APPENDIX D
DESCRIPTION OF ALTERNATIVE CONTAINER SYSTEMS AND OPERATIONS

TABLE OF CONTENTS

FIGURES

FIGURES (Cont)

APPENDIX D

D. DESCRIPTION OF ALTERNATIVE CONTAINER SYSTEMS AND OPERATIONS

D.1 Introduction

This appendix describes the alternative container systems considered for the storage, transport, and disposal of naval spent nuclear fuel and the operations associated with their use. The alternatives chosen for analysis in this Environmental Impact Statement (EIS) are representative of families or classes of container types. Containers similar to all of the alternatives may become available in the future and might be selected.

The descriptions of the alternative container systems proposed for naval spent nuclear fuel management include the basic components of the containers and the routine operations for their use. The containers discussed are those that would be used after 1998 for naval spent nuclear fuel transfer and dry storage at Idaho National Engineering Laboratory (INEL), transportation between INEL and a repository or centralized interim storage site, and disposal. The spent nuclear fuel container systems could also be used for special case waste. The discussion includes generalized equipment and operations required at INEL and at a repository. Six alternative container systems are described:

- Multi-Purpose Canister Alternative — Section D.2,
- No-Action Alternative — Section D.3,
- Current Technology Supplemented by High-Capacity Rail Cask (Current Technology/Rail) Alternative — Section D.4,
- Transportable Storage Cask Alternative — Section D.5,
- Dual-Purpose Canister Alternative — Section D.6, and
- Small Multi-Purpose Canister Alternative — Section D.7.

D.2 Multi-Purpose Canister Alternative

D.2.1 Technology and Related Hardware

The basic components of the Multi-Purpose Canister Alternative include the canisters; specialized overpacks for storage, transportation, and disposal; and on-site transfer overpacks. At least one private manufacturer has announced intentions to produce a multi-purpose canister, but the environmental evaluation of the Multi-Purpose Canister Alternative presented in this EIS was based on the system described in a conceptual design report for a multi-purpose canister-based system (TRW Environmental Safety Systems, Inc.; TRW 1993) that was commissioned by DOE. Containers similar to the one used for analysis purposes for this alternative may become available in the future and may be selected. Figure D.1 illustrates the steps for loading, storing, transporting, and disposing of multi-purpose canisters.

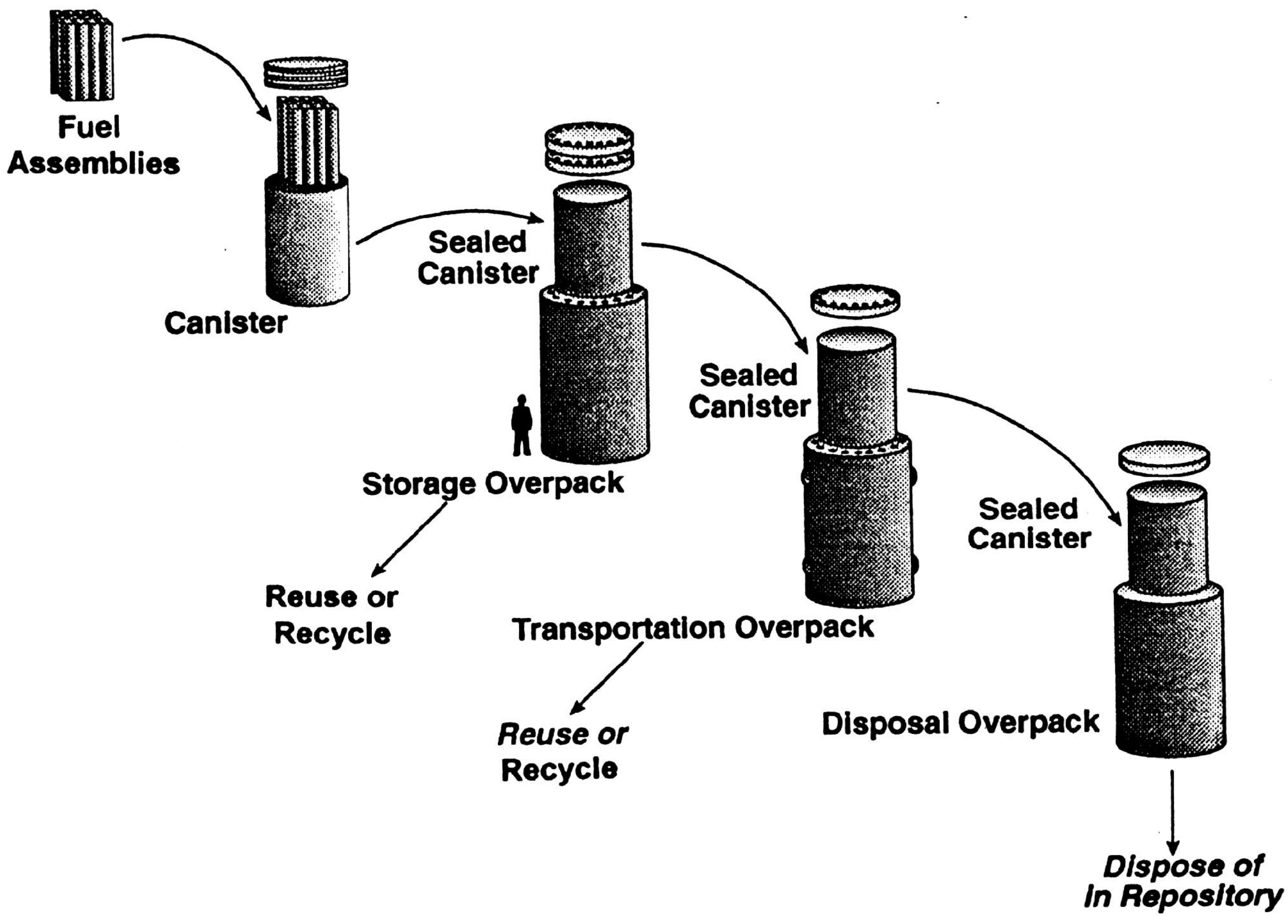

FIGURE D.1 Storage, Transport, and Disposal for the Multi-Purpose Canister System

Multi-Purpose Canister Equipment. Each multi-purpose canister would consist of a cylindrical stainless steel shell, with two lids at the top and a shield plug made of depleted uranium (or equivalent shielding material) between the lids. The shell is designed to provide structural support, heat transfer, and containment. Each canister would contain a fuel assembly basket, which is an internal rigid framework designed to maintain the arrangement of the naval spent nuclear fuel assemblies to provide criticality control. The multi-purpose canister itself is not designed to provide significant radiation shielding except for the shield plug at the top, which is included to provide protection for workers during closure operations. Radiation shielding of the sides and bottom of a multi-purpose canister would be provided by the separate specialized overpacks. All currently licensed or docketed canister-based systems use welded seals on the lid closure. The TRW conceptual design utilizes two lids on each canister that are welded to the shell wall. Other closure systems may also be used on the multi-purpose canister systems such as bolted lids. Bolted closures would require additional sampling and monitoring activities which would result in additional radiation exposure to perform these activities. If a different closure system were used, such as a bolted lid, it is expected that worker doses would be slightly different from those presented in the EIS. All other impacts would be expected to be similar.

Dry Storage Overpacks. For assessment purposes, the multi-purpose canisters were assumed to be stored in horizontal, reinforced-concrete storage overpacks or vaults. These storage overpacks represent a low-cost, reasonable storage option that has been demonstrated in practice. This system provides a conservative basis for assessment. The multi-purpose canister could also be stored in vertical, reinforced-concrete storage overpacks. The horizontal dry storage overpacks were assumed to be free-standing units that would be built as needed and placed on thick concrete pads constructed in accordance with commercial industry standards. The storage overpack, together with the multi-purpose canister, would be designed to meet the dry storage requirements specified in the Code of Federal Regulations (10 CFR Part 72). Multiple canisters could be stored in vaults built side by side. A representative horizontal dry storage system for canisters is illustrated in Figure D.2. A representative vertical dry storage system for canisters is illustrated in Figure D.3.

Transportation Overpacks. Multi-purpose canisters would be transported by rail in heavily shielded transportation overpacks designed to meet the standards established by the U.S. Nuclear Regulatory Commission under 10 CFR Part 71. The overpacks would be designed and constructed to contain the radioactivity in naval spent nuclear fuel during severe accidents. The conceptual designs of the transportation overpacks are based on existing and demonstrated technology. The overpacks consist of concentric shells of stainless steel, with layers of lead and depleted uranium in between for gamma radiation shielding. Neutron shielding is also provided. For transportation, the overpacks would be bolted closed and fitted with lightweight impact limiters on each end for protection during possible accidents. Impact limiters would be made from crushable, lightweight materials such as wood and aluminum, designed to provide sufficient energy absorption to prevent damage to the canisters in severe accidents. The transportation overpacks would be reusable and were assumed to have a useful life of 40 years.

Transfer Overpacks. The heavily shielded on-site transfer overpacks would be used to load and transfer multi-purpose canisters between overpacks at INEL because multi-purpose canisters are not heavily shielded. On-site transfer overpacks are similar to transportation overpacks, except they do not need to meet the stringent testing criteria required for off-site transportation as specified in 10 CFR Part 71.

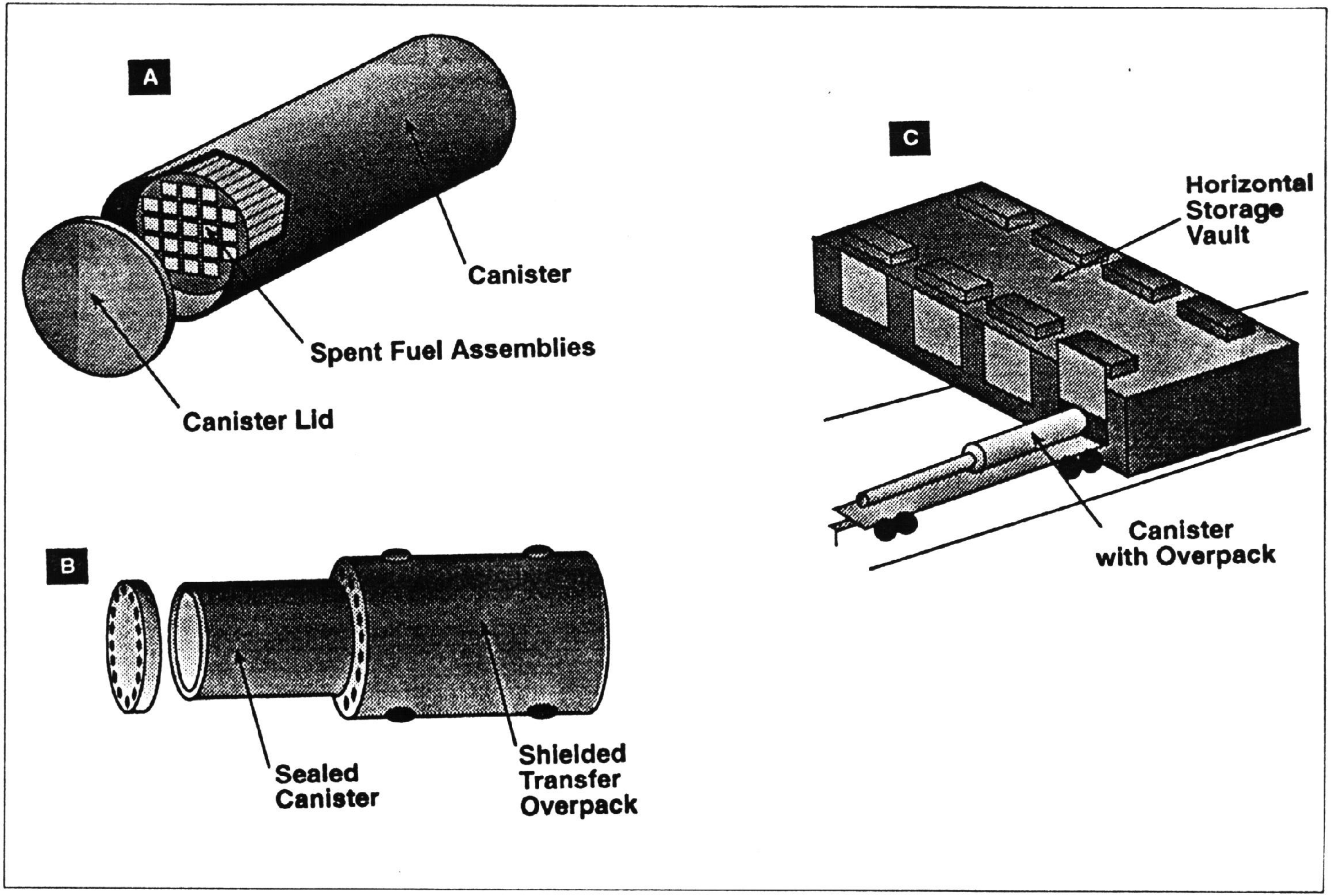

FIGURE D.2 Representative Canister-Based, Horizontal, Dry Storage System: (A) sealed canister with spent nuclear fuel basket; (B) sealed canister within an on-site, shielded transfer overpack; (C) sealed canister being placed in shielded, storage vault.

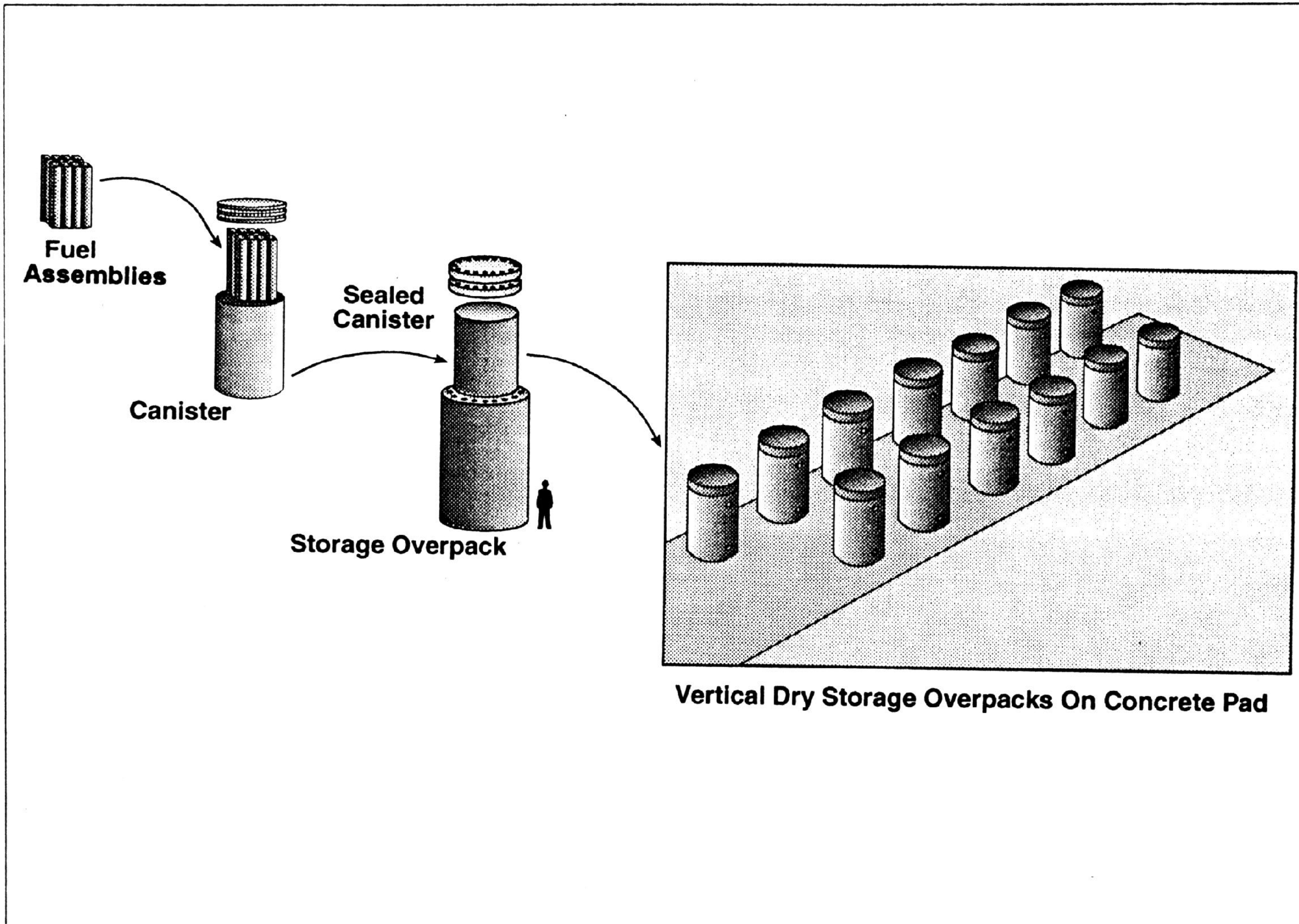

FIGURE D.3 Representative Vertical Dry Storage System for Multi-Purpose Canisters

Disposal Overpacks. Loaded multi-purpose canisters would be transferred to disposal containers (overpacks) at the surface facility of a repository. The disposal containers would be cylindrical overpacks constructed of highly corrosion-resistant metal alloys designed to meet 10 CFR Part 60 requirements. The disposal overpacks would have two lids that would be secured to the container shell by welding.

D.2.2 Handling, Storage, and Transportation Operations

Handling and storage operations associated with the Multi-Purpose-Canister Alternative would take place at INEL and the surface facility at a repository or centralized interim storage site. Multi-purpose canisters would be loaded at INEL for two purposes: (1) dry storage on-site or (2) direct shipment to a repository or centralized interim storage site. Multi-purpose canisters might be loaded either directly from a water pool or from a heavily shielded dry cell. The basic operations for loading a multi-purpose canister from a water pool or dry cell are shown schematically in Figures D.4 and D.5. The following is a general description of the procedures which may be used if this alternative were selected; it is intended to help the reader understand the process.

Prior to loading fuel from a water pool, an empty multi-purpose canister would be placed in an on-site transfer overpack with the lid of both the multi-purpose canister and the transfer overpack removed. The gap between the multi-purpose canister and transfer overpack would be filled with water and sealed with a temporary seal to prevent storage pool water from coming in contact with the clean outer surface of the multi-purpose canister. The transfer overpack containing the multi-purpose canister would then be filled with water, lowered into the pool by crane, and loaded with naval spent nuclear fuel assemblies.

After the multi-purpose canister had been filled with naval spent nuclear fuel assemblies, the end shield plug would be set in place and the transfer overpack removed from the water pool to a designated area for sealing. The multi-purpose canister closure would provide a high-integrity seal to contain radioactivity during storage and handling operation. After the canister is closed and sealed, the multi-purpose canister would be drained and vacuum dried, filled with an inert gas, and the access port would be sealed. The outer lid would then be welded. Although it is possible to design a multi-purpose canister with a bolted lid, it is anticipated that final design would feature welded lids, similar to the conceptual design. All currently licensed or docketed canister-based systems use welded seals. The transfer overpack lid would be bolted onto the transfer overpack, and the transfer overpack would be decontaminated for movement to either a storage overpack or transportation overpack.

Loading might also be accomplished in a dry cell facility, which would consist of shielded radiologically controlled areas with remotely operated equipment. The dry cell would provide a shielded barrier and radiological containment to load highly radioactive fuel into a canister. Fuel might also be removed from water pool storage and transferred to a dry cell for loading into canisters. Information about the proposed dry cell operations at the Expended Core Facility is contained in the Programmatic SNF and INEL EIS (DOE 1995, Volume I, Appendix D, Part B); information about the proposed Idaho Chemical Processing Plant dry cell facility is also included in the Programmatic SNF and INEL EIS (DOE 1995, Volume II, Part B).

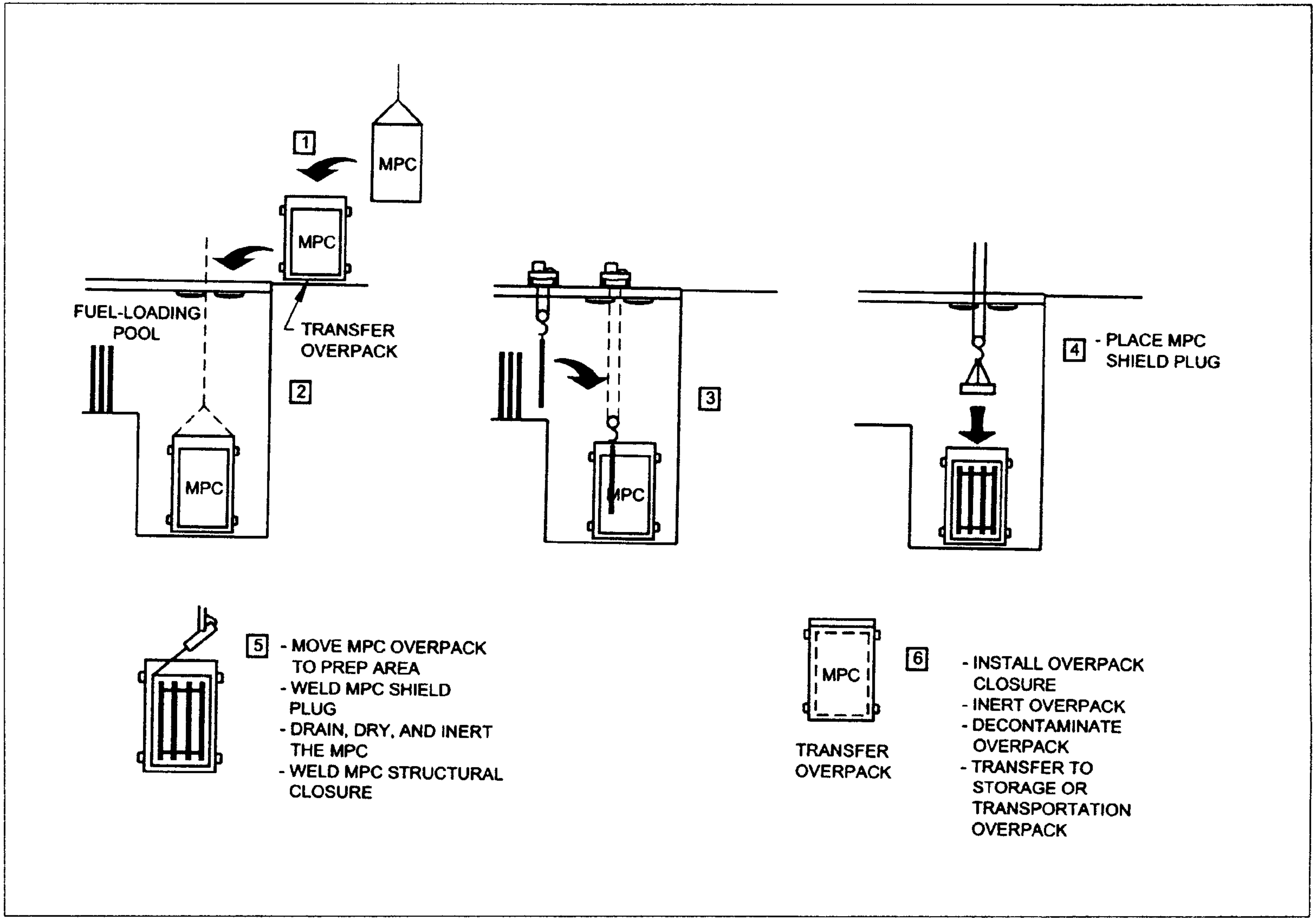

FIGURE D.4 Typical Operations for Loading a Multi-Purpose Canister (MPC) from a Pool (Source: Modified from DOE 1994)

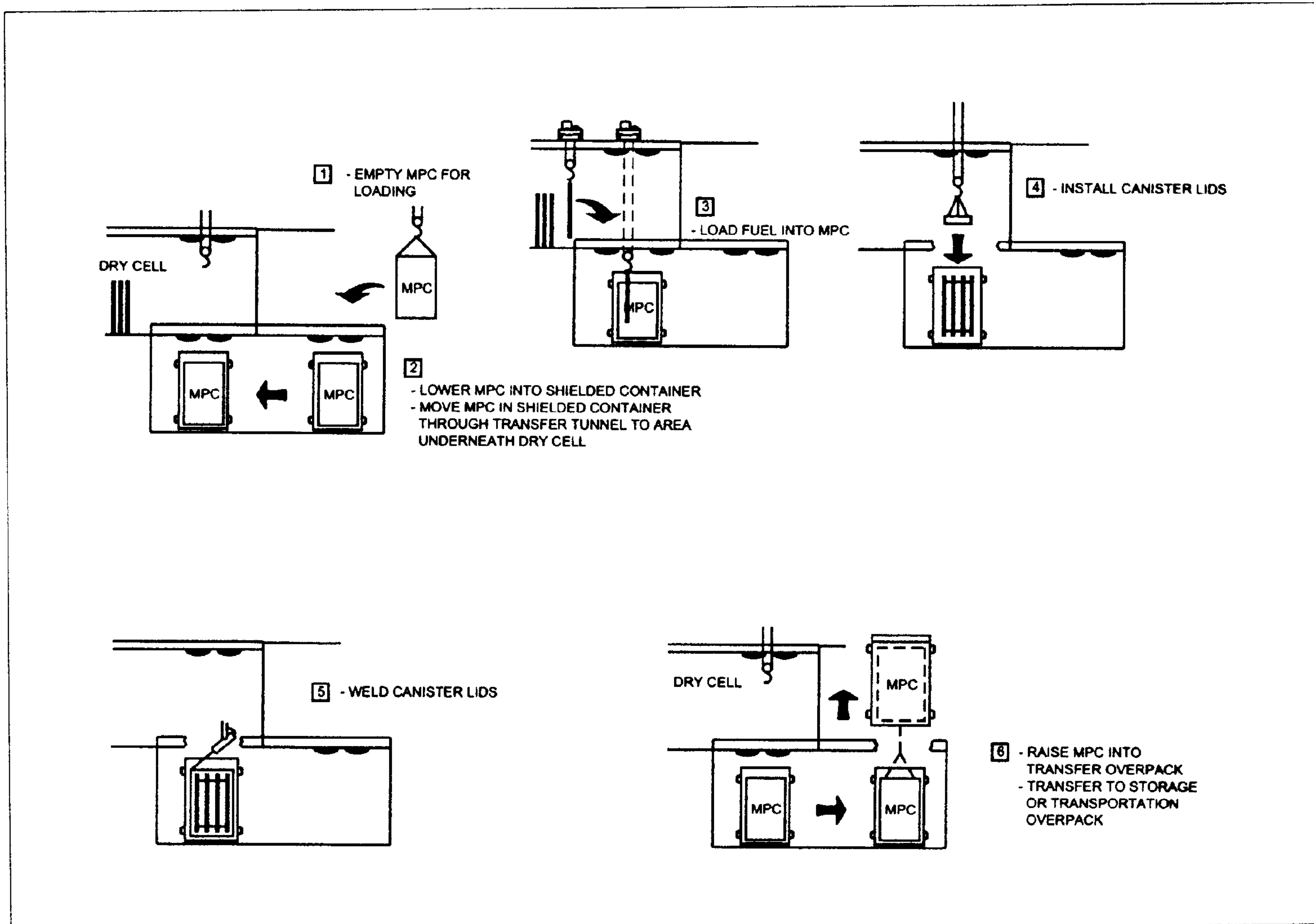

FIGURE D.5 Typical Operations for Loading a Multi-Purpose Canister (MPC) from a Dry Cell

If a dry cell were used, an empty canister would be loaded with naval spent nuclear fuel using fuel-handling equipment within the cell probably by lowering fuel assemblies into the multi-purpose canister through a hole in the bottom of the dry cell. Once the canister is filled, it would be closed and sealed. After the closure is complete, the canister would be inspected and tested for leaks. The loaded, sealed canister would be placed into a transfer overpack, which would be closed for movement to either a storage overpack or transportation overpack.

Once the transfer overpack would be loaded (in either a water pool or dry cell), an on-site transporter or heavy-haul truck would be used to transport the transfer overpack and its enclosed multi-purpose canister to an on-site storage location. Figure D.6 illustrates typical operations for horizontal dry storage of a multi-purpose canister. At the dry storage location, the multi-purpose canister would be transferred to its storage overpack, and the lid or door of the storage unit would be closed and secured, as appropriate, for security purposes. Once loaded in a storage overpack, the multi-purpose canister would require only occasional monitoring and maintenance. When the multi-purpose canister is prepared for off-site shipment, the storage overpack would be opened and the multi-purpose canister transferred from the storage overpack to the off-site transportation overpack. (This operation would be performed at the dry storage location or the multi-purpose canister would be returned to the location where it was loaded.) The lid would be bolted on the transportation overpack, the impact limiters installed, and the overpack would be readied for off-site shipment.

All shipments involving transportation of containers to a repository or centralized interim storage site would be made by train, using commercial rail lines. Heavy-haul transporters may be used for short portions of the trip. Dedicated trains might be used when appropriate. At a repository, loaded multi-purpose canisters would be transferred from transportation overpacks to disposal overpacks inside a shielded transfer room, and the disposal overpacks would be welded closed. The sealed waste package would then be prepared for movement to the underground disposal area.

For the Multi-Purpose Canister Alternative about 180 storage overpacks and 18 transportation overpacks would need to be managed at the end of the program. The scrap metal (including small amounts of lead) would be recycled, if possible. The concrete in the storage overpacks would be managed as non-radiological solid waste. These materials are not expected to be radiologically contaminated because the naval spent nuclear fuel would be contained within the multi-purpose canister. The canisters and the disposal overpacks would be disposed of with the naval spent nuclear fuel.

D.3 No-Action Alternative (Current Technology)

The No-Action Alternative is based on using existing technology at INEL to handle, store, and subsequently transport naval spent nuclear fuel to a geologic repository or centralized interim storage site using the M-140 transportation cask. Prior to shipment to a repository or centralized interim storage site, naval spent nuclear fuel would be stored at INEL in water pools or commercially available dry containers and then loaded into M-140 transportation casks. The loaded M-140 transportation casks would be shipped by rail to a repository or centralized interim storage site. At a repository, the naval spent nuclear fuel would be unloaded from the M-140 transportation casks and placed in a geologic repository's surface facilities for loading into disposal containers. Following unloading, the M-140 transportation casks would be returned to INEL for reuse. The M-140 trans-

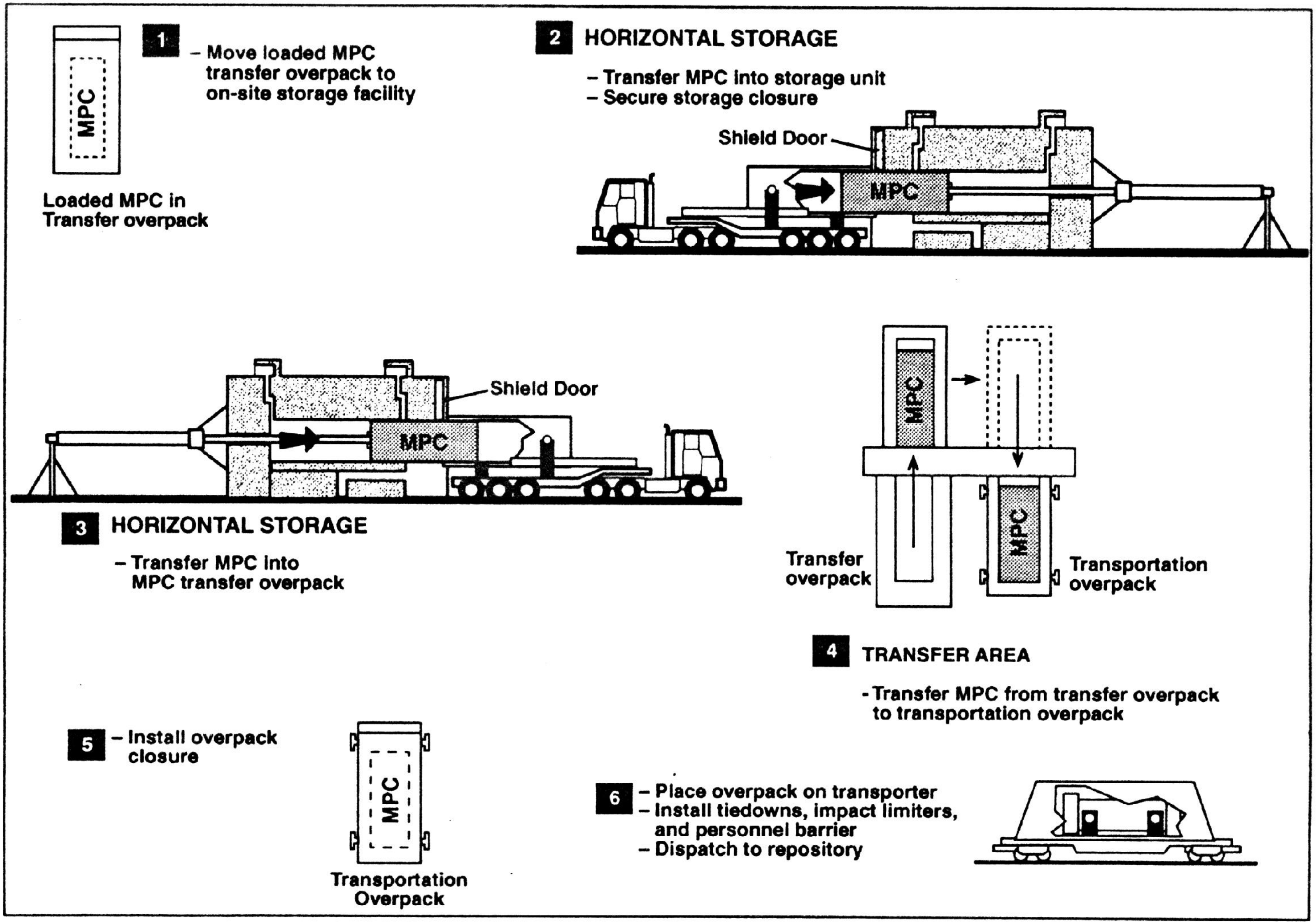

FIGURE D.6 Typical Operations for Loading a Multi-Purpose Canister (MPC) for Horizontal Dry Storage and Transfer to a Transportation Overpack (Source: Modified from DOE 1994)

portation cask used for naval spent nuclear fuel is unique to the Naval Nuclear Propulsion Programs. Figure D.7 shows the containers that would be required to load, store, transport, and dispose of naval spent nuclear fuel under the No-Action Alternative.

D.3.1 Technology and Related Hardware

M-140 Transportation Cask. The M-140 transportation cask is designed in accordance with U.S. Nuclear Regulatory Commission and U.S. Department of Transportation requirements and is used to transport naval spent nuclear fuel from naval sites to INEL. The M-140 transportation cask is a large stainless steel shipping container that is transported in the vertical position on a specially designed well-type railcar. The major components of the M-140 transportation cask include the shielded container, closure head, and protective dome. Internal basket assemblies are installed inside the container to hold the naval spent nuclear fuel assemblies in place and can be modified to accept different sized fuel assemblies. The container is shipped dry with the exception of a small amount of residual water. Cooling fins on the outside of the container are designed to dissipate the heat generated by the fuel.

The M-140 transportation cask and rail car weigh approximately 190 tons (approximately 172,000 kg) in the loaded condition. The existing M-140 transportation cask consists of a stainless steel container body, closure head, and a protective dome which fits over the closure head. |

Dry Storage Under the No-Action Alternative. The two basic types of dry storage systems that could be chosen are (1) canister-based systems (see Figures D.2 and D.3) and (2) cask-based systems (see Figure D.8). The systems are similar to one another in that each unit is designed to hold a small number of spent nuclear fuel assemblies, shielding is provided by large amounts of concrete or steel, and cooling relies on the natural flow of air. The systems differ fundamentally in the manner in which shielding and structural support are provided. The canister-based system was selected as a representative design for EIS assessment purposes and is not intended to represent all of the currently available dry storage hardware designs.

Single-Purpose Dry Storage Canisters. For this EIS, the NUHOMS® Dry Spent Fuel Management System (VECTRA Fuel Services 1993) is considered representative of current technology for single-purpose dry storage canisters, because it is commonly used. However, it might not be the specific design selected.

Similar to multi-purpose canisters, the single-purpose dry storage canisters would consist of cylindrical stainless steel shells, a closure lid assembly, a fuel assembly basket, and a shield plug. The currently existing storage canisters have capacities that exceed those of multi-purpose canisters, primarily because the current single-purpose designs are not constrained by the same transportation and disposal requirements.

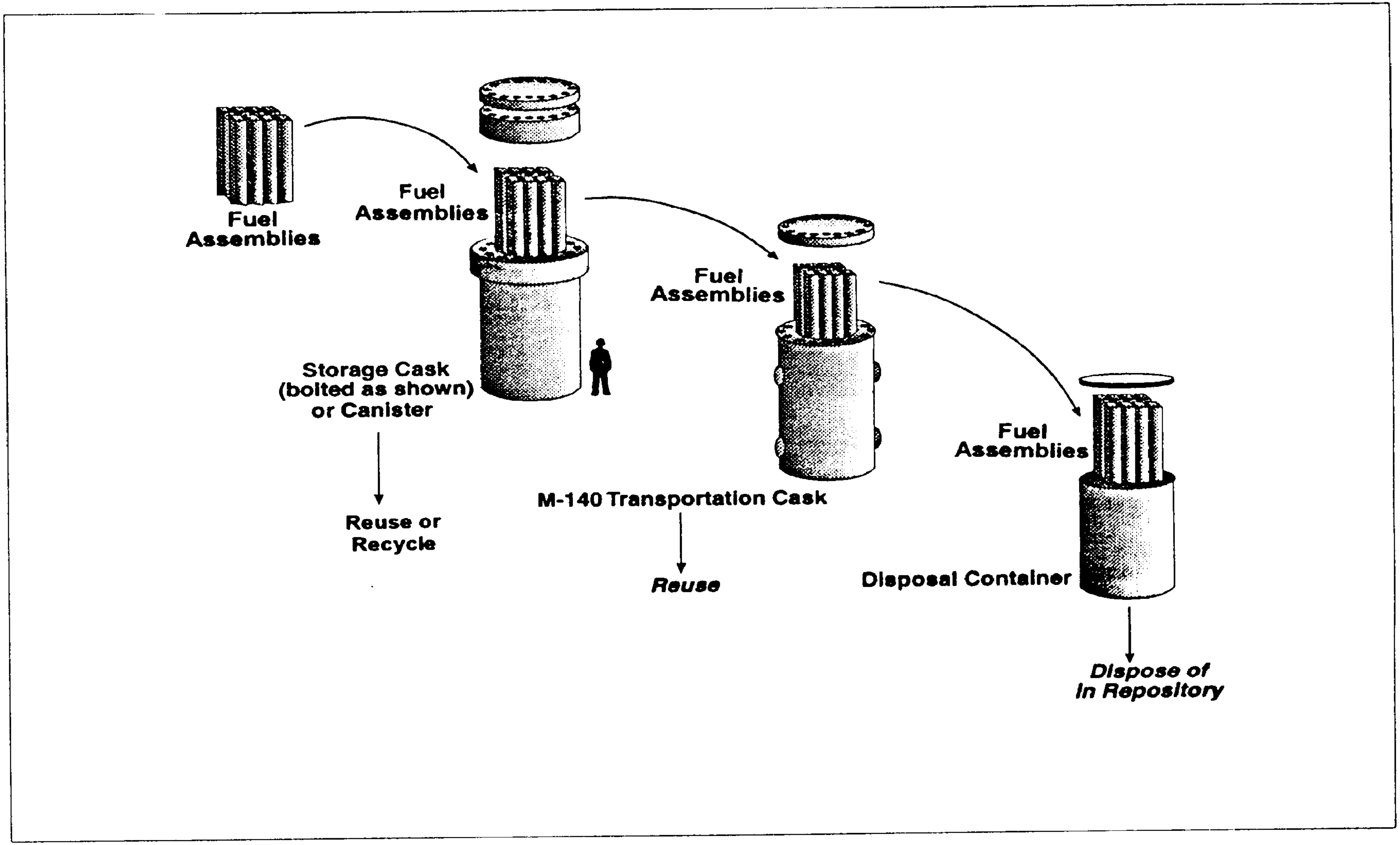

FIGURE D.7 Storage, Transport, and Disposal for the No-Action Alternative (Current Technology) System

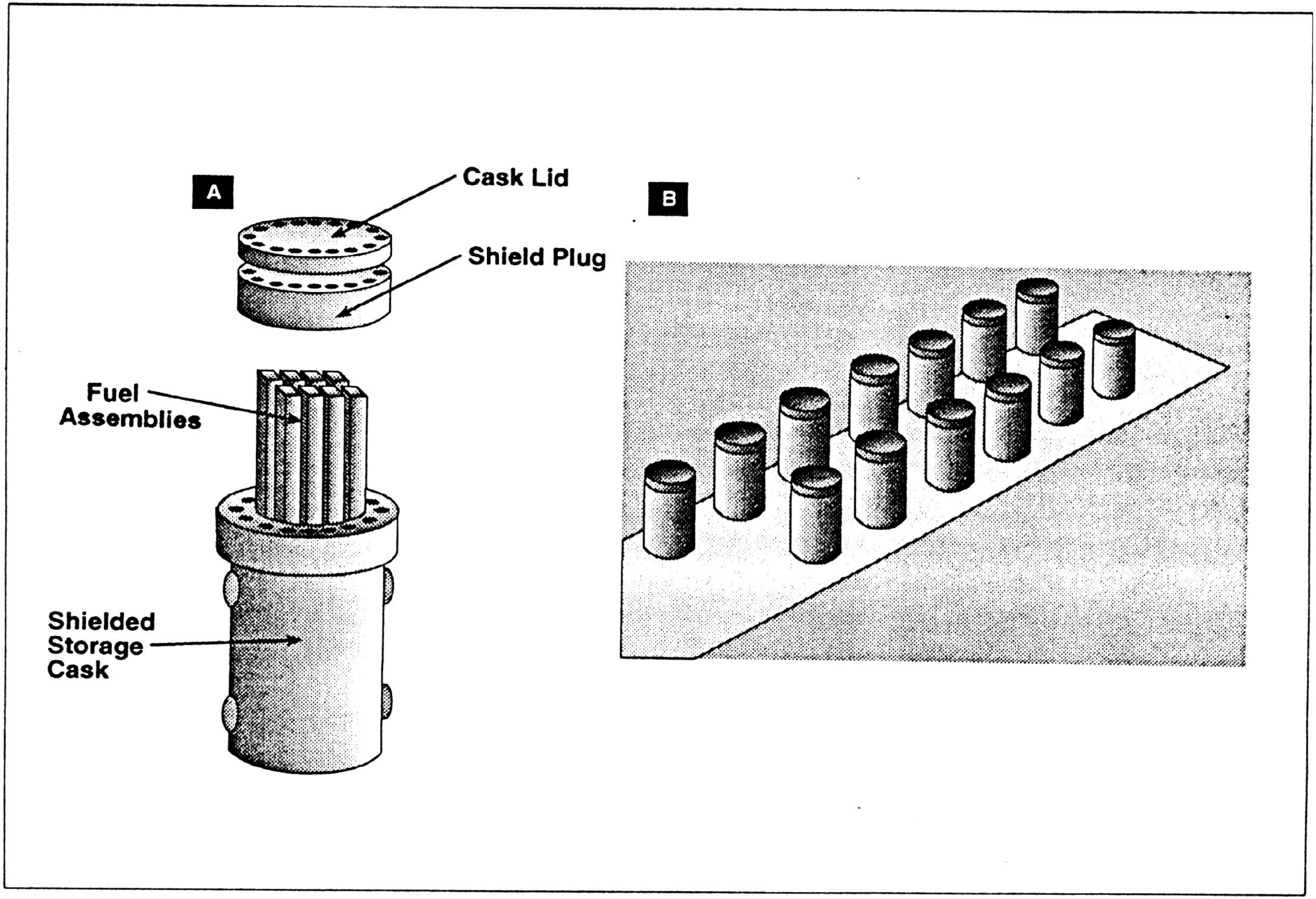

FIGURE D.8 Representative Cask-Based Dry Storage System: (A) shielded storage cask with bolted lid and spent fuel basket; (B) storage casks stored at an on-site storage facility.

The nontransportable single-purpose dry storage canisters would utilize transfer overpacks similar to those described in Section D.2.2 for the multi-purpose-canister system. In addition, dry storage was assumed to be provided in a manner similar to that described for the multi-purpose-canister system, using horizontal reinforced-concrete storage overpacks. The storage overpacks, together with the storage canister, would meet the dry storage requirements specified in 10 CFR Part 72.

Single-purpose canisters with welded closures were chosen as the representative single-purpose storage system for EIS evaluation because (1) recent trends indicate that commercial facilities are generally opting for welded systems, in part because they do not need to perform the sampling and inspections required by bolted closure systems; and (2) they generally result in slightly higher occupational doses than equivalent bolted systems, representing a conservative estimate of worker impacts for EIS purposes. Single-purpose dry storage cask systems with bolted closures are currently available and being used for dry storage at commercial facilities, and may be selected.

Disposal Containers. Naval spent nuclear fuel assemblies arriving at a repository in M-140 casks would be transferred to a large disposal container similar to the multi-purpose canister combined with its disposal overpack described in Section D.2.1.

D.3.2 Handling, Storage, and Transportation Operations

Under the No-Action Alternative, the Navy would obtain one of the commercially available storage systems designed to meet 10 CFR Part 72 for on-site dry storage. The system was assumed to be a nontransportable, sealed canister system, as described in Section D.3.1.

The basic loading procedures for single-purpose storage canisters would be similar to those described for the multi-purpose canister. However, at the time the naval spent nuclear fuel assemblies are prepared for off-site shipment, the sealed, nontransportable storage canisters would be repackaged. The canisters would be returned to the naval spent nuclear fuel water pool or dry cell where they would be opened. Fuel assemblies would be removed from the canisters using a fuel-handling machine, transferred to storage racks, and then loaded into M-140 casks. The M-140 casks would be bolted closed and prepared for shipment.

Naval spent nuclear fuel would be transferred directly to M-140 transportation casks from a water pool if it would be shipped directly to a repository or centralized interim storage site rather than placed in dry storage. The fuel-handling machine would be lowered into the water pool and the naval spent nuclear fuel would be lifted into the machine. The lower gate of the machine would be closed, and the loaded cask would be raised out of the water pool and moved into a position above an M-140 transportation cask. The fuel would then be lowered into the M-140 cask. Fuel-handling operations at the Expended Core Facility are described in the Programmatic SNF and INEL EIS (DOE 1995, Volume I, Appendix D, Part B). Loading at the Idaho Chemical Processing Plant would be handled in a similar way.

The M-140 casks loaded with naval spent nuclear fuel assemblies would be shipped directly to a repository or centralized interim storage site. All shipments would be made by train, using commercial rail lines. Dedicated trains might be used when appropriate. At a repository, all naval spent nuclear fuel assemblies arriving in M-140 transportation casks would be transferred inside shielded transfer cells into large disposal containers. The waste containers would be welded and decontaminated, as needed, before being moved underground for emplacement. Empty M-140 casks would be shipped back to INEL by rail for reuse.

For the No-Action Alternative about 255 storage overpacks, 255 storage containers and 28 casks would need to be managed at the end of the program. The concrete in the storage overpacks would be managed as non-radiological solid waste and the scrap metal recycled. The casks and storage containers would be reused or radiologically decontaminated prior to recycling. The disposal containers along with the naval spent nuclear fuel would be disposed of in the repository.

D.4 Current Technology Supplemented by High-Capacity Rail Cask

The hardware requirements for the Current Technology/Rail Alternative would be identical to those for the No-Action Alternative (Section D.3.1) but, under this alternative, the internal structure of the Navy's M-140 transportation cask would be modified to accommodate more naval spent nuclear fuel assemblies. Handling, storage, and transportation operations would also be the same, but fewer shipments would be required because of the increased capacity of the M-140 transportation casks.

For the Current Technology/Rail Alternative about 176 storage overpacks, 176 storage containers and 28 casks would need to be managed at the end of the program in the same manner described for the No-Action Alternative.

D.5 Transportable Storage Cask Alternative

D.5.1 Technology and Related Hardware

The hardware requirements for the Transportable Storage Cask Alternative would be similar to the Multi-Purpose Canister Alternative (Section D.2.1) except for a reliance on transportable storage casks instead of multi-purpose canisters. An existing, large transportable storage cask, having a capacity slightly greater than a large multi-purpose canister was used as an example in this EIS. The transportable storage cask design used in the assessment was based on the NAC International STC cask design (Danner 1994). The cask would be a cylindrical stainless steel cask incorporating lead as the primary gamma-shielding material. Unlike the canister-based systems, the basket would not be within a separate, sealed canister. The transportable storage cask design has a bolted closure. Containers similar to the one used for analysis purposes for this alternative may become available in the future and may be selected. The casks would be designed to meet the performance requirements specified in 10 CFR Part 72 and 10 CFR Part 71 for storage and transportation, respectively. A schematic diagram illustrating how transportable storage casks are loaded, stored, and transported is shown in Figure D.9.

D.5.2 Handling, Storage, and Transportation Operations

Handling, storage, and transportation operations for the Transportable Storage Cask Alternative would be similar to those described for the Multi-Purpose Canister Alternative (Section D.2.2), except transportable storage casks do not require separate, shielded overpacks. Under the Transportable Storage Cask Alternative, transportable storage casks would be loaded at INEL in a manner similar to canister-based storage systems. The cask would be placed in a water

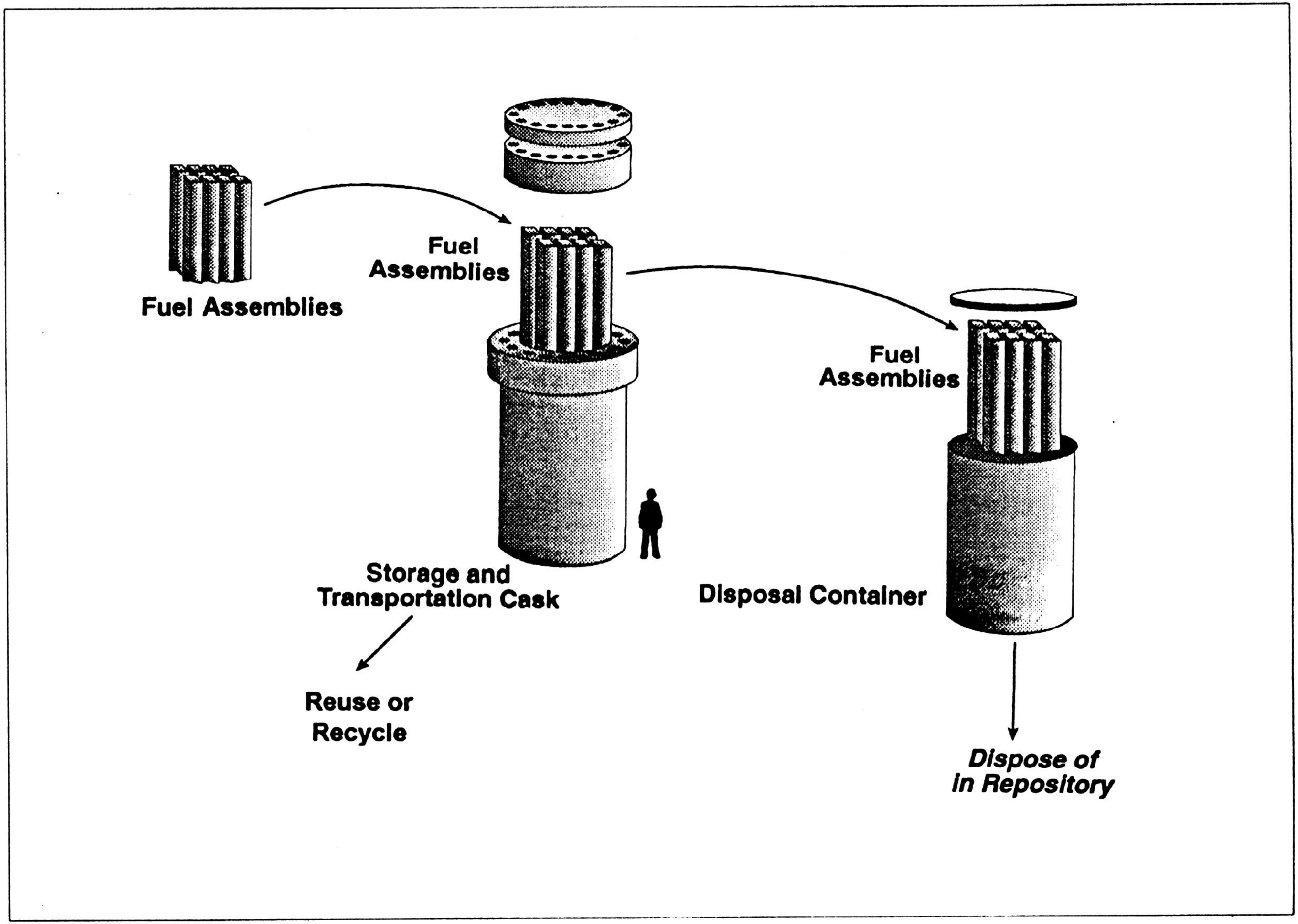

FIGURE D.9 Storage, Transport, and Disposal for the Transportable Storage Cask System

pool or dry cell, and naval spent nuclear fuel assemblies would be transferred into the cask. The lid of the transportable storage cask would be sealed. The transportable storage cask would be decontaminated and moved to an on-site storage area. For shipment to a repository or centralized interim storage site, the cask would be placed on a railcar either at the dry storage location or returned to the location where it was loaded. Subsequently, it would be prepared for shipment to a repository or centralized interim storage site.

The Transportable Storage Cask Alternative would rely on rail transportation. All shipments to a repository or centralized interim storage site would be made by train, using commercial rail lines. Dedicated trains might be used when appropriate. At a repository, all naval spent nuclear fuel assemblies arriving in transportable storage casks would be transferred into large disposal containers within shielded transfer cells. The disposal containers would be decontaminated, as needed, before being moved underground for emplacement. The empty transportable storage casks would be shipped back to INEL by rail for reuse.

At the end of the program about 171 casks for the Transportable Storage Cask Alternative would be reused or radiologically decontaminated prior to recycling. It is expected from the cask design, which includes lead shielding material, that the lead would not be radiologically contaminated. The metal portions would be recycled following any radiological decontamination of surfaces. The disposal containers and naval spent nuclear fuel would be placed in a repository.

D.6 Dual-Purpose Canister Alternative

D.6.1 Technology and Related Hardware

The hardware requirements of the Dual-Purpose Canister Alternative would be similar to the Multi-Purpose Canister Alternative, except it was assumed that the dual-purpose canister would not be compatible with the disposal requirements specified in 10 CFR Part 60. Figure D.10 illustrates how dual-purpose canisters are loaded, stored, transported, and disposed of. For assessment purposes, the NUHOMS-MP187® (VECTRA Fuel Services 1993) was selected as an example design for a dual-purpose canister system. Containers similar to the one used for assessment purposes for this alternative may become available in the future and may be selected. The dual-purpose canister system would have a capacity slightly greater than that of the large multi-purpose canister. The canisters were assumed to be stored within horizontal concrete storage overpacks, as described for the Multi-Purpose Canister Alternative.

D.6.2 Handling, Storage, and Transportation Operations

Handling, storage, and transportation operations for the Dual-Purpose Canister Alternative would be similar to those described for the Multi-Purpose Canister Alternative (Section D.2.2). At INEL, dual-purpose canisters would be loaded from a water pool or dry cell in the manner described for multi-purpose canisters.

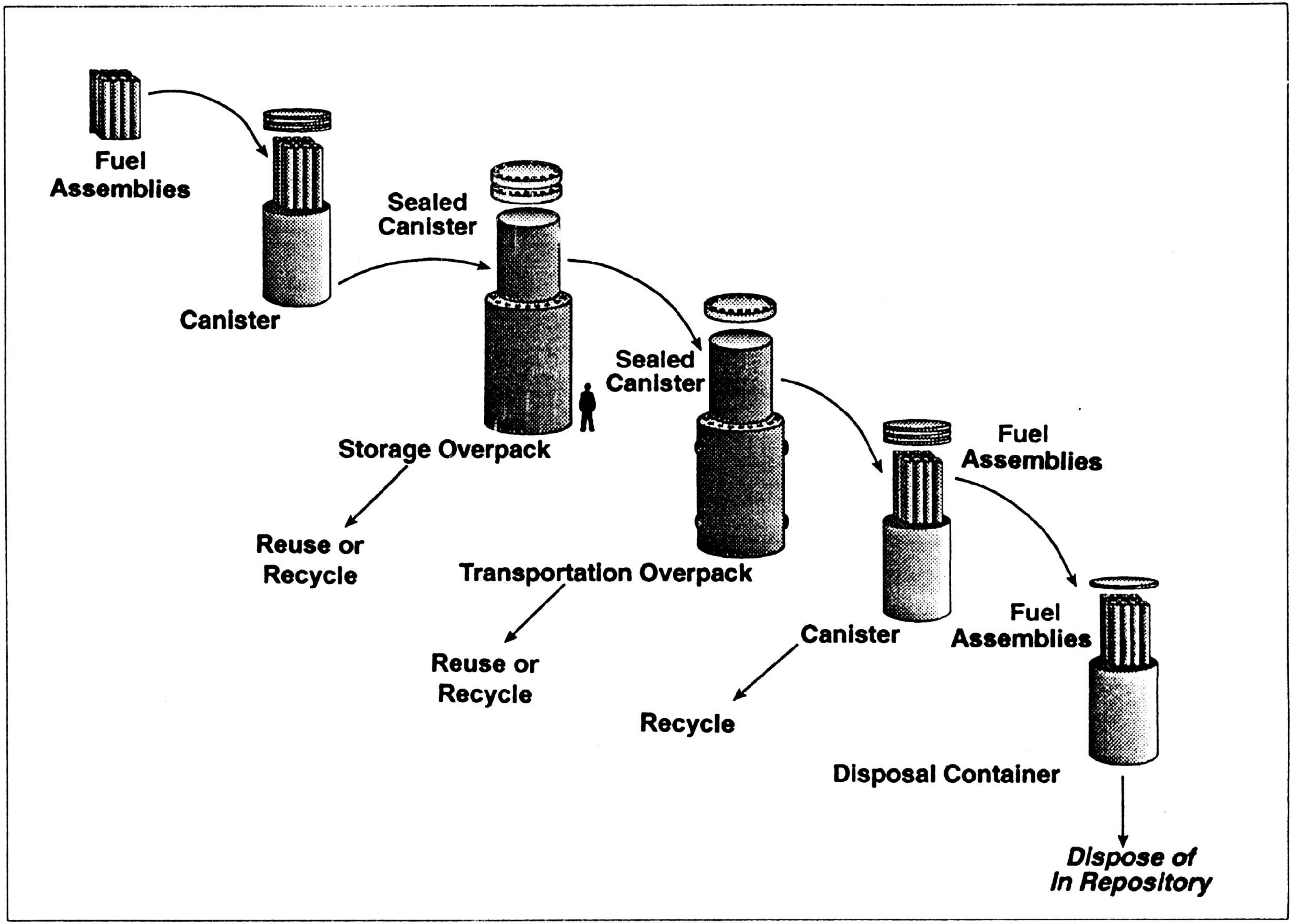

FIGURE D.10 Storage, Transport, and Disposal for the Dual-Purpose Canister System

The Dual-Purpose Canister Alternative would rely on rail transportation. All shipments to a repository or centralized interim storage site would be made by train, using commercial rail lines. Dedicated trains might be used when appropriate. At a repository, naval spent nuclear fuel assemblies arriving in dual-purpose canisters would be removed from the canisters and transferred into large disposal containers within shielded transfer cells. The disposal containers would be decontaminated, as needed, before being moved underground for emplacement. The empty dual-purpose canisters would be recycled or disposed of as low-level radioactive waste, as appropriate. The transportation overpack would be sent back to INEL for reuse.

At the end of the program about 345 canisters for the Dual-Purpose Canister Alternative would be reused or radiologically decontaminated prior to recycling. In addition 173 storage overpacks and 18 transportation overpacks would be prepared for recycling of metals including lead and disposal of the concrete as non-radiological solid waste. The disposal containers and naval spent nuclear fuel would be placed in a repository.

D.7 Small Multi-Purpose Canister Alternative

The Small Multi-Purpose Canister Alternative would be similar to the Multi-Purpose Canister Alternative (Section D.2), except that it would use a smaller, multi-purpose canister. This reduced capacity would limit the amount of fuel it could hold and would result in a greater number of handling operations at INEL and more shipments to the repository or centralized interim storage site. Although the smaller multi-purpose canisters would require more handling, handling operations may be accommodated better with smaller equipment (cranes, etc.). The small canisters would have lower thermal and radiation output which may also simplify handling operations and equipment.

For the Small Multi-Purpose Canister Alternative about 264 storage overpacks and 30 transportation overpacks would be managed at the end of the program in the same manner as the Multi-Purpose Alternative describes.