS

Systems engineering evaluations have shown that the MPC, TSC, and MPU system alternatives all offer potential advantages as compared to the individual SNF assembly handling system, with the MPC system being the most suitable for use in the CRWMS. The MPC system is safe, reliable, environmentally acceptable, and cost effective. The triple-purpose function of the MPC also simplifies CRWMS operations and reduces low-level radioactive wastes. Designs for the MRS facility and the MGDS are simplified since there is less handling of individual, uncanistered SNF assemblies with the MPC system. The MPC system standardizes SNF assembly storage operations and introduces overall system compatibility at Purchaser sites and throughout the CRWMS. The MPC system also decouples Purchaser operations for retrieving SNF from on-site dry storage facilities from operations in their spent fuel pools. This flexibility may allow Purchasers to decommission spent fuel pools prior to removal of SNF from their sites.

Use of the MPC system reduces the overall cost for the total system, which includes costs to both the CRWMS and Purchasers. This is accomplished by simplification, standardization, and uniform integration of SNF handling operations. Removal of the MRS facility from the MPC system offers further savings but results in increased costs to Purchasers for on-site storage.

Risks have been evaluated for major uncertainties that could be encountered during implementation of the MPC system. Contingency options have been formulated to remedy each major risk anticipated and to ensure options are available to avoid substantial delays. There is a high level of confidence that the MPC system can be successfully implemented to provide a waste handling system that meets all CRWMS program goals for health, safety, environment, throughput, cost, and schedule and that satisfies Purchaser needs.

An implementation plan has been developed to proceed with the design, procurement, fabrication, and start of operations of the MPC-based CRWMS. This plan provides for having the first MPCs and transportation casks available to Purchasers in 1998. As part of the implementation plan, a procurement strategy has been developed that makes use of existing nuclear industry technology to expedite acquisition of major MPC system components from vendors. A request for proposal has been issued to procure designs for major components of the MPC system. This is the first major step for ensuring success with the CRWMS goal of waste acceptance, storage, and disposal.

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Chapter 1

INTRODUCTION

This report provides summary information on the Department of Energy's (DOE's) investigations and evaluations leading to a decision to proceed with design and certification of the multi-purpose canister (MPC) system for handling, transporting, storing, and disposing of spent nuclear fuel (SNF) assemblies. Systems engineering evaluations of several alternative container concepts are included that were investigated in determining the most appropriate system to implement throughout the Civilian Radioactive Waste Management System (CRWMS). Comparisons are made to show why the MPC system was selected as the preferred concept.

The purposes of this report are to present major findings from alternative SNF container studies leading to a decision to design and certify the MPC system, and to provide the status of current development efforts. Information in this report was obtained from various detailed reports and studies produced during investigations of the MPC system. The information is organized to aid in understanding how the MPC system design concept was developed and to explain how the various reports, studies, and inputs fit together to support the decision to proceed with design and certification of the MPC system. Sources of key information are referenced to document the basis of the information and to allow the reader to seek additional detail if desired.

The following introductory sections provide a background discussion of how the MPC system evolved, descriptions of the various alternative design concepts, and a description of the scope of this report.

1.1 BACKGROUND

The Nuclear Waste Policy Act (NWPA) of 1982 was enacted to provide for permanent disposal of high-level radioactive wastes in an underground repository. The NWPA directed DOE to accept and take title to SNF assemblies from commercial utilities. In 1987, Congress passed the Nuclear Waste Policy Amendments Act, which authorized DOE to site, construct, and operate a monitored retrievable storage (MRS) facility that would provide for interim storage of SNF until a repository becomes available. Since receiving these directions from Congress, DOE has been working to develop systems for waste acceptance, transportation, interim storage, and permanent disposal of SNF assemblies.

The DOE Office of Civilian Radioactive Waste Management (OCRWM) directed the development of the CRWMS. The CRWMS includes the following elements: a permanent repository, or mined geologic disposal system (MGDS); an MRS facility for interim storage of SNF assemblies; a system for accepting SNF into the CRWMS; a transportation system for shipping SNF to storage and disposal sites; and control systems for coordinating activities within the CRWMS.

Until late 1992, efforts focused on handling individual SNF assemblies. Work was performed on the various system elements, and design products documented the basis for this work. These products include the *Monitored Retrievable Storage (MRS) Facility Conceptual Design Report* (hereafter referred to as the MRS CDR), issued in November 1992, and system requirements documents (SRDs) for the system and for each CRWMS element. During this period, design of the MGDS exploratory studies facility (ESF) was progressing, and site characterization activities continued for the proposed repository at Yucca Mountain.

For all the CRWMS element designs produced through 1992, the design basis assumed that SNF would be received into the CRWMS as individual, uncanistered assemblies. Waste acceptance and transportation element designs assumed that uncanistered SNF assemblies would be loaded into transportation casks for shipment to the MRS facility. At the MRS transfer facility, the individual assemblies would be packaged into storage casks or canisters for interim storage until the MGDS became available for permanent disposal. For shipment to the MGDS, the individual assemblies would be transferred out of storage and into transportation casks. At the MGDS, the individual SNF assemblies would be transferred into disposal packages for emplacement in the underground repository.

The operating philosophy for designs produced through 1992 assumed that transportation of individual SNF assemblies from utilities and other sources of SNF that participate in the CRWMS program (collectively referred to as Purchasers) to the MRS facility would initially make use of existing transportation cask designs. This would include a spectrum of existing truck and rail transportation casks. Rail casks would be used to the maximum extent possible, according to the capability of Purchaser sites. Truck casks would be used to transport SNF assemblies from Purchaser sites that could not accommodate rail shipments. Since existing rail and truck transportation casks have fairly low capacities, new, higher capacity transportation casks would be designed to accommodate CRWMS shipments of individual SNF assemblies to the MRS facility and to the MGDS. The new, innovative technology casks would accommodate more SNF assemblies per cask load and, thereby, provide for more efficient CRWMS operations.

Scoping studies were performed in parallel with the MRS CDR work to determine possible alternative container designs. Conclusions from these studies showed that multi-element sealed canisters, transportable storage casks, and universal casks offered potential advantages over the design concept for individual SNF assembly handling. These concepts were a natural progression from earlier SNF container concepts. Commercial applications were proposed by vendors. In reviews of previous conceptual designs, the Nuclear Regulatory Commission (NRC) and the Nuclear Waste Technical Review Board (NWTRB) had proposed canister systems to minimize SNF assembly handlings and to limit the spread of contamination during SNF handling operations at Purchaser sites, the MRS, and the MGDS. There was widespread support for these initiatives throughout the industry.

In October 1992, more detailed feasibility studies were initiated for integrating the MPC, a type of multi-element sealed canister, into the CRWMS. This direction was given because the MPC system design concept appeared to provide advantages for SNF assembly handling, transportation, storage, and disposal. Results of these feasibility studies were published in *A Preliminary Evaluation of Using Multi-Purpose Canisters Within the Civilian Radioactive Waste Management System* report (hereafter referred to as the MPC feasibility study), issued in March 1993.

A near-term implementation program was developed to evaluate MPC system integration using a systematic engineering analysis of the overall program. Conceptual designs for major components of an MPC-based CRWMS were a key element of this evaluation. The *Multi-Purpose Canister (MPC) Implementation Program Conceptual Design Phase Report*, issued in September 1993 (hereafter referred to as the MPC System CDR), was the product of that near-term implementation program effort. Supporting system studies contained in the MPC System CDR were updated in December 1993. The MPC System CDR was subsequently reviewed by DOE management and is in the process of being updated. Issues evaluated in the MPC System CDR included design, performance, environment, safety, health, cost, schedule, regulatory, licensing, utility impact, risks, contingencies, and alternative concepts. On the basis of these measures of effectiveness, the MPC system was determined to be superior to other alternative cask and canister concepts, such as the transportable storage cask (TSC) and multi-purpose unit (MPU) systems. Results of evaluations presented in the MPC System CDR showed that the MPC system significantly reduced the number of times SNF assemblies would have to be handled and improved interfaces with Purchaser sites through the use of standardized containers. The MPC system also offered a mechanism for Purchaser sites to place SNF assemblies in dry storage and to transfer MPCs directly from storage to transportation casks. This allows Purchasers to decommission their spent fuel pools prior to removing the SNF from the site. The overall life cycle cost (LCC) of the MPC system, including both CRWMS and Purchaser costs, was found to be slightly less than that for a system using individual SNF assembly handling, and significantly less than alternative container concepts.

The MPC system design concept was presented to parties involved with SNF production, handling, transportation, and storage (collectively referred to as stakeholders) at workshops in July and November 1993. Results of the workshops indicated that these stakeholders viewed the MPC system favorably. Endorsements came from groups such as the Independent Review Group (IRG), a team of program participants selected by DOE for evaluating the MPC system design, and from utilities represented by the Edison Electric Institute (EEI).

Following DOE management review of the MPC System CDR and supporting system studies, the Secretary of Energy issued a decision in February 1994 to proceed with design and certification of the MPC. This decision focused all CRWMS elements toward integrating MPCs into the program baseline.

1.2 OPERATING CONCEPTS

Several alternative container operating concepts were evaluated. Since previous system studies indicated that an MPC-based system was the preferred alternative, it was investigated in detail. The other alternatives were investigated as necessary to provide a consistent basis for comparison. These alternative concepts were compared to a system that involved handling individual SNF assemblies. This system was updated to provide a consistent basis for comparing the various alternative container designs. The following alternatives were investigated:

- MPC system
- MPC system with no MRS facility
- Dual-purpose cask system (transportable storage cask technology)

- Multi-purpose unit system (universal cask technology)
- Single-purpose cask system (individual SNF assembly handling system)
- Single-purpose cask system with no MRS facility

Figure 1.2-1 provides an illustration of the interaction of CRWMS elements in an MPC-based system. Two MPC system cases were evaluated: one with an MRS facility and one without an MRS facility. The no-MRS cases were investigated to determine the impacts to the overall CRWMS and Purchaser sites if the MRS facility is not included in the system.

In the MPC system, SNF assemblies are placed in the MPC at the Purchaser facility or at the MRS facility, and the canister is permanently sealed. The MPC provides confinement of SNF assemblies during handling, transportation, interim storage, and disposal. Based on Purchaser facility capabilities, two sizes of MPCs were developed. The large MPC has a nominal 125-ton package weight, and the small MPC has a nominal 75-ton package weight. Use of the different size MPCs depends upon the ability of each Purchaser facility to lift and transport MPCs in their respective casks. Both sizes of MPCs are transported by rail in casks that provide shielding and protection. MPC storage casks are used at the Purchaser site or the MRS facility, or both. Disposal overpacks are used for emplacement of the MPCs in the MGDS. Figure 1.2-2 illustrates the use of the MPC for storage, transportation, and disposal.

As an element of the MPC system, the on-site transfer and storage (OSTS) system provides components for loading and storing MPCs at Purchaser sites and for transferring MPCs into transportation casks. The MRS facility provides for transferring MPCs from transportation casks to storage casks for interim storage until the MGDS becomes available. The MGDS design includes MPCs as an integral part of the waste package for permanent disposal of SNF. For the no-MRS case, MPCs are transported directly from the Purchaser facility to the MGDS. Detailed descriptions of the conceptual design of each MPC system element are provided in Section 3.

In the TSC system, SNF assemblies are loaded into TSCs for storage and transportation. System operations are similar to the MPC system. Once the TSC is shipped to the MGDS, the SNF assemblies are transferred from the TSC into a waste package for disposal. A variation on the TSC concept involves the use of an internal canister system that is removable from the storage and transportation overpacks.

In the MPU system, SNF assemblies are loaded into the MPU, which is designed for storage, transportation, and disposal. No additional overpacks are required, except for a neutron shield used during transportation. Other operations are similar to the MPC system. MPUs are used for storage at Purchaser facilities and the MRS. At the MGDS, the MPU is a part of the engineered barrier system.

In order to compare the alternative container concepts, evaluations of the previously developed individual SNF assembly handling system were updated using consistent assumptions. In this way, an equivalent basis for cost, schedule, safety, and other evaluation parameters was available to compare the concepts. A no-MRS case for the individual SNF assembly handling system was also investigated for comparison purposes.

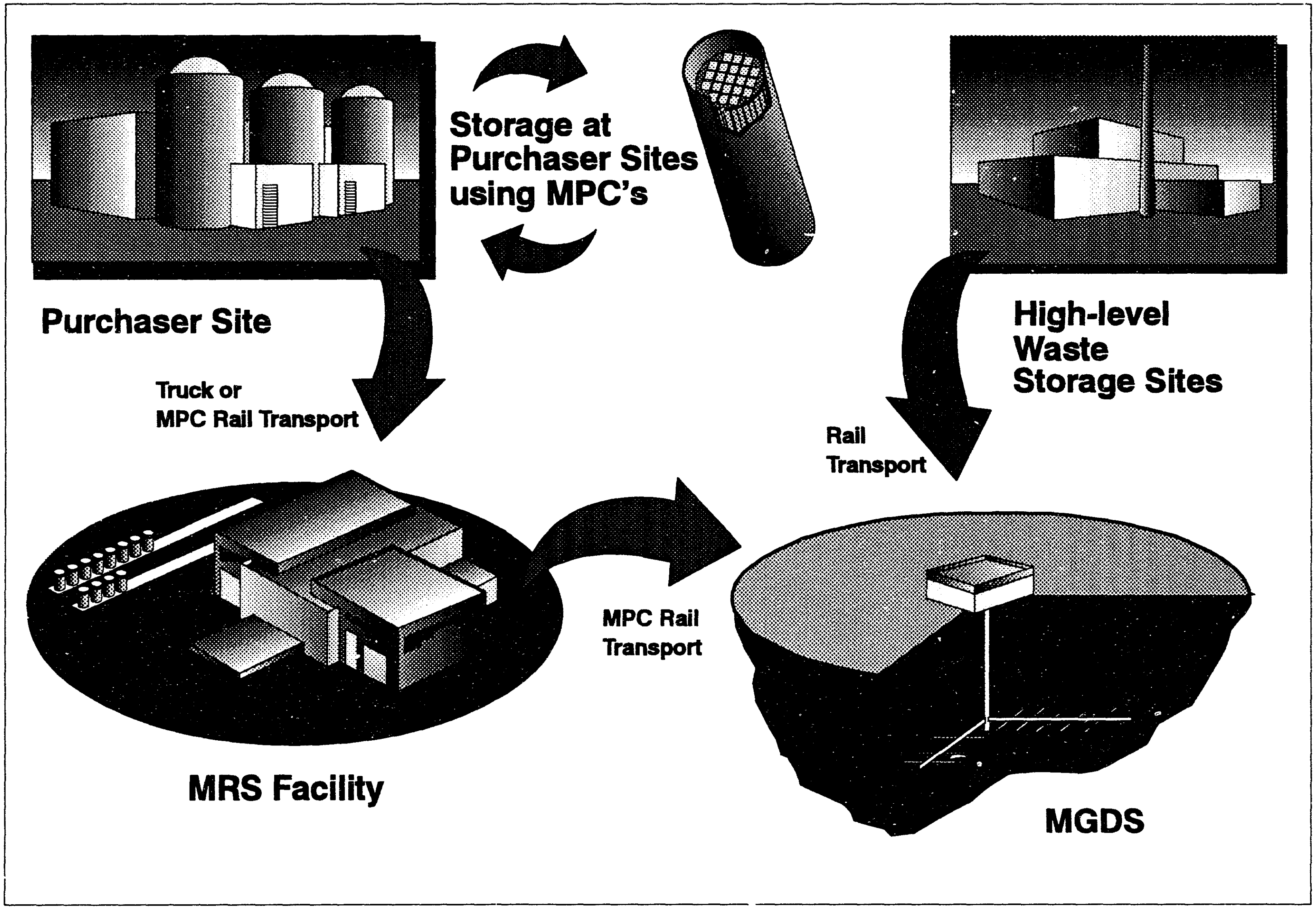

Figure 1.2-1 The Civilian Radioactive Waste Management System

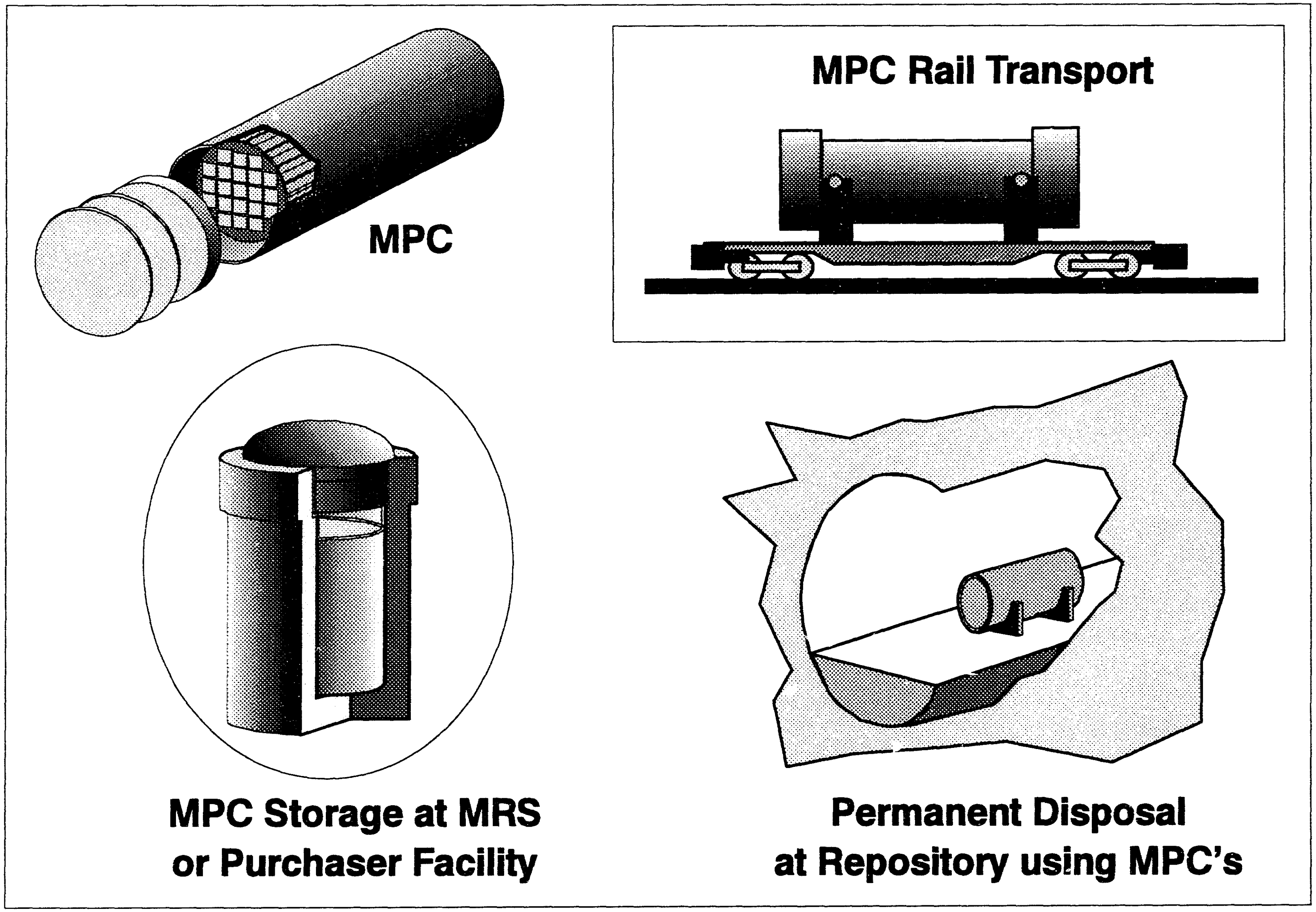

Figure 1.2-2 Multi-Purpose Canister (MPC) Transport, Storage, and Disposal

1.3 SCOPE

Information presented in this report is taken primarily from the MPC System CDR, including the series of systems engineering study reports in Volume V of that report. Other sources of information are also used to provide data current through July 1994. A complete list of references used in the development of this report is provided in Appendix A.

Chapter 2 presents the approach used to develop the MPC system, as well as the no-MRS case for the MPC system. This includes a description of the operating concept developed as the basis for SNF receipt and handling. Major requirements for the MPC-based CRWMS are provided. This includes general requirements for the MPC system, logistics or throughput requirements, and requirements for Purchaser site storage of SNF.

Chapter 3 describes the conceptual designs developed for the MPC-based CRWMS, including the MPC, MPC transportation cask, OSTS, MRS, and MGDS.

Chapter 4 provides summary information on the evaluation of significant aspects of the MPC system and the MPC system without an MRS compared to an equivalent system based on handling individual SNF assemblies. This includes health, safety, and environmental impacts of MPC implementation, as well as life cycle costs for implementing MPCs throughout the CRWMS. Risks associated with using the MPC system are identified, along with contingencies necessary for ensuring success with the program. Sensitivities are also presented for variants to specific features of the MPC system.

Chapter 5 describes the MPU and TSC alternative container concepts and compares the alternatives to the MPC system. The comparisons presented established a basis for selecting the MPC system as the preferred alternative.

Chapter 6 presents the plan for implementing the MPC system throughout the CRWMS. This includes discussions of the implementation strategy, MPC system design procurement specification development, and the procurement process. Major schedule milestones for MPC system implementation are also addressed.

Chapter 7 presents a summary of overall conclusions from evaluations of the various alternatives.

Chapter 2

SYSTEMS ENGINEERING APPROACH

A systems engineering approach was used in developing and evaluating the MPC system and alternative cask and canister systems based on TSCs and MPUs to determine their feasibility for implementation in the CRWMS. This approach began by performing functional analyses and identifying overall system requirements. Based on these requirements, an overall CRWMS concept was developed for handling SNF in MPCs. Operating concepts and requirements were then defined and allocated to each system element to ensure proper integration with the overall system concept. Using these operating concepts and requirements, conceptual designs were developed for the MPC system. These conceptual designs were used to evaluate the impact of MPC system implementation on each element. System studies and analyses were then performed to determine the impact of MPC system implementation on the overall CRWMS and Purchaser sites. This approach provided a complete analysis of the effect of implementing the MPC system, and these analyses, in turn, were the basis for decisions on program direction.

This section includes an explanation of the systems engineering strategy used to evaluate the MPC system and other alternatives. A summary is also provided of the concept of operations that served as the basis for developing the MPC system and alternatives.

2.1 SYSTEMS ENGINEERING STRATEGY

The systems engineering effort for MPC system design began by performing functional analyses, establishing overall systems requirements in a set of System Requirements Documents (SRDs), and developing an overall system philosophy for SNF assembly handling using MPCs. The CRWMS configuration, or architecture, was updated to accommodate the new components of the MPC-based design. Figure 2.1-1 shows this architecture and the items included within each element. The waste acceptance element provides interface with Purchaser sites for accepting SNF into the CRWMS. The transportation system element includes MPCs and transportation casks. The MRS system element includes the MRS facility and the OSTS subelement, which contains the on-site transfer, on-site storage, and bare SNF transfer subsystems. The MGDS element includes the site, the repository, and the engineered barrier system.

The four elements of the overall system were examined to determine how the MPC system could be successfully integrated in all areas. A concept of operations was developed for each alternative system design concept. Section 2.2 describes the concept of operations in more detail.

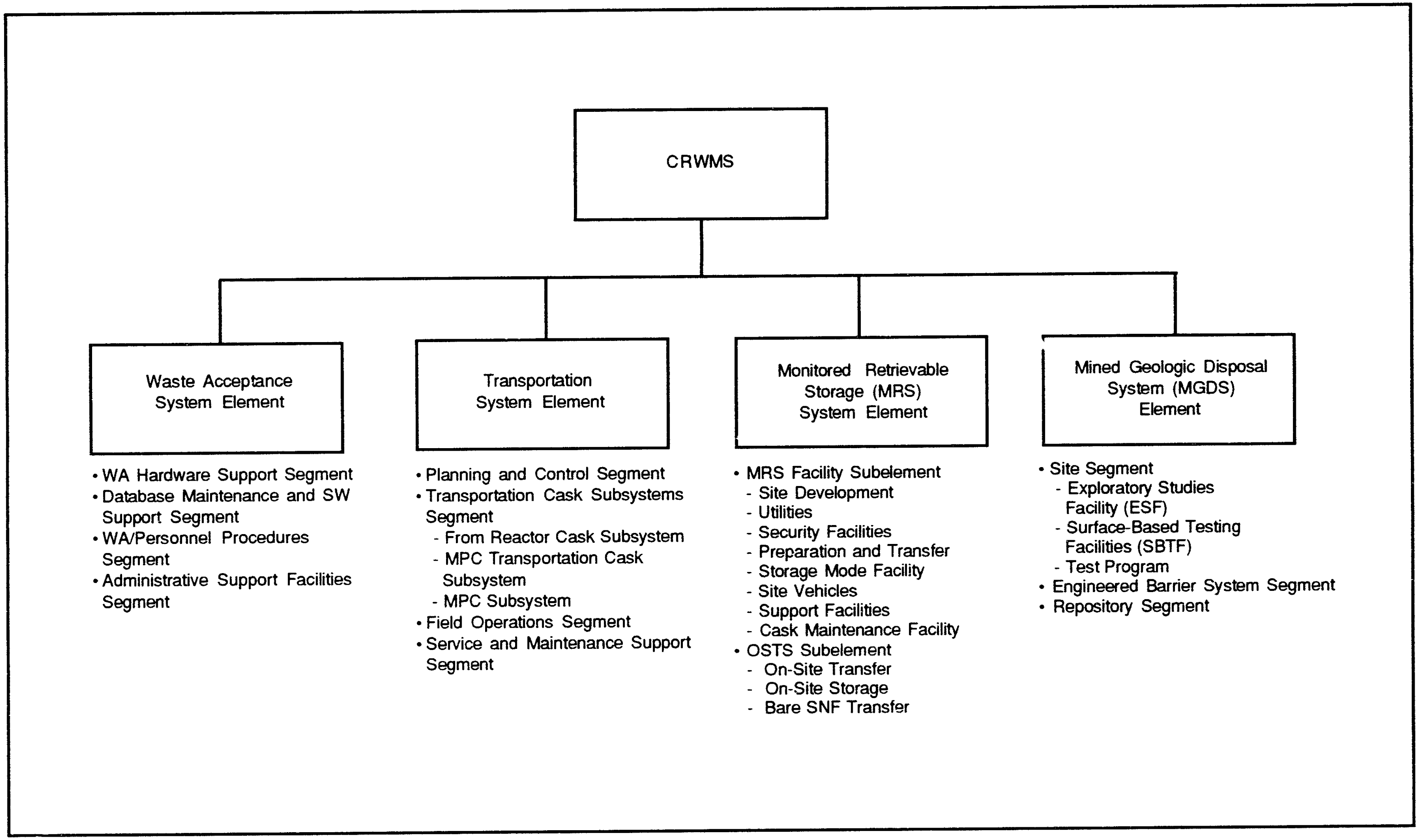

Figure 2.1-1 CRWMS System Architecture

In parallel with the development of operational concepts, requirements were refined for the MPC-based CRWMS and allocated as appropriate to each system element, subelement, and subsystem. Requirements for the MPC-based CRWMS were recorded in a series of SRDs that address requirements for the overall system and each of the four major system functions of waste acceptance, transportation, storage, and disposal. The following SRDs, approved in March 1994, present detailed requirements for the overall CRWMS system and each CRWMS element:

- *Civilian Radioactive Waste Management System Requirements Document*
- *Waste Acceptance System Requirements Document*
- *Transportation System Requirements Document*
- *Monitored Retrievable Storage System Requirements Document*
- *Mined Geologic Disposal System Requirements Document*

In order to properly evaluate the MPC system and alternatives, detailed logistics requirements were developed by performing operational throughput analyses for each of the system elements. The data developed included the number of SNF assemblies, quantity of SNF, and number of casks scheduled to arrive at CRWMS facilities on an annual basis, as well as information on Purchaser site transportation capabilities, the number of cask shipments, and the transportation cask fleet size. Computer models were used to generate logistics parameters for input into the conceptual design. These data were also used to evaluate life cycle costs and health and safety impacts of the MPC system, the individual SNF assembly handling system, and alternatives based on TSCs and MPUs. For comparison, cases were also evaluated in which there was no MRS. Detailed logistics requirements are presented in the *Operational Throughput for the Multi-Purpose Canister System* report, contained in Volume V of the MPC System CDR.

The newly developed MPC system operational concepts, and logistics data were used as the basis for conceptual designs. The SRD requirements were developed concurrent with the conceptual design as part of an interactive design process. Applicable requirements and functions were allocated, which provided the basis for design of each element and its subelements or subsystems. As the conceptual designs developed, systems engineers worked closely with designers to ensure compatibility between requirements and designs. This systems engineering process provided a documented and traceable mechanism to ensure the design met expectations and that no unnecessary items were incorporated.

The resulting conceptual designs, system studies, and analyses provided the basis for a comprehensive evaluation of the overall MPC-based CRWMS. These studies and analyses focused on key aspects of the design, such as environmental impact, safety, health impact, cost, schedule, regulatory and licensing considerations, and risks to the CRWMS program. The evaluations compared the MPC system and other alternatives on a system-wide basis.

Throughout the development of the MPC system and alternatives, input was solicited from external groups. Nuclear utilities and other Purchasers have a vested interest in the CRWMS operating concept because of their need for a viable system for disposing of SNF and a need for near-term storage of SNF until the MRS or MGDS is available. A DOE/utility working group was formed to specifically address MPC implementation. Other interested parties include state and local governments, potential DOE facility host communities, SNF transportation and storage container vendors, and public interest groups. These parties and the nuclear industry, collectively referred to as stakeholders, were involved early in the design process. Section 4.5 presents a summary of interactions with stakeholders.

2.2 CONCEPT OF OPERATIONS

The concept of operations defines the assumptions used as the basis for evaluation of the MPC system throughout the various phases of Purchaser interface, SNF acceptance, transportation, storage, and disposal. These assumptions include operational descriptions, system parameters, and transportation modal capability data. Operational descriptions describe the movement and handling of SNF through the CRWMS. System parameters define the number of Purchasers that can accommodate certain MPC and cask sizes, the number of SNF assemblies contained within each of these MPC or cask types, MRS facility and MGDS capacities, and time phasing for SNF acceptance in the CRWMS. Transportation modal capabilities are defined for Purchaser sites that will interface with the CRWMS, with the goal of optimizing the use of large rail shipments from as many facilities as possible. Since all sites cannot accommodate rail shipments, some Purchasers must use truck casks for shipping SNF. Purchaser capabilities for handling and transporting MPCs and casks are based on extensive analysis of data provided by utilities.

The following sections provide summaries of the concept of operations for Purchasers and each CRWMS element. Information presented in these sections is obtained from the *Concept of Operations for the Multi-Purpose Canister System* study report, contained in Volume V of the MPC System CDR. Descriptions of the concept of operations for the TSC system and MPU system alternatives are provided in Chapter 5.

2.2.1 Program Level Operations and Parameters

A common basis is used for the quantity and movement of SNF in the development of all alternatives. This ensures a consistent basis for the development and comparison of the alternatives. Table 2.2-1 provides a summary of SNF movement and quantities throughout the CRWMS. Data is provided for concepts with and without an MRS facility.

The basis for quantity and movement of SNF throughout the CRWMS assumes shipment of SNF from Purchaser sites beginning in the year 2000. From 2000 to 2010, all SNF is transported from Purchasers to the MRS facility and placed in storage, except for the no-MRS case in which the SNF remains at the Purchaser sites. When the MGDS begins operation in 2010, the MRS facility will provide SNF packaging and staging prior to its shipment to the MGDS. For the no-MRS case, shipment of SNF begins in 2010 with shipment directly to the MGDS.

Table 2.2-1 SNF Movement in the CRWMS (MTU)

Year	With MRS			No-MRS	MGDS Activity	
	Picked Up From Purchasers	Into MRS Storage	Inventory at MRS	Picked up from Purchasers	Emplaced in 1st MGDS	Emplaced in 2nd MGDS
2000	900	900	900	0	0	0
2001	900	900	1800	0	0	0
2002	900	900	2700	0	0	0
2003	900	900	3600	0	0	0
2004	900	900	4500	0	0	0
2005	900	900	5400	0	0	0
2006	900	900	6300	0	0	0
2007	900	900	7200	0	0	0
2008	900	900	8100	0	0	0
2009	900	900	9000	0	0	0
2010	1400	1100	10100	300	300	0
2011	2000	1400	11500	600	600	0
2012	2600	1400	12900	1200	1200	0
2013	3000	1000	13900	2000	2000	0
2014	3000	0	13900	3000	3000	0
2015	3000	0	13900	3000	3000	0
2016	3000	0	13900	3000	3000	0
2017	3000	0	13900	3000	3000	0
2018	3000	0	13900	3000	3000	0
2019	3000	0	13900	3000	3000	0
2020	3000	0	13900	3000	3000	0
2021	3000	0	13900	3000	3000	0
2022	3000	0	13900	3000	3000	0
2023	3000	0	13900	3000	3000	0
2024	3000	0	13900	3000	3000	0
2025	3000	0	13900	3000	3000	0
2026	3000	0	13900	3000	3000	0
2027	3000	0	13900	3000	3000	0
2028	3000	0	13900	3000	3000	0
2029	0	-3000	10900	3000	3000	0
2030	0	-3000	7900	3000	3000	0
2031	0	-3000	4900	3000	3000	0
2032	0	-3000	1900	3000	3000	0
2033	0	-1900	0	1900	1900	0
2034	2500	0	0	2500	0	2500
2035	3000	0	0	3000	0	3000
2036	3000	0	0	3000	0	3000
2037	3000	0	0	3000	0	3000
2038	3000	0	0	3000	0	3000
2039	3000	0	0	3000	0	3000
2040	3000	0	0	3000	0	3000
2041	2655	0	0	2655	0	2655
Total	86155	N/A	N/A	86155	63000	23155

Use of two MGDSs is assumed in the concept of operations to accommodate the quantity of SNF requiring disposal. The first MGDS is assumed to be located at Yucca Mountain, and the second MGDS is assumed to be located in the western United States. The second MGDS begins receiving SNF in 2034. Once 63,000 MTU of SNF has been emplaced in the first MGDS, the second MGDS becomes operational. SNF is then shipped directly to the second MGDS, and the MRS facility is decommissioned.

In all, a total of 86,155 MTU of SNF and 11,000 MTU equivalent of high level waste (HLW) are expected to be accepted into the CRWMS. Discharge projections of SNF are based on the 1992 Energy Information Administration projections for no new reactor orders and waste acceptance allocation and selection based on oldest fuel first (OFF). Acceptance of SNF from Purchaser independent spent fuel storage installations (ISFSIs) is deferred until the Purchaser's spent fuel pool is empty.

Except for the no-MRS case, all alternatives are based on the assumption that the MRS is located in the western United States. A single MRS facility is provided, which begins operations in the year 2000. The maximum allowable amount of SNF that can be stored at the MRS facility is 10,000 MTU prior to the commencement of emplacement of SNF at the MGDS and 15,000 MTU thereafter. After closure of the first MGDS, the MRS facility is decommissioned, and any MRS functions that need to continue are moved to the second MGDS.

2.2.2 MPC System Operating Concepts

The following paragraphs summarize operating concepts for the MPC system for the following areas: Purchasers, waste acceptance, transportation, MRS facility, and MGDS. For the no-MRS case, operating concepts are very similar to those described here, except there is no MRS facility, and SNF assemblies are taken directly from Purchaser sites to the MGDS. The no-MRS case also results in increased SNF storage at Purchaser sites.

Purchasers

In the MPC system design concept, individual SNF assemblies stored in Purchaser spent fuel pools are loaded into MPCs in transportation casks for acceptance into the CRWMS. Purchasers in need of additional storage space prior to acceptance of SNF into the CRWMS load SNF into MPCs for on-site dry storage. Interim storage of MPCs is accomplished by placing the loaded MPCs into storage casks that provide shielding while the MPCs remain at the Purchaser site awaiting transport to the MRS facility or the MGDS.

For Purchasers that use MPCs, all SNF is assumed to be removed from Purchaser spent fuel pools five years after reactor shutdown. Large MPCs are used to the maximum extent practical. Large MPCs have a capacity of either 21 PWR or 40 BWR SNF assemblies. Smaller MPCs, with a capacity of 12 PWR or 24 BWR SNF assemblies, are used at Purchaser sites that cannot handle large MPCs because of crane capacity limitations or for other reasons. Because of limitations on crane capacity, shipping routes, or plant designs, some Purchasers cannot accommodate either size MPC. The MPC system concept of operations assumes that these sites load individual, uncanistered SNF assemblies into small, non-transportable multi-element sealed canisters (MESCs) for on-site storage, if pool storage capacity is exceeded. The capacity of these

MESCs is assumed to be either 7 PWR or 17 BWR SNF assemblies. Assumed Purchaser capabilities are summarized as follows:

Large MPC	88 facilities
Small MPC	14 facilities
MESC	19 facilities

Waste Acceptance

At the time of waste acceptance into the CRWMS, individual SNF assemblies in Purchaser spent fuel pools are loaded into MPCs in transportation casks. MPCs in interim storage at Purchaser sites must be transferred to transportation casks for shipment to the MRS or MGDS. The process for retrieving MPCs from Purchaser on-site dry storage involves removing MPCs from storage casks by direct transfer or by using a transfer cask. The transfer operation allows for a loaded MPC to be inserted into a transportation cask without using the Purchaser's spent fuel pool. Once the transportation cask containing the loaded MPC is properly closed, the transportation cask is ready to be accepted into the CRWMS.

For Purchaser sites that utilize MESCs for interim storage because they cannot accommodate MPCs, SNF retrieval is accomplished by taking the MESCs back into the spent fuel pool, where the MESCs are opened, and the individual SNF assemblies are transferred into legal weight truck (LWT) transportation casks. Purchaser sites that can accommodate MPCs, but that have utilized MESCs prior to the availability of MPCs, transfer the SNF assemblies from the MESCs to MPCs.

The ability of Purchaser sites to accommodate handling and transportation of MPCs is based on current and potentially enhanced site infrastructures. Enhancements considered include some facility modifications, administrative upgrades, and extensive use of heavy-haul truck and barge transportation methods. In addition, use of an on-site MPC transfer cask is considered that would allow 32 utility sites with crane capacity limited to 100 tons to load large MPCs, and then transfer the MPCs to transportation casks outside of the Purchaser's spent fuel pool. The 100-ton transfer cask takes advantage of less restrictive design criteria for shielding and containment for on-site use. This results in considerable weight savings, and allows the use of existing cranes with 100-ton handling capability.

Transportation

MPCs are transported from Purchaser sites to the MRS facility or to the MGDS in rail transportation casks. At many sites, barges and/or heavy-haul trucks are used to enable the use of MPCs. Off-site heavy-haul trucks are used to transport MPCs in transportation casks from 9 Purchaser sites to off-site rail access locations. On-site heavy-haul vehicles are used to transport MPCs in transportation casks from 22 Purchaser sites to rail access locations near the site boundaries. On-site heavy-haul trucks are also used to transport MPCs in transportation casks from 18 Purchaser sites to barge access locations for subsequent transport to off-site rail access locations.

All truck shipments of individual SNF assemblies use 25-ton LWT transportation casks. These casks have a capacity of 4 PWR or 9 BWR SNF assemblies.

MRS Facility

At the MRS facility, MPCs are either transferred to a storage cask or shipped to the MGDS by rail. Uncanistered SNF assemblies arriving in truck casks are transferred to large MPCs in storage casks or large MPCs in rail transportation casks. When MPCs are retrieved from MRS storage, they are transferred to rail transportation casks for shipment to the MGDS. All MPC and individual SNF assembly transfer operations are performed inside a heavily shielded transfer facility.

An integrated cask maintenance facility (CMF) is located at the MRS facility for decontaminating, inspecting, repairing, and maintaining transportation casks. For the no-MRS cases, the CMF is located at the first MGDS.

MGDS

When MPCs arrive at the MGDS, they are transferred from their respective rail transportation casks to disposal containers. Transfer operations are performed in a heavily shielded transfer facility. If necessary to meet repository performance goals, filler material may be added to MPCs at the transfer facility. Disposal containers containing MPCs, referred to as waste packages, are then moved to the repository, where they are emplaced in-drift for disposal. In-drift emplacement entails placing the waste packages on the floors of tunnels and eventually adding backfill around the packages.

The first MGDS receives only rail cask shipments of MPCs. The second MGDS receives rail cask shipments of MPCs, as well as some LWT transportation cask shipments of uncanistered SNF assemblies, since the MRS facility is not operating during use of the second MGDS. All uncanistered SNF assemblies are transferred into large waste packages for disposal. A CMF is located at the second MGDS, after other CRWMS facilities cease operations.

2.2.3 Individual SNF Assembly Handling System Operating Concepts

The following paragraphs summarize assumed operating concepts for evaluating the individual SNF assembly handling system. SNF remains in spent fuel pools at Purchaser sites until it is accepted into the CRWMS. Purchasers in need of additional storage space prior to SNF acceptance by the CRWMS may choose to utilize MESCs to provide temporary dry storage for SNF assemblies. Purchaser sites with sufficient handling capabilities load SNF into large MESCs, which have capacities of 24 PWR or 52 BWR SNF assemblies. Purchasers that cannot handle large MESCs utilize small MESCs with capacities of 7 PWR or 17 BWR SNF assemblies.

At the time of waste acceptance, individual, uncanistered SNF assemblies in spent fuel storage pools are loaded in transportation casks. MESCs are brought back into the spent fuel storage pools, where they are opened and the individual SNF assemblies are transferred into transportation casks. Depending on each Purchaser's handling capability, the transportation casks may be either rail or truck casks. Two sizes of rail casks and one size truck cask are assumed for shipping individual, uncanistered SNF assemblies. These include a 100-ton rail cask concept, with a capacity of 21 PWR or 37 BWR SNF assemblies, and a 75-ton rail cask concept, with a capacity of 12 PWR or 24 BWR SNF assemblies. The truck cask used in this concept is a 25-ton LWT cask, which is identical to that used in the MPC system for individual SNF assemblies. The number of Purchaser sites that are assumed to handle each size transportation cask are as follows:

100-ton rail cask	88 facilities
75-ton rail cask	14 facilities
25-ton LWT truck cask	19 facilities

The transportation casks are shipped to the MRS facility, where SNF assemblies in rail casks are transferred into storage casks, or the casks are placed on trains for shipment to the MGDS. SNF assemblies arriving at the MRS facility in truck casks are either transferred to storage casks for storage at the MRS or to rail casks for shipment to the MGDS. For the no-MRS case, operating concepts are very similar to those described here, except there is no MRS facility, and SNF assemblies are shipped directly from Purchaser sites to the MGDS. Upon arrival at the MGDS, the SNF assemblies are transferred from the transportation casks to waste packages for emplacement in the underground repository.

Chapter 3

MULTI-PURPOSE CANISTER SYSTEM CONCEPTUAL DESIGN

As part of the MPC System CDR work effort, conceptual designs were developed for the MPC, MPC transportation casks, OSTS, and MRS facility. This section includes summary descriptions of the conceptual designs for the MPC, transportation, OSTS, and MRS portions of the CRWMS. It also includes a description of how the MPC may be accommodated at the MGDS based on the existing design requirements.

3.1 MULTI-PURPOSE CANISTER

Information presented here is a summary of the *MPC Conceptual Design Report,* Volume II.A of the MPC System CDR. The MPC has been designed to satisfy applicable Nuclear Regulatory Commission (NRC) requirements, as well as program requirements and assumptions as described in Chapter 2 of this report. The summary presented in this section provides discussions of the operation of the MPC, the design of the MPC, preliminary design analyses, and issues related to fabrication of MPCs.

3.1.1 Operations

Operating functions associated with using MPCs fall into four basic categories: MPC loading, container closure, MPC transfer, and operational MPC performance. Before loading with SNF, an empty MPC must first be inserted into either a transportation cask or a transfer cask to provide proper shielding. This operation may be performed outside the Purchaser's spent fuel pool with the MPC and transportation cask or transfer cask in the vertical position. Insertion of empty MPCs into transportation casks may take place at a CRWMS facility or in the Purchaser's spent fuel handling building.

Once the MPC is in the transportation cask or transfer cask, a seal is installed between the MPC and the inner wall of the transportation or transfer cask, and the annulus is filled with de-ionized water to prevent contaminated pool water from contacting the exterior of the MPC or the interior of the cask. The MPC is filled with water, and the transportation or transfer cask containing the MPC is then placed in the storage pool by using the fuel building overhead crane. The MPC is loaded by transferring SNF assemblies from the spent fuel pool racks into the MPC. After the MPC is loaded, a shield plug and inner lid are installed and temporarily secured, and the overhead crane lifts the transportation or transfer cask to the pool surface. The water level in the MPC is lowered to just below the shield plug, and the transportation or transfer cask is then removed from the pool and placed in an adjacent area for closure welding.

A semi-automatic welding system is attached to the inner lid to join the lid to the MPC shell. This requires a worker near the MPC to guide the system into place and center it on the lid. The worker leaves the area as soon as the welding system is properly setup in order to keep personnel exposures as low as is reasonably achievable (ALARA). After the inner lid weld is completed, nondestructive examination (NDE) is performed to ensure the integrity of the weld. The rest of the water in the MPC is pumped back into the spent fuel pool by accessing the MPC cavity through ports in the lid. The MPC is then vacuum-dried, and the MPC cavity is filled with an inert gas. A honeycomb type spacer is placed on the inner lid, and an outer lid is positioned on the MPC. Additional temporary shielding is placed on the lid to offset the increase in radiation due to the removal of water. The outer lid is welded to the MPC shell wall and inspections are performed similar to those described for the inner lid.

The MPC is designed to permit its transfer from the transportation cask or transfer cask into either a vertical or horizontal storage cask. Since the MPC is shielded at the top end only, the surrounding transportation cask or transfer cask must provide adequate shielding to assure personnel protection from radiation exposure. Section 3.3.3 provides information on MPC transfer into storage casks.

3.1.2 Design

The MPC is a triple-purpose, sealed, metallic container that is used for storing, transporting, and disposing of SNF assemblies. MPCs have a single shell with two lids that are welded to provide a dry, inert environment for the SNF. Each MPC is contained within an additional package designed uniquely for the system functions of storage, transportation, and geologic disposal.

Design of the MPC is based on existing technology adapted to the specific requirements of the multi-purpose environment. Two sizes of MPCs are provided: a large, nominally 125-ton MPC and a small, nominally 75-ton MPC. Selection of the MPC sizes was based on trade-off studies of Purchaser site handling and transportation capabilities. The purpose of the selection was to maximize the use of the large MPC while minimizing the number of different sizes of MPCs. Based on this evaluation, the large MPC was selected as the largest size practical for accommodating the majority of facilities. The small MPC accommodates most other facilities, except those that have crane capacity or other limitations.

Each MPC consists of a cylindrical shell with two lids, an SNF basket, and a shield plug. The basket provides structural support for the SNF assemblies and serves as a conduit for the transfer of the heat generated by the SNF into the MPC shell. The basket also provides criticality control to ensure that the SNF remains subcritical under all postulated circumstances. The cylindrical shell provides structural support for the basket and ensures the geometric stability of the basket structure. The cylindrical shell and inner lid provide a primary containment boundary that prevents the release of radioactive material from the SNF. The outer lid provides secondary containment and a redundant seal; however, the MPC is not credited for licensing purposes with providing a containment barrier during transportation. Instead, the MPC transportation cask provides the containment boundary necessary to assure compliance with transportation requirements.

The capacity of the large MPC conceptual design is 21 PWR assemblies, using burnup credit, or 40 BWR assemblies. The small MPC conceptual design has a capacity of 12 PWR assemblies or 24 BWR assemblies and is designed without burnup credit for either configuration. Only the large MPC for the PWR configuration relies on burnup credit. Burnup credit for the large PWR MPC design takes advantage of the lower reactivity inherent in SNF to ensure criticality control. Without using burnup credit, licensing precedent would necessitate that the criticality potential of new fuel be used in the MPC design. The burnup credit issue is currently being pursued with the NRC since burnup credit has never been relied upon in a licensed design. Figures 3.1-1 and

3.1-2 show the configuration for the large MPC with a 21 PWR basket. Figures 3.1.3 and 3.1-4 show the configuration of the small MPC for a 12 PWR basket. Configurations for the large and small BWR SNF assembly MPC designs are similar to the 21 PWR basket, with the exception of the basket arrangement.

The MPC must satisfy requirements for structural strength, heat transport, criticality safety, and radiation shielding. To provide for its various phases of use, the MPC is designed to 10 CFR Part 71 for SNF transportation, 10 CFR Part 72 for SNF storage, and 10 CFR Part 60 for SNF disposal. It is expected that a license for storage and a certification for transportation will be obtained that do not require opening MPCs after storage and prior to transportation to the MRS facility or to the MGDS. With the exception of the burnup credit issue, no new regulations or regulatory interpretations are needed for on-site storage or for transportation. Though sufficient information is not yet available to seek licensing of the MPC for permanent disposal, design features incorporate current licensing criteria for the disposal phase. This is accomplished by incorporating known design requirements into the MPC design.

The MPC is designed to maintain SNF cladding temperatures below 350°C for disposal conditions. Early MGDS studies indicated that the maximum MGDS thermal capability is reached with a waste package capacity of 21 PWR assemblies. However, current MGDS interface requirements are not expected to limit MPC capacity to 21 PWR assemblies. Packaging 24 assemblies instead of 21 assemblies could result in a significant reduction in overall system costs. Section 4.6.5 discusses evaluations of the cost impact of increasing the MPC capacity.

Stainless steel 316L was selected as the MPC shell material since it is the most economical of acceptable materials for the MGDS. The conceptual design assumes corrosion protection will be provided by the waste package overpacks.

The burnup credit issue must be resolved to allow full use of the 21 PWR MPC throughout the CRWMS and to support MGDS licensing efforts for all MPC designs. Regulatory approval and certification of burnup credit storage and transport package applications may not occur in the period necessary to support early deployment of burnup credit MPCs. Several MPC basket variations (including both burnup credit and non-burnup credit designs) are provided to maximize the effective cask capacity, to accommodate a large majority of PWR and BWR SNF types, and to enhance flexibility to support early deployment of MPCs prior to final resolution of the burnup credit issue, if necessary.

3.1.3 Design Analyses

The large and small MPC designs are analyzed to verify compliance with the requirements of storage and transportation. Design basis SNF parameters are established for use in analysis and design of the MPC. Analyses are performed for criticality safety, thermal, structural, and shielding considerations. Results of these analyses demonstrate that the MPC conceptual design is feasible, satisfies regulatory requirements, and can be fabricated for a reasonable cost.

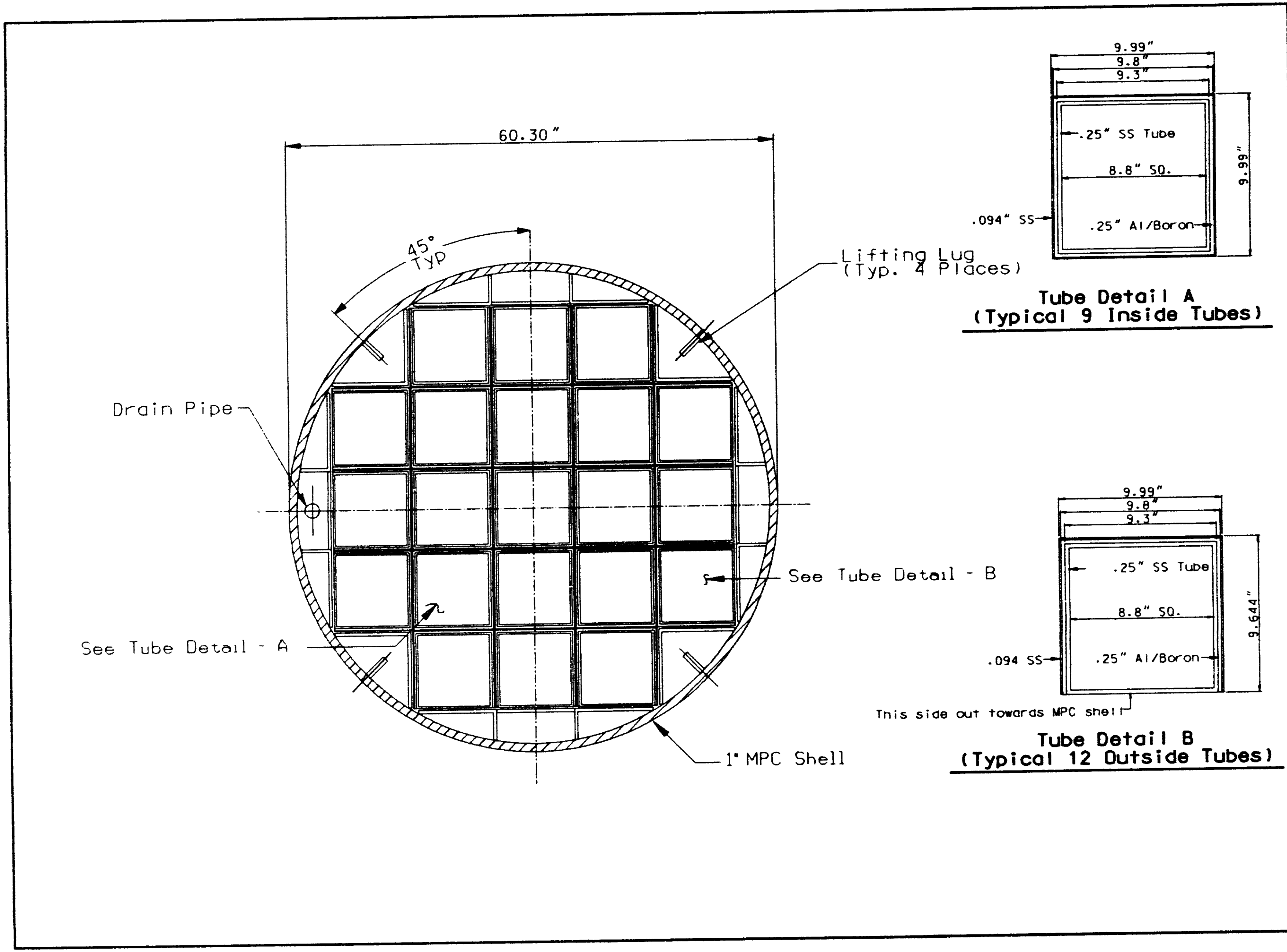

Figure 3.1-1 Large 21 PWR MPC (End Section View)

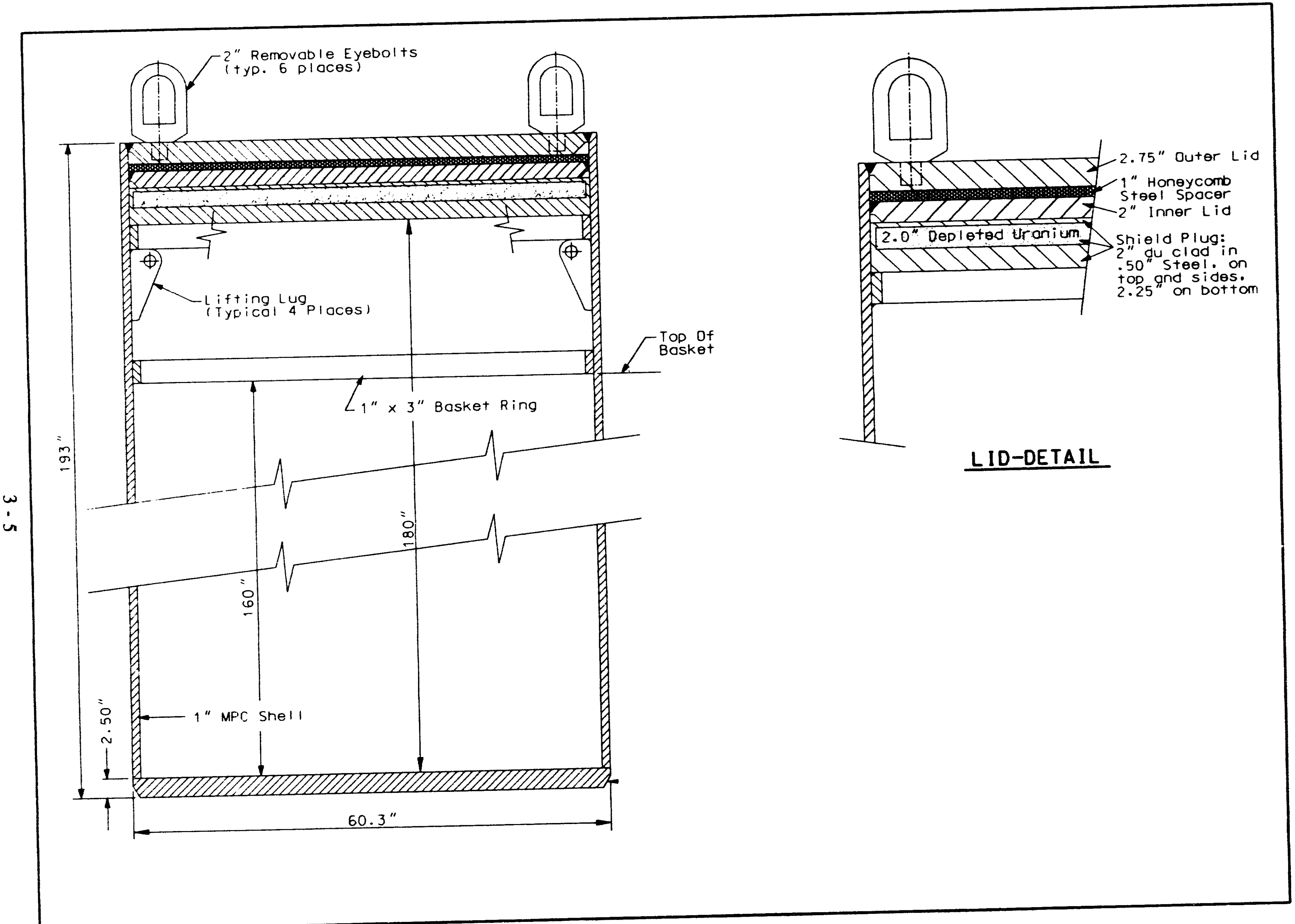

Figure 3.1-2 Large 21 PWR MPC (Side Section View)

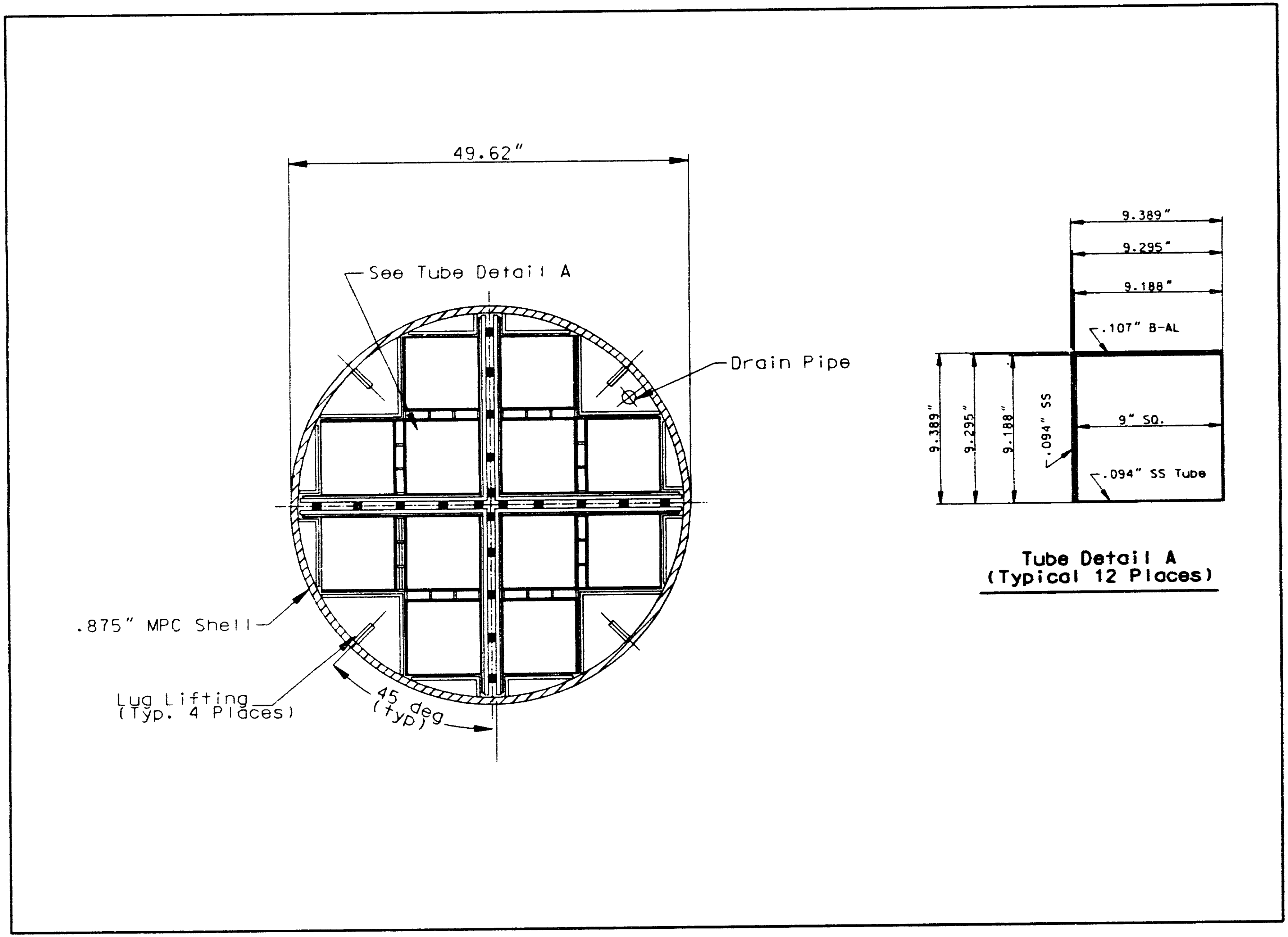

Figure 3.1-3 Small 12 PWR MPC (End Section View)

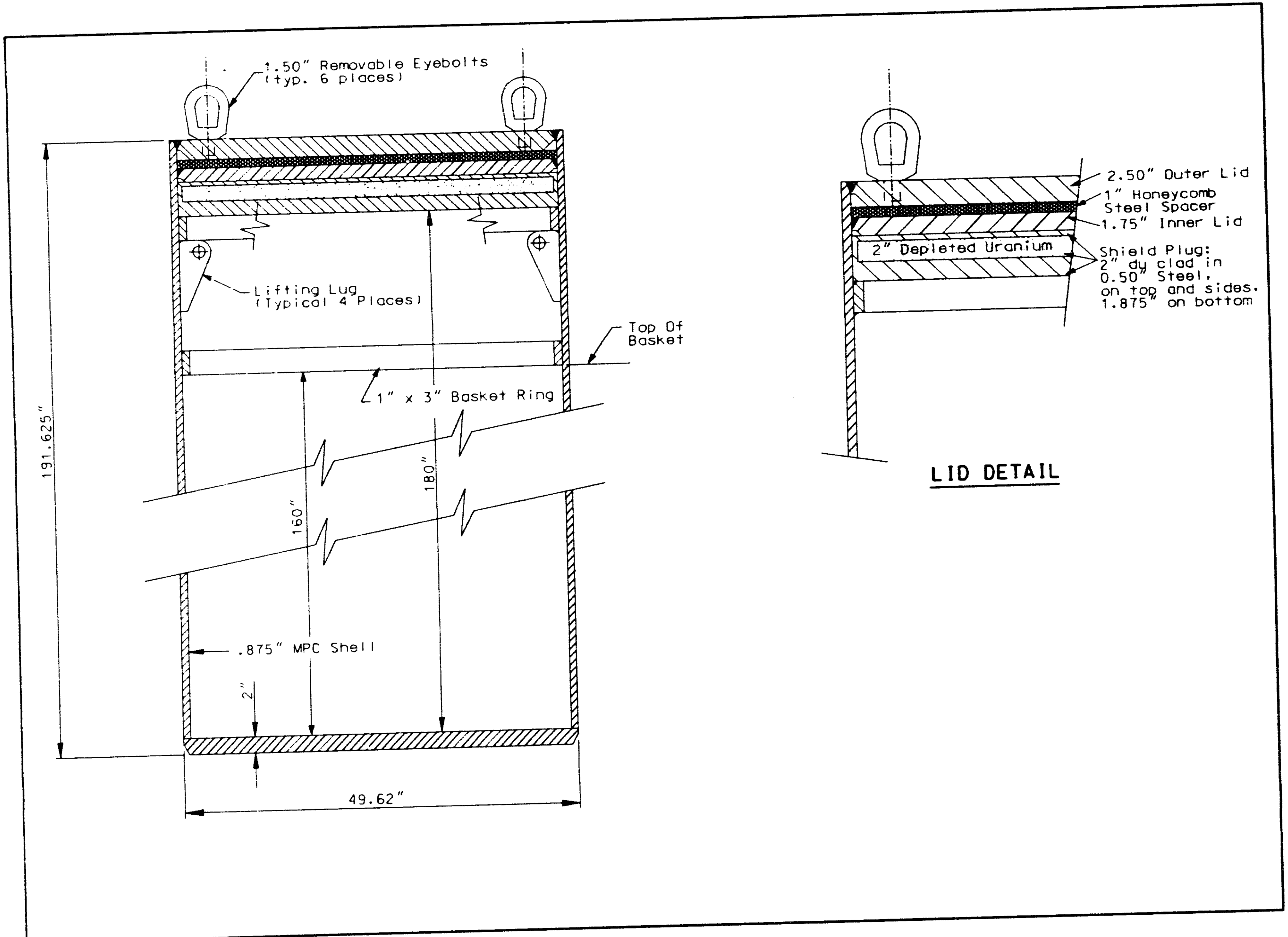

Figure 3.1-4 Small 12 PWR MPC (Side Section View)

Design Basis Fuel Assembly Parameters

The design basis fuel assemblies for the MPC conceptual design are PWR and BWR fuel assemblies with the parameters given in Table 3.1-1. These parameters represent acceptance goals established to assure at least 80 percent of the SNF available for acceptance in the first 10 years of CRWMS operations can be accommodated by the MPC system. Ultimately, 100 percent of available SNF will be accommodated by changes in the operations of the MPC system. Studies specified in the MPC system design procurement specifications will identify cost-effective methods to accommodate SNF that lies outside the parameters of Table 3.1-1.

Table 3.1-1 MPC Design Basis SNF Assembly Parameters

Parameter	PWR	BWR
Length (inch)	180	180
Width (inch)	9x9	6x6
Weight (pounds)	1,720	730
Age (years)		
Transportation	10	10
Storage	10[a]	10[a]
Disposal	20	20
Initial Enrichment (wt. percent U-235)	3.75	3.75
Burnup (MWD/MTU)		
Thermal/Shielding	40,000	40,000
Criticality	37,000	37,000

Note:

a) Age of SNF for storage has been revised to 5 year's old in the MPC system design procurement specification.

Criticality Safety Analyses

Only the large PWR MPC conceptual design must utilize burnup credit to demonstrate criticality safety. The other PWR basket design employs water gap flux trap arrangements to improve the effectiveness of borated aluminum neutron absorber panels in the baskets. The smaller size of the BWR SNF assemblies allows the borated aluminum panels to come closer to the center of the assemblies, and the neutron absorber panels are more efficient as a result. For the large PWR MPC, burnup credit is used to maximize the effective MPC system capacity and minimize cost. Burnup credit may prove to be the most reliable basis for demonstrating long-term criticality safety following disposal of intact SNF assemblies for all the MPC designs.

Criticality analyses take credit for only 75 percent of the original boron-10 content of the MPC borated aluminum panels to allow margin for depletion and other losses during the MGDS containment period. Water intrusion into the MGDS over the containment period may be possible and is considered in the conceptual MPC design. By taking credit for only 75 percent of the manufactured boron-10 content in the neutron absorber panels, the margins for criticality safety for long-term control are considered very conservative for the MPC.

The maximum fresh fuel enrichment limits for the MPC basket conceptual designs resulting from the criticality analyses are tabulated in Table 3.1-2.

Table 3.1-2 MPC Designs Fresh Fuel Enrichment Limits

MPC	**Maximum Initial Enrichment** (weight percent U-235)
Large, 125-ton, 21 PWR	>1.8 [a]
Large, 125-ton, 40 BWR	4.3
Small, 75-ton, 12 PWR	3.7
Small, 75-ton, 24 BWR	5.0

Note:

a) Large PWR MPC design is based on burnup credit. Without burnup credit, the maximum initial enrichment is 1.8 weight percent U-235. The allowable initial enrichment increases as the burnup of the SNF increases.

Thermal Analyses

Both the large and small MPCs are analyzed for thermal effects in transportation casks. Cladding temperatures during transportation exceed the temperatures that are expected for SNF assemblies in dry, ventilated storage casks, since ambient air is ducted directly over MPCs during storage. An SNF cladding temperature limit of 340°C is assumed as the storage and transportation design limit for thermal analyses. This limit is reasonable based on SNF inventories at Purchaser sites and Purchaser needs for SNF storage. This ensures storage limits are met with loaded MPCs in transportation casks, and certification of MPC transportation casks for storage is not precluded.

Fuel cladding temperatures calculated for the various MPC configurations are provided in Table 3.1-3. These temperatures are well under the 340°C storage and transportation limit for all basket designs. Calculations indicate that a three PWR assembly increase in the large MPC design (from 21 to 24 PWR assemblies) would result in an increase of only 10°C in the cladding temperature during transportation.

Table 3.1-3 MPC Fuel Cladding Temperatures

Large MPC	Small MPC
21 PWR 301°C (573°F)	12 PWR 249°C (480°F)
40 BWR 249°C (480°F)	24 BWR 226°C (438°F)

Interfaces of the MPC with the MGDS waste package may change as the MGDS design evolves. As described in Section 3.5.2, SNF cladding temperatures are assumed to be limited to 350°C at the MGDS. SNF cladding temperatures in the waste package must be evaluated to confirm compliance of the MPC design with the MGDS limit. The SNF cladding temperature issue is only one factor in evaluating potential increase in the large MPC capacity; other factors, such as criticality, would also have to be considered. Section 3.5 discusses thermal interfaces between the MPC and MGDS in more detail.

Structural Analyses

Structural analyses of the MPC in its transportation cask are based on a 60g acceleration design limit for the transportation hypothetical nine-meter drop accident scenario required by the NRC. Impact load limits are not included in 10 CFR Part 71, but the 60g limit has been imposed so that parallel conceptual design efforts of the MPC and MPC transportation cask could progress. The 60g acceleration design limit is a bounding value that light water reactor SNF assemblies can structurally withstand in a side drop accident scenario. Theoretical g-loads on the order of 30g for the large MPC and 35g for the small MPC have been determined for side drop and end drop scenarios, which are significantly less than the 60g acceleration used for MPC structural analyses.

The MPC shell supports the basket structure during the impact of a side drop. The shell must not deform significantly, since this could alter the support geometry for the basket. Analyses indicate that a 1-inch thick shell is sufficient for the large MPC and a 7/8-inch thick shell is adequate for the small MPC. Since shell strength is dependent primarily on geometry rather than material strength, these shell thicknesses are adequate for a variety of shell materials, such as alloy 825, stainless steel 316L, and ferritic steel A-516 Gr 60.

The bottom end, inner lid, and shell of the MPC provide the containment barrier during storage. As required by the NRC, design of these components must consider the pressure resulting from failure of 100 percent of the fuel rods. Therefore, the MPC is designed to withstand a 100 psig pressure load on the containment barrier. This pressure controls the design of the bottom and inner lids of the large and small MPCs, which results in bottom and inner lid thicknesses of 2.5 inches for the large MPC and a 2.0 inches for the small MPC.

The outer lid of each MPC provides redundant containment for storage as required by 10 CFR Part 72. The outer lid also provides the mounting locations for lifting the loaded MPC during transfer operations. Since the consequences of dropping SNF assemblies could be significant, stringent safety factors are required for design of lifting mechanisms and lift attachment points.

These lifting considerations control the thickness of the outer lid. An outer lid thickness of 2.75 inches is sufficient for the large MPC, and a 2.5-inch thick outer lid is adequate for the small MPC.

Tubes that form the basket structures in the MPCs must support the weight of SNF assemblies during a side drop accident scenario. Composite steel and aluminum tubes 0.25 inches thick are sufficient for the large PWR MPC and both the large and small BWR MPC basket designs. The small PWR MPC basket uses a plate structure for the main flux trap that provides additional structural support for the SNF assemblies. Therefore, 0.094-inch thick tubes are adequate for the small PWR MPC basket.

Shielding Analyses

Shielding of the cylindrical portion and bottom of the MPC is provided by overpacks. Depleted uranium is used in the shield plug at the top of the MPC to maintain personnel radiation exposures ALARA during closure operations and to make space for long SNF assemblies. Lead was not considered as a shielding material in the MPC in order to avoid the use of mixed waste at the MGDS. (Section 4.6.5 describes options for alternative shield plug materials.) Remote welding with a semi-automatic welding machine helps avoid much of the potential personnel radiation exposure; however, weld inspection and rework to correct weld defects may require direct human action. For this reason, dose rates on the surface of the MPC inner lid during closure operations are a primary concern. It is possible to perform many closure operations with most of the pool water still in the MPC cavity to take advantage of the shielding provided by the water. Estimated MPC dose rates, 12 inches from the shield plug surface, are provided in Table 3.1-4.

Table 3.1-4 MPC Inner Shield Plug Dose Rates (mrem/hour)

MREM Per Hour	Small MPC	Large MPC
Neutron	11.2	17.0
Gamma	82.5	100.3
Total	**93.7**	**117.3**

Notes:
Centerline dose rates are through shield plug at 12 inches from surface; scatter dose contribution from cask/MPC annular gap is not included. Transportation cask dose rates are provided in the *MPC Transportation Cask Conceptual Design Report.*

3.1.4 Fabrication Issues

As a guideline, it was assumed that the MPC would be fabricated in accordance with the ASME Boiler and Pressure Vessel Code, Section III Division 1, Nuclear Power Plant Components, Section NB-Class 1 Components. It is envisioned that the MPC would be assembled by fabricating a cylindrical shell and welding a bottom end plate to the shell. The SNF basket is inserted into the MPC shell and a retaining ring is welded to the shell at the top of the basket. Another ring is welded to the shell to form a shoulder to support the shield plug.

The basket is assembled by clamping tubes together in a manufacturing fixture and tack welding the tubes together with intermittent stitch welds. These welds allow the basket to be lifted as a unit for insertion into the MPC shell. The geometry of the basket prevents welding of all four corners of a tube to the adjacent tubes. Three sides are welded on a typical tube. Support for the basket is provided by the MPC shell. Angles are welded longitudinally to the shell to provide alignment and interface between the basket and the shell.

The MPC conceptual design employed depleted uranium in the MPC lid. The technology for construction of MPC lids using depleted uranium has been demonstrated in other cask designs. However, continued refinement of depleted uranium fabrication technology is an important step in ensuring that the MPC can be constructed as inexpensively as possible.

The technology used to weld the inner lid to the MPC is important because of its effect on personnel exposure and thermal distortion. Existing welding machines used at Purchaser facilities are semi-automatic, with manual welding required in some cases. The need for direct manual access for welding, inspection, and possible weld repair mandates the reduction of dose rates on the MPC inner lid surface to acceptable levels. In addition, heat input from the welding process could cause thermal distortion of the MPC cylinder wall. Investigation of the use of automatic welding machines to provide a reliable, quality weld could result in significant reductions in personnel exposure, weld temperatures, and the frequency of weld repairs. Sandia National Laboratories is currently investigating the use of automated welding techniques to reduce personnel exposures and to enhance weld quality. Study results should be available in late 1994.

3.2 TRANSPORTATION

This section presents results of the MPC transportation cask conceptual design effort. Information presented here is a summary of the *Transportation Cask Conceptual Design Report,* Volume II.B of the MPC System CDR. Transportation of MPCs containing SNF assemblies must be in transportation casks that are certified by the NRC under 10 CFR Part 71. Two transportation cask conceptual designs have been prepared, one to transport the large MPC and one to transport the small MPC. This summary provides discussions of transportation operations and design considerations, the approach used for conceptual design of transportation casks, and results of preliminary design analyses.

3.2.1 Operation and Design Considerations

Operations for loading MPCs into transportation casks are described in Section 3.3 for various methods of SNF assembly transfer. Once an MPC in a transportation cask is loaded with SNF assemblies and properly closed, a lid is installed on the cask, and the annulus between the transportation cask shell and MPC is drained, vacuum dried, and backfilled with helium. The loaded cask is then placed on a railcar, impact limiters are installed, and the cask is transported to the MRS facility or to the MGDS.

In order to accommodate Purchaser site handling capabilities, transportation casks with loaded MPCs must be a maximum of 125 tons for the large MPC and 75 tons for the small MPC. These limits refer to the maximum allowable "under-the-hook" weight at the spent fuel pool and include the MPC (with outer lid removed), SNF, water, transportation cask body (cask lid removed), and the lifting yoke. Another option is the use of a 100-ton transfer cask to permit increased use of the larger MPCs. This is discussed in Section 3.3.3. Additionally, the total weight of a loaded MPC, transportation cask, and lifting yoke must not exceed the 125-ton and 75-ton limits at the railcar, since the same facility crane that is used in the fuel pool area may also be used to place the transportation cask onto the railcar. The 125-ton transportation cask is shown in Figures 3.2-1 and 3.2-2, and the 75-ton transportation cask is shown in Figures 3.2-3 and 3.2-4.

Conceptual designs of the MPC transportation casks are based on existing technology, which is adapted to suit the requirements of the MPCs. MPC transportation cask capacities exceed the maximum capacities of previously certified transportation casks in the United States. Transportation cask conceptual designs use depleted uranium to provide an efficient gamma radiation shield and to minimize package weight. Depleted uranium has been used in certified casks.

3.2.2 Design Approach

The transportation cask conceptual design provides structurally conservative, efficiently shielded casks that satisfy "under-the-hook" weight limits. Structural conservatism is provided by inner and outer cask shell wall layers with thicknesses that can withstand a hypothetical nine-meter drop accident required by the NRC. A 60g acceleration value was used for MPC transportation cask structural analyses as described in Section 3.1.3. Structural design of the transportation cask and the MPC are closely interdependent. The use of a conservative 60g design acceleration limit allowed the MPC and transportation cask conceptual designs to be developed in parallel.

The conceptual design assumes that the structural components of the cask body are fabricated using 316L stainless steel. This ordinary type of stainless steel could be replaced with a high strength stainless material to provide additional strength if determined necessary during detailed design. The inner and outer shell walls of the cask enclose gamma shielding material that consists of depleted uranium and lead. Depleted uranium is used as gamma shielding material because of its high density. The circumferential layer of lead provides backing for the outer stainless steel shell to aid in withstanding the 10 CFR Part 71 one-meter (40 inch) pin puncture test. The pin puncture test dictates the thickness of the outer stainless steel shell. The inner stainless steel shell thickness is controlled by the 10 CFR Part 71 hypothetical nine-meter side drop accident, which must not cause the inner shell to yield or buckle.

Impact limiters are provided at both ends of the transportation cask to protect the cask during an accident. They are designed to restrict the impact load to less than the 60g design goal. The impact limiters are light weight, but they provide sufficient energy absorption capability to accommodate the hypothetical nine-meter drop accident.

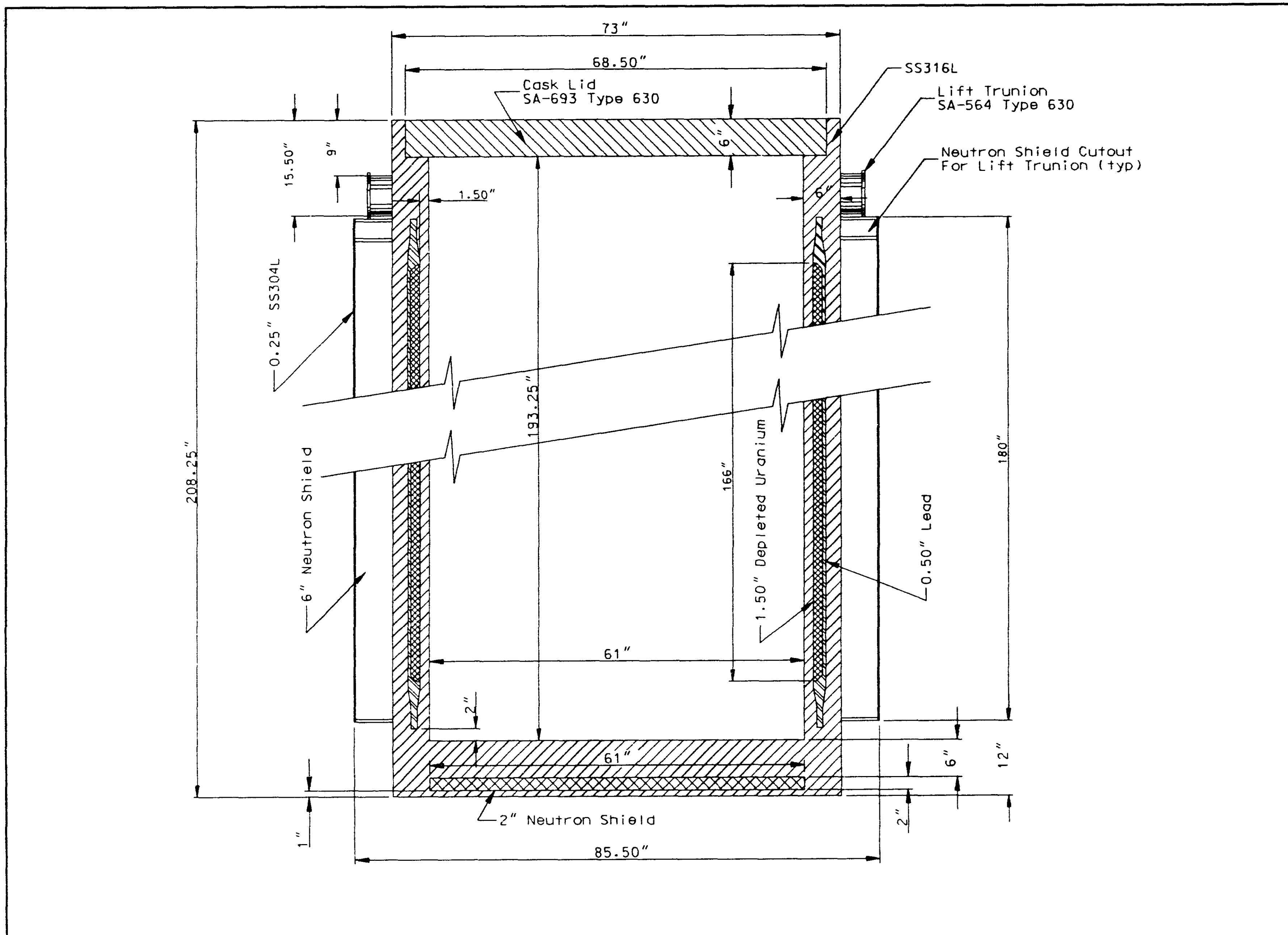

Figure 3.2-1 Large Transportation Cask (Side Section View)

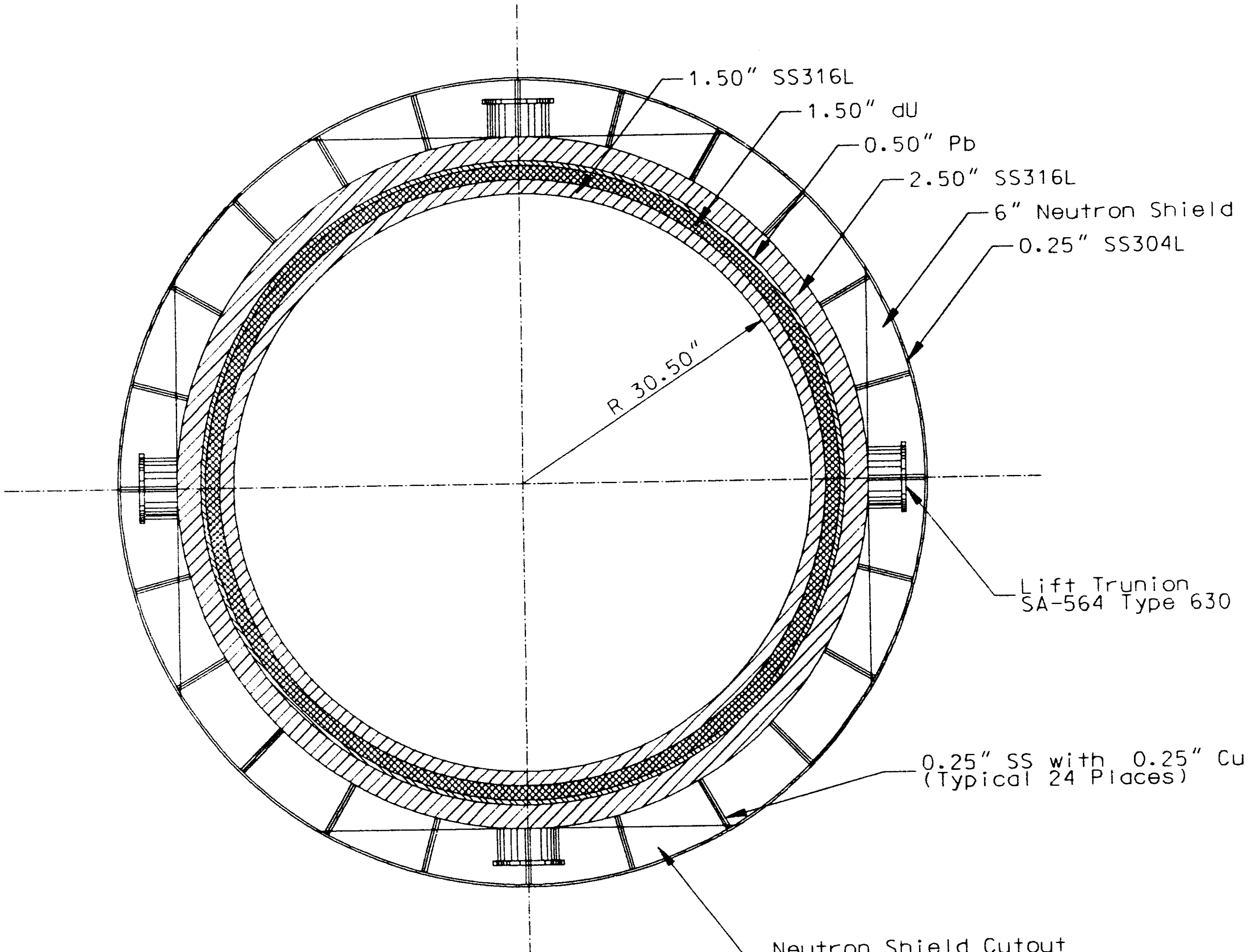

Figure 3.2-2 Large Transportation Cask (Top Section View)

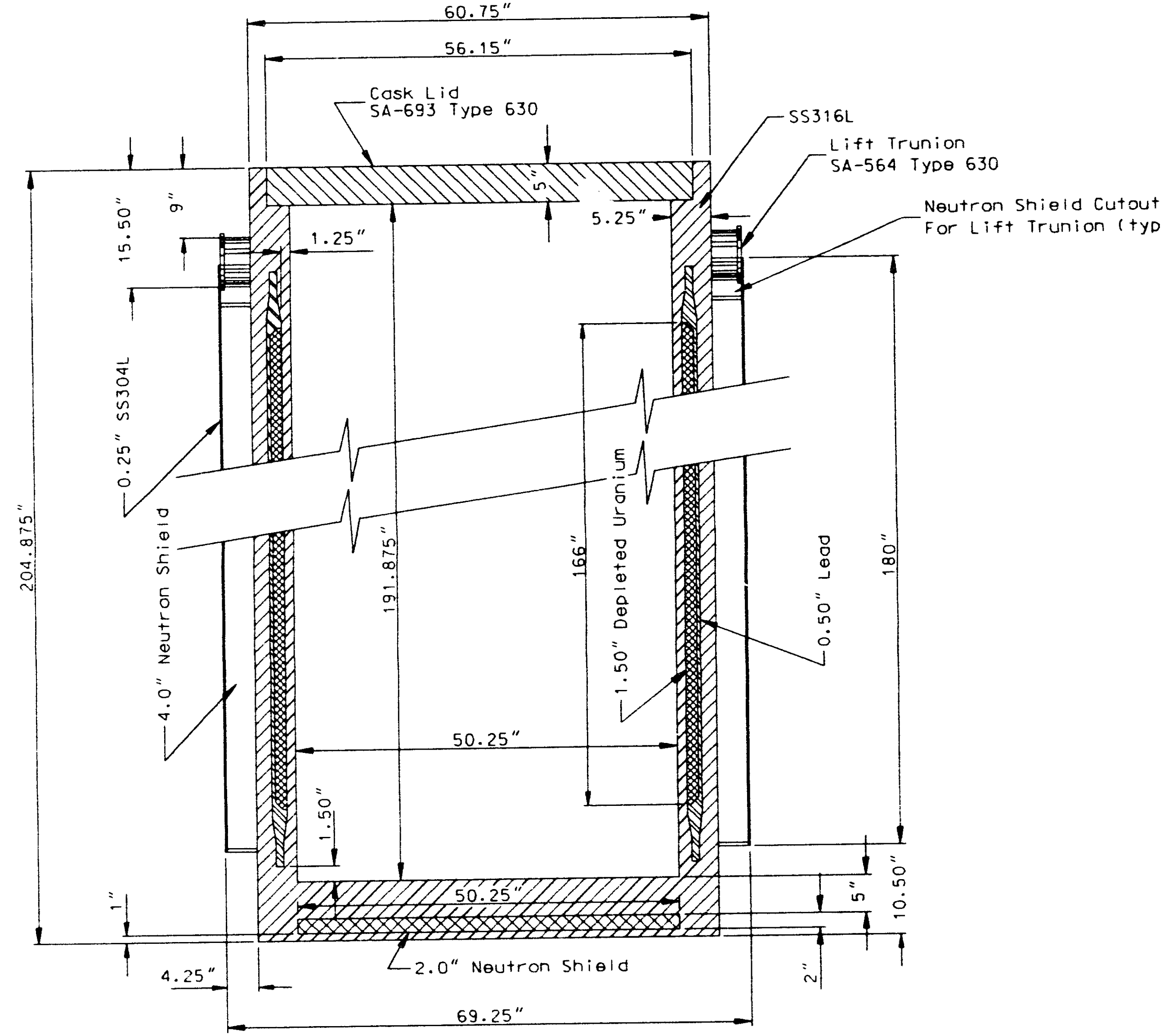

Figure 3.2-3 Small Transportation Cask (Side Section View)

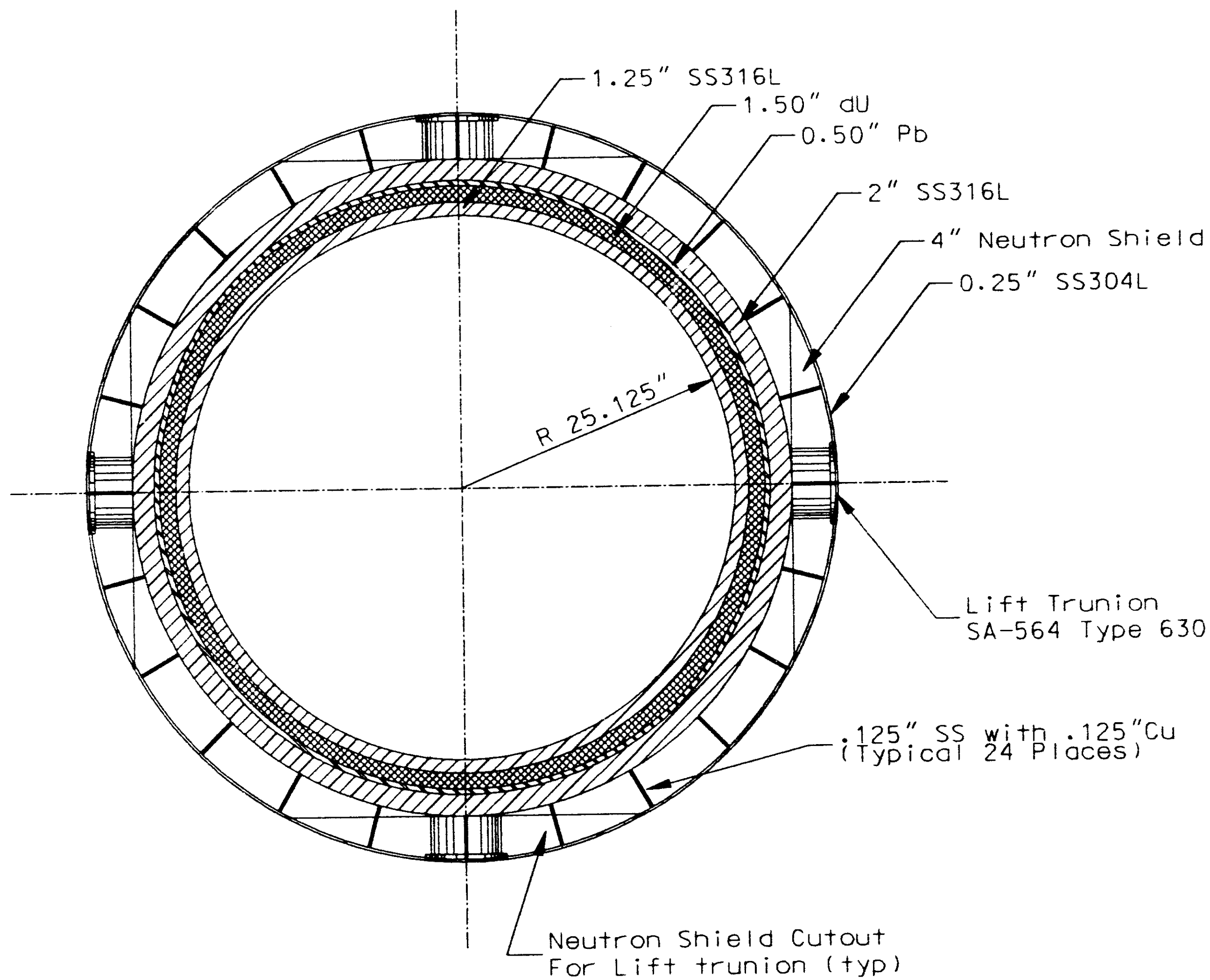

Figure 3.2-4 Small Transportation Cask (Top Section View)

Design temperature limits are established for MPC transportation casks to ensure the casks can be licensed for SNF storage, if desired. Shielding design is performed in accordance with the transportation requirements specified in 10 CFR Part 71. Shielding materials and configurations are well suited to existing fabrication techniques.

3.2.3 Design Analyses

Analyses were performed to confirm that transportation cask weight limits are met and that adequate structural strength is provided. Analyses also indicated that fuel cladding temperatures for all MPC configurations are acceptable. A preliminary shielding analysis showed that shielding is adequate to meet the 10 CFR Part 71 limits. Results of these analyses are provided in the following sections.

Package Weights

Estimated weights for the various MPC configurations are shown in Table 3.2-1. At-pool weights include the MPC (with outer lid removed), SNF, water, transportation cask body (with cask lid removed), and lifting yoke. At-rail weights include a loaded MPC, transportation cask, and lifting yoke. On-rail weights include the loaded MPC in a transportation cask, top and bottom impact limiters, personnel barriers, cask supports, intermodel cask support skid, and railcar.

Table 3.2-1 MPC Package Weights (Tons)

Configuration	75-Ton 12 PWR	75-Ton 24 BWR	125-Ton 21 PWR	125-Ton 40 BWR
At pool	74	73	106	105
At rail	73	72	105	105
On rail	114	114	183	183

Structural Margins

Impact limiter design for the transportation casks restricts impact loads to less than the design value of 60g. This provides substantial stress margins for the transportation cask designs. Actual end and side drop g-loads were estimated to be 32g and 30g, respectively, for the large MPC transportation cask as a result of the hypothetical accident. Similarly, 32g end and 34g side drop g-loads were estimated for the small MPC transportation cask. A corner drop scenario results in somewhat greater g-loads, which are effectively split into simultaneous axial and side g-loads on the transportation cask. These g-loads produce lower stresses overall than the individual scenarios for end and side drops. Significant structural margin is available for the 10 CFR Part 71 hypothetical nine-meter drop accident.

The outer stainless steel 316L shell thickness requirements for the transportation casks are controlled by the 10 CFR Part 71 one-meter pin puncture requirements. The theoretical required thickness for the outer shell of the large cask to resist pin puncture is 2.39 inches, and a 2.5-inch wall thickness is provided. For the small cask, a 1.83-inch thick outer shell is required, and a 2-inch wall thickness is provided.

Temperatures

The temperature of the SNF assembly cladding must be maintained at or below 340°C for dry storage. It is also desirable to maintain the cladding temperatures below this value during transportation to avoid limiting the time SNF can remain in a transportation cask. Calculated SNF cladding temperatures for all MPC transportation cask configurations are below the 340°C limit, as shown in Table 3.2-2.

Table 3.2-2 MPC Fuel Cladding Temperatures

Large Cask	Small Cask
21 PWR 301°C (573°F)	12 PWR 249°C (480°F)
40 BWR 249°C (480°F)	24 BWR 226°C (438°F)

Another important issue for transportation cask design is the temperatures of the SNF cladding and the lead shielding zone during a hypothetical fire accident. The maximum SNF cladding temperature expected after a transportation cask is exposed to a 10 CFR Part 71 design basis half-hour fire at 800°C is below the 340°C limit. Under these conditions, the maximum temperature of the transportation cask lead zone is estimated to be 186°C (367°F), which is substantially less than the 327°C (620° F) melting point of lead.

Shielding

Efficient shielding of the MPC transportation casks is provided by depleted uranium and lead, which are high-density materials. A series of analyses were performed to evaluate transportation cask surface dose rates. In accordance with 10 CFR Part 71, allowable dose rates are 200 mrem/hour on the accessible surface of the cask, and the dose rate at two meters from the transportation cask boundary must be less than 10 mrem/hour.

Gamma radiation comprises the largest portion of the transportation cask dose rate. Conceptual designs for the MPC transportation casks are estimated to have dose rates lower than the 10 CFR Part 71 limits at all locations around the casks. The neutron shields provided in the shells of the transportation casks are designed to overlap the end fittings of SNF assemblies so that radiation leaving the assemblies passes radially outward through the neutron shield, which also provides some gamma shielding. Radiation proceeding at a slant outward and downward below the ends of the neutron shields travels a longer distance through the depleted uranium gamma shielding, so it is effectively shielded. The end fittings of SNF assemblies are not a neutron radiation source. Therefore, the absence of neutron shielding at the top and bottom of the cask shells is not a concern. Dose rate estimates for MPC transportation casks are shown in Table 3.2-3. In the table, midplane dose rates refer to the expected dose rates on the cask surface midway along the length of the cask. The 2-meter dose rates indicate the highest dose rates expected anywhere around the cask at a distance of 2 meters from the cask surface. The peak dose rates are the maximum expected dose rates anywhere on the surface of the cask.

Table 3.2-3 MPC Transportation Cask Dose Rates (mrem/hour)

3.75% U-235, 40 GWD/MTU, 10 Year SNF	Large MPC Dose Rate	Small MPC Dose Rate
Midplane	21.7	60.3
2 Meter	7.5	9.5
Peak	111.5	172.4

3.3 ON-SITE TRANSFER AND STORAGE

This section presents results of the MPC OSTS subelement conceptual design effort (referred to as the utility transfer system, or UTS, in the MPC System CDR). Information presented here is a summary of the *MPC Utility Transfer System (UTS) Conceptual Design Report*, Volume II.D of the MPC System CDR. The OSTS is that part of the MPC system that interfaces with all Purchaser facilities, which consist of all existing commercial SNF storage sites as defined in the 10 CFR Part 961 standard contract, except Fort St. Vrain. The OSTS subelement addresses MPC system interfacing operations at 120 utility facilities and the G.E. Morris storage facility.

The OSTS provides for transferring SNF at Purchaser sites into MPCs for off-site shipment in transportation casks. It also provides for transfer of SNF to MPCs for Purchaser on-site dry storage in ISFSIs prior to transfer to a transportation cask for shipment. This section includes discussions of the operation and design considerations of the OSTS, the approach for conceptual design, and the five design concepts investigated.

3.3.1 Operation and Design Considerations

The purpose of the OSTS is to provide methods for Purchasers to utilize MPCs, with emphasis on optimizing use of the larger MPC. Purchaser facility constraints, such as physical dimensions, crane capacity, and rail access, require the use of a variety of methods for Purchasers to accommodate MPC handling. As described in Section 2.2, the concept of operations for Purchaser sites includes the use of large MPCs, small MPCs, and LWT transportation casks at some sites. Section 2.2 also describes the use of MESCs at Purchaser sites, both prior to MPC system implementation and for Purchaser facilities that cannot accommodate MPCs.

There are a total of 121 Purchaser SNF storage facilities. Of these, 102 can accommodate the use of MPCs. In turn, 70 of these facilities can handle MPCs directly. These consist of 56 facilities that can handle large MPCs and 14 facilities that can use small MPCs. Another 32 facilities, which otherwise would use small MPCs, can be enabled to handle large MPCs through the use of an on-site MPC transfer cask. This brings the usage of the large MPC to 88 facilities and usage of the small MPC to 14 facilities, for a total MPC usage at 102 facilities. The remaining 19 facilities, which cannot handle the small MPC without modifications, would handle individual SNF assemblies in LWT truck casks. Use of a bare SNF transfer system may allow some of these facilities to accommodate MPCs.

3.3.2 Design Approach

Since extensive information and hardware exists for transfer and storage of SNF at Purchaser sites, the OSTS conceptual design approach optimizes use of vendor designs as much as possible. Therefore, detailed conceptual designs were not produced for OSTS components. Rather, a method has been developed to integrate vendor inputs with Purchaser site needs and to incorporate this data into the MPC system design. Since some utilities cannot use the MPC system without substantial modifications to their facilities, the transfer of individual, uncanistered SNF assemblies into the CRWMS is also included in the OSTS design for completeness.

3.3.3 Design Concepts

Five basic transfer methods have been developed for handling MPCs and individual, uncanistered SNF assemblies and for storing MPCs at Purchaser ISFSIs. These methods are summarized as follows:

- Direct MPC transfer
- Enhanced MPC transfer
- Bare SNF assembly transfer
- MPC/ISFSI transfer and storage
- No MPC transfer.

Direct MPC Transfer

The direct MPC transfer method is intended for Purchaser facilities that currently have cask handling facilities, cask handling cranes, and rail transportation capability to load MPCs for the 75-ton or 125-ton hook weight transportation cask systems. Figure 3.3-1 shows the major tasks required to perform direct MPC transfer.

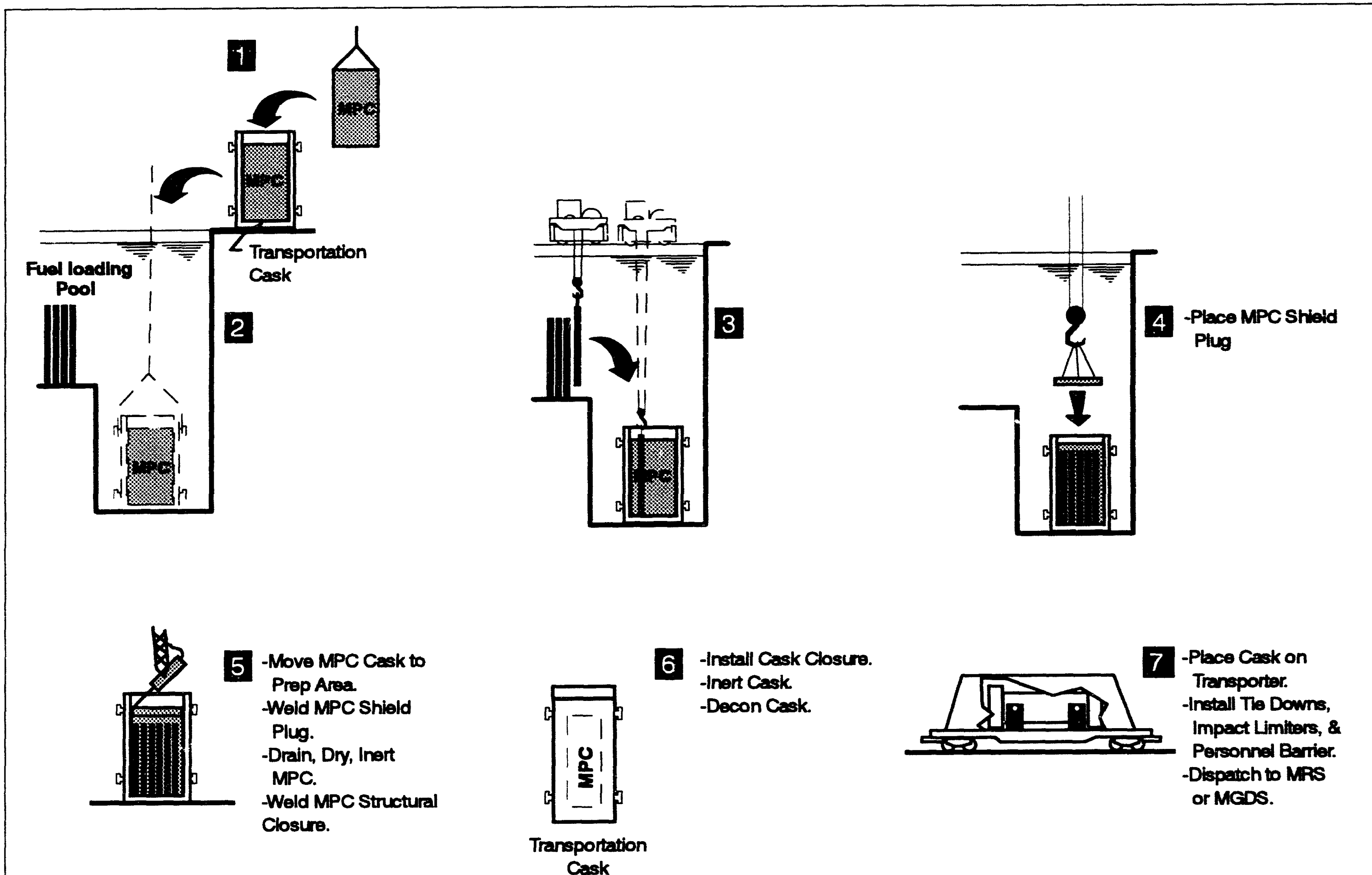

Figure 3.3-1 Direct MPC Transfer

For direct MPC transfer, an empty MPC is received at the Purchaser site and moved to the fuel pool preparation area, where it is placed in an MPC transportation cask. After installing contamination protection on the MPC and cask, the cask containing the MPC is placed in the fuel pool. SNF assemblies are loaded into the MPC, and the MPC shield plug and inner lid are installed. The cask and MPC are then moved from the pool to a preparation and decontamination area, where the cask exterior is decontaminated. The inner lid is welded on the MPC and properly inspected, and the MPC interior is drained, dried, backfilled with inert gas, and tested. A spacer is then installed on top of the inner lid, and the outer lid is set in place and welded on the MPC. The loaded cask is mounted on a cask transporter, and transport components are installed. A final radiological survey is performed, and the loaded MPC transportation cask is moved to the site gate for dispatch.

Enhanced MPC Transfer

The enhanced MPC transfer method is intended for Purchaser facilities that have a maximum of 100-ton crane capacity available in the pool preparation area and fuel loading pool. These sites are unable to handle a 125-ton hook weight MPC and MPC transportation cask. An on-site MPC transfer cask, weighing 100 tons or less when loaded, is utilized to transfer a large MPC from the fuel pool to an MPC transportation cask located adjacent to the fuel pool area. Figure 3.3-2 illustrates the major tasks for enhanced MPC transfer.

The enhanced MPC transfer method uses the on-site MPC transfer cask containing an MPC in the fuel pool in place of an MPC transportation cask. After loading the MPC in the transfer cask with SNF assemblies, the shield plug is installed on the MPC, and the transfer cask is moved from the pool to a preparation and decontamination area. Closure of the MPC with an inner and outer lid is accomplished in a similar manner as that described for the direct MPC transfer method. The loaded transfer cask is then mated to a transportation cask, the transfer cask discharge port is opened, and the MPC is transferred into the transportation cask. After removing the transfer cask, the transportation cask lid is installed, and the cask is prepared for dispatch in the same manner as described for direct MPC transfer.

Bare SNF Assembly Transfer

The bare SNF transfer (BST) method is intended for loading MPCs at Purchaser facilities with crane capacities less than the 75-ton MPC system package weight and with other physical constraints. Using a shielded device, individual SNF assemblies are transferred to an MPC at an out-of-pool location.

Figure 3.3-3 shows one example of BST that uses a mating device and existing Purchaser site facilities. The SNF transfer device is loaded with SNF assemblies in the pool. Once loaded, the transfer device is removed from the SNF loading area and prepared for transfer of the SNF to an MPC. This involves moving the device to a transfer area and aligning it with the MPC in a transportation cask. The MPC shield plug is moved to allow access to the MPC basket, and an access port in the bottom of the transfer device is opened. The SNF assemblies are then transferred to the MPC. The shield plug is repositioned on the MPC, and the transfer device is closed and moved away. This process is repeated until the MPC is full. The MPC is then sealed, and the transportation cask is prepared for shipment.

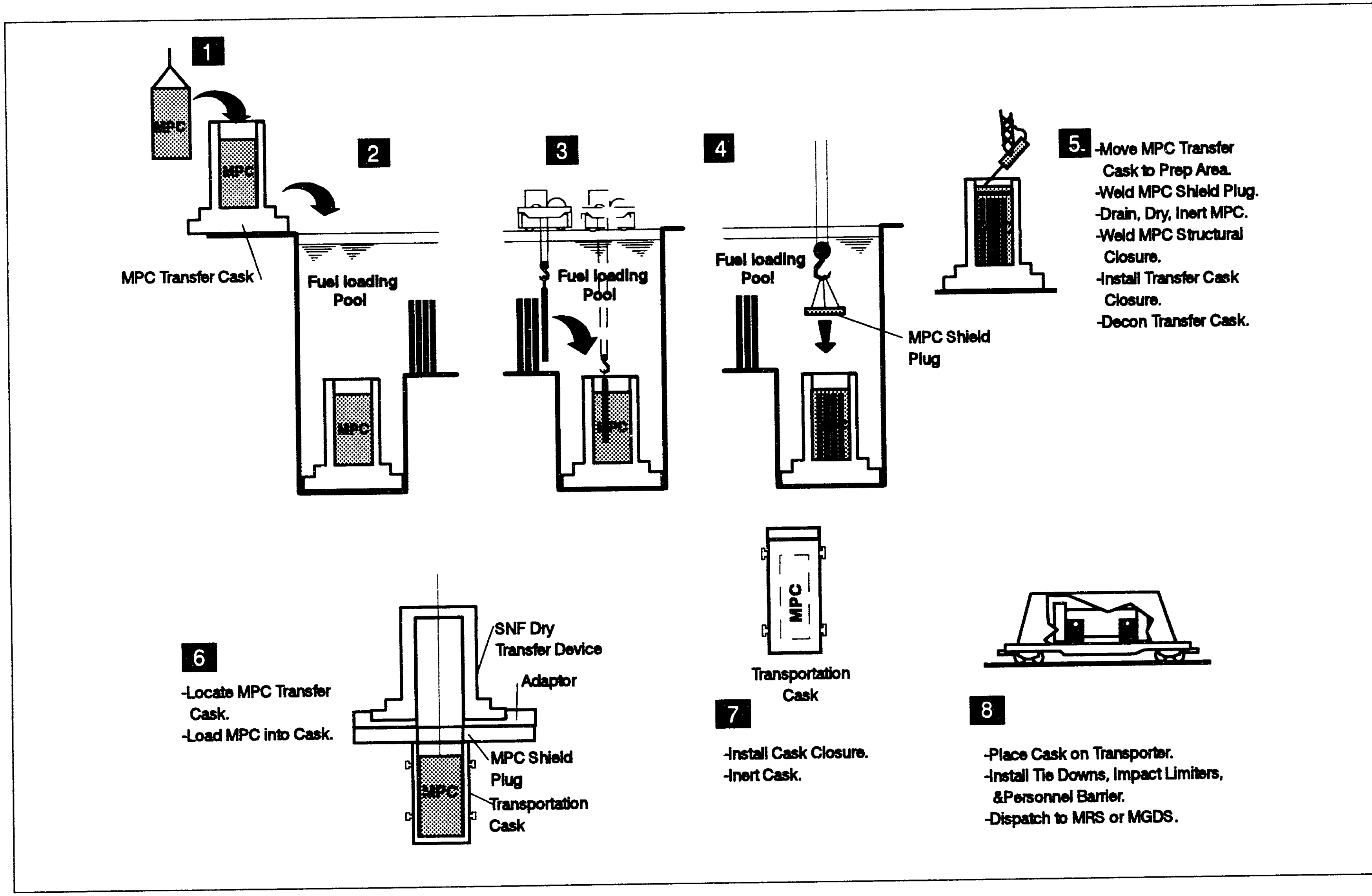

Figure 3.3-2 Enhanced MPC Transfer

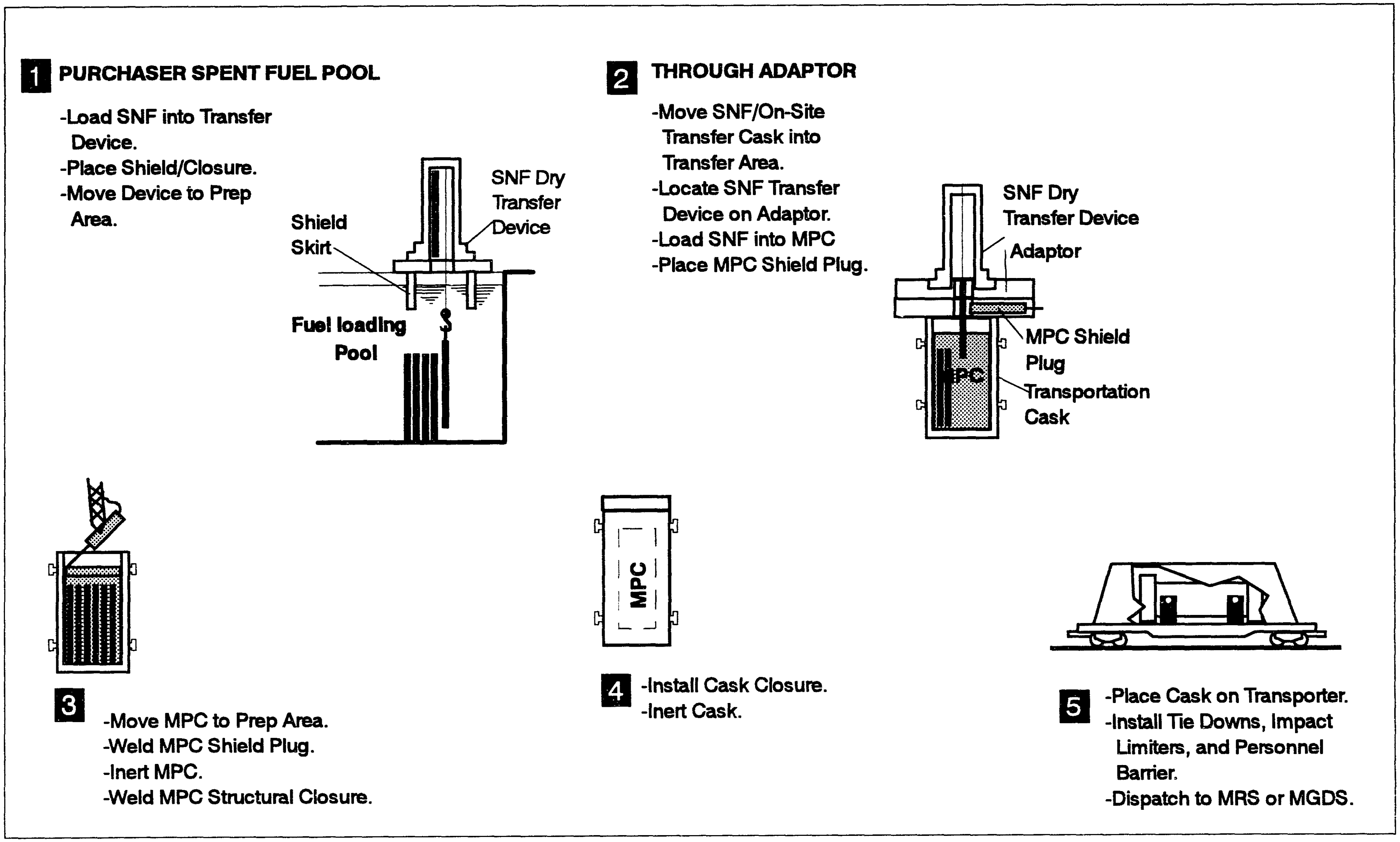

Figure 3.3-3 Bare SNF Transfer using a Mating Device

MPC/ISFSI Transfer and Storage

The MPC/ISFSI transfer and storage method provides for transfer of MPCs from Purchaser spent fuel pools to on-site ISFSIs for storage and later transfer to transportation casks. This method includes operations required to transfer SNF from the spent fuel pool into an MPC in a transfer cask, closure of the loaded MPC while in the transfer cask, transfer of the loaded MPC into a storage cask, and subsequent retrieval of the loaded MPC from storage and transfer to a transportation cask.

The MPC/ISFSI transfer and storage method can utilize either horizontal or vertical storage. Figures 3.3-4 and 3.3-5 illustrate the horizontal and vertical storage cases, respectively. For transfer of an MPC to horizontal storage, a transfer cask is used. The transfer cask containing a loaded MPC mates to the storage unit through a device that maintains shielding during transfer operations. A ram with a grappling attachment reaches through the storage unit and is coupled with the top of the loaded MPC. The MPC is drawn into the storage unit, which is then closed and sealed, and the transfer cask is removed. For transfer of an MPC to a vertical storage cask, a shielded transfer cask is required that directly interfaces with the storage cask. The MPC is then transferred to the vertical storage cask, and the transfer cask is removed to permit closure. Of six vendor concepts investigated for horizontal and vertical storage, all are compatible with MPCs; however, relicensing and modifications would be required for all concepts.

No-MPC Transfer

The no-MPC transfer method is used by Purchasers that cannot accommodate MPCs and ship individual, uncanistered SNF assemblies using LWT transportation casks. Figure 3.3-6 illustrates major features of the no-MPC transfer method. An unloaded LWT transportation cask is prepared for loading and moved to the spent fuel pool. SNF assemblies are loaded into the cask, and the cask lid is set in place. The cask is moved from the pool to an area where the cask exterior is decontaminated. The cask interior is drained and dried, and the cask lid is bolted in place. After filling the interior of the cask with an inert gas, the lid is tested for leaks. The cask is then loaded onto a trailer, and a final radiological survey is performed before shipping the cask off site.

3.4 MONITORED RETRIEVABLE STORAGE

This section presents results of the MPC MRS facility conceptual design effort. Information presented here is a summary of the *MPC MRS Facility Conceptual Design Report*, Volume II.C of the MPC System CDR. The MRS facility conceptual design has been evaluated to determine its feasibility and costs associated with handling and storing MPCs. Using the MRS CDR as a starting point, design refinements needed to accommodate loading, handling, and storing MPCs have been investigated. One design concept, which utilizes dry transfer and vertical concrete cask storage, has been evaluated in detail and is referred to as the MRS facility reference design. Five alternate MRS facility design concepts have been briefly reviewed to confirm their feasibility for use as an MPC-based MRS facility.

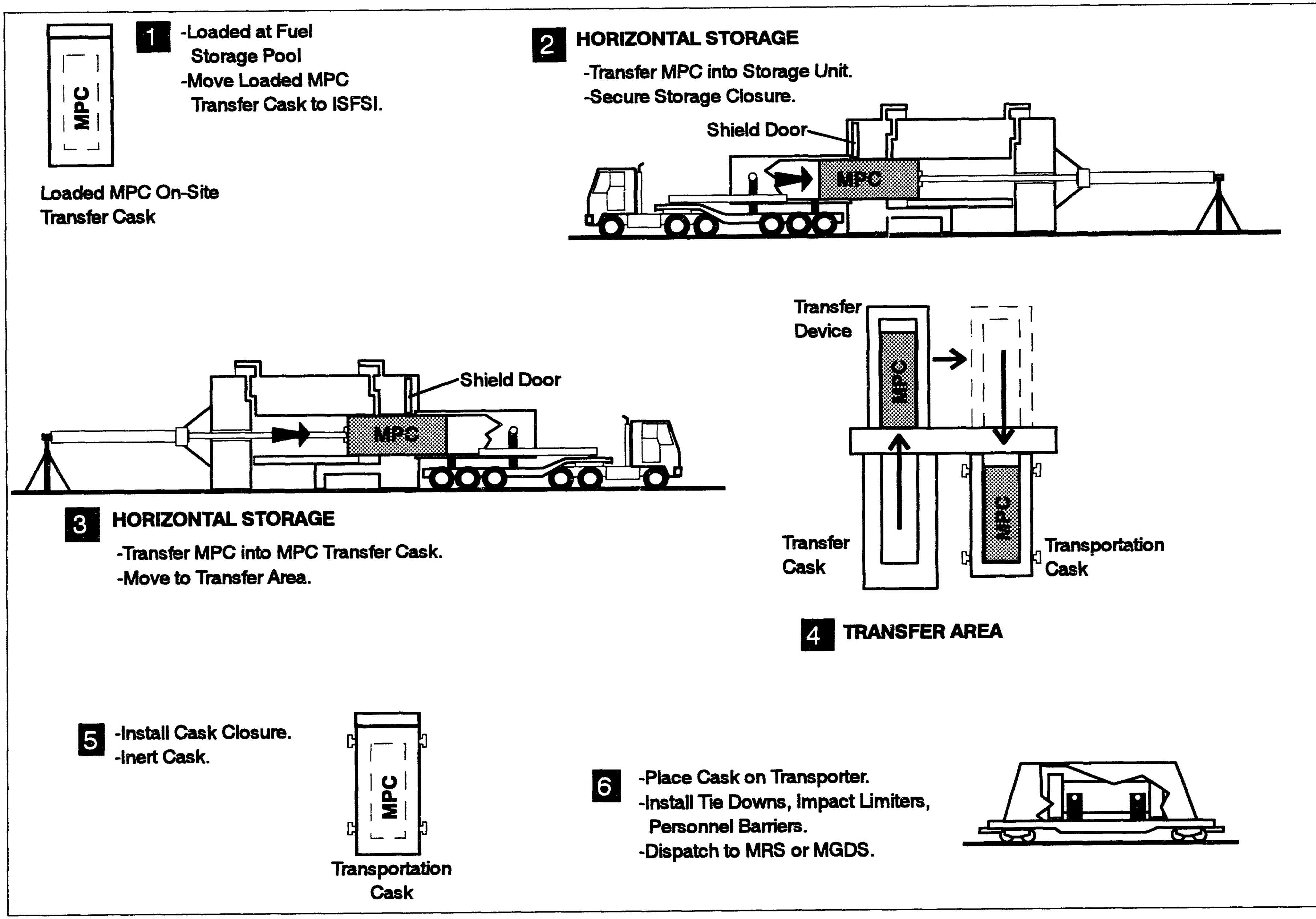

Figure 3.3-4 MPC Horizontal Storage

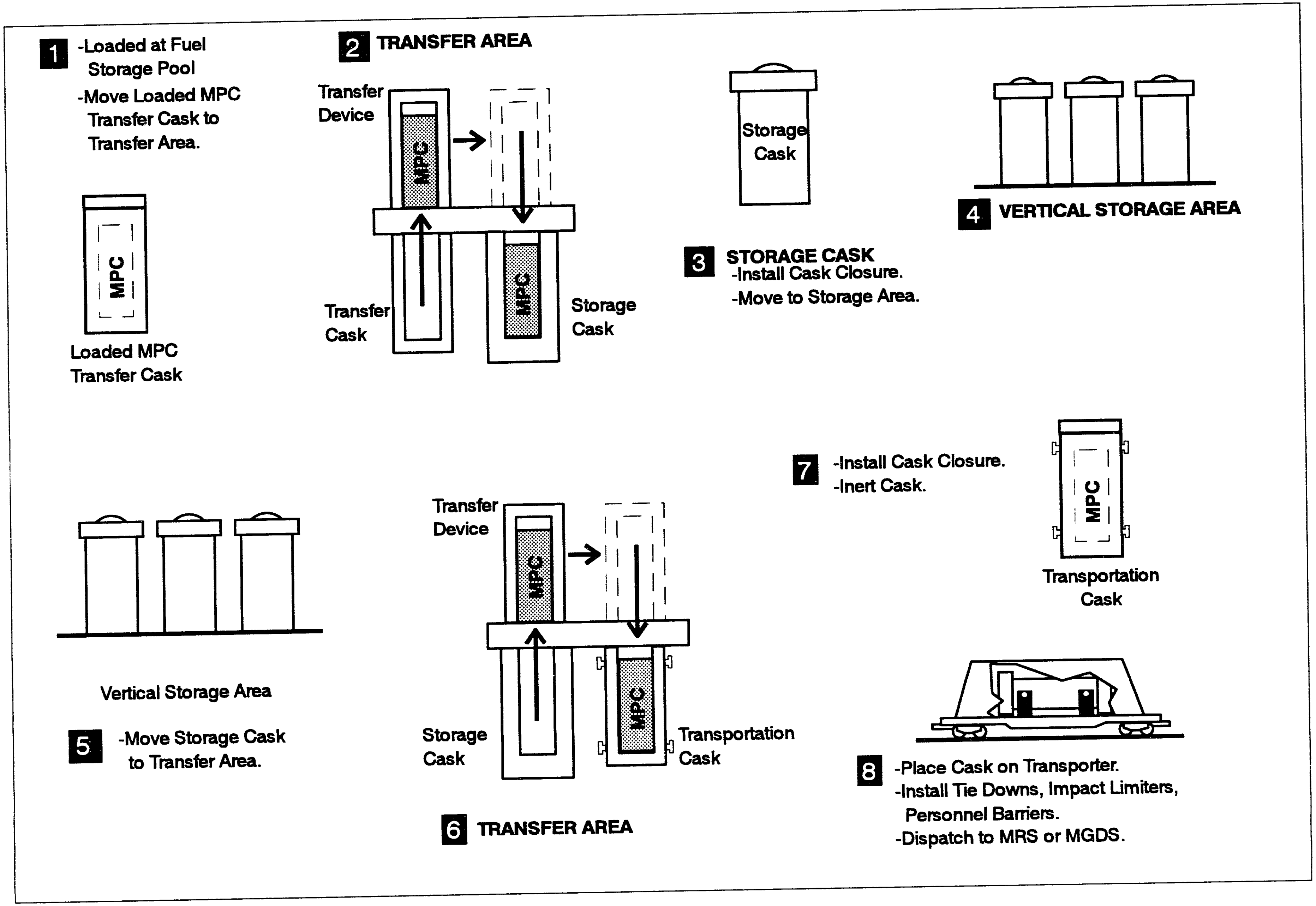

Figure 3.3-5 MPC Vertical Storage

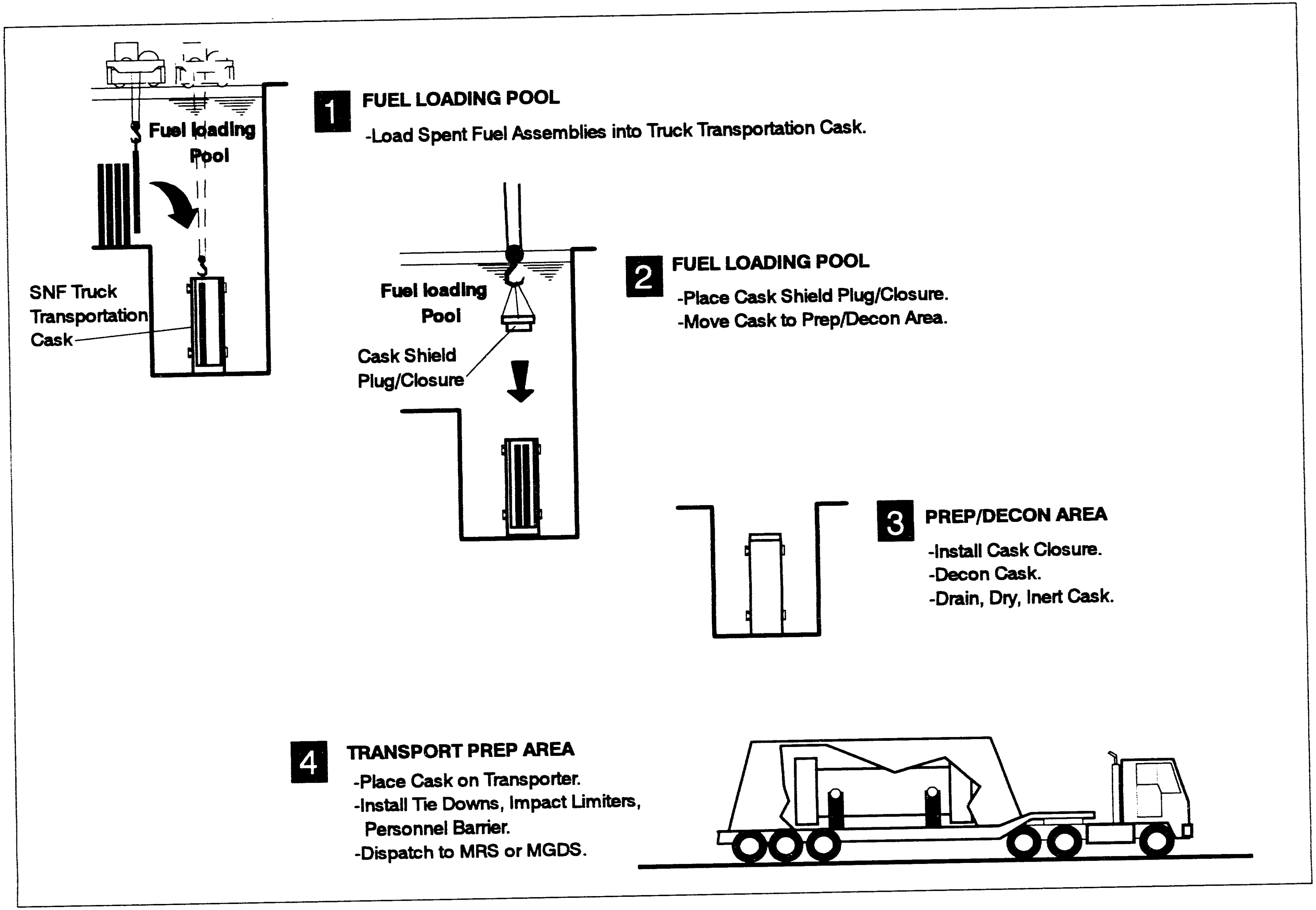

Figure 3.3-6 No MPC Transfer

This summary provides discussions of operation and design considerations for the MRS facility, the basis for conceptual design, and the six design concepts investigated.

3.4.1 Operation and Design Considerations

Prior to completion of the MGDS, the mission of the MRS facility is to accept MPCs and SNF assemblies from Purchaser sites and store them until the MGDS becomes operational. Once the MGDS begins operation, the MRS facility acts as a staging facility to manage the flow of MPCs to the MGDS. Most SNF assemblies received at the MRS facility are already contained in MPCs. Some individual, uncanistered SNF assemblies are also received in truck casks. Any individual SNF assemblies that are received are transferred into MPCs at the MRS facility prior to storage.

The MRS facility consists of three major areas: (1) receiving, handling, packaging, and shipping facilities; (2) storage areas; and (3) support and industrial services facilities. Operation of the MRS facility is based on an initial license period of 40 years, after which the license may be renewed. The MRS facility can be decommissioned once the MGDS is operating and all MPCs stored at the MRS facility have been removed. After decommissioning, the MRS facility site can be released for unrestricted use.

3.4.2 Design Basis

The MRS facility conceptual design can accommodate specified delivery and retrieval rates for all modes of operation. Handling and storage capabilities at the MRS facility are based on MPC and individual, uncanistered SNF assembly receipt and retrieval rates specified in the concept of operations described in Section 2.2 and in the MRS SRD. Figure 3.4-1 shows handling requirements for SNF for the various modes of MRS facility operation.

Rail shipments of large and small MPCs received from Purchaser facilities in transportation casks are transferred into storage casks for storage at the MRS facility. They may also be staged for direct shipment to the MGDS (flow-through operations). Truck shipments of individual, uncanistered SNF assemblies are received from Purchaser facilities that cannot accommodate MPCs. Individual SNF assemblies are transferred into large MPCs for storage at the MRS facility. Truck shipments of individual SNF assemblies may also be transferred into MPCs in rail transportation casks, which are then shipped directly to the MGDS without being stored at the MRS facility (pass-through operations). All storage at the MRS facility is with SNF assemblies contained in permanently sealed MPCs. In the remote event a problem is discovered with a stored MPC, recovery operations can be accomplished at the MRS facility.

Proven technology, similar to that used in the commercial nuclear industry, is used throughout the MRS facility reference design. This is important to ensure a licensable and workable design. Evaluations of the use of automation have been performed by Sandia National Laboratories for several MPC and individual SNF assembly handling areas of the MRS facility. The focus of these evaluations has been to determine where automation can be used to reduce worker radiation doses and to enhance operations.

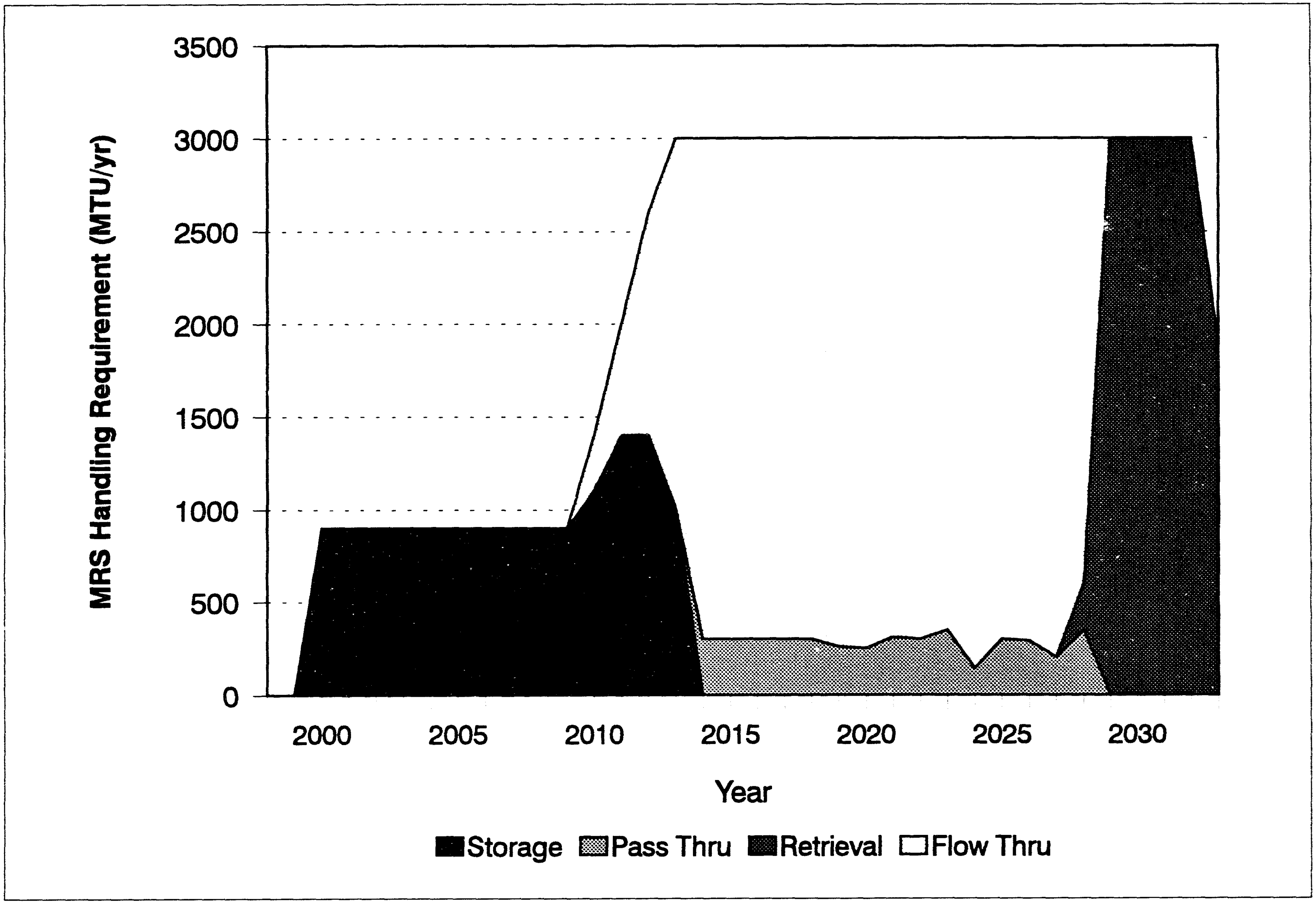

Figure 3.4-1 MRS Handling Requirements

Simulation modeling was used to confirm the adequacy of the MRS facility reference design. These modeling efforts indicated that two operating shifts a day are needed for handling individual SNF assemblies and for servicing casks in the CMF. One operating shift per day is needed for handling MPCs. The MRS facility design can accommodate uncertainties in transportation cask turnaround times and MPC closure times.

Since a site has not been identified for the MRS facility, a generic set of site characteristics was assumed. When an actual site is selected, the MRS facility design must be reviewed to ensure that assumed site characteristics envelop actual site conditions. Site layout and building and facility arrangements must also be reviewed and updated to ensure adaptability to actual site conditions.

3.4.3 Design Concepts

Six MRS facility design concepts were evaluated for handling MPCs and individual SNF assemblies and for storing MPCs. Of these six designs, only the MRS facility reference design concept of dry transfer and vertical concrete cask storage was evaluated in detail. Brief evaluations of the other five alternatives were performed to determine the feasibility of each for accommodating an MPC-based MRS facility. The six MRS facility design concepts evaluated are:

- Dry transfer and vertical concrete cask storage (MRS facility reference design)
- Wet transfer and storage
- Dry transfer and vault storage
- Dry transfer and horizontal module storage
- Dry transfer and metal cask storage
- Dry transfer and TSC storage.

Evaluation of the six concepts indicated that all but the wet transfer and storage design concept are feasible for an MPC-based MRS facility. Wet transfer and storage of MPCs is not considered practical because of the necessity for repeated wet and dry handling operations and uncertainties concerning long-term storage of MPCs in a wet environment. Other than the wet transfer and storage design concept, the other alternative concepts are equally feasible compared to the MRS facility reference design. Only the MRS facility reference design is described in the following paragraphs.

Figure 3.4-2 illustrates the overall site arrangement for the MRS facility reference design. Approximately 620 acres are needed for siting the MRS facility reference design, and approximately 1,960 concrete storage casks are required to store 15,000 MTU in MPCs.

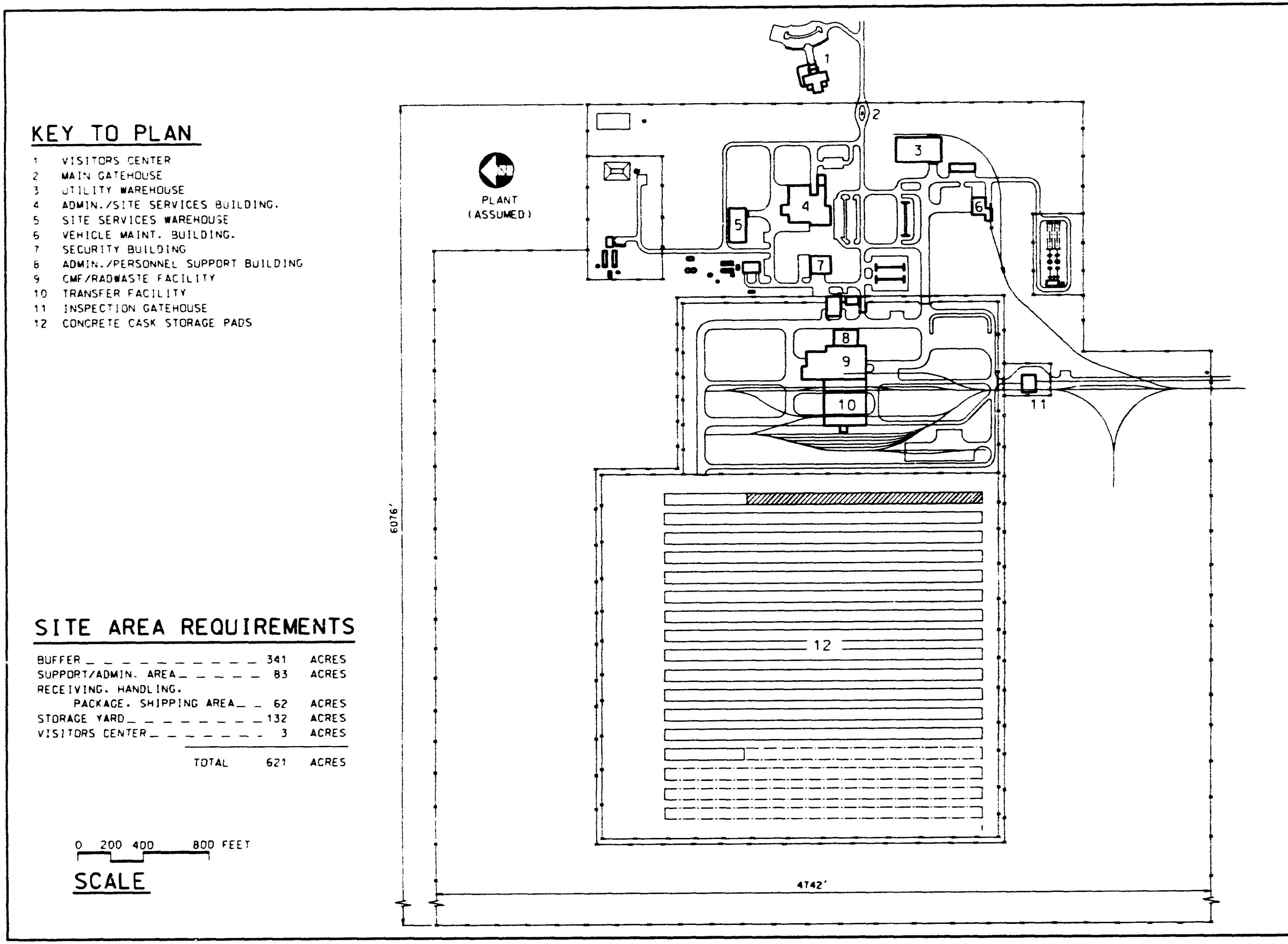

Figure 3.4-2 General Arrangement Plan of MRS/MPC Facility including Dry Storage Area

A transfer facility is provided for handling and packaging MPCs and individual SNF assemblies. Separate areas, or modules, are provided within the transfer facility for handling MPCs and individual SNF assemblies. Two modules are arranged in-line, with a shipping and receiving bay to one side for receiving and dispatching transportation casks and a transporter bay to the other side for handling storage casks. A diesel generator building is attached to the outside of the transporter bay for providing emergency power. Figure 3.4-3 shows the arrangement of the transfer facility for the MRS facility reference design.

Two MPC transfer systems are provided in the MPC transfer room module of the transfer facility. The MPC transfer room module is a heavily shielded, concrete room where transfer of MPCs from transportation casks to storage casks takes place. Because MPCs are sealed and external contamination is not expected to be significant, the MPC transfer room is relatively clean and does not normally need to perform a confinement function. As such, transportation casks and storage casks can be brought into the MPC transfer room, and most cask loading and unloading preparation activities can be performed manually by workers inside the room. During actual transfer of MPCs from transportation casks to storage casks and vice versa, workers leave the MPC transfer room, shield doors are closed for radiation protection, and operations are controlled remotely from an operating gallery adjacent to the room.

One bottom-loading transfer cell module is provided in the transfer facility for handling individual, uncanistered SNF assemblies. It has two in-load ports for unloading SNF assemblies from transportation casks and one out-load port for loading the assemblies into MPCs in storage casks. Two MPC cask lid welding areas are provided on the out-load side of the transfer cell to accommodate the time requirements for MPC lid closure.

The CMF is integrated with the transfer facility in the MRS facility reference design. The CMF is located immediately adjacent to one side of the shipping and receiving bay. This provides efficient material and personnel flow between the transfer facility and the CMF. Integration of the two buildings reduces capital costs by allowing shared use of cranes and other equipment. The radwaste facility is located within the CMF so that it is near to the source of greatest radwaste generation. A small administration area for the transfer facility, CMF, and radwaste facility complex is also located in the CMF. Other supporting facilities and services for MRS facility operations are housed in separate buildings around the site.

Personnel resources for the MRS facility reference design initially require 429 employees. This is based on a 5-day workweek with two operations shifts a day and one regular shift of management and support personnel. After the MGDS becomes operational, an additional operations shift consisting of 24 employees will be required for the CMF. This results in a total staff of 453 employees required for sustained operations of the MRS facility reference design.

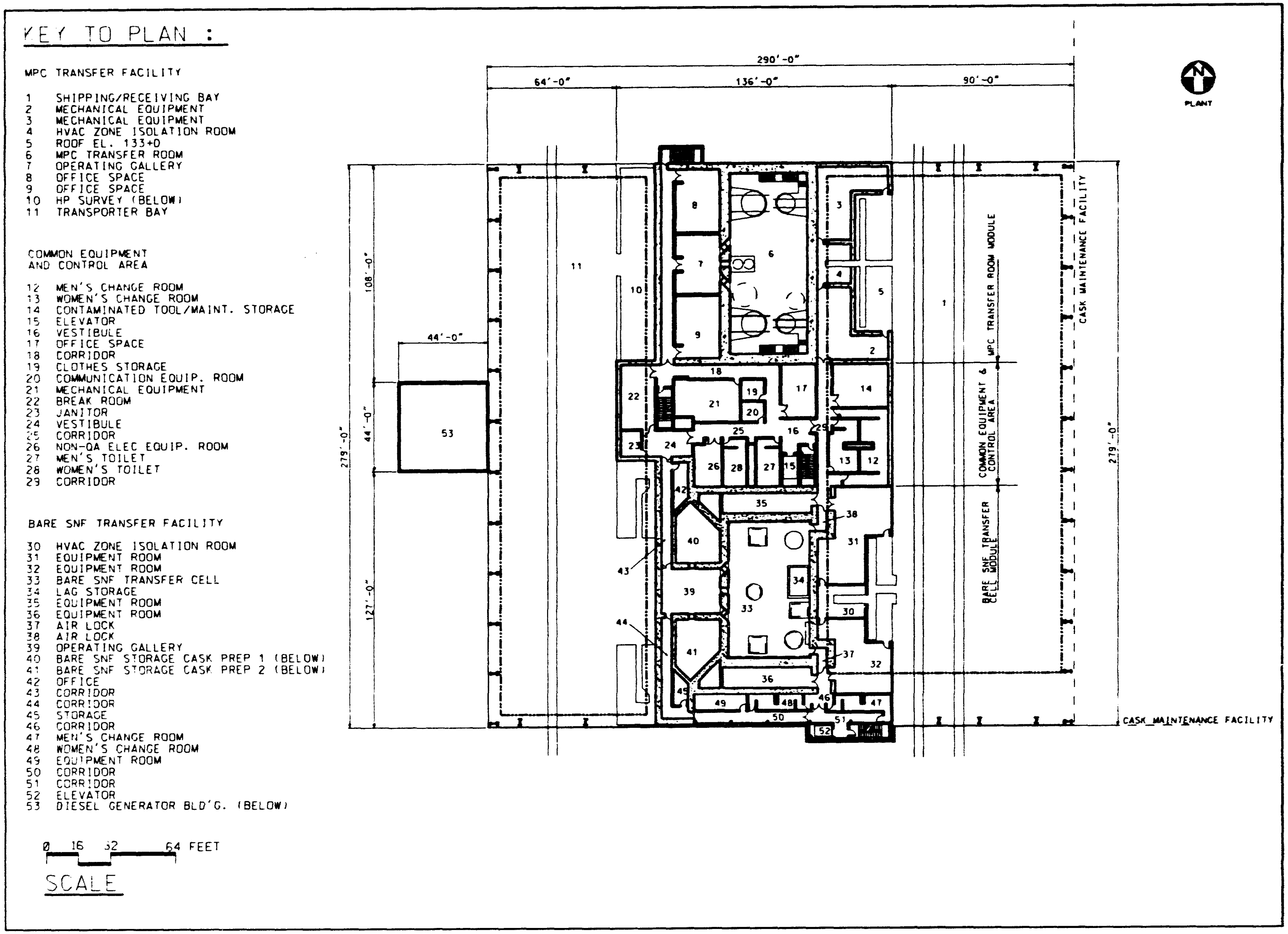

Figure 3.4-3 General Arrangement Plan at Ground Floor of MRS/MPC Transfer Facility

3.5 MINED GEOLOGIC DISPOSAL SYSTEM

This section presents an evaluation of the impacts of the MPC system on the current MGDS preliminary design. It also discusses MGDS requirements that have been factored into the design of the MPC system. Information is obtained from the *Mined Geological Disposal System Multi-Purpose Canister Design Considerations Report,* in Volume V of the MPC System CDR, and from other documents. The MGDS is affected by interface of the MPC system with the disposal container, waste handling operations, and subsurface emplacement operations. Each of these interfaces has been evaluated to identify key MGDS impacts attributable to implementation of the MPC system.

This section discusses MGDS operations relevant to the MPC system, waste package issues, repository thermal loading issues, surface facility impacts, and subsurface design considerations.

3.5.1 MGDS Operations

In the MGDS conceptual design, MPCs are received at the waste handling building where they are transferred from transportation casks to disposal containers. Transfer operations are performed inside a heavily shielded, confined transfer room. The disposal containers containing MPCs, referred to as waste packages, are sealed by welding inner and outer lids to complete the containment of the containers. The waste packages are then moved to a transfer vault, where they are loaded onto an underground waste transporter for movement into the repository. As assumed in the concept of operations, any individual SNF assemblies received at the second repository are transferred into large waste packages in a shielded transfer cell and then placed in the repository similar to MPCs.

The transporter containing the waste package descends into the repository via a ramp and travels to the waste emplacement drift. The transporter is controlled by an on-board operator until it reaches the entrance to the drift. In order to minimize worker radiation exposure, workers do not enter the waste emplacement rooms that contain radioactive waste packages. The transporter stops outside the emplacement area, and operation of the transporter is taken over remotely. A radiation barrier is opened, and the transporter transfers the waste package to a waste package emplacement machine. The waste package emplacement machine places the waste package in its designated disposal position in the drift. Retrieval of waste packages can be accomplished, if necessary, by reversing the emplacement process.

3.5.2 Waste Package Issues

A major design objective of the waste package is to provide an engineered barrier to the release of radionuclides that meets the requirements of 10 CFR Part 60. Currently, major issues associated with the waste package design and the impact of the MPC on this design remain undetermined. As the design of the total repository system develops, interface requirements with the MPC will be incorporated into the design. A number of important issues that may affect the MPC design are discussed in this section. These include waste package issues related to materials compatibility, long-term criticality control, and thermal design. These issues have been considered in the conceptual design of the MPC system, and will continue to be the subject of system evaluations and trade-off studies in later design phases.

Materials

For the conceptual design, 316L stainless steel was selected as the MPC shell material. This material possesses adequate thermal conductivity to transmit heat away from the SNF and into the disposal container. The disposal overpack will include a corrosion-resistant inner barrier (such as Alloy 825) and a corrosion allowance outer barrier (such as low-carbon steel) in order to meet long-term performance requirements for the waste package.

Basket material properties selected for the MPC conceptual design must provide good thermal conductivity, high neutron absorption cross-section, and sufficient corrosion resistance to maintain criticality control for SNF over the extended period of waste isolation. Thermal conductivity is important during the early part of the disposal period when the thermal load from the SNF is highest. The requirement for criticality control is important during the life of the system. Since MPCs will be vacuum dried and backfilled with an inert gas before sealing, the basket material will not be subjected to oxidation during the storage and transportation periods. During the latter period of disposal when the repository temperature has dropped below the boiling point of water, the aqueous corrosion properties of the basket could become important. At that time, water could potentially intrude into the repository environment and penetrate the overpack, the MPC shell, and the basket of the MPC. This leads to the requirement for corrosion resistant basket materials for the design of the MPC.

A combination of 316L stainless steel and borated aluminum are used for MPC basket materials in the MPC conceptual design. 316L stainless steel is not vulnerable to nitric acid corrosion, although it has some vulnerability to formic and oxalic acids. Aggressive environments that may penetrate a multi-barrier waste package would also attack an austenitic stainless steel basket by pitting attack or stress corrosion; however, these forms of localized attack will not greatly degrade the ability of the fuel basket to maintain criticality control. Borated aluminum alone, which has been used in baskets for storage and transportation casks, may not have adequate corrosion properties to withstand environments that are expected during long-term repository disposal. By cladding borated aluminum with stainless steel, a cost-effective and efficient neutron absorber material is provided for the MPC conceptual design.

Long-Term Criticality Control

Long-term criticality control for SNF following emplacement in the MGDS is a major issue. It is anticipated that a probablistic analysis approach will be used to demonstrate criticality safety. It is expected that this approach will include taking credit for the reduced reactivity of the SNF (burnup credit) and taking credit for supplemental neutron absorbing materials. The issue is that the criticality potential of SNF changes with time and neutron absorber materials may degrade over a period of time.

After discharge from the reactor, the reactivity of SNF decreases for approximately 200 years, and then increases for approximately 20,000 years before decreasing again. Figure 3.5-1 provides a graphic representation of the time effects on criticality potential assuming a fully flooded condition. The initial decrease in criticality potential is primarily caused by the decay of Pu-241, a fissile material. The subsequent increase in criticality potential results from the radioactive decay of neutron absorbers, like Pu-240. Conceptual design of the MPC accounts for this increase in criticality potential and provides for criticality control during the entire "isolation" phase, as specified in 10 CFR Part 60 and 40 CFR Part 191.

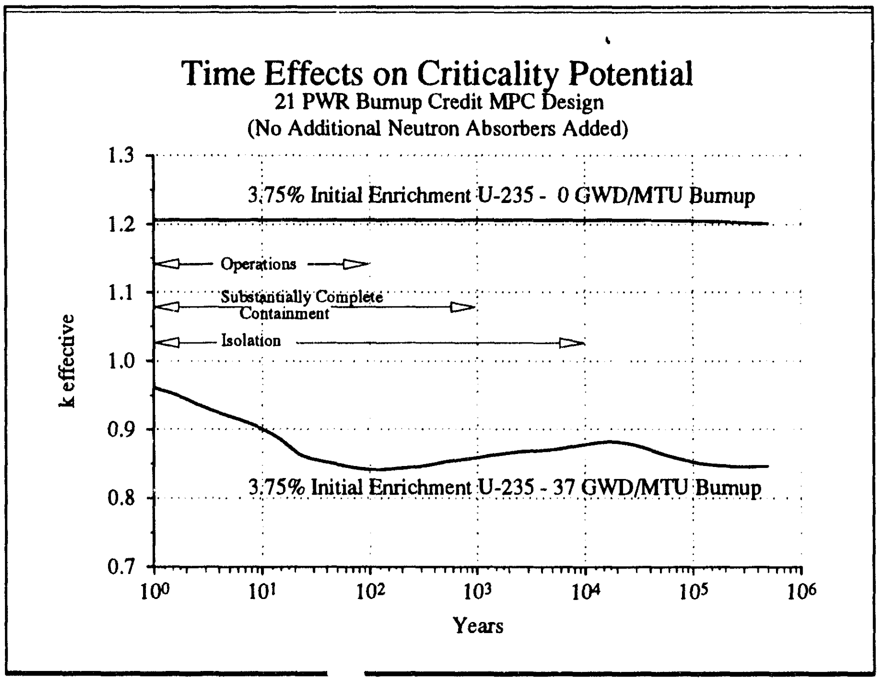

Figure 3.5-1 Time Effects on Criticality Potential

Materials used for constructing the MPC basket will degrade over the life of the repository. Degradation of the neutron absorber material over the disposal period needs to be addressed with regard to criticality control. Neutron absorber material may be depleted due to neutron flux and as a result of physical leaching caused by corrosion. Preliminary evaluations indicate that a reduction of up to about 16 percent of boron-10 could occur during the disposal period. Sufficient neutron absorbing material is provided in the MPC conceptual design to satisfy these concerns by including an additional 25 percent boron-10 content in the neutron absorber material.

Thermal Design

The number of SNF assemblies and the SNF assembly thermal output must be balanced to provide acceptable MPC internal temperatures and to maintain MGDS thermal goals. The thermal behavior of the waste package depends on a variety of factors. Thermal loading of the near-field (drift-scale) host rock is dependent on the waste package design. Since the MPC will form part of the waste package, effects of the MPC on the MGDS have been considered in the MPC conceptual design. In contrast, details of the waste package have a minimal impact on repository far-field (mountain-scale) thermal behavior, since far-field effects are dictated primarily by the heat imparted to the area over the long term. Therefore, far-field repository thermal response is independent of the waste package configuration. Section 3.5.3 discusses repository thermal loading considerations in more detail.

As part of the waste package, the MPC conceptual design complies with potential MGDS near-field temperature requirements. Two potential MGDS requirements affecting the MPC design include maintaining the drift wall temperature below 200° C and maintaining the SNF cladding temperature below 350° C. Local drift wall temperatures are controlled primarily by waste package thermal output and waste package spacing. Near-field temperature profiles are determined by such factors as the number of SNF assemblies per waste package, the age of the SNF, initial SNF enrichment and burnup, materials of construction, and configuration of the waste package. The MPC design can meet thermal design goals, and thermal output can be accommodated through additional SNF aging and emplacement approaches to meet MGDS thermal requirements.

Based on the conceptual design of the MPC and its associated disposal container design, a basis for the MPC thermal output at the repository was evaluated. Analysis of the large, 21-PWR burnup credit MPC assumes emplacement of 10-year old SNF with 40 GWD/MTU burnup. At initial emplacement, each SNF assembly generates 676 W of heat, resulting in a total initial package heat output of 14.2 kW. Analysis of the MPC in its disposal container indicates peak cladding temperatures of 354°C, which occur approximately one year after emplacement. This peak temperature is slightly above the cladding temperature goal of 350°C. The analysis also indicates that MPCs with different capacities, but with the same total package heat load of 14.2 kW, would also result in peak internal temperatures near the 350°C goal. Longer SNF cooling times are required to accommodate larger MPC capacities.

3.5.3 Repository Thermal Loading Considerations

In an effort to optimize waste disposal, a wide range of repository thermal loading options is being considered and evaluated. These options extend from minimally perturbed, in which the bulk average temperatures in the rock do not exceed the boiling point of water, to extended hot, where the repository center remains above boiling for thousands of years. Each of these thermal loading options may result in different requirements relative to the design of the waste package and its maximum power output. A decision has not been made on which thermal loading option will be used for design of the repository; however, a number of activities are underway to support the thermal loading decision process. These activities include a thermal loading system study, performance assessment code evaluations, laboratory testing, and field testing. The MPC conceptual design provides the flexibility to accommodate either MGDS thermal loading option.

Thermal loading affects near-field and far-field temperatures experienced in the repository as a result of heat generated by emplaced SNF. Near-field temperatures are primarily those affecting the engineered barrier system and rock temperatures at distances of no more than a few tens of meters from the drift. Near-field temperatures are primarily influenced by the areal power density (APD in watts per square meter or kilowatts per acre), which changes over time as the SNF decays, and by emplacement mode details. Near-field temperature effects on waste package design are discussed in Section 3.5.2. Far-field temperature changes result from heat generated by the SNF and occur over hundreds of meters. Far-field temperatures are primarily influenced by the density of emplaced waste, which is defined as areal mass loading (AML in kilograms uranium per square meter or metric tons uranium per acre), rather than the details of the waste package. As such, the MPC design has no impact on the MGDS for far-field temperatures.

Given the schedule for the thermal loading decision, it is apparent that an MPC design must be finalized before full compatibility with the repository design is ensured. Contingency options are available to remedy problems that may be found later with compatibility of the MPC design with the MGDS. These contingencies are discussed in Section 4.6. In order to mitigate any risks, results of repository studies and experiments must be integrated into the MPC design in a timely manner to ensure conformance with repository and overall CRWMS requirements.

3.5.4 Surface Facilities Design Impacts

Impacts of the MPC system on MGDS surface facilities are limited primarily to the waste handling building (WHB). MPCs are expected to arrive clean from Purchaser sites and the MRS facility. Even if an MPC arrives with its exterior contaminated, the contamination is expected to be far less than what would be produced from handling uncanistered SNF assemblies. As such, handling MPCs in the WHB is a cleaner operation than handling uncanistered SNF assemblies. Areas handling individual, uncanistered SNF assemblies are likely to be contaminated as a result of dust released from the cladding. Facilities for transferring MPCs and individual SNF assemblies at the MGDS are similar to the transfer facility described for the MRS facility in Section 3.4. If final repository design indicates the need for filler material in the MPC, this function can be assigned to the MGDS surface facilities. The CMF described as part of the MRS facility may be located at the MGDS if there is not an MRS facility.

Significant time savings are realized by handling MPCs as compared to handling individual, uncanistered SNF assemblies. As a result of these time savings, fewer parallel waste handling paths are needed. This results in a smaller WHB that costs less to construct and maintain.

Individual, uncanistered SNF assemblies arriving at the MGDS will be placed into large disposal containers in the WHB. This method has been selected in lieu of using MPCs for individual SNF assembly packaging because significant cost savings can be realized by not having to use a waste container that meets storage and transportation requirements. This method of disposal packaging for individual SNF assemblies will be used primarily at the second MGDS, which will receive significant amounts of individual SNF assemblies after the MRS facility is decommissioned.

3.5.5 Subsurface Design Impacts

Subsurface facilities at the MGDS have been investigated to determine the impacts of MPC system implementation. Several emplacement modes have been considered, including vertical, horizontal long-bore hole, and in-drift emplacement of MPCs. In-drift emplacement has been selected as the repository emplacement mode for MPC waste packages and large waste containers for individual SNF assemblies received at the MGDS. MPC waste packages are placed on the invert surface of the drift lengthwise along the centerline or adjacent to the opening wall.

In general, evaluations indicate that implementation of the MPC system does not have strong impacts on subsurface repository operations when compared with other subsurface waste handling options.

Chapter 4

MULTI-PURPOSE CANISTER SYSTEM EVALUATIONS

Evaluations were performed to determine the impact of using MPCs at Purchaser sites and throughout the CRWMS. These evaluations were performed so DOE could select the most appropriate option for handling, transporting, storing, and disposing of SNF assemblies.

This section includes summary descriptions of the MPC system evaluations, which address the following issues: health, safety, and environmental concerns; life cycle cost for the MPC system; regulatory and licensing concerns; Purchaser impacts; stakeholder involvement; and analysis of programmatic risks and contingencies associated with implementation of the MPC system.

4.1 HEALTH, SAFETY, AND ENVIRONMENT

This section discusses health, safety, and environmental impacts of the MPC system, and the individual SNF assembly handling system, both with and without an MRS facility. Health and safety impacts of the TSC system and MPU system alternatives are presented in Section 5.3.2. Additional information is presented in the *Health and Safety Impacts Analysis for the Multi-Purpose Canister System and Alternatives* report, issued in June, 1994.

4.1.1 Health and Safety Impacts

Health and safety impacts to the public and to CRWMS and Purchaser site workers are evaluated for the MPC system and the individual SNF assembly handling system, each considering cases with and without an MRS. Radiological and non-radiological impacts caused by routine (day-to-day) activities and by incidents (accidents) are included. Radiological impacts are measured by the radiological exposure received by members of the public and CRWMS workers. Non-radiological impacts are measured by fatalities, injuries, and the emission of non-radioactive toxic materials.

Health and safety impacts at facilities and during transportation are evaluated separately. Facilities include Purchaser sites, the MRS facility, the CMF, and the MGDS. Health and safety impacts at Purchaser sites, the MRS, and the MGDS are computed from impacts caused by handling SNF and SNF containers. Health and safety impacts at the MGDS also include those caused by the handling of HLW canisters and waste packages.

Table 4.1-1 summarizes total system radiological health and safety impacts resulting from routine activities and incidents. Non-radiological impacts were evaluated and found to be essentially equal for each of the systems.

Table 4.1-1 Total System Health and Safety Radiological Impacts
(Total Program Exposures in Person-Rem)

System Impact Area	MPC System		Individual SNF Assembly Handling System	
	With MRS	No MRS	With MRS	No MRS
Radiological Routine				
· Facilities	56,980	50,860	42,080	40,150
· Transportation[a]	1,450	1,450	1,450	1,450
Radiological Incident				
· Facilities[b]	0.04	0.04	0.1	0.1
· Transportation[a]	430	410	430	410

Notes:
a) Values shown are for all truck, rail, barge, and heavy-haul transportation.
b) Systems approximately the same; within regulatory limits.

As shown in the table, all radiological health and safety impacts are essentially equivalent for the systems, with the exception of at-facility routine exposures. Routine radiological exposures result in 99 percent of all exposures, with incidents contributing only about 1 percent for any of the systems evaluated. The following sections discuss safety and health impacts for the various areas in more detail.

Facility and Transportation Routine Radiological Impacts

Practically all of the facility radiological exposures are incurred by workers in the CRWMS facilities and at Purchaser sites. As can be seen in Table 4.1-1, at-facility routine radiological exposures are approximately 35 percent higher for the MPC system with an MRS than for the individual SNF assembly handling system with an MRS. If there is no MRS in each system, MPC system at-facility routine radiological exposures are approximately 27 percent higher than in the individual SNF assembly handling system. These higher exposures are caused primarily by MPC lid welding setup and weld inspection operations. Section 3.1.4 discusses investigations of the use of additional automated welding techniques to reduce personnel radiation exposures.

Table 4.1-2 illustrates how routine radiological exposures are distributed among the facilities and transportation.

Table 4.1-2 Total System Routine Radiological Impacts
(Person-Rem)

Impact	MPC System		Individual SNF Assembly Handling System	
	With MRS	No MRS	With MRS	No MRS
Facilities: · Purchaser Sites	25,660	28,270	13,110	17,380
· MRS	10,700	N/A	8,200	N/A
· CMF	60	60	160	160
· MGDS	20,560	22,530	20,610	22,610
Total	56,980	50,860	42,080	40,150
Transportation: · Occupational	770	770	770	770
· Public	680	680	680	680
Total	1,450	1,450	1,450	1,450
Program Total	58,430	52,310	43,530	41,600

Radiological exposures at Purchaser sites are about 100 percent higher for the MPC system with an MRS than for the individual SNF assembly handling system with an MRS. This is dominated by MPC lid welding setup and weld inspection operations. Though not as significant, welding operations at the MRS facility also have an impact. For the no-MRS cases, radiological exposures at Purchaser sites are 63 percent higher for the MPC system than for the individual SNF assembly handling system because of MPC lid welding operations. At-reactor exposures associated with CRWMS operations represent about 2 percent of total current at-reactor exposures.

For determining routine transportation exposures, each SNF cask is assumed to comply precisely with the maximum permissible regulatory criteria for routine radiation exposures. Occupational transportation exposures and public exposures are estimated to be the same for all systems. Total routine radiological exposures for facilities and transportation are very small relative to expected cumulative population background radiation exposures such as natural sources, medical uses, radon, etc.

Facility and Transportation Incident Radiological Impacts

Unplanned contact or "bumping" during the lift-handling (lift and movement) of casks, canisters, or SNF assemblies is the key factor associated with facility incident exposure. Expected incident exposures for all of the concepts are far below regulatory limits and are practically equivalent. Cask handling incidents at facilities are also considered. It is assumed that only lift-handling of casks can create situations that can result in damage to a cask. All cask and canister handling incidents at facilities result in negligible exposure for any of the concepts.

Total expected exposure from transportation radiological incidents are essentially the same for all systems. Over 70 percent of this exposure is attributable to truck transportation, with the remainder resulting from rail, barge, and heavy-haul transportation.

4.1.2 Environmental Impacts

The National Environmental Policy Act (NEPA) requires that federal agencies evaluate any major federal action that may impact the environment. On February 23, 1994, the Director of OCRWM determined that an MPC environmental impact statement (EIS) is the appropriate NEPA document to prepare prior to a DOE decision to fabricate and deploy the MPC system. As a separate action, all NEPA requirements for the use of the MPC as part of the waste package will be encompassed in the MGDS EIS. Preparation of an MPC EIS allows DOE to determine if there are any significant environmental issues related to the MPC system prior to fabricating and deploying the system.

There are numerous environmental permits and approvals that are required to operate facilities that generate pollutants. These requirements apply to the facility that generates the pollutant, not to the facility's product. The MPC is a canister and, as such, the MPC does not require any environmental permits or approvals beyond those required as part of the NEPA process. As a canister, the MPC is not subject to any of the land disposal restrictions contained in the Resource Conservation and Recovery Act (RCRA). If the MPC were not used for disposal, the SNF assemblies would be removed from the MPC and transferred to another waste package. In this case, the MPC would be decommissioned similar to used transportation casks. None of the materials used in the conceptual design of the MPC is listed as hazardous waste in 40 CFR Part 261. Lead has been specifically excluded as a shielding material in the MPC to avoid issues related to mixed waste. No MPC materials are anticipated to test positively when subjected to the toxicity characteristic leach evaluations described in 40 CFR Part 261. Therefore, geologic disposal of the MPC is not subject to the regulations of RCRA. The emptied MPC may, however, be subject to the regulations for low-level waste disposal under 10 CFR Part 61.

DOE has prepared a draft environmental evaluation of the MPC system. Environmental impacts are essentially the same for all of the systems evaluated. Table 4.1-3 summarizes the low-level radioactive waste (LLW) generated by each system. The individual SNF assembly handling system is expected to generate the largest quantity and activity level of annual LLW. The MPC system generates less LLW at a lower activity level because less contamination is created when SNF assemblies are placed in permanent canisters. Estimates of LLW resulting from decommissioning used canisters and casks are also shown in Table 4.1-3. The individual SNF assembly handling system produces more solid decommissioning LLW because of the numerous canisters that are used for storage at Purchaser sites and the MRS facility. Decommissioning of the MPC system produces much less solid LLW, since the MPC is used as part of the disposal waste package. In both the MPC system and the individual SNF assembly handling system, any reduction of low-level radioactive waste due to not having an MRS will likely be offset by the inefficiency resulting from spreading the remaining operations among Purchaser facilities. If the MPC is determined to be non-emplaceable as a waste package, the LLW estimate for the MPC system increases to 450,000 ft^3 with an activity of 75 Ci, which is still less than the individual SNF assembly handling system.

Table 4.1-3 Summary of Environmental Impacts

Impact	MPC System		Individual SNF Assembly Handling System	
	With MRS	No MRS	With MRS	No MRS
Annual Low-Level Radioactive Waste (ft^3/yr)	1,000	1,000	3,600	3,600
Annual Low-Level Radioactive Waste (Ci/yr)	100	100	1,400	1,400
Decommissioning Low-Level Radioactive Waste (ft^3)	180,000	180,000	1,000,000	1,000,000
Decommissioning Low-Level Radioactive Waste (Ci)	30	30	300	300

4.2 LIFE CYCLE COST

This section presents the results of a system life cycle cost (LCC) comparison conducted to determine the economic advantages or disadvantages of implementing the MPC system. Cost comparisons are made between the MPC system and the individual SNF assembly handling system for cases with and without an MRS facility. Cost comparisons for the TSC system and MPU system alternatives are provided in Section 5.3.3.

The LCC summary presented in the following sections is drawn from the *Life Cycle Cost Comparison for the MPC System* report, contained in Volume V of the MPC System CDR. This summary provides discussions of the scope of the LCC estimate, the methodology employed in developing the LCC, and LCC estimates for the MPC, waste acceptance, OSTS, transportation, MRS facility, and MGDS.

4.2.1 Scope and Methodology

Costs for the MPC system and individual SNF assembly handling system for cases with and without an MRS are compared in five areas: MPC, OSTS/waste acceptance, transportation, MRS facility, and MGDS. All cost comparisons are presented in constant 1993 dollars and represent an effective discount rate of zero percent. These are based on conceptual design work and parametric evaluations of existing systems and cost estimates.

For the cost comparison conducted in this analysis, new system element costs are developed only in the areas where there is a perceived difference between the individual SNF assembly handling system and the MPC system. For costs that reflect an incremental change, as well as all costs associated with the individual SNF assembly handling system, estimates are based on previous cost analyses and current program studies and planning documents adapted to the MPC. The differential impact of systems on development and evaluation (D&E) costs, benefits costs, and payments equal to taxes (PETT) is not included in the analysis. Costs for monitoring, contracts, and programmatic work for waste acceptance are assumed to be included in program D&E costs.

Costs presented for each of the program elements or subsystems are the sum of the LCC incremental differences between the individual SNF assembly handling system and the MPC system over the life of the CRWMS. Therefore, the values presented are the savings or costs that are realized over the life of each element or subsystem.

To provide a fair comparison with the MPC system, the individual SNF assembly handling system operational concept was defined to be similar to the MPC system, particularly with regard to transportation assumptions and disposal container design. System logistics were developed based on MPC system capacities and the assumptions outlined in the *Concept of Operations for the Multi-Purpose Canister System* report, which is summarized in Section 2.2. A set of linked computer models were used to simulate the operational characteristics of the CRWMS over its projected lifetime. The logistics results from these computer analyses were then used to determine the numbers of MPCs and transportation and storage casks required. These values were incorporated as incremental changes to CRWMS facility conceptual designs to determine the impact of MPC implementation on these facilities.

4.2.2 Canister Costs

Table 4.2-1 lists the quantity of MPCs required and the total cost to the CRWMS for MPCs, for cases with and without an MRS facility. Fewer MPCs are required in the no-MRS case because truck shipments are not transferred to MPCs. A 25 percent contingency was added to the total cost for conservatism. These costs are shown as an increase in initial system costs for the MPC system relative to the individual SNF assembly handling system.

Table 4.2-1. MPC System Cost for Canisters
(Millions of 1993 Dollars)

Cost Item	With MRS		No MRS	
	Quantity	Cost	Quantity	Cost
Large PWR MPC	5,768	+2,042	5,257	+1,861
Large BWR MPC	3,333	+1,440	2,819	+1,218
Small PWR MPC	698	+200	698	+200
Small BWR MPC	1,367	+377	1,367	+377
Total cost of MPCs		**+4,059**		**+3,656**
Total cost of MPCs with 25 percent contingency added		**+5,074**		**+4,570**

4.2.3 Waste Acceptance and On-Site Transfer and Storage Costs

Costs at Purchaser sites are divided into two categories: waste acceptance and storage. Waste acceptance costs include costs required to load a transportation cask or MPC in preparation for immediate off-site shipment and associated equipment costs, such as welding equipment. Storage costs are divided into two categories: costs for operating Purchaser facilities and costs for shutdown Purchaser facilities.

Waste Acceptance

The costs of burnup verification meters, welding equipment needed to seal MPCs, and on-site transfer casks required for transferring MPCs into transportation casks at 32 facilities (18 sites) are assumed to be borne by the CRWMS. Operational costs of loading, sealing, and handling casks and MPCs at Purchaser facilities are assumed to be borne by the Purchasers.

Analyses of waste acceptance equipment costs include only equipment that is perceived to be a discriminator between the individual SNF assembly handling system and the MPC system. This is limited to the MPC welding equipment, burnup verification meters required for loading large PWR MPCs, and on-site transfer casks needed at 32 facilities. Waste acceptance equipment is estimated to be $27 million higher for the MPC system than for the individual SNF assembly handling system.

An evaluation is made of operating costs associated with welding and loading of MPCs and transportation casks. Process times, staffing, and labor costs are estimated for Purchaser facilities for cask loading, sealing, decontamination, and preparation for shipment. Based on these cost estimates and appropriate logistics, Purchaser costs for waste acceptance operations are estimated to be $94 million higher for the MPC system than for the individual SNF assembly handling system.

Waste acceptance equipment and operating costs would not be affected by the absence of an MRS, since the quantity of MPCs or casks loaded at each Purchaser facility would not change.

Storage

Storage cost estimates are based on an operating scenario where SNF is stored in spent fuel pools at operating reactor sites, and any SNF in excess of pool capacity is placed in dry storage. Dry storage for operating reactor sites in the MPC system is accomplished using MPCs, whereas non-transportable MESCs are assumed to be used in the individual SNF assembly handling system. Small non-transportable MESCs are also used in the MPC system at sites without capabilities to handle at least small MPCs. For shutdown reactor sites, storage costs for the MPC system are estimated based on an operating scenario where all SNF remaining in the spent fuel pool is placed into MPC storage five years after shutdown. For shutdown reactor sites in the individual SNF assembly handling system, all SNF remains in the spent fuel pools (with the exception of SNF placed in MESC storage). SNF placed in dry storage prior to 1998 was not considered in either the operating or shutdown reactor site scenarios.

Analyses project the amount of SNF that will be placed in dry storage at operating reactor sites for the individual SNF assembly handling system and the MPC system. Equipment and operating costs are estimated, including costs for the concrete storage casks for MESCs or MPCs, concrete pads at ISFSIs, transfer casks for moving MPCs or MESCs to the ISFSIs, ISFSI site preparations, and consumables. Operation costs include costs for loading MESCs and MPCs and placing them in storage. For the individual SNF assembly handling system, storage costs also include costs for moving MESCs from ISFSIs to the pool, cutting them open, and transferring the SNF assemblies back to pool storage racks. (Loading of transportation casks with SNF assemblies removed from the MESCs is included in the waste acceptance operation costs.) For consistency between the systems, MPC system storage costs include the cost of retrieving MPCs from storage and transferring them to transportation casks for shipment off-site. For all systems, decommissioning costs were assumed to be 20 percent of capital costs.

At shutdown reactor sites, maintenance of ISFSIs and pools following shutdown is a significant cost driver. For the individual SNF assembly handling system in this analysis, shutdown reactor sites retain their SNF assemblies in the pool until they are accepted into the CRWMS. Operating costs estimated for the maintenance of pools at shutdown reactor sites are adapted from the *Cost Estimates of Operating On-Site Spent Fuel Pools After Final Reactor Shutdown* report, issued in 1991. For the MPC system, shutdown MPC-capable sites place all remaining SNF in MPCs five years after shutdown. When the SNF is accepted into the CRWMS, MPCs are transferred from storage modes to transportation casks without returning to the spent fuel pool. The significant costs associated with operating pools beyond five years after site shutdown are eliminated. Operation costs associated with maintaining ISFSIs after site shutdown are obtained from the *At-Reactor Dry Storage Issues* report, issued in December, 1993.

For cases with an MRS, Purchaser on-site storage costs are estimated to be $2.14 billion less for the MPC system than for the individual SNF assembly handling system. For the no-MRS cases, Purchaser on-site storage costs are estimated to be $2.38 billion less for the MPC system than for the individual SNF assembly handling system. This savings is due primarily to less expensive storage units since the MPC is considered a CRWMS cost. The additional cost for the no-MRS cases results from increased Purchaser on-site storage requirements. These costs are offset by the substantial savings of not providing an MRS facility as explained in Section 4.2.4.

4.2.4 Transportation Costs

Transportation costs include transportation cask purchases, all costs associated with shipping (such as freight costs, barge and heavy-haul operations, security, and state-managed emergency response capabilities), and support costs. Transportation costs also include costs for rail car and truck maintenance and the operations control center (OCC). The OCC is assumed to be located at the MRS facility and will provide dispatch and shipment tracking functions. For the no-MRS cases, the OCC would be located at the MGDS.

The numbers of casks required annually are based on the system throughput rate, destination and disposition of each shipment, turnaround time at the cask's destination, and requirements for maintenance at the CMF. For the cost analysis, each cask is assumed to have an operational life of 25 years. Cask decommissioning costs are calculated as a percentage of the capital cost, which is assumed to be 3 percent for truck casks and 7 percent for rail casks. The MPC system transportation cask costs, with associated hardware costs and 25 percent contingency added, are $3.28 million per large MPC cask and $2.66 million per small MPC cask. For the individual SNF assembly handling system, transportation casks are $4.74 million per large PWR rail cask, $4.86 million per large BWR rail cask, $3.44 million per small PWR rail cask, and $3.56 million per small BWR rail cask. MPC transportation cask unit costs are lower than individual SNF assembly handling system casks because the MPC serves as the cask basket. There is no difference in cost of truck transportation casks among the systems. The total cost difference for transportation cask fleets is estimated to be $253 million less for the MPC system than for the individual SNF assembly handling system, both with an MRS. For cases with no MRS, the total cost difference for transportation cask fleets is estimated to be $269 million less for the MPC system than for the individual SNF assembly handling system.

For each shipment, costs are computed for loaded and unloaded shipments, security, satellite tracking, Purchaser site operations related to transportation, barge and heavy-haul truck operations, and emergency response capabilities. The costs for barge and heavy-haul are based on an estimated charge per operation. For cases with an MRS, total shipment costs are estimated to be $25 million higher for the MPC system than for the individual SNF assembly handling system due to the greater weight of the MPC. For the no-MRS case, total shipment costs are estimated to be $12 million less for the MPC system. Because of assumptions in the concept of operations, this decrease is due to reduced security and tracking costs resulting from shorter turnaround times at the reactors. In the no-MRS case for the MPC system, loaded MPCs are immediately ready to be transferred to transportation casks for shipment off site. Conversely, in the no-MRS case for the individual SNF assembly handling system, it is assumed that transportation costs are incurred while SNF assemblies are loaded into transportation casks.

Annual transportation support costs are computed for rail car and truck maintenance and the OCC. For cases with and without an MRS, transportation support costs are estimated to be $1 million less for the MPC system than for the individual SNF assembly handling system. Table 4.2-2 summarizes the transportation cost differences for the systems.

Table 4.2-2 MPC System Transportation Cost Differences
(Millions of 1993 Dollars)

Cost Area	With MRS	No MRS
Cask purchases	- 253	-269
Shipments	+ 25	-12
Support	- 1	-1
Total Cost Difference	**- 229**	**-282**

Note:
Table entries show differences in costs between the MPC system and the individual SNF assembly handling system. Negative entries indicate a savings with the MPC system.

4.2.5 Monitored Retrievable Storage Facility Costs

Cost estimates for the MRS facility for the individual SNF assembly handling system and the MPC system are developed as incremental changes to estimates developed in the *MRS Facility Technologies Life Cycle Cost Analysis Report*, issued in January 1993, which was based on the MRS CDR. Cost elements of the MRS facility are divided into three categories: transfer facilities, storage mode facilities, and balance of plant. Costs for transfer facilities are adjusted based on revised transportation assumptions compared to the MRS CDR. The CMF is integrated with the MRS facility but tracked separately for analysis purposes. Cost functions for the MRS facility are segregated into four time phases: management and integration, engineering and construction (E&C), annual operations, and decontamination and decommissioning. It is assumed that management and integration costs for the MRS facility are identical for the individual SNF assembly handling system and the MPC system. A similar assumption is made for the CMF.

The MPC system requires more storage casks due to the lower capacity of the MPC relative to the storage cask in the individual SNF assembly handling system. The unit cost of the MPC storage cask is lower, since the MPC serves as the liner and basket of the storage cask. Total E&C costs including contingencies and indirect costs are estimated to be $237 million lower for the MPC system than for the individual SNF assembly handling system. This decrease is due to simplifying transfer facilities at the MRS, which handle relatively clean MPCs as opposed to the more contaminated individual, uncanistered SNF assemblies.

Operating costs for the MRS facility and CMF are computed based on an assumed operating life of 34 years. Low-level waste disposal is included in the cost of consumables. Total MRS facility operation costs including contingencies are estimated to be $41 million less for the MPC system than for the individual SNF assembly handling system, because of reductions in operating costs of the simplified transfer activities and reduced number of SNF assembly handlings.

Costs for decommissioning the MRS facility and CMF are also included. MPC system decommissioning costs are lower than for the individual SNF assembly handling system because use of sealed, relatively clean MPCs requires less decontamination. Total MPC system decommissioning costs are estimated to be $42 million and $2 million less for the MRS facility and CMF, respectively. Table 4.2-3 provides a summary of the MRS facility and CMF cost differences for the MPC system compared to the individual SNF assembly handling system.

With no MRS in the system, MPC system costs for the CMF are estimated to be $36 million less than for the individual SNF assembly handling system. This results from a reduction in the number of years of operation of the CMF, since it is not provided until the first MGDS becomes operational.

Table 4.2-3 MPC System MRS Facility and CMF Cost Differences
(Millions of 1993 Dollars)

Cost Item	With MRS	No MRS
MRS Facility:		
Management & Integration	0	0
Engineering & Construction	- 237	0
Operations	- 41	0
Decommissioning	- 42	0
Total for MRS Facility	**- 320**	**0**
CMF:		
Management & Integration	0	0
Engineering & Construction	- 2	-2
Operations	- 46	-32
Decommissioning	- 2	-2
Total for CMF	**- 50**	**-36**
Total Cost Difference for MRS & CMF	**- 370**	**-36**

Note:

Table entries show differences in costs between the MPC system and the individual SNF assembly handling system. Negative entries indicate a savings with the MPC system.

4.2.6 Mined Geologic Disposal System Costs

Costs for the MGDS for the MPC system are presented for differences in the disposal containers as compared to the individual SNF assembly handling system. These costs are then tabulated as comparative costs with the other MGDS costs for the first MGDS. Due to inherent uncertainties in surface and subsurface designs, comparative costs for the second MGDS include only the disposal container costs.

Cost estimates for disposal containers for all systems are developed for large-scale production. These costs include a 25 percent contingency. MPC disposal container costs are lower than costs for individual SNF assembly disposal containers because the MPC serves as the basket of the waste package. The no-MRS case requires a combination of MPC disposal containers and individual SNF assembly disposal containers, since the MRS facility is not available to package all SNF assemblies in MPCs prior to shipment to the first MGDS. Requirements for providing performance confirmation disposal containers are assumed to be the same for all systems, and their relative costs are included.

The cost of disposal containers are added to costs for the first MGDS surface and subsurface facilities developed for the MPC conceptual design phase. Simplified surface facilities reduce costs for the MPC system. On the other hand, excavation costs increase for the MPC system because more space is necessary for the greater number of 75-ton MPC waste packages in these systems as compared to the large waste packages used in the individual SNF assembly handling system. Table 4.2-4 shows the total cost comparison for the first repository. Only disposal container costs are considered for the second repository. The container costs for the second repository are $772 million less for the MPC system than for the individual SNF assembly handling system.

Table 4.2-4 MPC System First MGDS Cost Differences
(Millions of 1993 Dollars)

Cost Item	With MRS	No MRS
Management & integration	0	0
Site preparation	0	0
Surface facilities	- 74	0
Shafts/ramps - underground	0	0
Subsurface excavations	+ 116	+116
Underground service systems	0	0
Disposal container fabrication	-2,272	-1,946
Low-level waste disposal	0	0
Total Cost Difference	**- 2,230**	**-1,830**

Note:
Table entries show differences in costs between the MPC system and the individual SNF assembly handling system. Negative entries indicate a savings with the MPC system.

4.2.7 Summary

For cases with an MRS, the canisters in the MPC system add $5.1 billion to the total system cost as compared to the individual SNF assembly handling system. Of this, approximately $3.6 billion is offset by savings in transportation ($229 million), the MRS facility ($320 million), the CMF ($50 million), and disposal container costs at the first and second MGDS ($2.2 billion and $772 million, respectively). The net result is an increase in CRWMS LCC of $1.5 billion for the MPC system with an MRS. When Purchaser costs are included, $2.1 billion in savings in on-site storage results in a $550 million decrease in total system costs (CRWMS plus Purchasers) for the MPC system. The cost differences are relatively small and within the uncertainty of this analysis. These results are summarized in Table 4.2-5.

For the no-MRS cases, the MPC system is estimated to cost $605 million less than the individual SNF assembly handling system. This is essentially the same as the difference between the systems including an MRS; therefore, having or not having an MRS is not a discriminator between the systems.

Table 4.2-5 Total MPC System Life Cycle Cost Differences
(Millions of 1993 Dollars)

Cost Item	With MRS	No MRS
CRWMS:		
Multi-Purpose Canisters	+ 5,074	+ 4,570
Waste Acceptance Equipment	+ 27	+ 27
Transportation	- 229	- 282
MRS Facility	- 320	0
CMF	-50	- 36
First MGDS	- 2,230	- 1,830
Second MGDS	- 772	- 772
Total Cost Difference for CRWMS	**+ 1,500**	**+ 1,677**
Purchasers:		
Waste Acceptance Operations	+ 94	+ 94
Purchaser On-Site Storage	- 2,144	- 2,376
Total Cost Difference for Purchasers	**- 2,050**	**- 2,282**
Total System Cost Difference	**- 550**	**-605**

Note:
Table entries show differences in costs between the MPC system and the individual SNF assembly handling system. Negative entries indicate a savings with the MPC system.

4.3 REGULATORY AND LICENSING

This section discusses major regulatory and licensing considerations associated with implementing the MPC system into the CRWMS. Major, identifiable licensing issues are addressed relative to Purchaser site storage, bare SNF transfer, transportation, the MRS facility, and the MGDS. The licensing strategy for MPC system implementation is also discussed.

4.3.1 Purchaser Site Storage

MPC system operations at a Purchaser site are governed by two regulations: 10 CFR Part 50, *Domestic Licensing of Production and Utilization Facilities*, and 10 CFR Part 72, *Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste*. Activities occurring inside a Purchaser's auxiliary building or spent fuel pool area are associated with the 10 CFR Part 50 power reactor operating license. These activities include the loading of SNF assemblies into an MPC contained in a transfer or transportation cask and may include transfer of the MPC into the storage cask and subsequent transportation of the storage cask out of the Purchaser's auxiliary building. Activities occurring outside of a Purchaser's auxiliary building or spent fuel pool area are associated with an ISFSI and are licensed under 10 CFR Part 72. These activities include the receipt, possession, storage, and transfer of SNF at an ISFSI, including the transfer of SNF between a 10 CFR Part 50 licensed facility and an ISFSI. Operations associated with a bare SNF transfer device can also be performed under the 10 CFR Part 72 license. Requirements of 10 CFR Part 71, *Packaging and Transportation of Radioactive Material*, are applicable when the MPC and its transportation cask leave the Purchaser site.

There are currently two types of licenses under which Purchasers are authorized to store SNF on-site in accordance with 10 CFR Part 72. The first type of license is a site-specific license in which the Purchaser submits a license application to the NRC and goes through a formal licensing process. This is also the type of license required for the MRS facility. The second type of license authorizing Purchaser on-site dry storage of SNF is the general license. The general license process is similar to the process used for certifying and using SNF transportation casks. The NRC reviews a vendor's topical safety analysis report (TSAR) for the dry storage technology and issues a certificate of compliance for the cask system to be used for the storage of SNF. The approved cask system is then listed in 10CFR72.214. Any Purchaser holding a commercial reactor operating license under 10 CFR Part 50 may then use the approved storage casks within the constraints of the certificate of compliance for the storage of SNF, following an internal safety evaluation process and verification that there are no unreviewed safety questions. The general license is the preferred manner for implementing the MPC system at Purchaser sites.

Regardless of whether a Purchaser has a site-specific ISFSI license or stores SNF under the provisions of a general license, the impact of storage activities must be evaluated relative to the 10 CFR Part 50 reactor license. Similarly, the impacts of loading a transportation cask in the spent fuel pool area requires evaluation by the Purchaser. Most 10 CFR Part 50 concerns associated with transferring SNF assemblies from spent fuel pools into MPCs relate to the handling of heavy loads. Heavy loads must be evaluated as static loads on existing 10 CFR Part 50 facility structures and must also be analyzed for potential dropping of the heavy loads on structures, equipment, or SNF assemblies.

4.3.2 Bare SNF Transfer

There are 19 Purchaser facilities at 16 sites that may not be able to use MPCs and that are assumed to use LWT shipping casks to transport individual SNF assemblies. One potential component of the MPC system is a bare SNF transfer (BST) device, which may be used by sites that are currently limited to LWT shipments. Additional design work is necessary to fully evaluate the practicality and licensability of BST systems. Because the design, licensing, and construction of a BST system can be pursued in parallel with the implementation of the MPC system, it can be maintained as an option without impacting the deployment of MPCs or the overall waste management program.

4.3.3 Transportation

The MPC canister and transportation cask must be certified by the NRC for transportation use under 10 CFR Part 71. There will be no overall system benefit, compared to existing MESC storage technologies, if the MPC system is not certified for transport after storage at a Purchaser site or MRS facility. The 10 CFR Part 71 design criteria that must be satisfied in order to receive the NRC certificate of compliance are generally considered to be more stringent than the 10 CFR Part 72 storage requirements. For this reason, it is prudent to obtain the storage and transportation certificates at the same time or to pursue the 10 CFR Part 71 NRC reviews prior to the 10 CFR Part 72 reviews.

4.3.4 Monitored Retrievable Storage Facility

If an MRS facility is provided, it will be licensed in accordance with 10 CFR Part 72. DOE will submit a license application for a specific license for the MRS facility since the requirements for storage of SNF under a general license are not applicable. The MPC system is not expected to have any negative impacts on licensing of the MRS facility. The greatest system benefits are realized when all SNF is received at the MRS facility in MPCs. If uncanistered SNF assemblies must be handled routinely at the MRS facility, then there will be no reduction in the MRS licensing issues that must be resolved. Because some Purchaser facilities cannot handle MPCs, additional importance is placed upon the development of a BST system.

4.3.5 Mined Geologic Disposal System

The MGDS will be licensed in accordance with 10 CFR Part 60, *Disposal of High-Level Radioactive Wastes in Geologic Repositories*, which establishes specific design criteria for the waste package. Although the MPC is similar to the robust waste package previously considered for the MGDS, repository licensing impacts of the MPC system are somewhat uncertain because the design bases for the final waste package have not yet been developed. Some licensing issues may limit the size of the MPC. There are also unknowns associated with whether MPCs will have to be opened at the MGDS to place a filler material in the canisters for improved nuclide retention, heat transfer, or moderator displacement for long-term criticality control. Any long-term performance credit for the MPC will depend also on materials selected. If stainless steel is used to fabricate the MPC, the waste package overpack must be designed for increased corrosion resistance. Waste package design bases must be developed, and safety margins must be analyzed before resolution of all MGDS licensing issues. Based upon current schedules for repository design activities, there are certain at-risk decisions that must be made relative to implementing the MPC system.

4.3.6 Licensing Strategy for MPC System

One of the benefits of the MPC system is the use of a standardized Purchaser site storage technology, which eliminates the need for additional routine SNF handling by Purchasers prior to DOE waste acceptance. For this reason, MPCs should be made available to Purchasers that require on-site dry storage of SNF. This necessitates timely approval of the MPC system by the NRC for use under a general license. Licensing issues associated with using the MPC for dry storage in accordance with 10 CFR Part 72 are generally straightforward. The MPC needs to be approved for both storage and transportation of SNF in order to be acceptable to Purchasers. It is expected that NRC approval of the MPC for storage and transportation will occur prior to approval for disposal.

Unique requirements related to disposal that 10 CFR Part 60 may impose on the MPC design are not fully established at this time. These issues include items such as thermal loading requirements for the repository, maximum weight limitations of the emplaced package, shielding requirements, long-term criticality, retrieval, and material compatibility issues. Some of these repository licensing issues may not be finalized at the time MPCs need to be available for use for storage and transportation. Early interaction with the NRC is planned to address significant 10 CFR Part 60 licensing issues.

Licensing of the MPC system for storage, transportation, and disposal is expected to be a relatively complex process. Ensuring that technical issues are addressed and resolved on a schedule consistent with that required for MPC deployment will require successful implementation of an issue resolution initiative. This is a licensing strategy whereby DOE and the NRC engage in pre-licensing interactions to develop a common understanding of the regulations. This aids in defining the technical information that must be developed to demonstrate compliance with all relevant regulations. DOE has implemented an issue resolution initiative for the MPC system that is modeled after the issue resolution process that has been utilized successfully for the Yucca Mountain Project. This process has already begun on generic issues such as burnup credit as described in Section 4.5.3.

4.4 PURCHASER IMPACTS

Although a substantial amount of discharged SNF can be stored in existing spent fuel pools at Purchaser sites, storage capacity is limited. Once pool storage capacity for a given site has been reached, all future SNF discharges will require additional storage capacity outside the pool. To date, Purchasers have selected the use of dry storage technologies to satisfy their needs for out-of-pool SNF storage. Until the CRWMS begins to accept SNF, Purchasers will continue to store SNF on site in ISFSIs. A large number of Purchasers are projected to ultimately require some amount of on-site dry storage. In addition, Purchaser sites that are shutdown may use dry storage as a method for removing all SNF from their spent fuel pools, which could allow decommissioning of these pools prior to SNF being accepted into the CRWMS. This strategy for shutdown sites requires a dry storage technology that has the capability for transferring SNF directly to transportation casks without having to go back through the spent fuel pool at the time of SNF retrieval.

The *At-Reactor Dry Storage Issues* study, contained in Volume V of the MPC System CDR, analyzes impacts of the MPC system and other alternatives on Purchaser facilities. Bases for the analyses in that study are the concept of operations, as described in Section 2.2, and the *Operational Throughput for the Multi-Purpose Canister System* report, contained in Volume V of the MPC System CDR. This section provides results of the logistical comparison among the systems.

4.4.1 Comparison Between MPC System and Individual SNF Assembly Handling System - Both With an MRS

Comparison of the MPC system and the individual SNF assembly handling system indicates that there are no significant differences in the two with respect to the number of Purchaser facilities requiring on-site dry storage, the number of shutdown reactor spent fuel pools, and the number of SNF assemblies in on-site dry storage as a result of exceeding spent fuel pool capacities. One primary difference between the two concepts is the number of SNF assemblies in on-site dry storage as a result of unloading spent fuel pools at shutdown reactors, which is done in the MPC system but not in the individual SNF assembly handling system. This results in an increase in the number of SNF assemblies in dry storage from 32,831 in the individual SNF assembly handling system to 66,222 in the MPC system, in order to allow Purchaser facilities to decommission spent fuel pools earlier. Another difference between the two concepts is the number of dry storage canisters required. This is driven by the difference in the capacities of MPCs and MESCs, as well as the difference in the treatment of SNF storage at shutdown reactors. From a logistics standpoint, the MPC system and the individual SNF assembly handling system are very similar. The only differences are driven by canister capacity and shutdown reactor assumptions.

4.4.2 Comparison Between MPC System With and Without an MRS

A comparison of the MPC System with and without an MRS reveals that there are significant differences for Purchaser on-site dry storage if there is no MRS facility in the MPC system. These differences can be categorized into two parts: (1) impacts on Purchaser on-site dry storage and shutdown reactor storage prior to the year 2010 when the MGDS begins operations; and (2) impacts on the maximum on-site dry storage and shutdown reactor storage requirements.

Figure 4.4-1 presents a comparison between the total amount of SNF in Purchaser on-site dry storage for the MPC system with and without an MRS. The figure also provides a comparison of the number of Purchaser spent fuel pools that have reached their storage capacities and require some amount of dry storage. The most significant difference occurs during the years 2014 through 2028, when the total MTU of SNF in Purchaser on-site dry storage for the no-MRS case is twice as high as the dry storage required with an MRS. In the years 1998 and 1999, the issue of whether or not an MRS facility is provided does not have a major impact on the amount of Purchaser on-site dry storage required.

Figure 4.4-2 presents a comparison of the total amount of SNF stored in spent fuel pools at shutdown reactors for the MPC system with and without an MRS. The figure also provides a comparison of the number of spent fuel pools in use at shutdown reactors for each case. Having an MRS facility in the system reduces the total amount of SNF stored in spent fuel pools at shutdown reactors; however, the total number of shutdown reactor spent fuel pools in use is almost unaffected by the MRS assumptions.

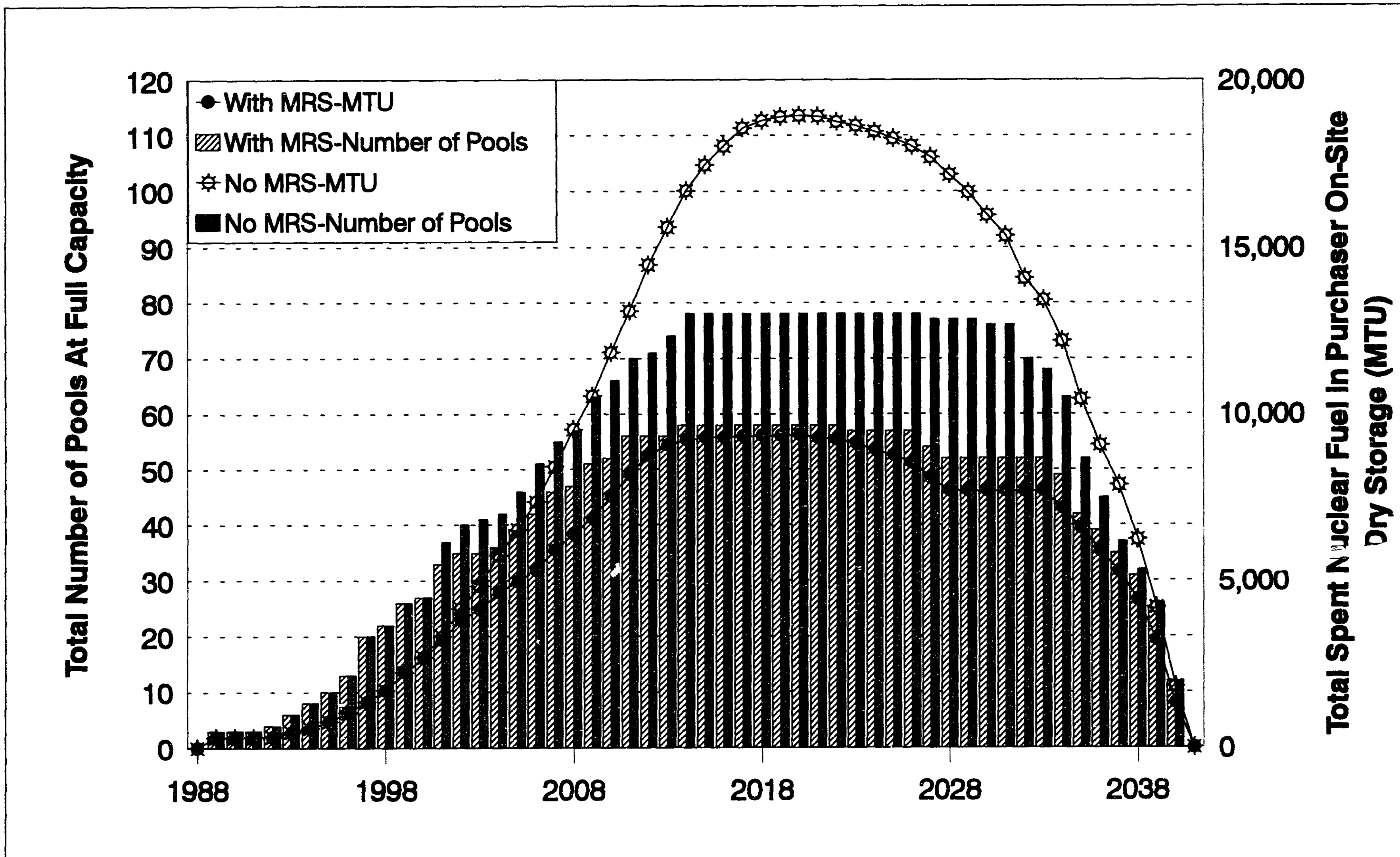

Figure 4.4-1 Comparison of Purchaser On-Site Dry Storage for MPC System Design Concept with and without an MRS

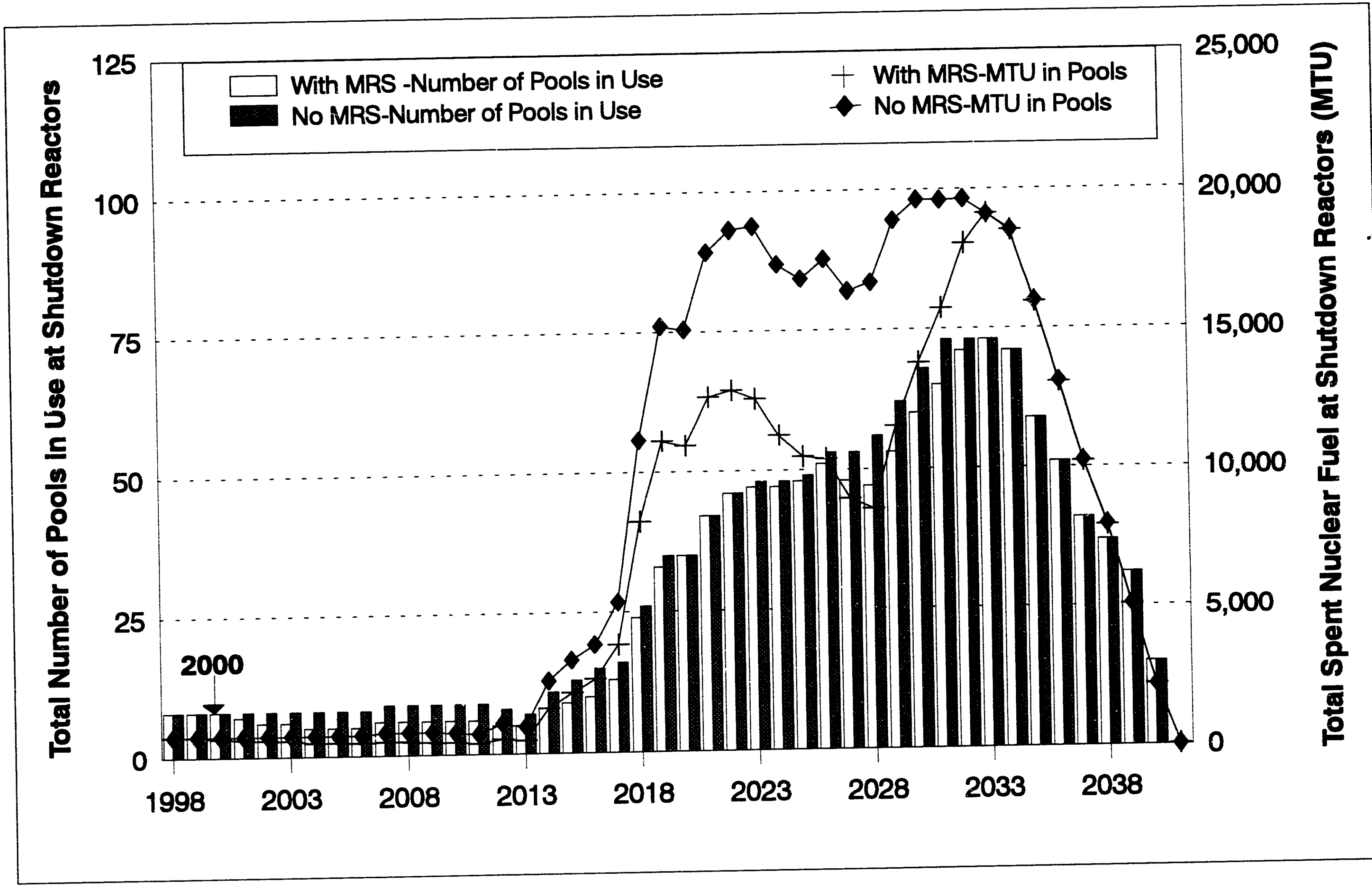

Figure 4.4-2 Comparison of Spent Fuel Pool Storage at Shutdown Reactors for MPC System with and without an MRS

Similar results were determined for the individual SNF assembly handling system with and without an MRS for Purchaser on-site dry storage requirements. However, a significant difference is that the MPC system permits spent fuel pool decommissioning and the individual SNF assembly handling system does not.

4.5 STAKEHOLDER INVOLVEMENT

DOE is committed to involving interested external parties, or stakeholders, in its decision-making process. This section summarizes the approach used to obtain stakeholder input and incorporate stakeholder comments and concerns in development of the MPC system. Major comments from stakeholder workshops and specific stakeholder groups are summarized, and DOE responses to significant stakeholder concerns are addressed.

4.5.1 Approach to Stakeholder Involvement

Numerous stakeholders have been involved in the CRWMS program since OCRWM was established by the NWPA. Principle stakeholders include electric utility companies who own or operate nuclear power plants; potentially affected governments at the state, local, and tribal levels; potential DOE facility host communities; and manufacturers, or vendors, of nuclear fuel transfer and storage technologies. Involving stakeholders, as well as the general public, in development of the CRWMS helps ensure that the program will meet its goals by drawing on the experience and addressing the concerns of affected parties.

OCRWM sponsored two workshops to provide close stakeholder interaction with MPC system development. The first workshop was held in July 1993 in Arlington, Virginia, and the second workshop was held in November 1993 in Washington, D.C. The first workshop focused on identification of stakeholder issues related to the conceptual design of an MPC-based CRWMS. The second workshop examined how these issues had been dealt with in the draft of the MPC System CDR. The primary purpose of these workshops was to ensure that major issues and alternatives were addressed prior to a DOE decision on implementation of the MPC system. Results of the first workshop are presented in the *Stakeholder Involvement Report for the Multi-Purpose Canister System,* which is included in Volume V of the MPC System CDR. Results of the second workshop are documented in the *Multi-Purpose Canister Workshop Report to Participants,* dated December 6, 1993.

Aside from the information obtained during the workshops, comments have been received from various committees within the Edison Electric Institute's Utility Nuclear Waste and Transportation Program (EEI/UWASTE). (Note that EEI is now represented by the Nuclear Energy Institute.) EEI/UWASTE is a group within EEI that represents electric utilities with nuclear energy programs. EEI/UWASTE has been involved throughout the conceptual design process. Several meetings and continuing discussions and correspondence have taken place between EEI/UWASTE and DOE. Comments were also received from the Independent Review Group (IRG) after the second workshop was held. The IRG is an independent group appointed by DOE to perform a peer review of the CRWMS.

Issues identified by stakeholders have been considered throughout the development of the MPC system. The NWTRB provided comments based on the MPC System CDR. These and other issues, concerns, and recommendations will continue to be considered as the MPC system detailed design is performed.

4.5.2 Stakeholder Concerns

Stakeholders have shown support for a shift to a concept that incorporates MPCs as the primary component handled throughout the CRWMS. They also agree that DOE should proceed with the design, licensing, fabrication, and testing of the MPC system as part of the overall strategy for implementing the CRWMS. Several issues have been identified that should be addressed in further development of the MPC system. These are summarized as follows:

- Decision Process — DOE should make sound decisions on an expeditious schedule. This will provide the basis for Purchasers to proceed with implementation of near-term, on-site SNF management activities, with reduced economic risk, and it will allow progress to be made toward the goal of initiating acceptance of SNF as required by the NWPA.

- Procurement Strategy — Appropriate roles should be determined for both DOE and the private sector in the development of a procurement strategy for MPCs. DOE's role of integrating system-wide CRWMS requirements should be continued, and the role of the private sector should be maximized in developing the MPC system.

- System Schedule — The schedule for MPC licensing is very aggressive and limits time for NRC licensing review or rulemaking under 10CFR72, Subpart K. Significant schedule advantages might be obtained if existing technologies are used as a starting point for the MPC system.

- System Flexibility — The MPC system must have the capability to reasonably accommodate SNF from all Purchaser sites, including the ability to load MPCs through the use of transfer casks. The CRWMS must accommodate Purchaser needs for storage and transportation technologies other than MPCs. This flexibility should include an efficient LWT cask for the shipment of individual, uncanistered SNF assemblies.

- 100 Percent SNF Design Coverage — The conceptual design of the MPC system accommodates 80 percent of the SNF assemblies expected to be available during the first ten years of CRWMS operation. The system must accommodate the remaining SNF that is not bounded by the MPC System CDR fuel design parameters.

- Facility Outliers — DOE must specifically address facilities that cannot use the MPC due to facility interface restrictions, such as crane capacity restrictions, structural and dimensional limitations, rail access limitations, and non-standard SNF assembly dimensions.

- Burnup Credit Issue — Resolution of the burnup credit issue is one of the critical path items in development of the MPC-based CRWMS. An agreement is needed with the NRC to ensure an integrated review by affected branches will be completed on schedule.

- Thermal Load Assumptions — In the MPC System CDR, the maximum MPC capacity of 21 PWR SNF assemblies was selected based on assumed repository thermal loading criteria and 10-year-old SNF. Repository thermal loading is a primary technical concern, and an assessment of loading the repository with 20-year-old SNF should be performed. Large MPCs should also be assessed for extending the capacity beyond 21 PWR SNF assemblies.

4.5.3 Resolution of Stakeholder Concerns

DOE has addressed major issues raised by stakeholders, and many issues have already been incorporated in the ongoing development of the MPC system. Resolution of stakeholder concerns is a major priority for DOE. The following items discuss how key stakeholder issues have been incorporated into the ongoing development of the MPC system:

- DOE has responded to stakeholder concerns about the need for an expeditious decision on a CRWMS SNF handling system by deciding in February 1994, to proceed with design and certification of the MPC system. DOE will prepare an EIS for the decision to proceed with MPC fabrication and deployment.

- DOE has placed a priority on the use of proven technologies and existing industry experience in the development of the MPC system. This is evidenced by DOE's decision to primarily use vendor design, fabrication, testing, and production of MPCs, transportation casks, transfer casks, and Purchaser on-site storage casks. The MPC System Request for Proposal (RFP) was issued to vendors in June 1994 to expedite vendor participation in the CRWMS.

- DOE has established working groups to reach resolution with the NRC concerning use of burnup credit in the design of the MPC and to expedite NRC acceptance for using the MPC as a waste package at the MGDS. DOE intends to submit a topical report on the use of burnup credit to the NRC early to resolve this issue.

- Use of MPCs in waste packages at the MGDS continues to be investigated. Repository site characterization parameters are being determined and should be better defined by the time the MPC detailed design starts. This should reduce the risk of proceeding with implementation of the MPC system prior to finalization of MGDS parameters.

- Design procurement specifications included in the MPC System RFP specify requirements for vendors to make provisions to handle 100 percent of standard SNF assemblies. These include requirements for alternate MPC designs to accommodate all SNF types.

- Bare SNF transfer mechanisms and other SNF handling schemes are being studied that would allow broader use of MPCs at Purchaser sites. Of the 19 Purchaser facilities that could not accommodate the MPCs as presented in the MPC System CDR, current investigations show that this number may be reduced to as few as 4 facilities that would have to use some type of cask other than the MPC.

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4.6 PROGRAMMATIC RISK AND CONTINGENCY ANALYSIS

Throughout the conceptual design of the various CRWMS elements, a priority has been placed on the use of proven technology. Incorporation of new or untried components has been kept to a minimum. Design methods used in formulating the MPC system conceptual design are based almost solely on proven methods that have been used for years in the nuclear industry. Even though the MPC itself is a new design that has yet to be licensed, few problems are envisioned that could have negative impacts on implementation of the system. The MPC system design is relatively straightforward and should proceed with a minimum of delays. Even so, it is appropriate to assess any perceived negative aspects of the system so that contingencies will be available if problems arise.

An important part of the MPC system evaluation is consideration of potential downside risks related to the design. These risks are driven by uncertainties in CRWMS program assumptions. Significant risks include those associated with MGDS technical issues, MPC transportability after long-term dry storage, and MGDS schedule. An evaluation was performed to identify unresolved issues that introduce major financial risks as a result of the implementation of the MPC system. That evaluation also developed remedies that might be employed to recover from adverse outcomes and estimated the costs associated with these remedies. Results of the evaluation are documented in the *Programmatic Risk and Contingency Analysis for the Multi-Purpose Canister System* report, which is contained in Volume V of the MPC System CDR, and are summarized in this section.

The following sections identify programmatic risks and contingencies associated with the MPC-based CRWMS. Underlying issues and remedies are identified for resolving each issue. Sensitivity analyses are discussed with regard to impact of specific risk issues on the MPC system.

4.6.1 Contingencies and Underlying Issues

Nineteen uncertainties are identified as contingency issues resulting from the MPC conceptual design phase. These contingency issues are summarized in Table 4.6-1, along with the underlying issue categories into which the specific issues are grouped. Table 4.6-1 also shows ten issues classified as important potential discriminators between the MPC system and the individual SNF assembly handling system. Three underlying issues are identified that encompass the ten potential discriminators. These underlying issues are "MGDS Delay," "MPC Non-Transportability (after long-term storage)," and "MPC Non-Emplaceability."

Table 4.6-1 Summary of Contingency Issues

Contingency Issue	Discriminator Between MPC System and Individual SNF Assembly Handling System	Underlying Issue
General System Issues		
Number of MRSs	No	n/a
Location of MRSs	No	n/a
MGDS Delay	Yes	MGDS Delay
MGDS Thermal Loading	Yes	MPC Non-Emplaceability
MGDS Location and Geology	Yes	MGDS Delay
MPC-Specific Issues		
Condition and Integrity of MPC and Contents	Yes	MPC Non-Transportability (After long-term storage)
Accountability/Identity for Safeguards and QA	Yes	MPC Non-Transportability and MPC Non-Emplaceability
Burnup Credit for Transportation	No	n/a
Fuel Outside MPC Design Envelope	No	n/a
Waste Package Criticality	Yes	MPC Non-Emplaceability
Waste Package Size	Yes	MPC Non-Emplaceability
Waste Package Internal Temperature	Yes	MPC Non-Emplaceability
Waste Package Filler Requirements	Yes	MPC Non-Emplaceability
Other Issues		
All MPC System	No	n/a
Dry Storage Technology	No	n/a
Shutdown Reactor Dry Storage	Yes	MPC Non-Transportability (After long-term storage)
MPC Materials Availability	No	n/a
MPC Derating/Blending	No	n/a
Waste Package Shielding	No	n/a

4.6.2 Remedies

Remedies are identified to mitigate the negative impact of each of the three underlying issues. Some of the underlying issues have several remedies that relate to the severity of the issue. The remedies identified for each of the underlying issues are discussed in the following paragraphs:

MGDS Delay

In the event the MGDS is delayed, emplacement would begin later than the current assumption of 2010. For this analysis, 2020 is assumed as the new emplacement start date. This would also require additional dry storage at Purchaser sites.

MPC Non-Transportability

In the event MPCs are determined to be non-transportable after long-term storage, the two basic remedies considered are: (1) opening and reusing the MPCs, and (2) opening and discarding the MPCs. For the first remedy, two sub-remedies are considered: inspecting and resealing the MPCs, or modifying and then resealing the MPCs. For the second remedy, two sub-remedies are also considered: reverting to the individual SNF assembly handling system, or redesigning the MPC.

MPC Non-Emplaceability

In the event MPCs are determined to be non-emplaceable, the three basic remedies considered are: (1) opening and retaining the MPCs, (2) opening and discarding the MPCs and then reverting to the individual SNF assembly handling system, and (3) opening and discarding the MPCs as part of a dual-purpose MPC strategy. For the first remedy, two sub-remedies are considered: modifying and then resealing the MPCs, and redesigning an emplaceable MPC. For the second remedy, each phase is considered separately. For the third remedy, two sub-remedies are considered: implementation of a lower-cost, dual-purpose MPC, and operating a hybrid system where the MPC is used when storage is needed and the individual SNF assembly handling system is used otherwise.

4.6.3 Evaluation Methodology

As described in Section 4.2.7 and discussed in the *Life Cycle Cost Comparison for the Multi-Purpose Canister System* task report, the MPC system could save $550 million in total system costs relative to the individual SNF assembly handling system. Those cost evaluations are performed for a nominal case and do not include potential contingencies. In contrast, the evaluation described here is intended to identify the potential impact of risks and contingencies and to determine if any contingencies are significant enough to advise caution or warrant change in the MPC system implementation strategy. The $550 million LCC savings estimated for the MPC system without contingencies is the starting point for this work and provides a standard for judging the significance of the results.

Remedies identified for each underlying issue represent the bounds of the potential downside risk for the MPC system and, as such, provide the potential cost range impacts associated with each issue. Each remedy and sub-remedy has been evaluated to determine the economic impact for the MPC system relative to the individual SNF assembly handling system.

Evaluation of the issues and their associated remedies focuses on costs associated with facilities, equipment, and operations. It does not consider incremental changes in programmatic costs, such as those associated with development and evaluation, design, and licensing.

4.6.4 Evaluation Results and Conclusions

Results of the evaluation of each of the three underlying issues are provided in this section. Conclusions from the risk and contingency analysis are then described with regard to impacts of MPC system implementation on the overall CRWMS.

MGDS Delay

In the event of a 10-year delay in commencement of MGDS operations, the MPC system has a lower cost increase than the individual SNF assembly handling system. The LCC increase resulting from a 10-year delay in beginning MGDS operations is $2.52 billion for the MPC system and $4.39 billion for the individual SNF assembly handling system. The increase for the individual SNF assembly handling system is due primarily to Purchaser on-site storage costs ($3.6 billion) and an increase at the MRS facility ($315 million) due to the extended operating life. For the MPC system, the increase in Purchaser on-site storage costs is less pronounced ($2.19 billion), and MRS facility costs also increase less ($300 million) because of lower annual operating costs. The remainder of the cost increase for both systems is due to additional transportation casks required for the life of the program.

MPC Non-Transportability

In the event the MPC is determined to be non-transportable after long-term storage, several remedies are identified and evaluated. These remedies are evaluated for the year 2000, which is the first date that an MPC could be shipped to the MRS facility, and the year 2010, which is the first date that an MPC could be shipped to the MGDS. One remedy that is not time-dependent is listed as "Year N/A" (not applicable) in the table. These remedies and their associated cost increases relative to the basic individual SNF assembly handling system are shown in Table 4.6-2. Some remedies in this section involve hybrids of the MPC system and the individual SNF assembly handling system. For simplicity, all cost comparisons are shown relative to the individual SNF assembly handling system with an MRS.

As can be seen in Table 4.6-2, if the decision is made to abandon the MPC system and revert to the individual SNF assembly handling system in the year 2000, the total cost of the CRWMS would be $30 million greater than the cost of the basic individual SNF assembly handling system. If the decision is made to revert to the individual SNF assembly handling system in 2010, the total cost of the CRWMS would be $810 million greater than the cost of the basic individual SNF assembly handling system. Similarly, if the decision is made in 2000 to redesign the MPC and use transportation casks for SNF assemblies that had originally been stored in MPCs, the total cost of the CRWMS would be $430 million less than the individual SNF assembly handling system. The remainder of the data in Table 4.6-2 can be interpreted in a similar manner. The impact of non-transportability can be dramatically reduced by making a decision sooner regarding MPC transportability after long-term storage.

The evaluation indicates that the lowest-cost remedies are modifying the existing MPC and inspecting and resealing the MPC. If these remedies are determined to be insufficient to overcome the non-transportability problem, higher-cost actions could be taken, such as redesigning the MPC or reverting to the individual SNF assembly handling system.

Table 4.6-2 MPC Non-Transportability Cost Differences
(Millions of 1993 Dollars)

Remedy	Year 2000	Year 2010	Year N/A
Revert to Individual SNF Assembly Handling System	+30	+810	
Redesign MPC:			
Unload Old MPC into New Design	-490	+500	
Unload Old MPC into Transportation Cask	-430	+460	
Modify Existing MPC	-540	-350	
Inspect and Reseal MPC:			
Percent of MPCs			-520
All MPCs			-250

Note:
Table entries show differences in costs between the MPC system and the individual SNF assembly handling system. Negative entries indicate a savings with the MPC system.

MPC Non-Emplaceability

Several remedies are identified and evaluated in the event the MPC is determined to be non-emplaceable. These remedies and their associated cost differences compared to the basic individual SNF assembly handling system are shown in Table 4.6-3. These remedies are evaluated for the years 2001 (MGDS construction license submittal), 2004 (NRC authorization for construction), and 2010 (NRC authorization for operation). The remedy to inspect and reseal MPCs is not time-dependent prior to the commencement of MGDS operation; this is listed as "Before 2010" in the table. Since some remedies are hybrid systems, all cost differences are expressed relative to the individual SNF assembly handling system with an MRS.

The evaluation indicates that the lowest-cost remedy is designing a new triple-purpose MPC, if this could be accomplished early-on without increasing the cost of the MPC itself. The cost associated with this ranges from $330 million less than the individual SNF assembly handling system to convert to a new MPC in 2001 with the same capital cost as the original MPC design, to $1.75 billion more to convert to a new MPC in 2010 that costs 30 percent more than the original MPC design. The next lowest-cost remedy is to revert to the individual SNF assembly handling system at a cost of $240 million more than the individual SNF assembly handling system in 2001, which increases to $970 million more if delayed until 2010.

One contingency also worth considering, in the event MPCs are determined to be non-emplaceable, is a dual-purpose MPC. There are two approaches to this contingency: a hybrid system and a dual-purpose design. With the hybird system, the originally designed MPC would continue to be used for storage and transportation only for those cases where SNF would need to be stored at Purchaser sites or the MRS facility. These MPCs would be discarded after the SNF assemblies are transferred to a separate waste package at the MGDS. All other SNF assemblies would be shipped in single-purpose transportation casks, just as in the individual SNF assembly handling system. This decision to switch to the hybrid system could be made anytime prior to start of MGDS operations in 2010. The cost of the hybrid system is estimated to be $1.15 million more than the cost of the individual SNF assembly handling system. The dual-purpose design approach is similar to the hybird system in that MPCs are used only for storage and transportation; however, a decision is made early on to switch to a less expensive MPC design that only provides this dual-purpose function for shipping and storing all SNF. Depending on the per unit cost savings and the timeframe that the conversion takes place, the overall system cost increase for the dual-purpose design compared to the individual SNF assembly handling system could range from $1.28 billion to $2.19 billion.

Contingency cost impacts can be mitigated by determining MPC emplaceability as soon as possible and then modifying the MPC design, if necessary. Contingency costs could also be reduced by designing the MPC to be opened and resealed. This would require analysis of potential impacts associated with an MPC that can be opened (e.g., potentially increased monitoring and increased cost of the MPC).

Table 4.6-3 MPC Non-Emplaceability Cost Differences
(Millions of 1993 Dollars)

Remedy	Year 2001	Year 2004	Year 2010	Before 2010
Redesign Triple-Purpose MPC:				
Modify Existing MPC	+90	+90	+100	
New MPC Design -				
0 Percent MPC Cost Increase	-330	-50	+490	
15 Percent MPC Cost Increase	+410	+650	+1,120	
30 Percent MPC Cost Increase	+1,150	+1,360	+1,750	
Revert to Individual SNF Assembly Handling System	+240	+480	+970	
Replace with Dual-Purpose MPC:				
Hybrid System				+1,150
Dual-Purpose Design -				
15 Percent MPC Cost Decrease	+2,070	+2,110	+2,190	
30 Percent MPC Cost Decrease	+1,280	+1,360	+1,520	

Note:
Table entries show differences in costs between the MPC system and the individual SNF assembly handling system. Negative entries indicate a savings with the MPC system.

4.6.5 Sensitivity Analyses

Several sensitivity evaluations were performed for specific components of the MPC system design concept. These evaluations are documented in the *Sensitivity Analyses for the Multi-Purpose Canister System Conceptual Design Phase* report, issued in June, 1994. All sensitivity analyses use LCC as a measure of the impact on system operations. Results of these evaluations are described below:

Parametric Analysis of Purchaser Pool Operating Costs

The LCC comparison for the MPC system assumed an annual cost of $4.24 million to maintain a spent fuel pool at a shutdown reactor, based on the report entitled *Cost Estimates of Operating Onsite Spent Fuel Pools After Final Reactor Shutdown*, issued in 1991. A parametric cost analysis was also conducted assuming shutdown reactor annual pool maintenance costs of $8 million, $10.6 million, and $12 million.

These pool maintenance costs were used in analyses of pool storage at shutdown reactors in the individual SNF assembly handling system and pool storage at shutdown "truck" reactors in the MPC system. For comparison purposes, the costs of maintaining the dry storage facilities at shutdown reactors were added. Table 4.6-4 shows the resulting LCC for storage at shutdown reactors in both the individual SNF assembly handling system and the MPC system.

Table 4.6-4 Life Cycle SNF Storage Costs at Shutdown Reactors
(Millions of 1993 Dollars)

Annual Pool Storage Costs	Individual SNF Assembly Handling System	MPC System
$ 4.24 million	4,650	1,800
$8.00 million	9,020	2,770
$10.60 million	12,040	3,450
$12.00 million	14,500	4,000

Because of the much larger volume of pool storage at shutdown reactors in the individual SNF assembly handling system, higher annual pool maintenance costs result in significantly higher life cycle storage costs for the individual SNF assembly handling system than for the MPC system.

Analysis of Not Emptying Purchaser Pools to Dry Storage Following Reactor Shutdown

A total system cost analysis was conducted for the MPC-based CRWMS in which SNF at shutdown reactors would not be removed from the pools and placed in dry storage, but rather would be stored in the pools until it is picked up. At the time of pickup, the SNF would be sealed in MPCs in transportation casks and shipped to the MRS or MGDS. MPCs would continue to be used for dry storage overflow at operating reactors in the MPC system.

The analysis showed that the cost of the "no-unload" MPC case would be identical to that of the basic MPC system in all cost areas except Purchaser on-site storage. All transportation, MRS, and MGDS costs would remain unchanged. Pool overflow storage at operating reactors would be the same for both the basic MPC system and the "no-unload" MPC case. Thus, the cost of operating reactor dry storage would be the same for both cases. At shutdown reactors, the "no-unload" MPC case would be identical to the individual SNF assembly handling system in which the SNF remains in the pools until pickup. The cost of shutdown reactor storage for the "no-unload" MPC case would be the same as for the individual SNF assembly handling system. The impact on MPC system cost of not unloading the pools at shutdown reactors into MPC dry storage was computed based on these observations. Under these conditions, the MPC system would cost approximately $1.37 billion more than the individual SNF assembly handling system.

Analysis of Thinner MPC Shell

A cost estimate was developed for large and small MPCs with shell wall thicknesses less than those developed in the MPC conceptual design. The 0.875" to 1.0" wall thickness of the conceptual design is very robust and may offer opportunities for optimization and cost savings. This estimate included only the material cost for the MPC shell; it was assumed that the fabrication cost of the thinner shell would be identical to that of the thicker shell. The shell material in both cases is stainless steel. Table 4.6-5 shows the dimensions and associated costs for both the thick wall design and the thin wall design.

Table 4.6-5. MPC Shell Material Costs

MPC Configuration	Conceptual Design			Thinner Shell		
	Shell Thickness (in.)	Shell Weight (lb.)	Shell Material Cost	Shell Thickness (in.)	Shell Weight (lb.)	Shell Material Cost
21 PWR	1.000	10,292	$21,800	0.625	6,433	$13,600
40 BWR	1.000	10,292	$21,800	0.625	6,433	$13,600
12 PWR	0.875	7,368	$15,600	0.500	4,210	$8,900
24 BWR	0.875	7,368	$15,600	0.500	4,210	$8,900

The savings in shell material costs were applied to the required quantities of each size MPC to obtain the potential total system cost savings resulting from adopting the thinner shell designs. These savings are shown in Table 4.6-6. As shown in the table, the estimated total system cost savings from using a thin-walled MPC design is approximately $90 million. This small potential cost savings could be offset by fabrication problems with maintaining shell tolerances.

Table 4.6-6. Total LCC Savings For Thinner Shells

MPC Configuration	Quantity	Unit Cost Savings	Total Savings
21 PWR	5,768	$8,200	$47 million
40 BWR	3,333	$8,200	$27 million
12 PWR	698	$6,700	$5 million
24 BWR	1,367	$6,700	$9 million
Total			**$88 million**

Comparison of 21PWR/40BWR Versus 24PWR/52BWR MPC Capacity

An LCC comparison was made between the 21PWR/40BWR MPC and a larger, 24PWR/52BWR alternative MPC to explore the cost sensitivity of increasing the capacity of the large MPC. The study considered both direct and indirect, or operational, costs. Direct cost savings were those associated with the need to fabricate fewer, although more expensive, MPCs. Indirect costs evaluated included overall system cost ramifications resulting from processing fewer, but larger capacity, MPCs. Table 4.6-7 shows the number of large MPCs required under both capacity options. Results indicate that all the major functions (waste acceptance, Purchaser dry storage, transportation, MRS, and MGDS) would experience some degree of operational cost savings due to a reduction in the handling and shipment of MPCs and their associated casks. In addition, fewer transportation and Purchaser dry storage casks would be required in the system, thereby providing a direct cost savings. Table 4.6-8 summarizes the cost savings estimated for increasing the capacity of the large MPC to 24 PWR and 52 BWR SNF assemblies.

Table 4.6-7. Required Quantities of Large MPCs

Configuration	21/40 MPC	24/52 MPC
First MGDS		
Large PWR MPC	4,252	3,726
Large BWR MPC	2,416	1,860
Second MGDS		
Large PWR MPC	1,516	1,329
Large BWR MPC	917	711
Total Large MPCs	**9,101**	**7,626**

Table 4.6-8. Large MPC Increased Capacity Cost Differences
(Millions of 1993 Dollars)

Cost Item	Cost Savings
MPCs	162
Waste Acceptance Equipment & Operations	21
Purchaser Site Dry Storage	105
Transportation	191
MRS & CMF	75
MGDS	214
Total System Savings	**768**

Comparison of Carbon Steel Shield Plug Versus Depleted Uranium Shield Plug

An MPC with a carbon steel shield plug has been proposed as a lower cost alternative to a depleted uranium shield plug. In order to provide shielding equivalent to depleted uranium, the carbon steel shield plug would be approximately 4 inches thicker than the depleted uranium shield plug. Accordingly, for the same MPC outside length, the MPC cavity length would need to be decreased by the same amount. These dimensions and associated costs for each type shield plug are shown in Table 4.6-9.

Table 4.6-9. Shield Plug and Cavity Dimensions and Costs

MPC	Depleted Uranium			Carbon Steel		
	Shield Plug Thickness (in.)	Cavity Length (in.)	Shield Plug Cost	Shield Plug Thickness (in.)	Cavity Length (in.)	Shield Plug Cost
Large PWR	4.750	180.000	$80,000	9.000	175.750	$18,000
Large BWR	4.750	180.000	$80,000	9.000	175.750	$18,000
Small PWR	4.375	180.000	$59,000	9.000	175.375	$13,000
Small BWR	4.375	180.000	$59,000	9.000	175.375	$13,000

In order to calculate potential system cost savings resulting from using a lower cost carbon steel shield plug for most MPCs, an assessment has been made of the lengths of the SNF assemblies that are anticipated to be loaded in each size MPC. The assessment considers whether any assemblies would be too long for the decreased MPC cavity length resulting from the thicker shield plug. This assumes that, if necessary, non-fuel components (NFC) would be removed and shipped separately. The assessment indicates that SNF assemblies contained in a total of 3,445 large MPCs and 406 small MPCs could not be accommodated by the shorter cavity length. It should be noted that South Texas Project SNF will not fit into either the 180" or 175" MPC cavity length, even with non-fuel components removed. Special measures will be developed to accommodate the South Texas SNF.

Total potential savings resulting from using carbon steel shield plugs are calculated by multiplying the shield plug unit cost difference by the total number of large and small MPCs in the system, minus the MPCs that require a longer cavity. Unit cost savings represent the difference between the cost of the depleted uranium and carbon steel shield plugs, which are shown in Table 4.6-10. The estimated total system cost savings of using carbon steel shield plugs in place of depleted uranium shield plugs is approximately $427 million.

Table 4.6-10 Potential Total System Savings Using Carbon Steel Shield Plugs

MPC Configuration	Quantity of MPCs with Carbon Steel Shield Plugs	Unit Cost Savings	Total Cost Savings
Large MPC	5,656	$62,000	$351 million
Small MPC	1,659	$46,000	$76 million
Total Savings			**$427 million**

Chapter 5

ALTERNATIVE CONTAINER SYSTEMS

Several alternative systems were evaluated for handling, storing, and transporting SNF assemblies in the CRWMS. A TSC system and a MPU system were evaluated and compared to the MPC system and the individual SNF assembly handling system. These evaluations were performed for generic designs of the alternative container systems. The purpose of these evaluations was to provide information to support DOE in making a decision on the most appropriate alternative to implement throughout the CRWMS.

This section includes discussions of the TSC system and the MPU system alternatives. Brief descriptions and operational concepts are provided for each alternative. A comparison of the alternatives with the MPC system and the individual SNF assembly handling system is also provided.

5.1 TRANSPORTABLE STORAGE CASK SYSTEM

The TSC system is an alternative system for SNF handling in which SNF assemblies are sealed in a dual-purpose cask or canister that is optimized for storage and transportation. A separate container is needed for SNF disposal at the MGDS. There are two types of TSCs: one that utilizes a cask with an integral basket, referred to here as a TSC metal cask system; and another that utilizes a canister system that is inserted into a dual-purpose cask for transportation and storage, referred to here as a TSC canister system. The following sections describe the TSC metal cask system and the TSC canister system.

5.1.1 TSC Metal Cask System

This section provides a summary description of the operational and design characteristics of the TSC metal cask system. Information presented in this section is summarized from the *Evaluation of Alternative Cask/Canister Systems* report in Volume V of the MPC System CDR.

The TSC metal cask system includes a cask with an inner basket that maintains the SNF geometry and provides criticality control during storage and transportation operations. The basket is an integral part of the TSC metal cask. As a dual-purpose cask, the TSC metal cask serves as a transportation cask certified to 10 CFR Part 71 and as a storage cask certified to 10 CFR Part 72. This system utilizes a separate, large waste package for repository disposal of SNF; the TSC is not used in the disposal phase. Two bolted lids are used for closure of the TSC metal cask, which allows for retrieval of the SNF assemblies for transfer to a waste package. Figure 5.1-1 illustrates the conceptual use of a TSC metal cask system.

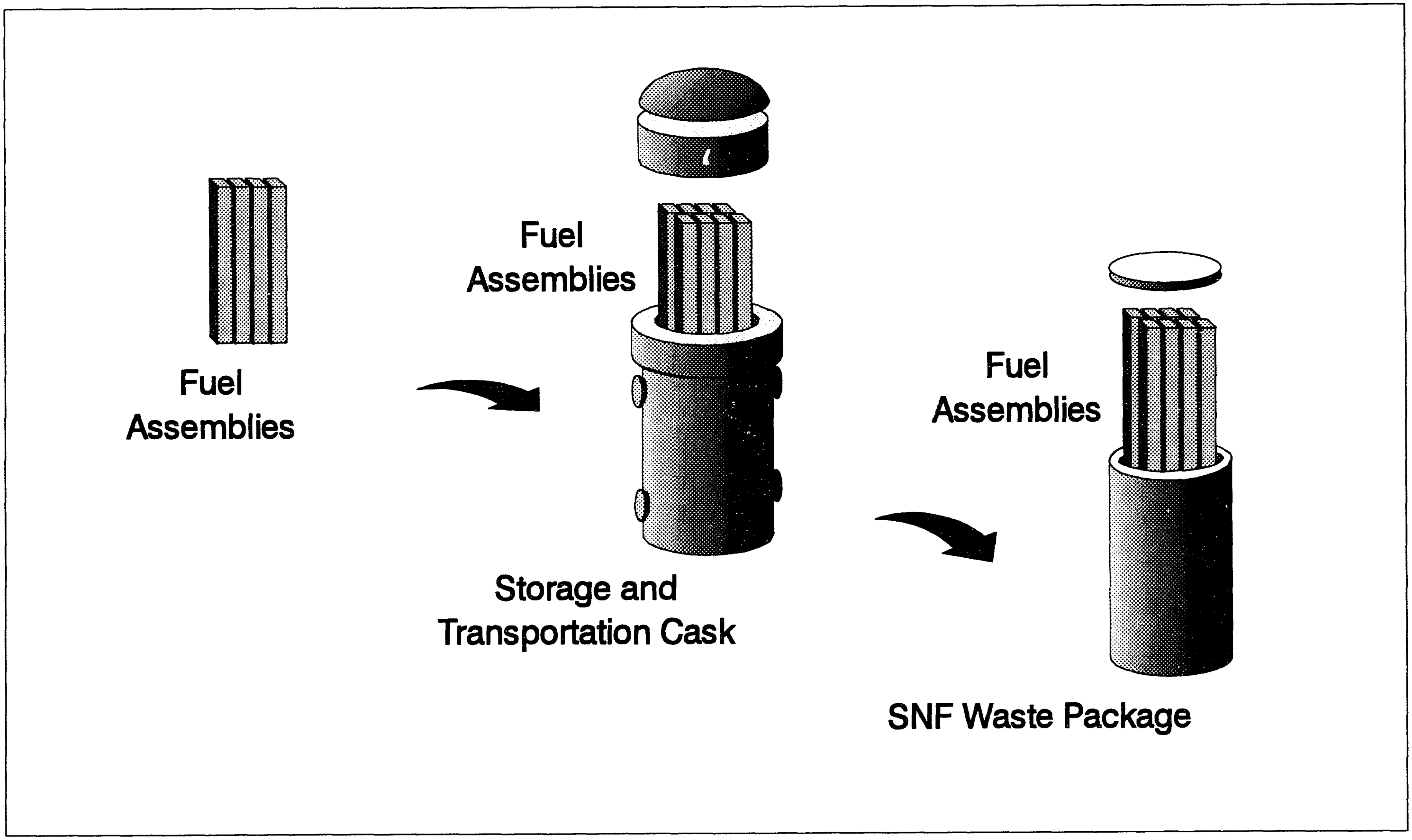

Figure 5.1-1 TSC Metal Cask System

Conceptual designs have been developed for two sizes of TSC metal casks, a 100-ton cask and a 75-ton cask, to better accommodate Purchaser site handling capabilities. These sizes were selected to provide the same handling capability among facilities as provided by the MPC system, and therefore provide the same basis of comparison. The large TSC is limited to 100 tons because the basket is not removable, and use of a heavier TSC would limit the number of Purchaser facilities that could accommodate the large cask. Each size TSC metal cask can accommodate either PWR or BWR SNF assemblies. The capacities of each of these configurations are shown in Table 5.1-1, and are the same as those for the MPC system. Figures 5.1-2 through 5.1-5 provide design details for each size TSC metal cask.

Table 5.1-1 TSC Metal Cask Configuration Capacities

TSC Metal Cask Size	SNF Assembly Capacity (No. of Assemblies)	
	PWR Fuel	BWR Fuel
100-ton cask	21	40
75-ton cask	12	24

In the TSC metal cask system alternative, Purchasers that require additional storage capacity and that have the capability to handle large casks load SNF assemblies into TSC metal casks for on-site dry storage. This allows Purchaser facilities that can accommodate TSC metal casks the option to unload their spent fuel pools into ISFSI storage and decommission their pools. Purchaser facilities requiring additional storage that cannot accommodate either size TSC metal cask utilize a non-transportable storage mode for ISFSI storage. For these facilities, the non-transportable storage modes must be returned to the spent fuel pools to transfer the SNF assemblies into LWT casks for acceptance into the CRWMS. Therefore, the spent fuel pools for these sites must remain operational until all SNF is removed from ISFSI storage.

At the time of waste acceptance into the CRWMS, SNF assemblies are loaded into TSC metal casks in the spent fuel pools of those Purchaser facilities that can accommodate them. The TSC metal casks are then shipped to the MRS facility by rail, where the casks are either placed on a storage pad or placed on a train for shipment to the MGDS. Purchaser facilities that cannot handle TSC metal casks ship individual SNF assemblies in LWT casks to the MRS facility, where the SNF assemblies are then transferred to large TSC metal casks and placed in storage or shipped to the MGDS by rail.

At the MGDS, all TSC metal casks are taken to a transfer facility where they are opened and the SNF assemblies are transferred to large waste packages. After proper closure, the waste packages are emplaced in the underground repository. The first MGDS receives only TSC metal casks by rail from the MRS facility. The second MGDS receives LWT casks by truck and TSC metal casks by rail directly from Purchaser sites. Empty TSC metal casks can be reused for transporting additional SNF assemblies to the MGDS.

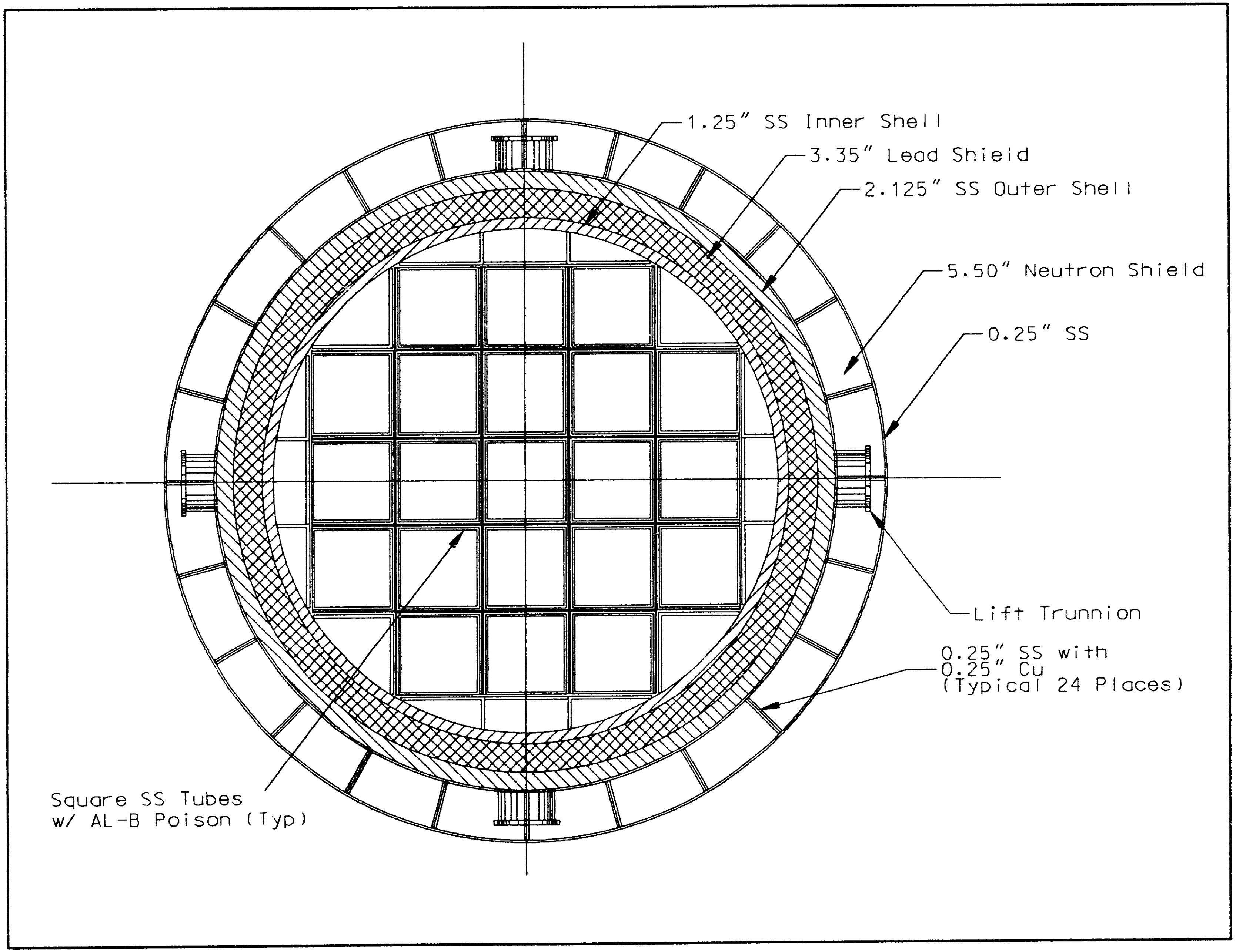

Figure 5.1-2 100-Ton TSC Metal Cask For 21 PWR Fuel Assemblies (End Section View)

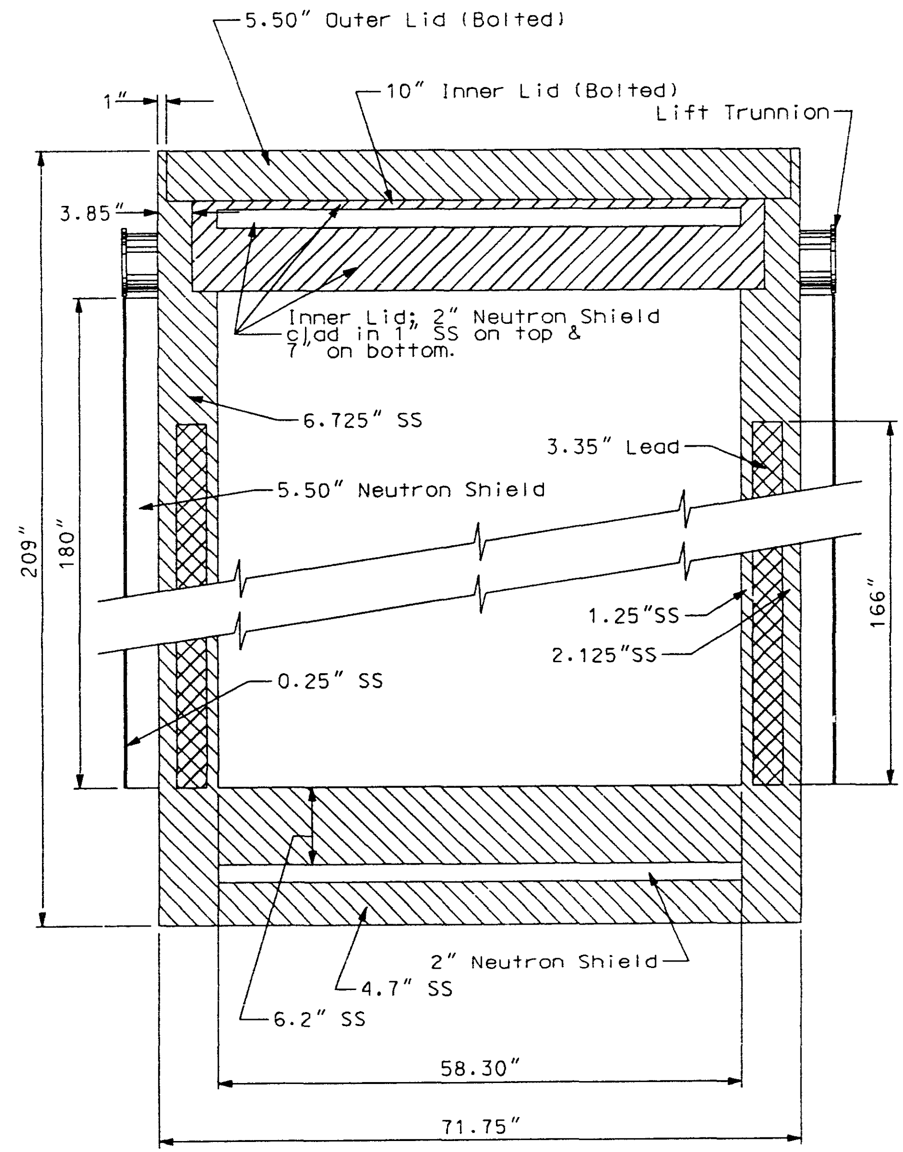

Figure 5.1-3 100-Ton TSC Metal Cask (Side Section View)

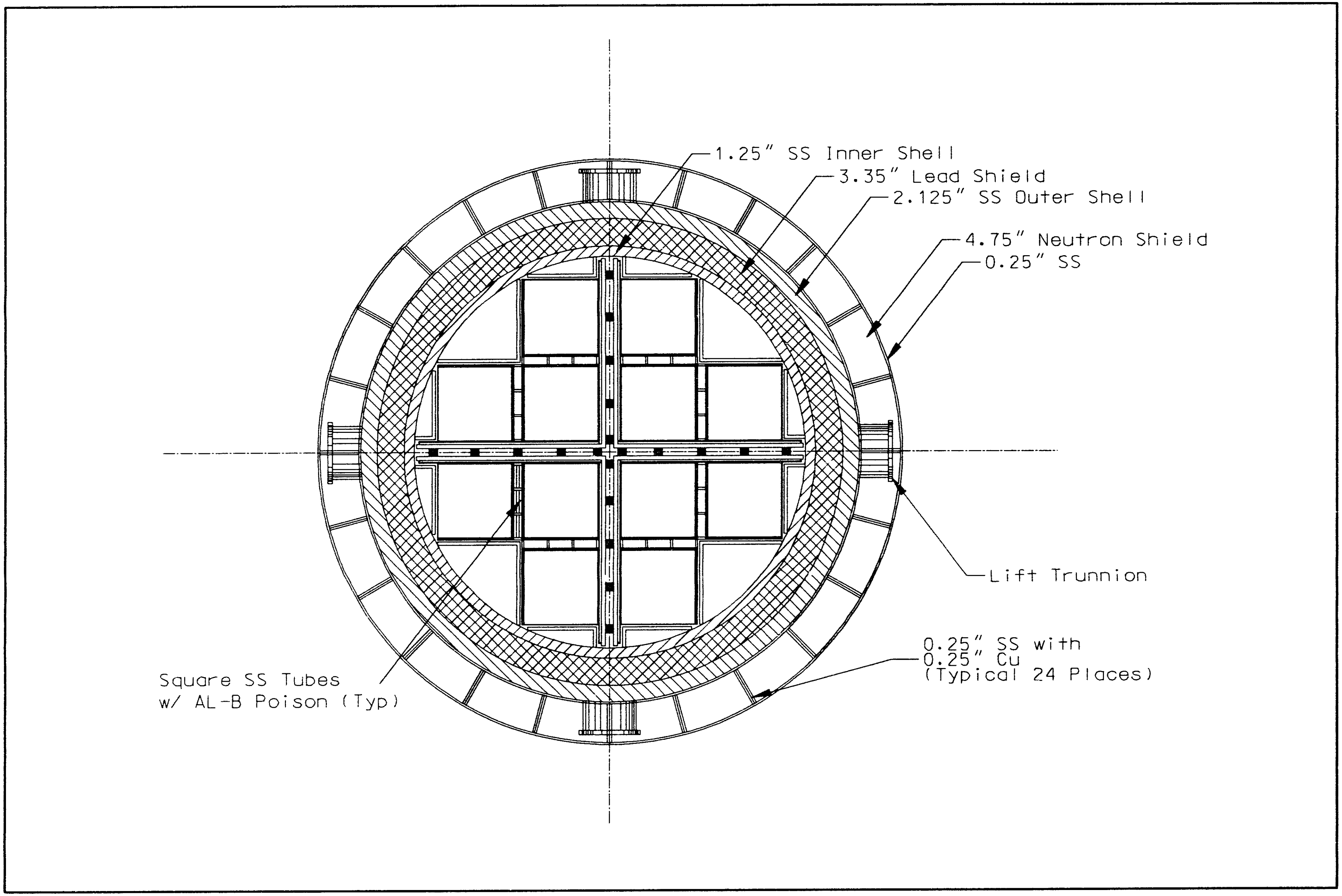

Figure 5.1-4 75-Ton TSC Metal Cask For 12 PWR Fuel Assemblies (End Section View)

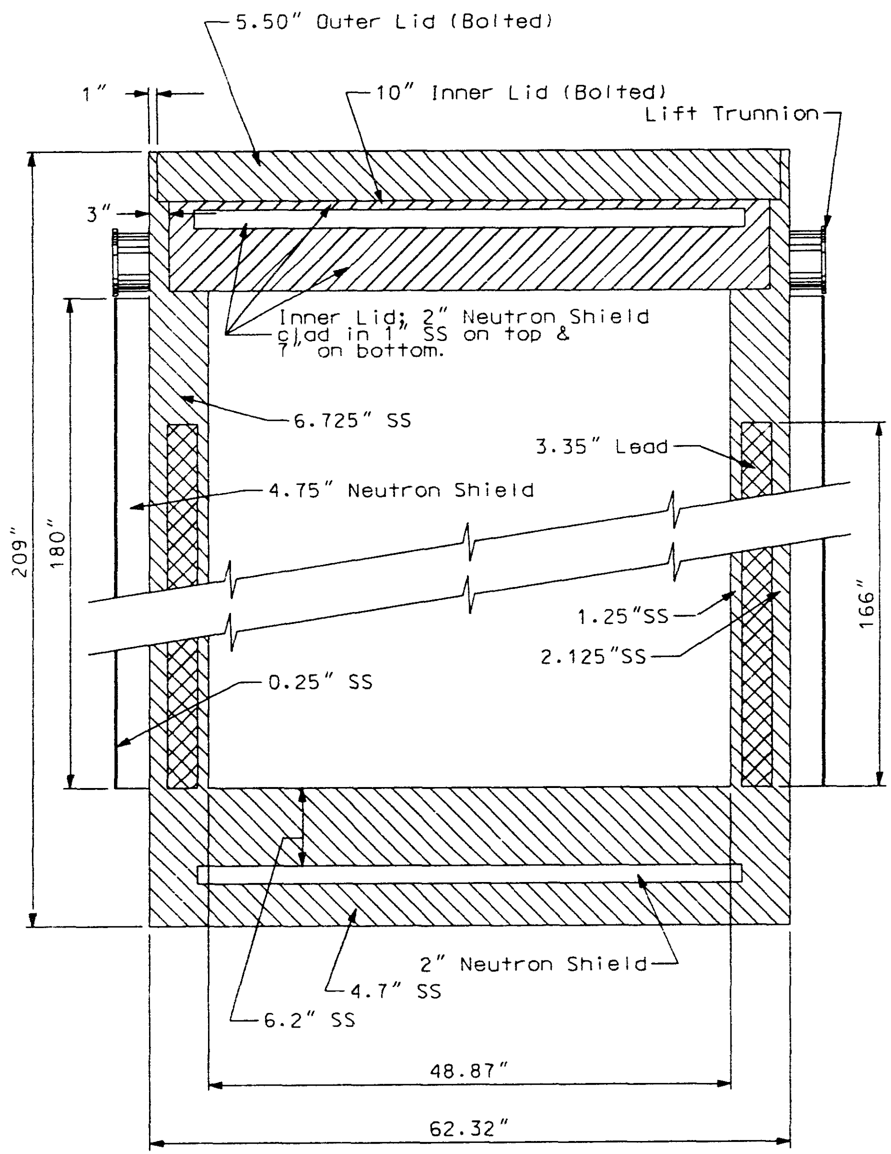

Figure 5.1-5 75-Ton TSC Metal Cask (Side Section View)

Purchaser facility modal capabilities for the TSC metal cask system alternative are based on some Purchaser facility modifications, administrative upgrades, and use of heavy-haul and barge. Of the 121 Purchaser facilities, 88 facilities are assumed to accommodate the large TSC metal cask, 14 facilities are assumed to accommodate the small TSC metal cask, and 19 facilities are assumed to use truck transportation casks.

An example of a commercial application of the TSC metal cask system is provided by Nuclear Assurance Corporation's Storable Transport Cask (NAC-STC) design. Information on this design is available from the NAC-STC Safety Analysis Report, Docket No. 71-9235, Revision 2, dated July 1993. The NAC-STC design includes two bolted lids with O-ring seals. It can hold 26 PWR SNF assemblies, and is somewhat shorter than the MPC conceptual design. The NAC-STC cask is designed to accommodate 6.5-year old SNF assemblies with an enrichment of 4.2 weight percent at 40,000 MWD/MTU burnup. The shell and shield plug of the NAC-STC cask are fabricated from stainless steel. Borated aluminum neutron absorber panels are used in the cask basket, and a flux trap design provides criticality control. The design does not rely on burnup credit.

5.1.2 TSC Canister System

The TSC canister system is similar to the MPC system except that the TSC canister only serves a dual-purpose function as a storage and transportation canister, rather than a triple-purpose function like the MPC. With regard to function and design, the TSC canister is very similar to the TSC metal cask, except that the inner canister in this system is separate from the storage and transportation overpack. Figure 5.1-6 illustrates the conceptual use of a TSC canister system. Because of its close similarities to these other systems, the TSC canister system has not yet been examined in detail. Studies are ongoing to develop more detailed estimates of canister capacities, cask weights, and LCC evaluations for the TSC canister system.

The TSC canister system includes an inner canister with a basket that maintains the SNF geometry and provides criticality control during storage and transportation operations. Two welded lids are provided to seal the canister. The canister is positioned in a storage and transportation overpack. Options are also available to store the canister in a separate storage mode facility, either vertical or horizontal, and later retrieve it into the cask overpack for transportation. This overpack is a metal cask with a bolted lid. As a dual-purpose container design, the TSC canister system is certified to the transportation requirements of 10 CFR Part 71 and the storage requirements of 10 CFR Part 72. A separate, large waste package is used for disposal of the SNF at the repository. Neither the TSC canister nor its overpack is used during the disposal phase.

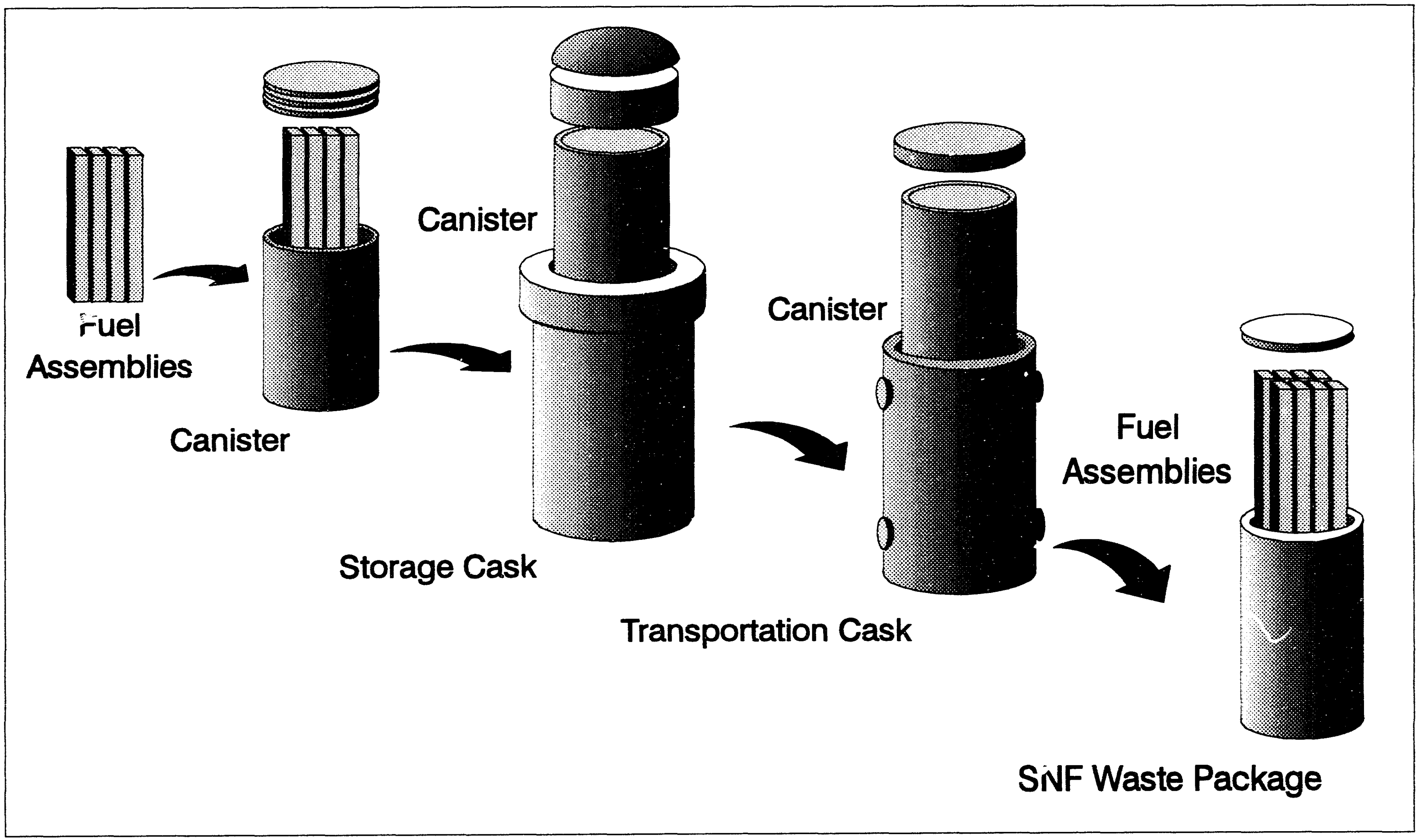

Figure 5.1-6 TSC Canister System

Since the canister can be handled separately from the TSC overpack, the TSC canister can be accommodated at some Purchaser facilities that cannot otherwise handle large casks. A transfer cask can be used to permit loading of the TSC canister in a Purchaser's spent fuel pool and to transfer the canister to the TSC overpack or storage mode outside of the pool. As with the TSC metal cask and MPC systems, Purchaser facilities that can accommodate TSC canisters would have the flexibility to unload their spent fuel pools into canisters in ISFSIs and decommission their pools prior to SNF acceptance into the CRWMS. Purchaser facilities that cannot accommodate TSC canisters must utilize LWT casks and would not be able to decommission their pools prior to SNF acceptance.

Waste acceptance and MRS facility operations for the TSC canister system are very similar to operations described for the MPC system. All shipments of TSC canisters are by rail. At the MGDS, all TSC canisters are taken to a transfer facility where they are opened and the SNF assemblies are transferred to large waste packages. The waste packages are then closed and emplaced in the repository. The TSC canister is not reusable, although the overpack cask could be reused.

Purchaser site modal capabilities for the TSC canister system have not been examined in detail. With the use of transfer casks for handling TSC canisters at sites that cannot accommodate TSC canisters in their respective overpacks, it is expected that the modal capability for the TSC canister system would be close to that described for the MPC system.

An example of a commercial application of the TSC canister system is provided by Pacific Nuclear Systems' Transportable NUHOMS MP-187 design. Information on the MP-187 design is available from the Pacific Nuclear Systems Safety Analysis Report, Docket No. 71-9255, Revision 0, dated September 1993. The MP-187 weighs approximately 117 tons and can hold 24 PWR SNF assemblies. It is somewhat shorter than the MPC conceptual design and is designed to accommodate 8-year old SNF assemblies with an enrichment of 3.43 weight percent at 38,268 MWD/MTU burnup. The shell of the MP-187 canister is fabricated from 0.625-inch thick stainless steel, and the shield plug is carbon steel. A borated aluminum composite is used as the basket material, and a flux trap design provides criticality control. Double seal welds provide sealing of the lids to the canister. The overpack cask in the MP-187 design utilizes layered neutron and gamma shielding materials and a bolted lid with O-ring seals. The canister can be stored horizontally in a separate storage facility and retrieved directly into the overpack cask for transportation.

5.2 MULTI-PURPOSE UNIT SYSTEM

This section provides a summary description of the operational and design characteristics of the MPU system. Information presented in this section is summarized from the *Evaluation of Alternative Cask/Canister Systems* report in Volume V of the MPC System CDR.

The MPU system is an alternative system for SNF handling in which SNF assemblies are placed in a sealed, multi-purpose cask that is optimized for storage, transportation, and disposal. Once the assemblies are placed in the MPU, they do not need to be removed. As with the MPC system, the MPU system alternative reduces to the maximum extent possible the handling of individual SNF assemblies in the CRWMS.

The MPU system includes a cask with an inner sealed canister, similar to an MPC. The canister maintains the SNF geometry, provides criticality control, and provides SNF containment. Except for some cases during loading, this inner canister is always contained in the cask, which provides shielding and impact resistance. The MPU is used for transportation, storage, and disposal (after permanent sealing). As such, the MPU is a triple-purpose cask that is certified to the requirements of 10 CFR Part 71 for transportation, 10 CFR Part 72 for storage, and 10 CFR Part 60 for disposal. Two welded lids are used to seal the inner canister of the MPU, and a bolted lid is placed on the outer cask during the storage and transportation phases. Figure 5.2-1 illustrates a generic design for the MPU system cask.

Conceptual designs have been developed for two sizes of MPUs, a 125-ton MPU and a 90-ton MPU, to better accommodate Purchaser site cask handling capabilities. These sizes were selected to provide the same handling capability among facilities as provided by the MPC system and, therefore, the same basis of comparison. Each size MPU can accommodate either PWR or BWR SNF assemblies. The use of alternate transfer systems provides four additional configurations. The capacities of each of these configurations are shown in Table 5.2-1. Figures 5.2-2 through 5.2-7 provide design details for each size MPU cask.

Table 5.2-1 MPU Configuration Capacities

MPU Size	SNF Assembly Capacity (No. of Assemblies)	
	PWR Fuel	BWR Fuel
125-ton MPU	21	40
100-ton Transfer Cask for 125-ton MPUs	21	40
90-ton MPU	12	24
75-ton Transfer Cask for 90-ton MPUs	12	24

In the MPU system alternative design concept, Purchaser facilities that require additional storage capacity and that can handle large casks load SNF assemblies into MPUs for on-site dry storage. This allows Purchaser facilities that can accommodate MPUs the option to unload their spent fuel pools into ISFSI storage and decommission their pools. Purchaser facilities requiring additional storage that cannot accommodate either size MPU use a non-transportable storage cask for ISFSI storage. The non-transportable storage casks must be returned to the spent fuel pools to transfer the SNF into LWT casks for acceptance into the CRWMS.

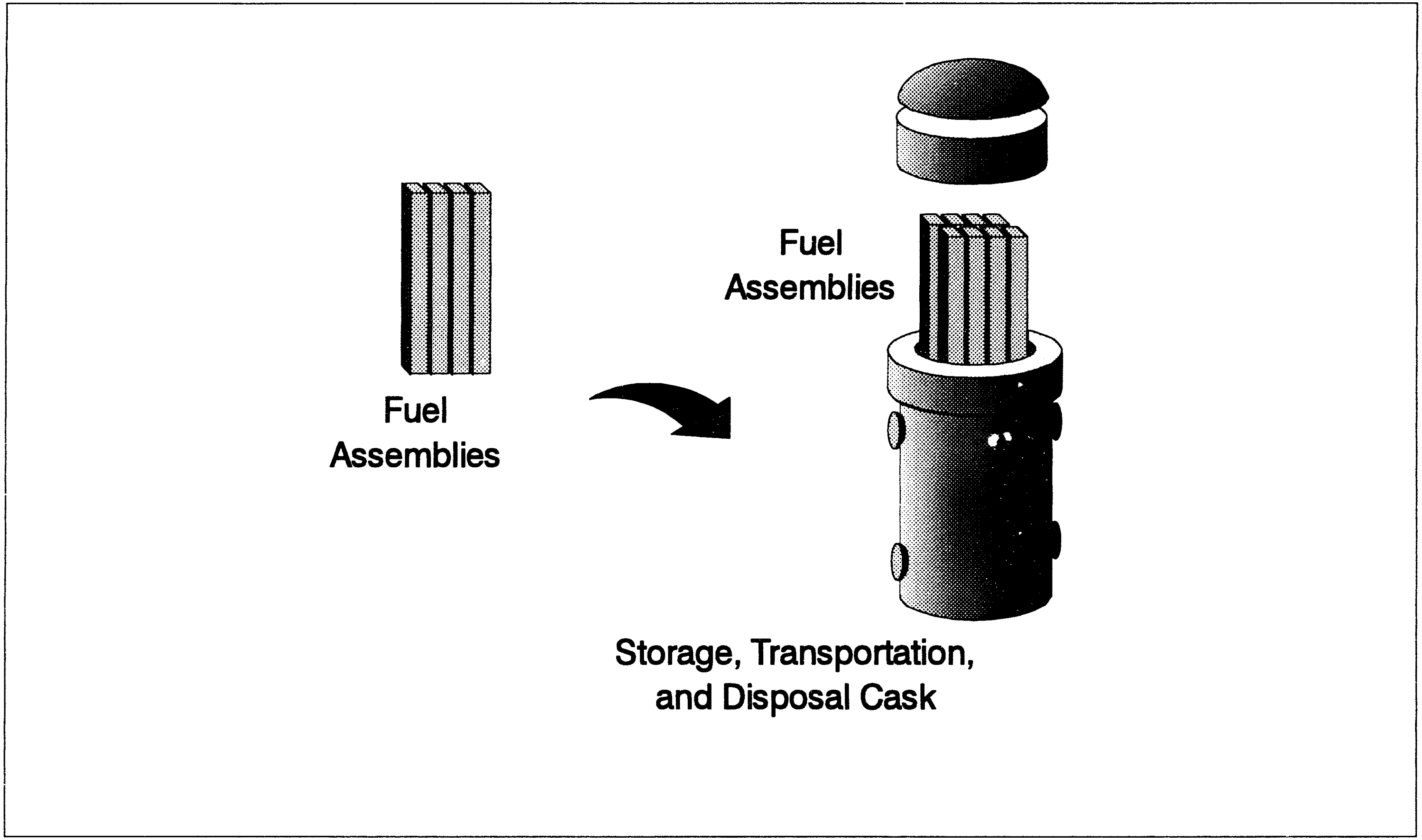

Figure 5.2-1 MPU System

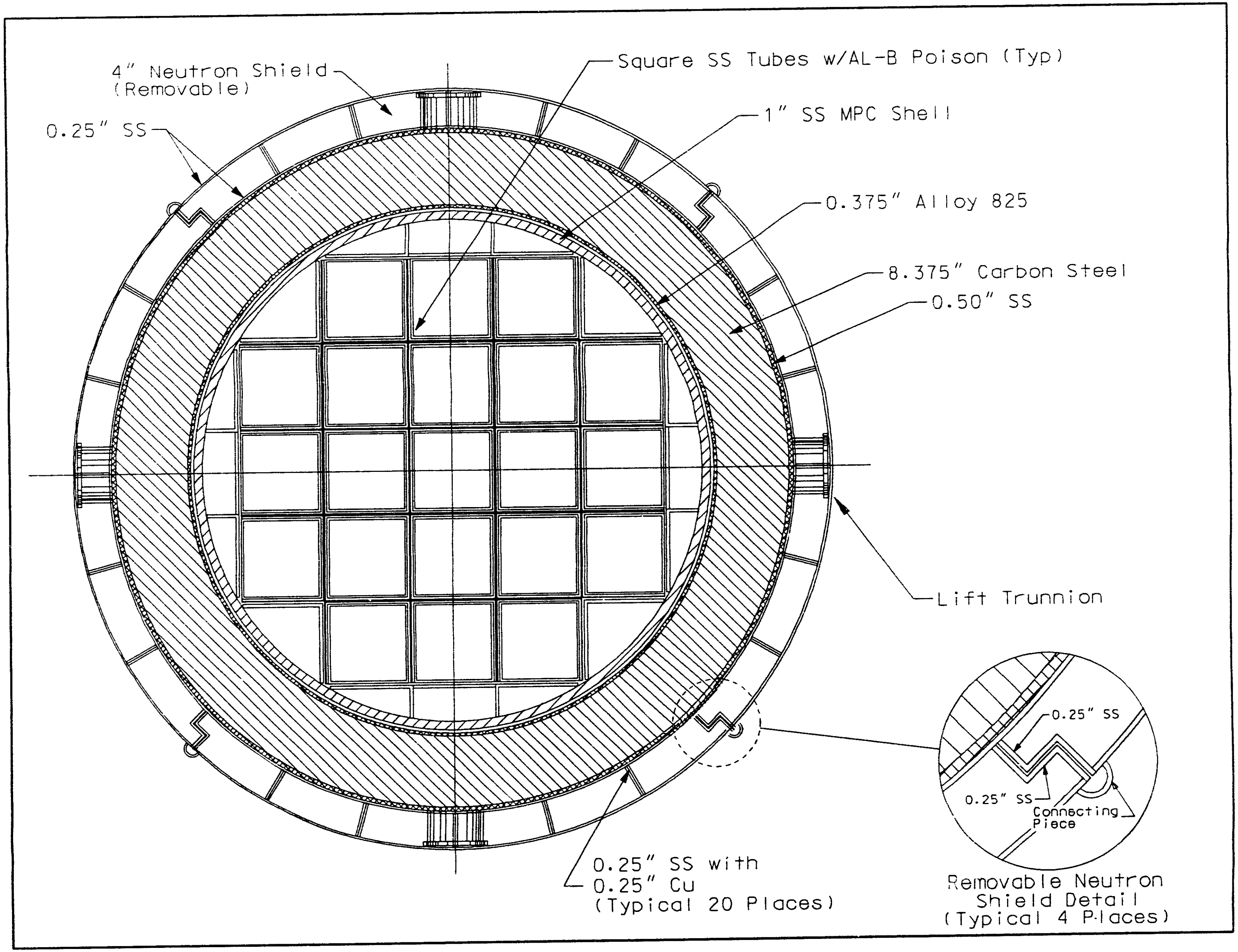

Figure 5.2-2 125-Ton MPU For 21 PWR Fuel Assemblies (End Section View)

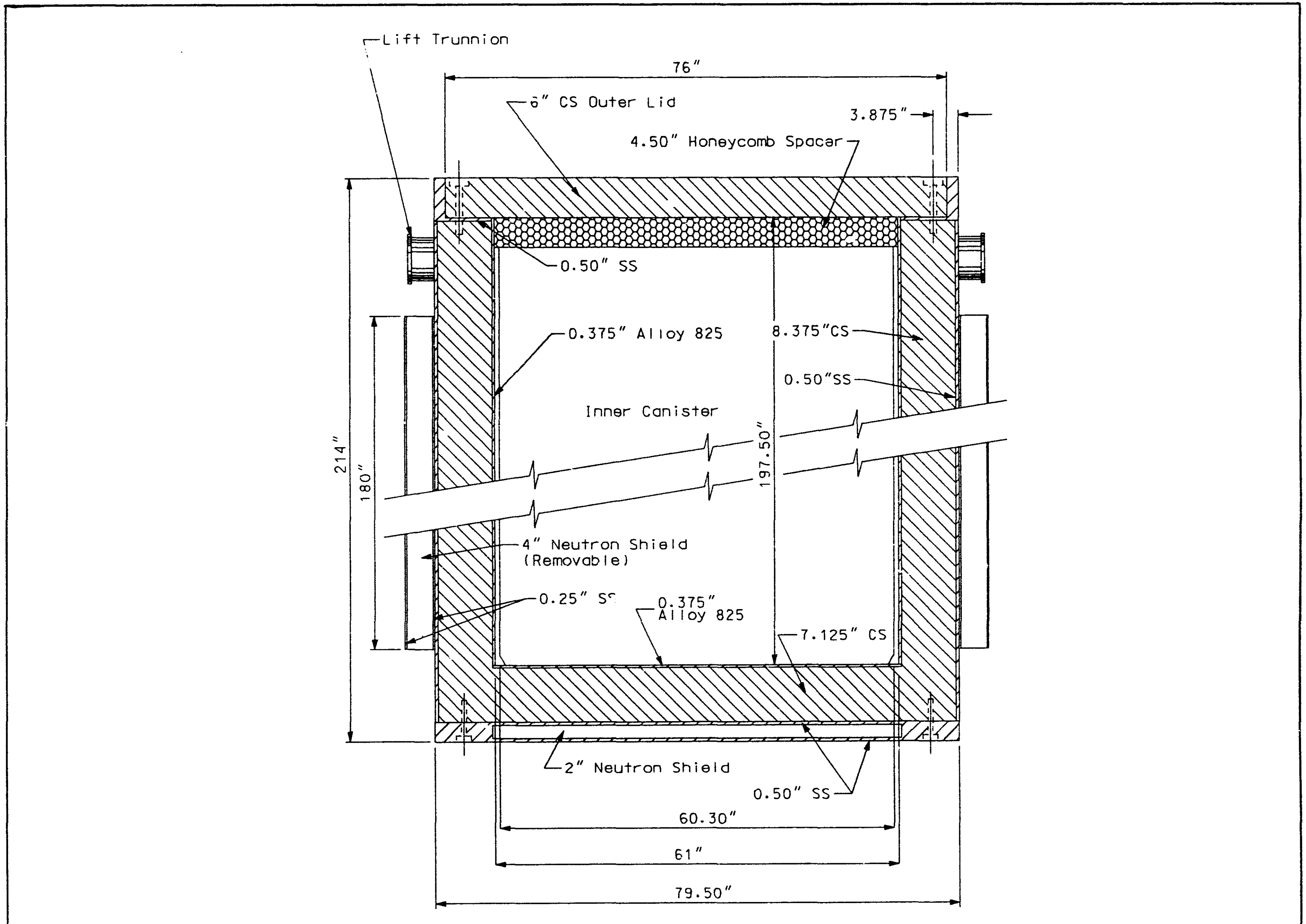

Figure 5.2-3 125-Ton MPU Outer Body (Side Section View)

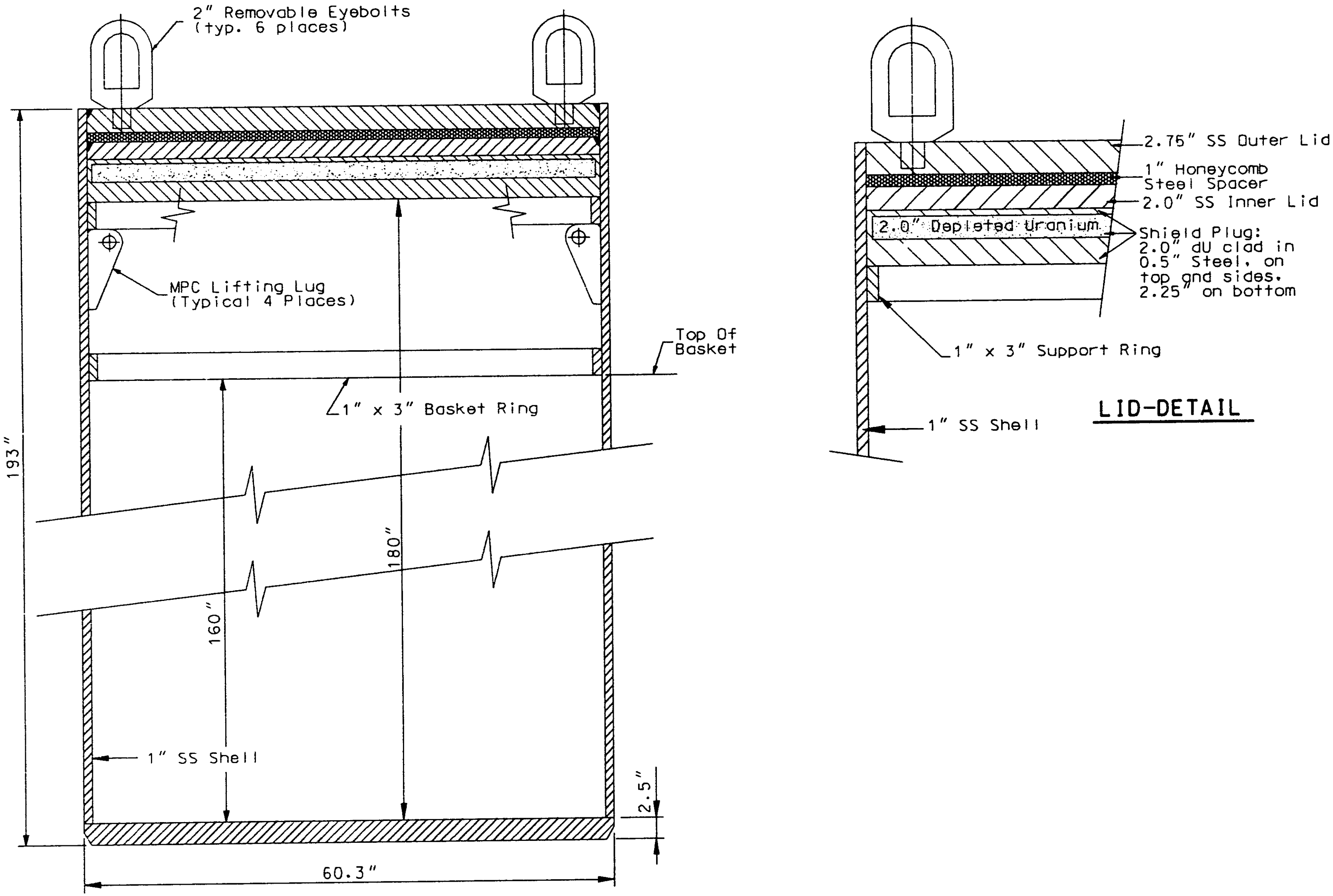

Figure 5.2-4 125-Ton MPU Inner Canister (Side Section View)

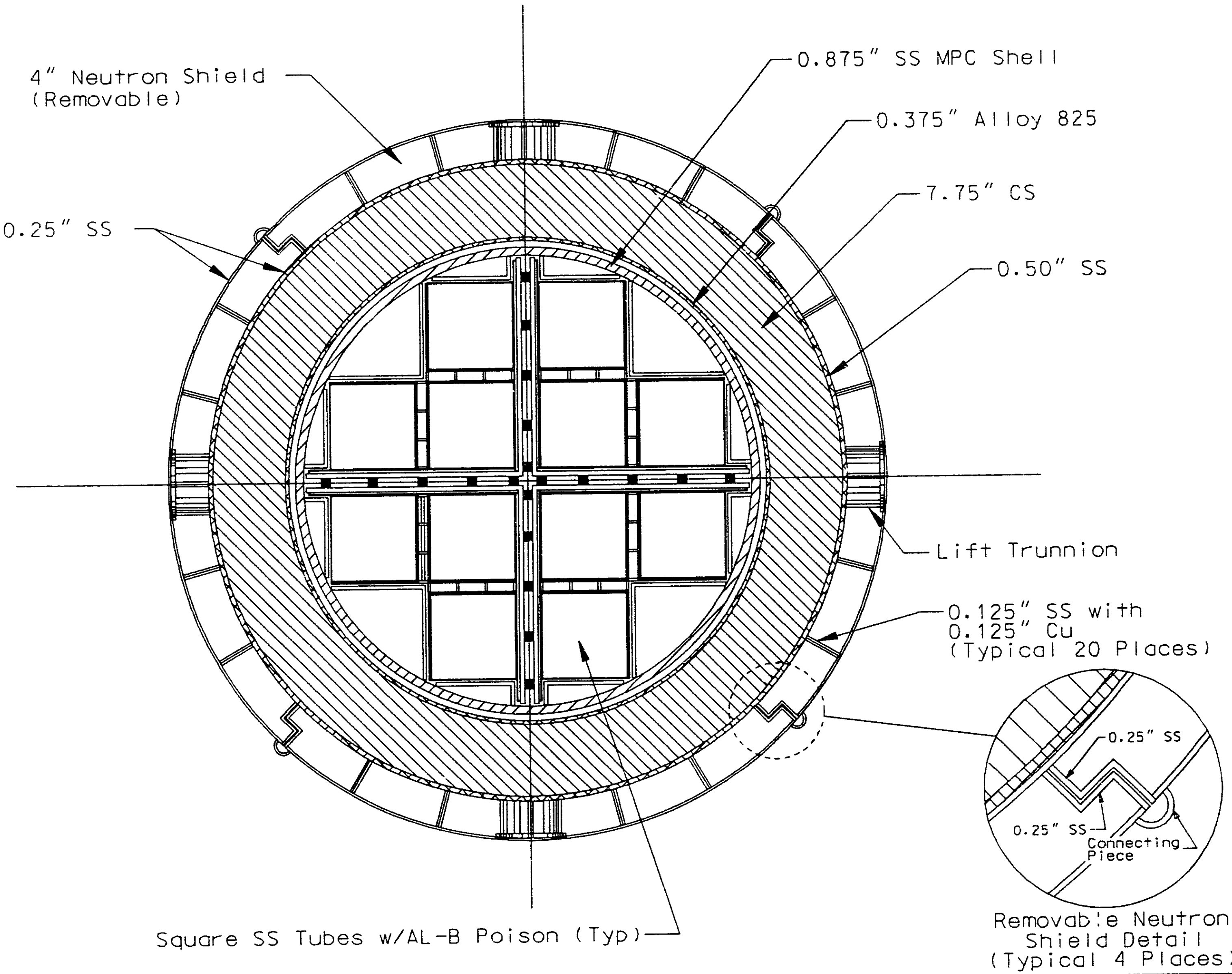

Figure 5.2-5 90-Ton MPU For 12 PWR Fuel Assemblies (End Section View)

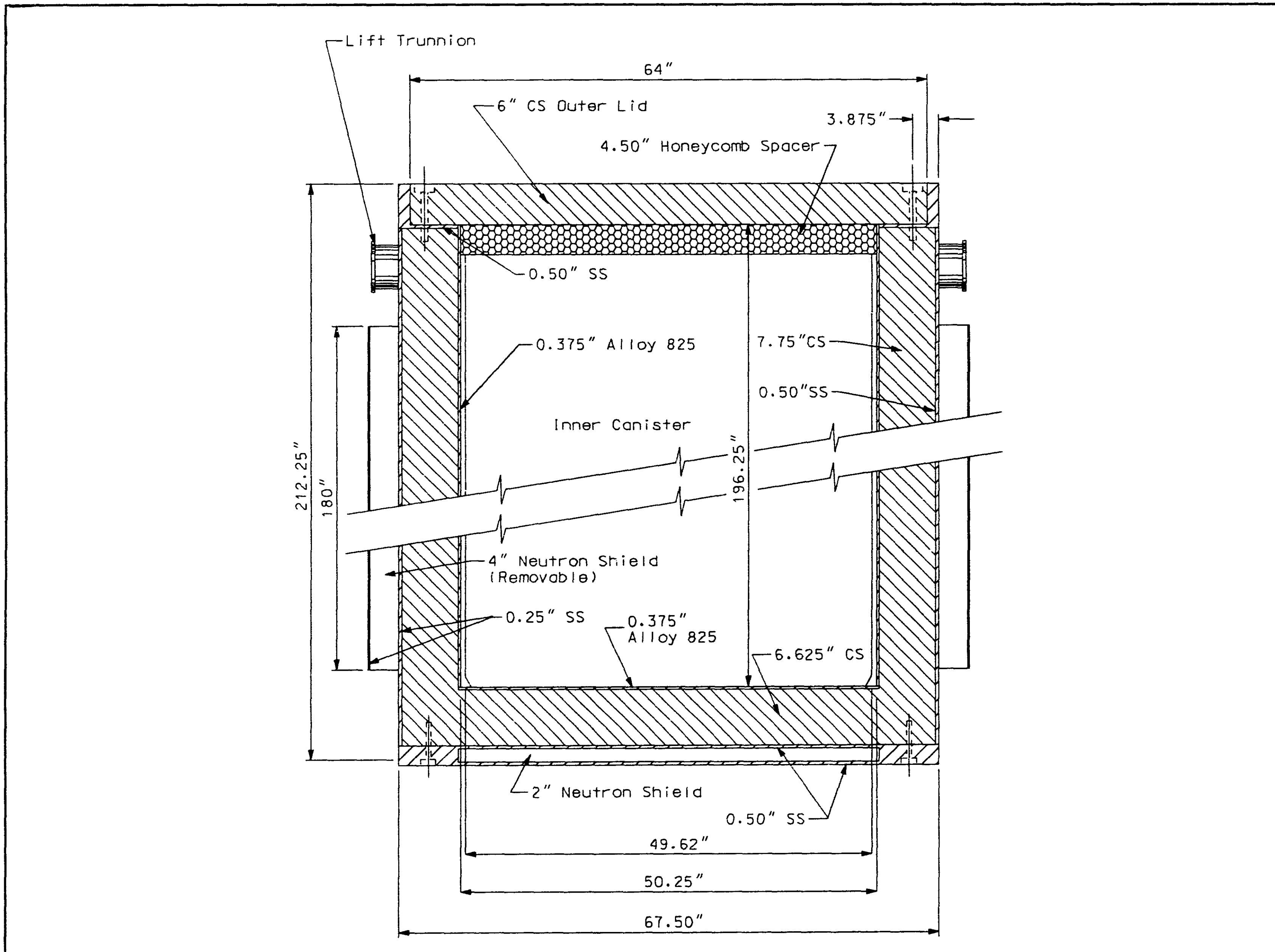

Figure 5.2-6 90-Ton MPU Outer Body (Side Section View)

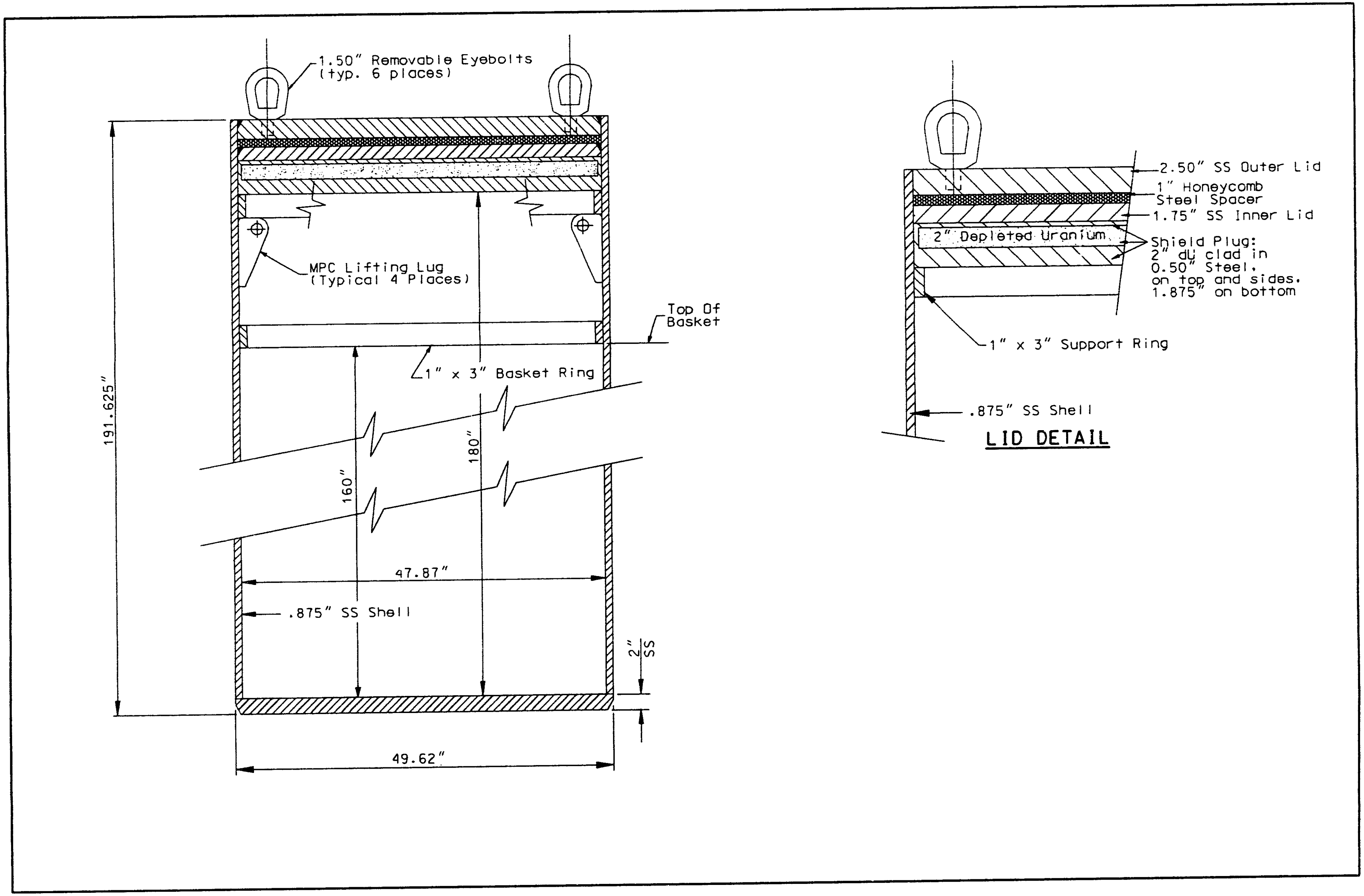

Figure 5.2-7 90-Ton MPU Inner Canister (Side Section View)

At the time of waste acceptance into the CRWMS, SNF assemblies are loaded into MPUs in the spent fuel pools of those Purchaser facilities that can handle MPUs. A removable neutron shield is attached to the MPU prior to shipment to provide the necessary shielding required during transportation. The MPUs are then shipped to the MRS facility by rail, where the MPUs are either placed on concrete storage pads or placed on a train for shipment to the MGDS. The neutron shield is removed once the MPU arrives at the MRS facility or the MGDS.

At some Purchaser facilities, crane capacities do not allow the use of the 125-ton MPU, but a 100-ton transfer cask similar to that used in the MPC system can be accommodated. For these facilities, the inner canister of the MPU is placed inside the transfer cask for loading with SNF assemblies in the spent fuel pool. After loading and closing the inner canister, the canister is transferred to the MPU outer cask outside of the pool. Similarly, a 75-ton transfer cask is provided to load 90-ton MPUs at Purchaser facilities that could not otherwise accommodate the 90-ton MPU. Purchaser facilities that cannot handle MPUs, even with a transfer cask, ship SNF in LWT casks to the MRS facility, where the SNF assemblies are transferred to MPUs for storage or shipment to the MGDS by rail.

At the MGDS, the neutron shield and bolted lid are removed from the outer cask of the MPU, and a thin, corrosion resistant lid is welded to the inner liner of each cask. A thick carbon steel lid is then welded to each cask to provide corrosion allowance protection and to form the final waste package. The waste packages are then emplaced in the underground repository. The first MGDS receives only MPUs by rail from the MRS facility, and the second MGDS receives both MPUs by rail and LWT casks by truck directly from Purchaser sites.

Purchaser facility modal capabilities for the MPU system alternative are based on some Purchaser facility modifications, administrative upgrades, use of heavy-haul and barge, and use of the 100-ton and 75-ton transfer casks. Of 121 Purchaser facilities, 88 facilities are assumed to accommodate large MPUs, 14 facilities are assumed to accommodate small MPUs, and 19 facilities are assumed to use truck transportation casks.

5.3 COMPARISON OF ALTERNATIVE SYSTEMS

Comparisons of the TSC and MPU alternatives with the MPC system and the individual SNF assembly handling system are provided in this section. Information presented for the TSC alternative is for the TSC metal cask system. Comparisons among the various alternatives are made with regard to container capacities, modal capabilities, health and safety aspects, and costs. Information presented here is a summary of data contained in the *Evaluations of Alternative Cask/Canister Systems* report presented in Volume V of the MPC System CDR. Additional information has been produced since that report was published to augment comparison among the alternatives.

5.3.1 Container Capacities and Modal Capabilities

Table 5.3-1 shows the capacities and weights of the containers used in each of the alternatives. Large and small configurations for PWR and BWR SNF assemblies are provided for each alternative. Capacities of MESCs used at Purchaser sites are not shown in this table, since they are dependent on Purchaser decisions.

Table 5.3-1 Container Capacities
(Number of SNF Assemblies)

Container Configuration	TSC System	MPU System	MPC System	Individual SNF Assembly Handling System
Large	21 PWR 40 BWR (100 ton)	21 PWR 40 BWR (125 ton)	21 PWR 40 BWR (125 ton)	21 PWR 37 BWR (100 ton)
Small	12 PWR 24 BWR (75 ton)	12 PWR 24 BWR (90 ton)	12 PWR 24 BWR (75 ton)	12 PWR 24 BWR (75 ton)
Truck	4 PWR 9 BWR (25 ton)	4 PWR 9 BWR (25 ton)	4 PWR 9 BWR (25 ton)	4 PWR 9 BWR (25 ton)

5.3.2 Health and Safety

Table 5.3-2 summarizes total system health and safety impacts for each alternative resulting from both radiological and non-radiological routine activities and incidents. The basis for the information presented is similar to that described in Section 4.1.1. Values presented are a summary of data contained in the *Health and Safety Impacts Analysis for the Multipurpose Canister System and Alternatives* report, issued June 15, 1994.

Table 5.3-2 Health and Safety Radiological Impacts of Alternatives With an MRS
(Total Program Exposures in Person-Rem)

System Impact Area	TSC System	MPU System	MPC System	Individual SNF Assembly Handling System
Radiological Routine				
· Facilities	43,820	53,920	56,980	42,080
· Transportation[a]	1,450	1,450	1,450	1,450
Radiological Incident				
· Facilities[b]	0.08	0.04	0.04	0.1
· Transportation[a]	430	430	430	430

Notes:
a) Values shown are for all truck, rail, barge, and heavy-haul.
b) Systems approximately the same, within regulatory limits.

As shown in the table, all health and safety impacts are equivalent for the four systems evaluated, with the exception of at-facility routine radiological exposures. (Differences in radiological incident exposures are not significant). Routine radiological exposures result in 99 percent of all exposures, with incidents contributing only about 1 percent for any of the alternatives evaluated.

5.3.3 Costs

Costs have been generated for the TSC system and MPU system alternatives based on evaluation of the designs using cost data consistent with that used in the *Life Cycle Cost Comparison for the Multi-Purpose Canister System*, issued December 10, 1993. Using this data, facility, equipment, and operating costs associated with the CRWMS elements have been developed based on the concept of operations previously described for the alternative concepts. Adjustments are made for operational differences of the TSC and MPU systems. Costs associated with the disposal of HLW are not considered in this comparative analysis since HLW would be handled identically in all the concepts. The relative total system LCC for the TSC system and MPU system alternatives, as well as the costs for the MPC system, are compared to the individual SNF assembly handling system in Table 5.3-3.

Though not evaluated in detail, it is expected that TSC and MPU systems without an MRS would result in a small additional savings, similar to the results presented in Section 4.2 for the MPC system.

Table 5.3-3 Total System Life Cycle Cost Differences for Alternatives
(Millions of 1993 Dollars)

Cost Item	**TSC System**	**MPU System**	**MPC System**
CRWMS			
Multi-purpose Cask/Canisters	+ 8,180	+ 12,600	+ 5,074
Waste Acceptance Equipment	0	+ 31	+ 27
Transportation	- 2	- 513	- 229
MRS/CMF	- 885	- 938	- 370
First/Second MGDS	0	- 5,030	- 3,002
Total cost difference for CRWMS	**+ 7,293**	**+ 6,150**	**+1,500**
Purchasers			
Waste Acceptance Operations	- 3	+ 101	+ 94
Purchaser Site Storage	- 2,990	- 3,010	- 2,144
Total cost difference for Purchasers	**- 2,993**	**- 2,909**	**-2,050**
Total system cost difference	**+ 4,300**	**+ 3,241**	**- 550**

Note:
Table entries show differences in costs between each alternative system and the individual SNF assembly handling system. Negative entries indicate a savings with the alternative system.

5.3.4 Alternative System Comparison Conclusions

The MPC system offers the lowest cost alternative compared to the TSC system and MPU system alternatives and the individual SNF assembly handling system. (Refer to Section 4.2 for further discussion of cost comparisons for the MPC system and the individual SNF assembly handling system.) Though the TSC and MPU systems are more costly, they are technically feasible alternatives. Table 5.3-3 shows that the TSC system is the most costly alternative. This conclusion is a direct result of assuming that SNF assemblies stored in the pools at shutdown reactors are transferred to TSCs within five years after Purchaser facility final SNF discharge. If the assumption were changed to allow the SNF to remain in the pools at shutdown reactors until CRWMS acceptance, the cost of the TSC system would be about $1.5 billion lower. This would make the TSC system less costly than the MPU system, but still more expensive than the MPC system and the individual SNF assembly handling system.

The TSC system may offer a cask certified for use by the NRC at an earlier date than the MPC or MPU systems, because, as previously discussed, several commercial TSC designs are already being developed. In addition, the TSC and other dual-purpose container designs are independent of waste package design. For these reasons, the TSC and other dual-purpose concepts could offer contingency options for early CRWMS operation.

The TSC system and MPU system alternatives, like the MPC system, do not rely on routine handling of individual, uncanistered SNF assemblies throughout the CRWMS. As with the MPC system, the TSC or MPU system alternatives can provide an option for Purchaser site storage, in the event that MRS facility negotiated siting is delayed further .

Chapter 6

MULTI-PURPOSE CANISTER SYSTEM IMPLEMENTATION PLAN

Since the decision in February 1994 to proceed with design and certification of the MPC system, expedited work activities have begun to ensure the MPC and its associated components and facilities can be licensed, procured, fabricated, tested, and placed into service on schedule. This section describes DOE's plans for implementing the MPC system throughout all elements of the CRWMS and with interfacing Purchasers. These plans include: methods for completing design, fabrication, and construction of the various parts of the MPC system; plans for procuring portions of the MPC system; and schedule estimates for MPC system implementation.

6.1 MPC SYSTEM DESIGN IMPLEMENTATION

An overall strategy has been developed to successfully implement the MPC system throughout the various CRWMS elements and to ensure an operating system is provided that meets required demands. This strategy has been developed to manage design of the overall MPC-based CRWMS and to control the acquisition of key elements of the MPC system design. Tasks are included to develop the various CRWMS elements through design, procurement, NRC certification, fabrication, construction, deployment, and start of operations. Integral with this strategy are methods for ensuring satisfaction of federal, state, and local requirements and Purchaser needs. These include putting mechanisms into place to satisfy requirements for ensuring safety, adherence to environmental laws and objectives, conformance with performance goals, acceptable cost, conformance with established schedules, and compliance with Purchaser needs.

The MPC system design continues to be refined through the systems engineering approach to ensure program and stakeholder needs are satisfied. All MPC system design aspects are being linked formally to CRWMS requirements to ensure that products meet program needs and that no extraneous items are being developed. System requirements documents for the various CRWMS elements have been updated to document these requirements. This work is being performed in accordance with stringent CRWMS quality assurance procedures.

In order to satisfy federal environmental requirements, the DOE has developed a preliminary environmental strategy for MPC implementation. This strategy includes early development of an environmental evaluation for the MPC system and subsequent preparation of an EIS prior to fabrication and deployment of the MPC system. Review and approval of environmental aspects of the CRWMS is a lengthy process. The environmental strategy assures that these evaluations will be completed and submitted to the Environmental Protection Agency (EPA) in sufficient time to support the MPC system implementation schedule.

All elements of the MPC-based CRWMS that could potentially affect the health and safety of the public or plant workers must be licensed by the NRC. Commercial nuclear industry experience has shown that NRC license approval is the most important milestone in scheduling facility start-up. A strategy has been developed for performing designs of the MPC system elements for NRC review. This strategy includes preparation of SARs and TSARs. Meetings with NRC and DOE management have been held to ensure that the 10 CFR Part 71 and 10 CFR Part 72 reviews can proceed expeditiously. It is expected that NRC approval of the MPC for storage and transportation will occur prior to approval for disposal.

The MPC system implementation strategy makes use of existing nuclear industry expertise and experience in SNF handling, packaging, and storage systems design. Major portions of CRWMS elements are being procured from vendors. DOE is exercising management control of the procurement process to ensure that procured items are designed, certified, fabricated, and tested in conformance with established CRWMS requirements. The systems engineering approach is used to provide integration and traceability of requirements throughout all portions of the design, even designs performed by vendors, to ensure the designs meet their intended purpose and no weaknesses exist.

The MPC System RFP includes provisions to accommodate non-design basis SNF types in the MPC design. A working group has been established to address the issue of using burnup credit in MPC design, with an emphasis on gaining NRC acceptance of such an approach. Effects of utilizing MPCs as part of waste packages at the MGDS continue to be investigated to confirm compatibility of the MPC concept with repository thermal loading strategies. Contingency positions are being formulated to reduce the risk in the event that MPCs cannot be used in the disposal package at the MGDS. These include the possibility of adding filler material to MPCs at the MGDS to ensure long-term performance objectives.

Modal capabilities of Purchaser facilities are being examined to determine if the number of facilities that cannot accommodate MPCs can be reduced. Current investigations indicate that this number may be reduced to as few as 4 facilities that would have to use other than MPCs for removing SNF.

6.2 PROCUREMENT PLAN

A procurement plan has been developed to define the requirements and identify the processes necessary to successfully manage the acquisition of key components of the MPC system, should an EIS support a decision to move forward with solicitation and deployment. This plan includes vendor design of these components, NRC certification of the design, and an option for fabrication of an initial inventory of MPC subsystems to support deployment in 1998. The MPC System RFP has been released, and methods for evaluating bids and selecting suppliers have been developed.

One of the first steps in developing controls for the procurement of major MPC system components is to issue specifications for procuring design services. Design procurement specifications have been developed for the MPC, the MPC transportation cask, and the OSTS.

The three design specifications, the statement of work, and contractual documents are included as part of the MPC System RFP package that was released for bids in June 1994 to procure design services for the MPC, transportation cask, and on-site transfer and on-site storage segments. The MPC System RFP package comprises the design, certification, testing, and options for fabrication and delivery of specific components of the MPC system.

The MPC System RFP is the first major step in the overall procurement for MPC system implementation. It requires vendors to submit firm, fixed-price proposals for a three-phase development contract for large and small MPC systems. The three phases of the contract are: SAR design, certification, and fabrication. The SAR design phase includes preparation of design reports for the MPC subsystem, the MPC transportation cask subsystem, and the OSTS segments, as well as preparation of SARs for the MPC transportation cask and the OSTS segments. The certification phase includes performance of regulatory testing of scale models and certification of the MPC system designs. It also includes fabrication of prototypes of the MPCs, transportation casks, and the OSTS system. The optional fabrication phase includes fabrication of up to the first 2 year's supply of MPCs. Contract awards will also proceed in phases. Awards will be based on evaluations of vendor technical performance, business management planning, and price.

6.3 IMPLEMENTATION MILESTONES

Once NRC approval of the MPC system is obtained, construction and final procurement activities can begin. Time must be allotted for testing and start-up of MPC systems prior to commencement of full operations. Design, fabrication, and procurement of the various MPC system components must be integrated and sequenced to support the licensing and construction processes. Figure 6.3-1 shows the schedule for implementing the MPC-based CRWMS. As can be seen from this compressed schedule, requirements for design, procurement, NRC licensing, fabrication, construction, testing, and start-up necessitate an intense and dedicated effort to ensure timely acceptance of SNF into the CRWMS. The schedule will be re-evaluated upon receipt of vendors' proposals.

Task Name	Years (93–0)
MPC AND TRANSPORTATION CASKS	
Procurement Package	03 Jun 94
Bidding and Proposal Evaluation	16 Mar 95
Award Design Contract(s)	△16 Mar 95
SAR Design	15 Mar 96
NRC Licensing	30 Jun 97
NRC Issues COC	△30 Jun 97
MPC Fabrication	
Initial Two-Year Production	30 Jun 99
First MPC Available	△30 Jan 98
Award Fabrication Contract for Later Years	△30 Mar 99
Fabrication for Later Years	
ON-SITE TRANSFER AND STORAGE	19 Aug 98
STORAGE AND TRANSFER AT PURCHASER SITE	26 Dec 97
Procurement Package	03 Jun 94
Bidding and Proposal Evaluation	16 Mar 95
Award Design Contract(s)	△16 Mar 95
SAR Design	15 Mar 96
NRC Licensing	26 Dec 97
NRC Issues SER and COC	△26 Dec 97
BARE SNF TRANSFER	19 Aug 98
Procurement Package	30 Dec 94
Bidding and Proposal Evaluation	24 May 95
Award Design Contract	△24 May 95
BST Design and Topical Report	23 May 96
NRC Licensing	26 May 98
BST Available	△19 Aug 98

Figure 6.3-1 MPC System Overall Schedule

Chapter 7

CONCLUSIONS

Of the alternatives evaluated, the MPC system is the most suitable option for providing standardized containers for handling SNF assemblies throughout the CRWMS and for meeting the needs of Purchasers. It provides the triple-purpose function of SNF assembly transportation, storage, and disposal at a significantly reduced cost as compared to other alternatives, and at a cost comparable to the individual SNF assembly handling system. Conceptual design efforts have shown that the individual SNF assembly handling system, the TSC system alternative, and the MPU system alternative are also feasible options for handling SNF, although they do not offer all the advantages of the MPC system.

A systems engineering approach was used to evaluate available system alternatives considering all aspects of Purchaser interface, waste acceptance, transportation, MRS facility storage, and MGDS disposal. This approach provided a mechanism to investigate thoroughly the ability of all alternatives to meet all CRWMS requirements. Systems engineering methodology continues to be used to refine the MPC system and fully integrate it throughout the various elements of the CRWMS. Emphasis has been placed on ensuring the MPC system can meet transportation, storage, and disposal needs. The systems engineering approach has provided a technical basis for establishing design parameters that ensure the MPC will meet CRWMS needs and that the design has adequate flexibility to accommodate MGDS site characterization refinements.

Systems engineering evaluations of the available system alternatives considered health, safety, environment, cost, schedule, regulatory, licensing, Purchaser impacts, stakeholder concerns, and risk and contingency analysis. Results of these evaluations indicate the following advantages are offered by the MPC system as compared to the other alternatives:

- The MPC system provides for safe, reliable, and environmentally sound SNF handling operations with acceptable levels of radiological exposure.

- The MPC system simplifies Purchaser and CRWMS operations and reduces low-level radioactive wastes by allowing SNF assemblies to be placed in permanent packages for dry storage, transportation, and disposal.

- A significant reduction in the number of SNF handlings is offered by the MPC system as compared to the individual SNF assembly handling system.

- The MPC system decouples operations for retrieving SNF from Purchaser ISFSIs from operations in Purchaser spent fuel pools, which could allow spent fuel pools to be decommissioned prior to removal of SNF from Purchaser sites.

- The MPC system standardizes SNF assembly packaging at Purchaser sites, which reduces costs, enhances licensing efforts, and provides for uniform integration of SNF handling operations throughout the industry.

The MPC system conceptual design can accommodate at least 80 percent of the SNF projected to be available during the first 10 years of CRWMS operation. Ultimately, 100 percent of available SNF will be accommodated by small adjustments in the operations of the MPC system. The MPC System RFP includes requirements for bidders to propose designs that will accommodate SNF assembly types that are beyond the design basis presented in the MPC System CDR. In addition, efforts are underway to find ways to utilize MPCs at as many Purchaser sites as possible and to minimize the number of sites that have to ship individual, uncanistered SNF assemblies in truck casks or use MESCs for on-site storage. The MPC system may include a BST system that would allow many Purchaser facilities to accommodate MPCs that otherwise could not. The BST system would allow SNF transfer from a Purchaser's pool to an MPC outside of the pool. Purchaser facility transportation capabilities for handling MPCs in transportation casks or individual SNF assemblies in truck casks were estimated for the conceptual design as follows:

- Large MPCs in rail transportation casks accommodated at 88 facilities
- Small MPCs in rail transportation casks accommodated at 14 facilities
- Individual SNF assemblies in truck casks accommodated at 19 facilities

Capacity sensitivity studies for the MPC have been performed. These studies have considered the triple-purpose function of the MPC as part of a storage package, a transportation package, and a disposal package. A 24-PWR assembly large MPC has been evaluated as one possible option for increased MPC capacity. Contingency options are also being investigated to ensure the MPC will be appropriate as part of the waste package at the MGDS. Options to add filler materials to MPCs prior to disposal are being examined to ensure there is adequate flexibility in the design in the event this is needed.

Credit has been taken for burnup of the SNF assemblies in design of the large PWR MPC. A working group has been established to interface with the NRC and expedite resolution of this issue. Other than the burnup credit issue, no unusual issues are expected for licensing of the MPC system for storage and transportation.

Public and worker safety and health and protection of the environment have been high priority objectives throughout the conceptual design of the MPC system. Transportation casks for MPCs are designed to stringent criteria that ensure SNF containment is maintained even during extreme accident conditions. Facilities for handling and storing MPCs and other SNF containers will be designed to withstand the most severe environmental conditions. Sandia National Laboratories is investigating remote and automated MPC handling and closure techniques to keep worker radiation exposures ALARA. Human factors engineering has been considered in the conceptual design of the MPC system and will be used extensively in more detailed design of the system. Table 7-1 summarizes health and safety impacts resulting from radiological routine activities and incidents that can be expected for each of the alternatives.

Table 7-1 Health and Safety Radiological Impacts of Alternatives With an MRS
(Total Program Exposures in Person-Rem)

System Impact Area	MPC System	TSC System	MPU System	Individual SNF Assembly Handling System
Radiological Routine				
· Facilities	56,980	43,820	53,920	42,080
· Transportation	1,450	1,450	1,450	1,450
Radiological Incident				
· Facilities	0.04	0.08	0.04	0.1
· Transportation	430	430	430	430

Preliminary environmental evaluations indicate that the MPC system will have no significant impact on the environment. Before proceeding with MPC fabrication, an EIS will be prepared for the MPC system.

Table 7-2 provides a comparison of total costs for the MPC system and the TSC and MPU system alternatives in relation to the individual SNF assembly handling system. Costs have been evaluated for the CRWMS and for Purchasers to determine overall cost savings or increases associated with each option. The MPC system provides a total cost savings of $550 million as compared to the individual SNF assembly handling system. This cost savings is relatively small compared to total system costs. Primary contributors to cost savings with the MPC system are the advantages offered by using one canister for containing SNF assemblies throughout all CRWMS activities, simplification of SNF assembly handling facilities, and the ability to shutdown reactor spent fuel pools earlier than would otherwise be possible.

Table 7-2 Total System Life Cycle Cost Differences
(Millions of 1993 Dollars)

Cost Item	With MRS			No MRS
	MPC System	TSC System	MPU System	MPC System
CRWMS				
Containers	+ 5,074	+8,180	+12,600	+4,570
Waste Acceptance Equipment	+27	0	+31	+27
Transportation	-229	-2	-513	-282
MRS/CMF	-370	-885	-938	-36
First/Second MGDS	-3,002	0	-5,030	-2,602
Total Cost Difference for CRWMS	**+1,500**	**+7,293**	**+6,150**	**+1,677**
Purchasers				
Waste Acceptance Operations	+94	-3	+101	+94
Purchaser Site Storage	-2,144	-2,990	-3,010	-2,376
Total Cost Difference for Purchasers	**-2,050**	**-2,993**	**-2,909**	**-2,282**
Total System Cost Difference	**-550**	**+4,300**	**+3,241**	**-605**

Note:
Table entries show differences in LCC between the alternative systems and the individual SNF assembly handling system. Negative entries indicate a savings with the alternative.

Several conclusions can be drawn from the information in Table 7-2. First, there is a significant cost advantage of the MPC system over the TSC and MPU system alternatives. Second, within the uncertainty of cost analyses performed, the MPC system cost is comparable to that of the individual SNF assembly handling system. Third, the decision to implement the MPC system, as opposed to the individual SNF assembly handling system, is independent of whether or not there is an MRS facility in the system.

Since the decision was made in February 1994 to proceed with design and certification of the MPC system, a schedule has been developed for designing, licensing, procuring, constructing, and starting operation of the MPC-based CRWMS. An implementation plan has been established for the MPC system that provides for having the first MPCs and transportation casks available in early 1998. A procurement strategy has also been developed to expedite acquisition of major components of the MPC system. The first phase of this procurement strategy was completed in June 1994 with issue of the MPC System RFP. The MPC System RFP includes design procurement specifications for MPCs, transportation casks, and Purchaser OSTS components.

Risks have been evaluated for major problems that could be encountered during implementation of the MPC system. Contingency options have been formulated to remedy each major risk anticipated and to ensure options are available to avoid substantial delays. Stakeholders have expressed support for DOE's decision to implement the MPC system. They view the decision as a milestone toward success in meeting the requirements of the NWPA. There is a high level of confidence that the MPC system can be implemented successfully to provide a waste handling system that meets all CRWMS program goals for safety, health, environment, throughput, cost, and schedule and that satisfies Purchaser needs.

Appendix A

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Appendix B

LIST OF ACRONYMS

AML	Areal Mass Loading
APD	Areal Power Density
ALARA	As Low As is Reasonably Achievable
BST	Bare SNF Transfer
BWR	Boiling Water Reactor
CDR	Conceptual Design Report
CMF	Cask Maintenance Facility
COC	Certificate of Compliance
CRWMS	Civilian Radioactive Waste Management System
DOE	Department Of Energy
D&E	Development and Evaluation
EEI	Edison Electric Institute
EIS	Environmental Impact Statement
HLW	High Level Waste
IRG	Independent Review Group
ISFSI	Independent Spent Fuel Storage Installation
LCC	Life Cycle Cost
LLW	Low Level Waste
LWT	Legal Weight Truck
MESC	Multi-Element Sealed Canister
MGDS	Mined Geological Disposal System

MPC	Multi-Purpose Canister
MPU	Multi-Purpose Unit
MTU	Metric Tons Uranium
MWD	Megawatt Days
NAC	Nuclear Assurance Corporation
NDE	Nondestructive Examination
NEPA	National Environmental Policy Act
NFC	Non-Fuel Components
NRC	Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act
NWTRB	Nuclear Waste Technical Review Board
OCC	Operations Control Center
OCRWM	Office of Civilian Radioactive Waste Management
OFF	Oldest Fuel First
OSTS	On-Site Transfer and Storage
PETT	Payments Equal to Taxes
PWR	Pressurized Water Reactor
QA	Quality Assurance
RCRA	Resource Conservation and Recovery Act
RFP	Request For Proposal
SER	Safety Evaluation Report
SAR	Safety Analysis Report
SNF	Spent Nuclear Fuel
STC	Storable Transport Cask

SRD	System Requirements Document
TSAR	Topical Safety Analysis Report
TSC	Transportable Storage Cask
UTS	Utility Transfer System
UWASTE	Utility Nuclear Waste and Transportation Program
WHB	Waste Handling Building

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