

REQUIREMENTS FOR NORMAL AND OFF-NORMAL CONDITIONS OF STORAGE

The MPC uses multiple confinement barriers provided by the fuel cladding and the MPC enclosure vessel to assure that there is no release of radioactive material to the environment. Chapter 3 shows that all confinement boundary components are maintained within their Code-allowable stress limits during normal and off-normal storage conditions. Chapter 4 shows that the peak confinement boundary component temperatures and pressures are within the design basis limits for all normal and off-normal conditions of storage. Section 7.1 provides a discussion as to how the Holtec MPC design, welding, testing and inspection requirements meet the guidance of ISG-18 such that leakage from the confinement boundary may be considered non-credible. Since the MPC confinement vessel remains intact, and the design bases temperatures and pressure are not exceeded, leakage from the MPC confinement boundary is not credible during normal and off-normal conditions of storage.

CONFINEMENT REQUIREMENTS FOR HYPOTHETICAL ACCIDENT  
CONDITIONS

The MPC uses redundant confinement closures to assure that there is no release of radioactive materials, including fission gases, volatiles, fuel fines or crud, for postulated storage accident conditions. The analyses presented in Chapters 3 and 11 demonstrate that the MPC remains intact during all postulated accident conditions, including the associated increased internal pressure due to decay heat generated by the stored fuel. The MPC is designed, fabricated, and tested in accordance with the applicable requirements of ASME, Section III, Subsection NB [7.1.1], with certain NRC-approved alternatives as listed in Table 2.2.15. Section 7.1 provides a discussion as to how the Holtec MPC design, welding, testing and inspection requirements meet the guidance of ISG-18 such that leakage from the confinement boundary may be considered non-credible. In summary, there is no mechanistic failure that results in a breach of and associated leakage of radioactive material from the MPC confinement boundary.

7.4            REFERENCES

- [7.0.1] 10CFR72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste.
- [7.0.2] NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems", January, 1997.
- [7.0.3] ANSI N14.5-1997, American National Standard for Radioactive Materials – Leakage Tests on Packages for Shipment”.
- [7.1.1] American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code, Section III, Division 1, Subsection NB, Class 1 Components, 1995 Edition.
- [7.1.2] Interim Staff Guidance 18, “The Design/Qualification of Final Closure Welds on Austenitic Stainless Steel Canisters as Confinement Boundary for Spent Fuel Storage and Containment Boundary for Spent Fuel Transportation,” May 2003.
- [7.2.1] Deleted
- [7.2.2] Deleted.
- [7.3.1] Deleted.
- [7.3.2] Deleted.
- [7.3.3] Deleted.
- [7.3.4] Deleted.
- [7.3.5] Deleted.
- [7.3.6] Deleted.
- [7.3.7] Deleted.
- [7.3.8] Deleted.
- [7.3.9] Deleted.
- [7.3.10] Deleted.

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HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL

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Rev. 5

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HI-STORM 100 FSAR  
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## SUPPLEMENT 7.I

### CONFINEMENT EVALUATION OF THE HI-STORM 100U SYSTEM

#### 7.1.1 INTRODUCTION

This supplement is solely focused on providing an evaluation of confinement safety of the HI-STORM 100U System. The evaluation presented herein supplements those evaluations of the HI-STORM 100 and HI-STORM 100S overpacks contained in the main body of Chapter 7 of this FSAR.

#### 7.1.2 ACCEPTANCE CRITERIA

The acceptance criteria for confinement evaluations for the HI-STORM 100U system are identical to the criteria for the HI-STORM 100 System analyzed in the main body of Chapter 7.

#### 7.1.3 EVALUATION

The HI-STORM 100U System differs from the HI-STORM 100 System only in the use of a different storage overpack, the HI-STORM 100U vertical ventilated module (VVM). All MPCs are identical between the two systems.

In summary, as the MPC design is unchanged by the addition of the HI-STORM 100U VVM, the material presented in Section 7.1.6 certifying that the MPC meets the criteria of ISG-18, is valid for the HI-STORM 100U System. Therefore, leakage from the MPC confinement boundary is not considered credible and no confinement analysis is required.

## CHAPTER 8: OPERATING PROCEDURES†

### 8.0 INTRODUCTION:

This chapter outlines the loading, unloading, and recovery procedures for the HI-STORM 100 System for storage operations. The procedures provided in this chapter are prescriptive to the extent that they provide the basis and general guidance for plant personnel in preparing detailed, written, site-specific, loading, handling, storage and unloading procedures. Users may add, modify the sequence of, perform in parallel, or delete steps as necessary provided that the intent of this guidance is met and the requirements of the CoC are met. The information provided in this chapter meets all requirements of NUREG-1536 [8.0.1].

Section 8.1 provides the guidance for loading the HI-STORM 100 System in the spent fuel pool. Section 8.2 provides the procedures for ISFSI operations and general guidance for performing maintenance and responding to abnormal events. Responses to abnormal events that may occur during normal loading operations are provided with the procedure steps. Section 8.3 provides the procedure for unloading the HI-STORM 100 System in the spent fuel pool. Section 8.4 provides the guidance for MPC transfer to the HI-STAR 100 Overpack for transport or storage. Section 8.4 can also be used for recovery of a breached MPC for transport or storage. Section 8.5 provides the guidance for transfer of the MPC into HI-STORM from the HI-STAR 100 transport overpack. Equipment specific operating details such as Vacuum Drying System, valve manipulation and Transporter operation are not within the scope of this FSAR and will be provided to users based on the specific equipment selected by the users and the configuration of the site.

The procedures contained herein describe acceptable methods for performing HI-STORM 100 loading and unloading operations. Unless otherwise stated, references to the HI-STORM 100 apply equally to the HI-STORM 100, 100S and 100S Version B. Users may alter these procedures to allow alternate methods and operations to be performed in parallel or out of sequence as long as the general intent of the procedure is met. In the figures following each section, acceptable configurations of rigging, piping, and instrumentation are shown. In some cases, the figures are artist's renditions. Users may select alternate configurations, equipment and methodology to accommodate their specific needs provided that the intent of this guidance is met and the requirements of the CoC are met. All rigging should be approved by the user's load handling authority prior to use. User-developed procedures and the design and operation of any alternate equipment must be reviewed by the Certificate holder prior to implementation.

Licensees (Users) will utilize the procedures provided in this chapter, equipment-specific operating instructions, and plant working procedures and apply them to develop the site specific written, loading and unloading procedures.

The loading and unloading procedures in Section 8.1 and 8.3 can also be appropriately revised

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† This chapter has been prepared in the format and section organization set forth in Regulatory Guide 3.61. However, the material content of this chapter also fulfills the requirements of NUREG 1536. Pagination and numbering of sections, figures, and tables are consistent with the convention set down in Chapter 1, Section 1.0, herein. Finally, all terms-of-art used in this chapter are consistent with the terminology of the glossary (Table 1.0.1) and component nomenclature of the Bill-of-Materials (Section 1.5).

into written site-specific procedures to allow dry loading and unloading of the system in a hot cell or other remote handling facility. The Dry Transfer Facility (DTF) loading and unloading procedures are essentially the same with respect to loading removing moisture, and inerting, of the MPC. The dry transfer facility shall develop the appropriate site-specific procedures as part of the DTF facility license.

Tables 8.1.1 through 8.1.4 provide the handling weights for each of the HI-STORM 100 System major components and the loads to be lifted during various phases of the operation of the HI-STORM 100 System. Users shall take appropriate actions to ensure that the lift weights do not exceed user-supplied lifting equipment rated loads. Table 8.1.5 provides the HI-STORM 100 System bolt torque and sequencing requirements. Table 8.1.6 provides an operational description of the HI-STORM 100 System ancillary equipment along with its safety designation, where applicable. Fuel assembly selection and verification shall be performed by the licensee in accordance with written, approved procedures which ensure that only SNF assemblies authorized in the Certificate of Compliance and as defined in Section 2.1.9 are loaded into the HI-STORM 100 System.

In addition to the requirements set forth in the CoC, users will be required to develop or modify existing programs and procedures to account for the operation of an ISFSI. Written procedures will be required to be developed or modified to account for such things as nondestructive examination (NDE) of the MPC welds, handling and storage of items and components identified as Important to Safety, 10CFR72.48 [8.1.1] programs, specialized instrument calibration, special nuclear material accountability at the ISFSI, security modifications, fuel handling procedures, training and emergency response, equipment and process qualifications. Users are required to take necessary actions to prevent boiling of the water in the MPC. This may be accomplished by performing a site-specific analysis to identify a time limitation to ensure that water boiling will not occur in the MPC prior to the initiation of draining operations. Chapter 4 of the FSAR provides some sample time limits for the time to initiation of draining for various spent fuel pool water temperatures using design basis heat loads. Users are also required to take necessary actions to prevent the fuel cladding from exceeding temperature limits during drying operations and during handling of the MPC in the HI-TRAC transfer cask. Section 4.5 of the FSAR provides requirements on the necessary actions, if any, based on the heat load of the MPC.

Table 8.1.7 summarizes some of the instrumentation used to load and unload the HI-STORM 100 System. Tables 8.1.8, 8.1.9, and 8.1.10 provide sample receipt inspection checklists for the HI-STORM 100 overpack, the MPC, and the HI-TRAC Transfer Cask, respectively. Users may develop site-specific receipt inspection checklists, as required for their equipment. Fuel handling shall be performed in accordance with written site-specific procedures.

## **Technical and Safety Basis for Loading and Unloading Procedures**

The procedures herein are developed for the loading, storage, unloading, and recovery of spent fuel in the HI-STORM 100 System. The activities involved in loading of spent fuel in a canister system, if not carefully performed, may present risks. The design of the HI-STORM 100 System, including these procedures, the ancillary equipment and the Technical Specifications, serve to minimize risks and mitigate consequences of potential events. To summarize, consideration is given in the loading and unloading systems and procedures to the potential events listed in Table 8.0.1.

The primary objective is to reduce the risk of occurrence and/or to mitigate the consequences of the event. The procedures contain Notes, Warnings, and Cautions to notify the operators to upcoming situations and provide additional information as needed. The Notes, Warnings and Cautions are purposely bolded and boxed and immediately precede the applicable steps.

In the event of an extreme abnormal condition (e.g., cask drop or tip-over event) the user shall have appropriate procedural guidance to respond to the situation. As a minimum, the procedures shall address establishing emergency action levels, implementation of emergency action program, establishment of personnel exclusions zones, monitoring of radiological conditions, actions to mitigate or prevent the release of radioactive materials, and recovery planning and execution and reporting to the appropriate regulatory agencies, as required.

Table 8.0.1  
OPERATIONAL CONSIDERATIONS

<b>POTENTIAL EVENTS</b>	<b>METHODS USED TO ADDRESS EVENT</b>	<b>COMMENTS/ REFERENCES</b>
Cask Drop During Handling Operations	Cask lifting and handling equipment is designed to ANSI N14.6. Procedural guidance is given for cask handling, inspection of lifting equipment, and proper engagement to the trunnions.	See Section 8.1.2.
Cask Tip-Over Prior to welding of the MPC lid	The Lid Retention System is available to secure the MPC lid during movement between the spent fuel pool and the cask preparation area.	See Section 8.1.5. See Figure 8.1.15.
Contamination of the MPC external shell	The annulus seal, pool lid, and Annulus Overpressure System minimize the potential for the MPC external shell to become contaminated from contact with the spent fuel pool water.	See Figures 8.1.13 and 8.1.14.
Contamination spread from cask process system exhausts	Processing systems are equipped with exhausts that can be directed to the plant's processing systems.	See Figures 8.1.19-8.1.22.
Damage to fuel assembly cladding from oxidation	Fuel assemblies are never subjected to air or oxygen during loading and unloading operations.	See Section 8.1.5, and Section 8.3.3
Damage to Vacuum Drying System vacuum gauges from positive pressure	Vacuum Drying System is separate from pressurized gas and water systems.	See Figure 8.1.22 and 8.1.23.
Ignition of combustible mixtures of gas (e.g., hydrogen) during MPC lid welding or cutting	The area around MPC lid shall be appropriately monitored for combustible gases prior to, and during welding or cutting activities. The space below the MPC lid shall be purged prior to, and during these activities.	See Section 8.1.5 and Section 8.3.3.

Table 8.0.1  
OPERATIONAL CONSIDERATIONS  
(CONTINUED)

<b>POTENTIAL EVENTS</b>	<b>METHODS USED TO ADDRESS EVENT</b>	<b>COMMENTS/ REFERENCES</b>
Excess dose from failed fuel assemblies	MPC gas sampling allows operators to determine the integrity of the fuel cladding prior to opening the MPC. This allows preparation and planning for failed fuel. The RVOAs allow the vent and drain ports to be operated like valves and prevent the need to hot tap into the penetrations during unloading operation.	See Figure 8.1.16 and Section 8.3.3.
Excess dose to operators	The procedures provide ALARA Notes and Warnings when radiological conditions may change.	See ALARA Notes and Warnings throughout the procedures.
Excess generation of radioactive waste	The HI-STORM system uses process systems that minimize the amount of radioactive waste generated. Such features include smooth surfaces for ease of decontamination efforts, prevention of avoidable contamination, and procedural guidance to reduce decontamination requirements. Where possible, items are installed by hand and require no tools.	Examples: HI-TRAC bottom protective cover, bolt plugs in empty holes, pre-wetting of components.
Fuel assembly misloading event	Procedural guidance is given to perform assembly selection verification and a post-loading visual verification of assembly identification prior to installation of the MPC lid.	See Section 8.1.4.
Incomplete moisture removal from MPC	The vacuum drying process reduces the MPC pressure in stages to prevent the formation of ice. Vacuum is held below 3 torr for 30 minutes with the vacuum pump isolated to assure dryness. If the forced helium dehydration process used, the temperature of the gas exiting the demoisurizer is held below 21 °F for a minimum of 30 minutes. The TS require the surveillance requirement for moisture removal to be met before entering transport operations	See Section 8.1.5

Table 8.0.1  
OPERATIONAL CONSIDERATIONS  
(CONTINUED)

<b>POTENTIAL EVENTS</b>	<b>METHODS USED TO ADDRESS EVENT</b>	<b>COMMENTS/ REFERENCES</b>
Incorrect MPC lid installation	Procedural guidance is given to visually verify correct MPC lid installation prior to HI-TRAC removal from the spent fuel pool.	See Section 8.1.5.
Load Drop	Rigging diagrams and procedural guidance are provided for all lifts. Component weights are provided in Tables 8.1.1 through 8.1.4.	See Figures 8.1.6, 8.1.7, 8.1.9, 8.1.25 and 8.1.27. See Tables 8.1.1 through 8.1.4.
Over-pressurization of MPC during loading and unloading	Pressure relief valves in the water and gas processing systems limit the MPC pressure to acceptable levels.	See Figures 8.1.20, 8.1.21, 8.1.23 and 8.3.3.
Overstressing MPC lift lugs from side loading	The MPC is upended using the upending frame.	See Figure 8.1.6 and Section 8.1.2.
Overweight cask lift	Procedural guidance is given to alert operators to potential overweight lifts.	See Section 8.1.7 for example. See Tables 8.1.1 through 8.1.4.
Personnel contamination by cutting/grinding activities	Procedural guidance is given to warn operators prior to cutting or grinding activities.	See Section 8.1.5 and Section 8.3.3.
Transfer cask carrying hot particles out of the spent fuel pool	Procedural guidance is given to scan the transfer cask prior to removal from the spent fuel pool.	See Section 8.1.3 and Section 8.1.5.
Unplanned or uncontrolled release of radioactive materials	The MPC vent and drain ports are equipped with metal-to-metal seals to minimize the leakage during moisture removal and helium backfill operations. Unlike elastomer seals, the metal seals resist degradation due to temperature and radiation and allow future access to the MPC ports without hot tapping. The RVOAs allow the port to be opened and closed like a valve so gas sampling may be performed.	See Figure 8.1.11 and 8.1.16. See Section 8.3.3.

## 8.1 PROCEDURE FOR LOADING THE HI-STORM 100 SYSTEM IN THE SPENT FUEL POOL

### 8.1.1 Overview of Loading Operations:

The HI-STORM 100 System is used to load, transfer and store spent fuel. Specific steps are performed to prepare the HI-STORM 100 System for fuel loading, to load the fuel, to prepare the system for storage and to place it in storage at an ISFSI. The MPC transfer may be performed in the cask receiving area, at the ISFSI, or any other location deemed appropriate by the user. HI-TRAC and/or HI-STORM may be transferred between the ISFSI and the fuel loading facility using a specially designed transporter, heavy haul transfer trailer, or any other load handling equipment designed for such applications as long as the lift height restrictions are met (lift height restrictions apply only to suspended forms of transport). Users shall develop detailed written procedures to control on-site transport operations. Section 8.1.2 provides the general procedures for rigging and handling of the HI-STORM overpack and HI-TRAC transfer cask. Figure 8.1.1 shows a general flow diagram of the HI-STORM loading operations.

Refer to the boxes of Figure 8.1.2 for the following description. At the start of loading operations, an empty MPC is upended (Box 1). The empty MPC is raised and inserted into HI-TRAC (Box 2). The annulus is filled with plant demineralized water<sup>†</sup> and the MPC is filled with either spent fuel pool water or plant demineralized water (borated as required) (Box 3). An inflatable seal is installed in the upper end of the annulus between the MPC and HI-TRAC to prevent spent fuel pool water from contaminating the exterior surface of the MPC. HI-TRAC and the MPC are then raised and lowered into the spent fuel pool for fuel loading using the lift yoke (Box 4). Pre-selected assemblies are loaded into the MPC and a visual verification of the assembly identification is performed (Box 5).

While still underwater, a thick shielded lid (the MPC lid) is installed using either slings attached to the lift yoke or the optional Lid Retention System (Box 6). The lift yoke remotely engages to the HI-TRAC lifting trunnions to lift the HI-TRAC and loaded MPC close to the spent fuel pool surface (Box 7). When radiation dose rate measurements confirm that it is safe to remove the HI-TRAC from the spent fuel pool, the cask is removed from the spent fuel pool. If the Lid Retention System is being used, the HI-TRAC top lid bolts are installed to secure the MPC lid for the transfer to the cask preparation area. The lift yoke and HI-TRAC are sprayed with demineralized water to help remove contamination as they are removed from the spent fuel pool.

HI-TRAC is placed in the designated preparation area and the Lift Yoke and Lid Retention System (if utilized) are removed. The next phase of decontamination is then performed. The top surfaces of the MPC lid and the upper flange of HI-TRAC are decontaminated. The Temporary Shield Ring (if utilized) is installed and filled with water and the neutron shield jacket is filled with water (if drained). The inflatable annulus seal is removed, and the annulus shield (if utilized) is installed. The Temporary Shield Ring provides additional personnel shielding around the top of the HI-TRAC during MPC closure operations. The annulus shield provides additional personnel shielding at the top of the annulus and also prevents small items from being dropped

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<sup>†</sup> Users may substitute domestic water in each step where demineralized water is specified.

into the annulus. Dose rates are measured at the MPC lid to ensure that the dose rates are within expected values.

The MPC water level is lowered slightly, the MPC is vented, and the MPC lid is seal welded using the automated welding system (Box 8). Visual examinations are performed on the tack welds. Liquid penetrant (PT) examinations are performed on the root and final passes. An ultrasonic or multi-layer PT examination is performed on the MPC Lid-to-Shell weld to ensure that the weld is satisfactory. As an alternative to volumetric examination of the MPC lid-to-shell weld, a multi-layer PT is performed including one intermediate examination after approximately every three-eighth inch of weld depth. The MPC Lid-to-Shell weld is then pressure tested followed by an additional liquid penetrant examination performed on the MPC Lid-to-Shell weld to verify structural integrity. To calculate the helium backfill requirements for the MPC (if the backfill is based upon helium mass or volume measurements), the free volume inside the MPC must first be determined. This free volume may be determined by measuring the volume of water displaced or any other suitable means.

Depending upon the burn-up or decay heat load of the fuel to be loaded in the MPC, moisture is removed from the MPC using either a vacuum drying system or forced helium dehydration system. For MPCs without high burn-up fuel and with sufficiently low decay heat, the vacuum drying system may be connected to the MPC and used to remove all liquid water from the MPC in a stepped evacuation process (Box 9). A stepped evacuation process is used to preclude the formation of ice in the MPC and vacuum drying system lines. The internal pressure is reduced to below 3 torr and held for 30 minutes to ensure that all liquid water is removed.

For high-burn-up fuel or MPCs with high decay heat, or as an alternative for MPCs without high burn-up fuel and with lower decay heat, a forced helium dehydration system is utilized to remove residual moisture from the MPC. Gas is circulated through the MPC to evaporate and remove moisture. The residual moisture is condensed until no additional moisture remains in the MPC. The temperature of the gas exiting the system demister is maintained below 21 °F for a minimum of 30 minutes to ensure that all liquid water is removed.

Following MPC moisture removal, the MPC is backfilled with a predetermined amount of helium gas. If the MPC contains high burn-up fuel or has a sufficiently high decay heat load, then a Supplemental Cooling System (SCS) is connected to the HI-TRAC annulus prior to helium backfill and is used to circulate coolant to maintain fuel cladding temperatures below ISG-11 Rev. 3 limits (See Figure 2.C.1). The helium backfill ensures adequate heat transfer during storage, and provides an inert atmosphere for long-term fuel integrity. Cover plates are installed and seal welded over the MPC vent and drain ports with liquid penetrant examinations performed on the root and final passes (for multi-pass welds) (Box 10). The cover plate welds are then leak tested.

The MPC closure ring is then placed on the MPC and dose rates are measured at the MPC lid to ensure that the dose rates are within expected values. The closure ring is aligned, tacked in place and seal welded providing redundant closure of the MPC confinement boundary closure welds. Tack welds are visually examined, and the root and final welds are inspected using the liquid penetrant examination technique to ensure weld integrity.

The annulus shield (if utilized) is removed and the remaining water in the annulus is drained. The Temporary Shield Ring (if utilized) is drained and removed. The MPC lid and accessible areas of the top of the MPC shell are smeared for removable contamination. HI-TRAC top lid<sup>3</sup> is installed and the bolts are torqued (Box 11). HI-TRAC surface dose rates are measured in accordance with the technical specifications. The MPC lift cleats are installed on the MPC lid. The MPC lift cleats are the primary lifting point on the MPC. MPC slings are installed between the MPC lift cleats and the lift yoke (Box 12).

If the HI-TRAC 125 is being used, the transfer lid is attached to the HI-TRAC as follows. The HI-TRAC is positioned above the transfer slide to prepare for bottom lid replacement. The transfer slide consists of an adjustable-height rolling carriage and a pair of channel tracks. The transfer slide supports the transfer step which is used to position the two lids at the same elevation and creates a tight seam between the two lids to eliminate radiation streaming. The overhead crane is shut down to prevent inadvertent operation. The transfer slide carriage is raised to support the pool lid while the bottom lid bolts are removed. The transfer slide then lowers the pool lid and replaces the pool lid with the transfer lid. The carriage is raised and the bottom lid bolts are replaced. The MPC lift cleats and slings support the MPC during the transfer operations. Following the transfer, the MPC slings are disconnected and HI-TRAC is positioned for MPC transfer into HI-STORM.

MPC transfer may be performed inside or outside the fuel building (Box 13). Similarly, HI-TRAC and HI-STORM may be transferred to the ISFSI in several different ways (Box 14 and 15). The empty HI-STORM overpack is inspected and positioned with the lid removed. Vent duct shield inserts<sup>1</sup> are installed in the HI-STORM exit vent ducts. The vent duct shield inserts prevent radiation streaming from the HI-STORM Overpack as the MPC is lowered past the exit vents. If the HI-TRAC 100D or 125D is used, the mating device is positioned on top of the HI-STORM. The HI-TRAC is placed on top of HI-STORM. An alignment device (or mating device in the case of HI-TRAC 100D and 125D) helps guide HI-TRAC during this operation<sup>2</sup>. The MPC may be lowered using the MPC downloader, the main crane hook or other similar devices. The MPC downloader (if used) may be attached to the HI-TRAC lid or mounted to the overhead lifting device. The MPC slings are attached to the MPC lift cleats.

If used, the Supplemental Cooling System (SCS) will be disconnected from the HI-TRAC and the HI-TRAC annulus drained, prior to transfer of the MPC from the HI-TRAC to the HI-STORM. If the transfer doors are used (i.e. not the HI-TRAC 100D or 125D), the MPC is raised slightly, the transfer lid door locking pins are removed and the doors are opened. If the HI-TRAC 100D or 125D is used, the pool lid is removed and the mating device drawer is opened. Optional trim plates may be installed on the top and bottom of both doors (or drawer for HI-TRAC 100D and 125D) and secured using hand clamps. The trim plates eliminate radiation streaming above and below the doors (drawer). The MPC is lowered into HI-STORM.

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<sup>1</sup> Vent duct shield inserts are only used on the HI-STORM 100.

<sup>2</sup> The alignment guide may be configured in many different ways to accommodate the specific sites. See Table 8.1.6.

<sup>3</sup> Users with the optional HI-TRAC Lid Spacer shall modify steps in their procedures to install and remove the spacer together with top lid

Following verification that the MPC is fully lowered, the MPC slings are disconnected from the lifting device and lowered onto the MPC lid. The trim plates are removed, the doors (or drawer) are closed. The empty HI-TRAC must be removed with the doors open when the HI-STORM 100S is used to prevent interference with the lift cleats and slings. HI-TRAC is removed from on top of HI-STORM. The MPC slings and MPC lift cleats are removed. Hole plugs are installed in the empty MPC lifting holes to fill the voids left by the lift cleat bolts. The alignment device (or mating device with pool lid for HI-TRAC 100D and 125D) and vent duct shield inserts (if used) are removed, and the HI-STORM lid is installed. The exit vent gamma shield cross plates, temperature elements (if used) and vent screens are installed. The HI-STORM lid studs and nuts or lid closure bolts are installed. HI-STORM surface dose rates are measured in accordance with the technical specifications. The HI-STORM is secured to the transporter (as applicable) and moved to the ISFSI pad. The HI-STORM Overpack and HI-TRAC transfer cask may be moved using a number of methods as long as the lifting equipment requirements are met. For sites with high seismic conditions, the HI-STORM 100A is anchored to the ISFSI. Once located at the storage pad, the inlet vent gamma shield cross plates are installed. Finally, the temperature elements and their instrument connections are installed (if used), and the air temperature rise testing (if required) is performed to ensure that the system is functioning within its design parameters.

#### 8.1.2 HI-TRAC and HI-STORM Receiving and Handling Operations

**Note:**

HI-TRAC may be received and handled in several different configurations and may be transported on-site in a horizontal or vertical orientation. This section provides general guidance for HI-TRAC and HI-STORM handling. Site-specific procedures shall specify the required operational sequences based on the handling configuration at the sites.

##### 1. Vertical Handling of HI-TRAC:

- a. Verify that the lift yoke initial acceptance testing and any periodic recertifications are current, in accordance with ANSI N14.6.
- b. Visually inspect the lifting device (lift yoke or lift links) and the lifting trunnions for gouges, cracks, deformation or other indications of damage. Replace or repair damaged components as necessary.
- c. Engage the lift yoke to the lifting trunnions. See Figure 8.1.3.
- d. Apply lifting tension to the lift yoke and verify proper engagement of the lift yoke.

**Note:**

Refer to the site's heavy load handling procedures for lift height, load path, floor loading and other applicable load handling requirements.

**Warning:**

When lifting the loaded HI-TRAC with only the pool lid, the HI-TRAC should be carried as low as practicable. This minimizes the dose rates due to radiation scattering from the floor. Personnel should remain clear of the area and the HI-TRAC should be placed in position as soon as practicable.

- e. Raise HI-TRAC and position it accordingly.
2. Upending of HI-TRAC in the Transfer Frame:
    - a. Position HI-TRAC under the lifting device. Refer to Step 1, above.
    - b. If necessary, remove the missile shield from the HI-TRAC Transfer Frame. See Figure 8.1.4.
    - c. Verify that the lift yoke initial acceptance testing and any periodic recertifications are current, in accordance with ANSI N14.6.
    - d. Visually inspect the lift yoke and the lifting trunnions for gouges, cracks, deformation or other indications of damage. Repair or replace damaged components as necessary.
    - e. Deleted.
    - f. Engage the lift yoke to the lifting trunnions. (The use of a ratchet strap or similar device to restrain the lift yoke arms is recommended during HI-TRAC Upending Operations.) See Figure 8.1.3.
    - g. Apply lifting tension to the lift yoke and verify proper engagement of the lift yoke.
    - h. Slowly rotate HI-TRAC to the vertical position keeping all rigging as close to vertical as practicable. See Figure 8.1.4.
    - i. If used, lift the pocket trunnions clear of the Transfer Frame rotation trunnions.
  3. Downending of HI-TRAC in the Transfer Frame:

**ALARA Warning:**

Due to the higher dose rates under the pool and transfer lid, use of auxiliary shielding should be considered when downending a loaded HI-TRAC.

- a. Position the Transfer Frame under the lifting device.
- b. Verify that the lift yoke initial acceptance testing and any periodic recertifications are current, in accordance with ANSI N14.6.
- c. Visually inspect the lift yoke and the lifting trunnions for gouges, cracks, deformation or other indications of damage. Repair or replace damaged components as necessary.
- d. Deleted.
- e. Deleted.

- f. Engage the lift yoke to the lifting trunnions. (The use of a ratchet strap or similar device to restrain the lift yoke arms is recommended during HI-TRAC Downending Operations.) See Figure 8.1.3.
- g. Apply lifting tension to the lift yoke and verify proper lift yoke engagement.
- h. Position the pocket trunnions to receive the Transfer Frame rotation trunnions. See Figure 8.1.4 (Not used for HI-TRAC 100D and 125D).
- i. Slowly rotate HI-TRAC to the horizontal position keeping all rigging as close to vertical as practicable.
- j. Disengage the lift yoke.

4. Horizontal Handling of HI-TRAC in the Transfer Frame:

**ALARA Warning:**

Due to the higher dose rates under the pool and transfer lid, use of auxiliary shielding should be considered when handling a loaded HI-TRAC in horizontal orientation.

- a. Verify that the Transfer Frame is secured to the transport vehicle as necessary.
- b. Downend HI-TRAC on the Transfer Frame per Step 3, if necessary.
- c. If necessary, install the HI-TRAC missile Shield on the HI-STAR 100 Transfer Frame (See Figure 8.1.4).

5. Vertical Handling of HI-STORM:

**Note:**

The HI-STORM 100 Overpack may be lifted with a special lifting device that engages the overpack anchor blocks with threaded studs and connects to a cask transporter, crane, or similar equipment. The device is designed in accordance with ANSI N14.6.

- a. Visually inspect the HI-STORM lifting device for gouges, cracks, deformation or other indications of damage.
- b. Visually inspect the transporter lifting attachments for gouges, cracks, deformation or other indications of damage.
- c. If necessary, attach the transporter's lifting device to the transporter and HI-STORM.
- d. Raise and position HI-STORM accordingly. See Figure 8.1.5.

6. Empty MPC Installation in HI-TRAC:

**Note:**

To avoid side loading the MPC lift lugs, the MPC must be upended in the MPC Upending Frame (or equivalent). See Figure 8.1.6.

- a. If necessary, rinse off any road dirt with water. Remove any foreign objects from the MPC internals.

- b. If necessary, upend the MPC as follows:
1. Visually inspect the MPC Upending Frame for gouges, cracks, deformation or other indications of damage. Repair or replace damaged components as necessary.
  2. Install the MPC on the Upending Frame. Make sure that the banding straps are secure around the MPC shell. See Figure 8.1.6.
  3. Inspect the Upending Frame slings in accordance with the site's lifting equipment inspection procedures. Rig the slings around the bar in a choker configuration to the outside of the cleats. See Figure 8.1.6.
  4. Attach the MPC upper end slings of the Upending Frame to the main overhead lifting device. Attach the bottom-end slings to a secondary lifting device (or a chain fall attached to the primary lifting device) (See Figure 8.1.6).
  5. Raise the MPC in the Upending Frame.

**Warning:**

The Upending Frame corner should be kept close to the ground during the upending process.

6. Slowly lift the upper end of the Upending Frame while lowering the bottom end of the Upending Frame.
  7. When the MPC approaches the vertical orientation, tension on the lower slings may be released.
  8. Place the MPC in a vertical orientation.
  9. Disconnect the MPC straps and disconnect the rigging.
- c. Install the MPC in HI-TRAC as follows:
1. Install the four point lift sling to the lift lugs inside the MPC. See Figure 8.1.7.
  2. Raise and place the MPC inside HI-TRAC.

**Note:**

An alignment punch mark is provided on HI-TRAC and the top edge of the MPC. Similar marks are provided on the MPC lid and closure ring. See Figure 8.1.8.

3. Rotate the MPC so the alignment marks agree and seat the MPC inside HI-TRAC. Disconnect the MPC rigging or the MPC lift rig.

8.1.3 HI-TRAC and MPC Receipt Inspection and Loading Preparation

**Note:**

Receipt inspection, installation of the empty MPC in the HI-TRAC, and lower fuel spacer installation may occur at any location or be performed at any time prior to complete submersion in the spent fuel pool as long as appropriate steps are taken to prevent contaminating the exterior of the MPC or interior of the HI-TRAC.

**ALARA Note:**

A bottom protective cover may be attached to HI-TRAC pool lid bottom. This will help prevent imbedding contaminated particles in HI-TRAC bottom surface and ease the decontamination effort.

1. Place HI-TRAC in the cask receiving area. Perform appropriate contamination and security surveillances, as required.
2. If necessary, remove HI-TRAC Top Lid by removing the top lid bolts and using the lift sling. See Figure 8.1.9 for rigging.
  - a. Rinse off any road dirt with water. Inspect all cavity locations for foreign objects. Remove any foreign objects.
  - b. Perform a radiological survey of the inside of HI-TRAC to verify there is no residual contamination from previous uses of the cask.
3. Disconnect the rigging.
4. Store the Top Lid and bolts in a site-approved location.
5. If necessary, configure HI-TRAC with the pool lid as follows:

**ALARA Warning:**

The bottom lid replacement as described below may be performed only on an empty HI-TRAC.

- a. Inspect the seal on the pool lid for cuts, cracks, gaps and general condition. Replace the seal if necessary.
- b. Remove the bottom lid bolts and store them temporarily.
- c. Raise the empty HI-TRAC and position it on top of the pool lid.
- d. Inspect the pool lid bolts for general condition. Replace worn or damaged bolts with new bolts.
- e. Install the pool lid bolts. See Table 8.1.5 for torque requirements.
- f. If necessary, thread the drain connector pipe to the pool lid.
- g. Store the HI-TRAC Transfer Lid in a site-approved location.

6. At the site's discretion, perform an MPC receipt inspection and cleanliness inspection in accordance with a site-specific inspection checklist.
7. Install the MPC inside HI-TRAC and place HI-TRAC in the designated preparation area. See Section 8.1.2.

**Note:**

Upper fuel spacers are fuel-type specific. Not all fuel types require fuel spacers. Upper fuel spacer installation may occur any time prior to MPC lid installation.

8. Install the upper fuel spacers in the MPC lid as follows:

**Warning:**

Never work under a suspended load.

- a. Position the MPC lid on supports to allow access to the underside of the MPC lid.
  - b. Thread the fuel spacers into the holes provided on the underside of the MPC lid. See Figure 8.1.10 and Table 8.1.5 for torque requirements.
  - c. Install threaded plugs in the MPC lid where and when spacers will not be installed, if necessary. See Table 8.1.5 for torque requirements.
9. At the user's discretion perform an MPC lid and closure ring fit test:

**Note:**

It may be necessary to perform the MPC installation and inspection in a location that has sufficient crane clearance to perform the operation.

- a. Visually inspect the MPC lid rigging (See Figure 8.1.9).
- b. At the user's discretion, raise the MPC lid such that the drain line can be installed. Install the drain line to the underside of the MPC lid. See Figure 8.1.11.

**Note:**

The MPC Shell is relatively flexible compared to the MPC Lid and may create areas of local contact that impede Lid insertion in the Shell. Grinding of the MPC Lid below the minimum diameter on the drawing is permitted to alleviate interference with the MPC Shell in areas of localized contact. If the amount of material removed from the surface exceeds 1/8", the surface shall be examined by a liquid penetrant method (NB-2546). The weld prep for the Lid-to-Shell weld shall be maintained after grinding.

- c. Align the MPC lid and lift yoke so the drain line will be positioned in the MPC drain location. See Figure 8.1.12. Install the MPC lid. Verify that the MPC lid fit and weld prep are in accordance with the design drawings.

**ALARA Note:**

The closure ring is installed by hand. Some grinding may be required on the closure ring to adjust the fit.

- d. Install, align and fit-up the closure ring.

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- e. Verify that closure ring fit and weld prep are in accordance with the fabrication drawings or the approved design drawings.
  - f. Remove the closure ring, vent and drain port cover plates and the MPC lid. Disconnect the drain line. Store these components in an approved plant storage location.
10. At the user's discretion, perform an MPC vent and drain port cover plate fit test and verify that the weld prep is in accordance with the approved fabrication drawings.

**Note:**

Fuel spacers are fuel-type specific. Not all fuel types require fuel spacers. Lower fuel spacers are set in the MPC cells manually. No restraining devices are used.

11. Install lower fuel spacers in the MPC (if necessary). See Figure 8.1.10.
12. Fill the MPC and annulus as follows:
- a. Fill the annulus with plant demineralized water to just below the inflatable seal seating surface.

**Caution:**

Do not use any sharp tools or instruments to install the inflatable seal. Some air in the inflatable seal helps in the installation.

- b. Manually insert the inflatable annulus seal around the MPC. See Figure 8.1.13.
- c. Ensure that the seal is uniformly positioned in the annulus area.
- d. Inflate the seal.
- e. Visually inspect the seal to ensure that it is properly seated in the annulus. Deflate, adjust and inflate the seal as necessary. Replace the seal as necessary.

**ALARA Note:**

Bolt plugs installed, and/or waterproof tape over empty bolt holes, reduce the time required for decontamination.

13. At the user's discretion, install HI-TRAC top lid bolt plugs and/or apply waterproof tape over any empty bolt holes.

**ALARA Note:**

Keeping the water level below the top of the MPC prevents splashing during handling.

14. Fill the MPC with either demineralized water or spent fuel pool water to approximately 12 inches below the top of the MPC shell. Refer to Tables 2.1.14 and 2.1.16 for boron concentration requirements.
15. If necessary for plant crane capacity limitations, drain the water from the neutron shield jacket. See Tables 8.1.1 through 8.1.4 as applicable.
16. Place HI-TRAC in the spent fuel pool as follows:

**ALARA Note:**

The term "Spent Fuel Pool" is used generically to refer to the users designated cask loading location. The optional Annulus Overpressure System is used to provide further protection against MPC external shell contamination during in-pool operations.

- a. If used, fill the Annulus Overpressure System lines and reservoir with demineralized water and close the reservoir valve. Attach the Annulus Overpressure System to the HI-TRAC. See Figure 8.1.14.
- b. Verify spent fuel pool for boron concentration requirements in accordance with Tables 2.1.14 and 2.1.16.
- c. Engage the lift yoke to HI-TRAC lifting trunnions and position HI-TRAC over the cask loading area with the basket aligned to the orientation of the spent fuel racks.

**ALARA Note:**

Wetting the components that enter the spent fuel pool may reduce the amount of decontamination work to be performed later.

- d. Wet the surfaces of HI-TRAC and lift yoke with plant demineralized water while slowly lowering HI-TRAC into the spent fuel pool.
- e. When the top of the HI-TRAC reaches the elevation of the reservoir, open the Annulus Overpressure System reservoir valve. Maintain the reservoir water level at approximately 3/4 full the entire time the cask is in the spent fuel pool.
- f. Place HI-TRAC on the floor of the cask loading area and disengage the lift yoke. Visually verify that the lift yoke is fully disengaged. Remove the lift yoke from the spent fuel pool while spraying the crane cables and yoke with plant demineralized water.
- g. Observe the annulus seal for signs of air leakage. If leakage is observed (by the steady flow of bubbles emanating from one or more discrete locations) then immediately remove the HI-TRAC from the spent fuel pool and repair or replace the seal.

8.1.4 MPC Fuel Loading

**Note:**

An underwater camera or other suitable viewing device may be used for monitoring underwater operations.

**Note:**

When loading MPCs requiring soluble boron, the boron concentration of the water shall be checked in accordance with Tables 2.1.14 and 2.1.16 before and during operations with fuel and water in the MPC.

1. Perform a fuel assembly selection verification using plant fuel records to ensure that only fuel assemblies that meet all the conditions for loading as specified in Section 2.1.9 have been selected for loading into the MPC.

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2. Load the pre-selected fuel assemblies into the MPC in accordance with the approved fuel loading pattern.
3. Perform a post-loading visual verification of the assembly identification to confirm that the serial numbers match the approved fuel loading pattern.

#### 8.1.5 MPC Closure

**Note:**

The user may elect to use the Lid Retention System (See Figure 8.1.15) to assist in the installation of the MPC lid and lift yoke, and to provide the means to secure the MPC lid in the event of a drop accident during loaded cask handling operations outside of the spent fuel pool. The user is responsible for evaluating the additional weight imposed on the cask, lift yoke, crane and floor prior to use. See Tables 8.1.1 through 8.1.4 as applicable. The following guidance describes installation of the MPC lid using the lift yoke. The MPC lid may also be installed separately.

Depending on facility configuration, users may elect to perform MPC closure operations with the HI-TRAC partially submerged in the spent fuel pool. If opted, operations involving removal of the HI-TRAC from the spent fuel pool shall be sequenced accordingly.

1. Remove the HI-TRAC from the spent fuel pool as follows:
  - a. Visually inspect the MPC lid rigging or Lid Retention System in accordance with site-approved rigging procedures. Attach the MPC lid to the lift yoke so that MPC lid, drain line and trunnions will be in relative alignment. Raise the MPC lid and adjust the rigging so the MPC lid hangs level as necessary.
  - b. Install the drain line to the underside of the MPC lid. See Figure 8.1.17.
  - c. Align the MPC lid and lift yoke so the drain line will be positioned in the MPC drain location and the cask trunnions will also engage. See Figure 8.1.11 and 8.1.17.

**ALARA Note:**

Pre-wetting the components that enter the spent fuel pool may reduce the amount of decontamination work to be performed later.

- d. Slowly lower the MPC lid into the pool and insert the drain line into the drain access location and visually verify that the drain line is correctly oriented. See Figure 8.1.12.
- e. Lower the MPC lid while monitoring for any hang-up of the drain line. If the drain line becomes kinked or disfigured for any reason, remove the MPC lid and replace the drain line.

**Note:**

The outer diameter of the MPC lid will seat flush with the top edge of the MPC shell when properly installed. Once the MPC lid is installed, the HI-TRAC /MPC removal from the spent fuel pool should proceed in a continuous manner to minimize the rise in MPC water temperature.

- f. Seat the MPC lid in the MPC and visually verify that the lid is properly installed.
- g. Engage the lift yoke to HI-TRAC lifting trunnions.
- h. Apply a slight tension to the lift yoke and visually verify proper engagement of the lift yoke to the lifting trunnions.

**ALARA Note:**

Activated debris may have settled on the top face of HI-TRAC and MPC during fuel loading. The cask top surface should be kept under water until a preliminary dose rate scan clears the cask for removal. Users are responsible for any water dilution considerations.

- i. Raise HI-TRAC until the MPC lid is just below the surface of the spent fuel pool. Survey the area above the cask lid to check for hot particles. Remove any activated or highly radioactive particles from HI-TRAC or MPC.
- j. Visually verify that the MPC lid is properly seated. Lower HI-TRAC, reinstall the lid, and repeat as necessary.
- k. Install the Lid Retention System bolts if the lid retention system is used.
- l. Continue to raise the HI-TRAC under the direction of the plant's radiological control personnel. Continue rinsing the surfaces with demineralized water. When the top of the HI-TRAC reaches the same elevation as the reservoir, close the Annulus Overpressure System reservoir valve (if used). See Figure 8.1.14.

**Caution:**

Users are required to take necessary actions to prevent boiling of the water in the MPC. This may be accomplished by performing a site-specific analysis to identify a time limitation to ensure that water boiling will not occur in the MPC prior to the initiation of draining operations. Chapter 4 of the FSAR provides some sample time limits for the time to initiation of draining for various spent fuel pool water temperatures using design basis heat loads. These time limits may be adopted if the user chooses not to perform a site-specific analysis. If time limitations are imposed, users shall have appropriate procedures and equipment to take action. Users shall initiate a course of action which involves initiating and maintaining forced water circulation at a required flow rate through the MPC. Any site-specific analysis shall identify the methods to respond should it become likely that the imposed time limit could be exceeded. Refer to Tables 2.1.14 and 2.1.16 for boron concentration requirements whenever water is added to the loaded MPC.

- m. Remove HI-TRAC from the spent fuel pool while spraying the surfaces with plant demineralized water. Record the time.

**ALARA Note:**

Decontamination of HI-TRAC bottom should be performed using remote cleaning methods, covering or other methods to minimize personnel exposure. The bottom lid decontamination may be deferred to a convenient and practical time and location. Any initial decontamination should only be sufficient to preclude spread of contamination within the fuel building.

- n. Decontaminate HI-TRAC bottom and HI-TRAC exterior surfaces including the pool lid bottom. Remove the bottom protective cover, if used.
- o. If used, disconnect the Annulus Overpressure System from the HI-TRAC See Figure 8.1.14.
- p. Set HI-TRAC in the designated cask preparation area.

**Note:**

If the transfer cask is expected to be operated in an environment below 32 °F, the water jacket shall be filled with an ethylene glycol solution (25% ethylene glycol). Otherwise, the jacket shall be filled with demineralized water. Depending on weight limitations, the neutron shield jacket may remain filled (with pure water or 25% ethylene glycol solution, as required). Users shall evaluate the cask weights to ensure that cask trunnion, lifting devices and equipment load limitations are not exceeded.

- q. If previously drained, fill the neutron shield jacket with plant demineralized water or an ethylene glycol solution (25% ethylene glycol) as necessary.
- r. Disconnect the lifting slings or Lid Retention System (if used) from the MPC lid and disengage the lift yoke. Decontaminate and store these items in an approved storage location.

**Warning:**

MPC lid dose rates are measured to ensure that dose rates are within expected values. Dose rates exceeding the expected values could indicate that fuel assemblies not meeting the CoC may have been loaded.

- s. Measure the dose rates at the MPC lid and verify that the combined gamma and neutron dose is below expected values.
- t. Perform decontamination and a dose rate/contamination survey of HI-TRAC.
- u. Prepare the MPC annulus for MPC lid welding as follows:

**ALARA Note:**

If the Temporary Shield Ring is not used, some form of gamma shielding (e.g., lead bricks or blankets) should be placed in the trunnion recess areas of the HI-TRAC water jacket to eliminate the localized hot spot.

- v. Decontaminate the area around the HI-TRAC top flange and install the Temporary Shield Ring, (if used). See Figure 8.1.18.

**ALARA Note:**

The water in the HI-TRAC-to-MPC annulus provides personnel shielding. The level should be checked periodically and refilled accordingly.

- w. Attach the drain line to the HI-TRAC drain port and lower the annulus water level approximately 6 inches.

- 2. Prepare for MPC lid welding as follows:

**Note:**

The following steps use two identical Removable Valve Operating Assemblies (RVOAs) (See Figure 8.1.16) to engage the MPC vent and drain ports. The MPC vent and drain ports are equipped with metal-to-metal seals to minimize leakage during drying, and to withstand the long-term effects of temperature and radiation. The RVOAs allow the vent and drain ports to be operated like valves and prevent the need to hot tap into the penetrations during unloading operations. The RVOAs are purposely not installed until the cask is removed from the spent fuel pool to reduce the amount of decontamination.

**Note:**

The vent and drain ports are opened by pushing the RVOA handle down to engage the square nut on the cap and turning the handle fully in the counter-clockwise direction. The handle will not turn once the port is fully open. Similarly, the vent and drain ports are closed by turning the handle fully in the clockwise direction. The ports are closed when the handle cannot be turned further.

**Note:**

Steps involving preparation for welding may occur in parallel as long as precautions are taken to prevent contamination of the annulus.

- a. Clean the vent and drain ports to remove any dirt. Install the RVOAs (See Figure 8.1.16) to the vent and drain ports leaving caps open.

**ALARA Warning:**

Personnel should remain clear of the drain hoses any time water is being pumped or purged from the MPC. Assembly crud, suspended in the water, may create a radiation hazard to workers. Controlling the amount of water pumped from the MPC prior to welding keeps the fuel assembly cladding covered with water yet still allows room for thermal expansion.

**Caution:**

Personnel shall ensure that the water level is not lowered below the top of the fuel cladding to avoid exposing the fuel to atmosphere to prevent oxidation and potential fuel damage.

- b. Attach the water pump to the drain port (See Figure 8.1.19) and lower the water level to keep moisture away from the weld region.
- c. Disconnect the water pump.

- d. Carefully decontaminate the MPC lid top surface and the shell area above the inflatable seal
- e. Deflate and remove the inflatable annulus seal.

**ALARA Note:**

The MPC exterior shell survey is performed to evaluate the performance of the inflatable annulus seal. Indications of contamination could require the MPC to be unloaded. In the event that the MPC shell is contaminated, users must decontaminate the annulus. If the contamination cannot be reduced to acceptable levels, the MPC must be returned to the spent fuel pool and unloaded. The MPC may then be removed and the external shell decontaminated.

- f. Survey the MPC lid top surfaces and the accessible areas of the top three inches of the MPC.

**ALARA Note:**

The annulus shield is used to prevent objects from being dropped into the annulus and helps reduce dose rates directly above the annulus region. The annulus shield is hand installed and requires no tools.

- g. Install the annulus shield. See Figure 8.1.13.

3. Weld the MPC lid as follows:

**ALARA Warning:**

Grinding of MPC welds may create the potential for contamination. All grinding activities shall be performed under the direction of radiation protection personnel.

**ALARA Warning:**

It may be necessary to rotate or reposition the MPC lid slightly to achieve uniform weld gap and lid alignment. A punch mark is located on the outer edge of the MPC lid and shell. These marks are aligned with the alignment mark on the top edge of the HI-TRAC Transfer Cask (See Figure 8.1.8). If necessary, the MPC lid lift should be performed using a hand operated chain fall to closely control the lift to allow rotation and repositioning by hand. If the chain fall is hung from the crane hook, the crane should be tagged out of service to prevent inadvertent use during this operation. Continuous radiation monitoring is recommended.

- a. If necessary center the lid in the MPC shell using a hand-operated chain fall.

**Note:**

The MPC is equipped with lid shims that serve to close the gap in the joint for MPC lid closure weld.

- b. As necessary, install the MPC lid shims around the MPC lid to make the weld gap uniform.

**ALARA Note:**

The AWS Baseplate shield is used to further reduce the dose rates to the operators working around the top cask surfaces.

- c. Install the Automated Welding System (AWS) baseplate shield. See Figure 8.1.9 for rigging.
- d. If used, install the Automated Welding System Robot.

**Note:**

It may be necessary to remove the RVOAs to allow access for the automated welding system. In this event, the vent and drain port caps should be opened to allow for thermal expansion of the MPC water.

**Note:**

Combustible gas monitoring as described in Step 3e and the associated Caution block are required by the HI-STORM 100 CoC (CoC Appendix B (and B-100U), Section 3.8) and may not be deleted without prior NRC approval via CoC amendment.

**Caution:**

Oxidation of neutron absorber panels contained in the MPC may create hydrogen gas while the MPC is filled with water. Additionally, radiolysis of the water may occur in high flux conditions creating additional combustible gases. Appropriate monitoring for combustible gas concentrations shall be performed prior to, and during MPC lid welding operations per CoC Appendix B (and B-100U), Section 3.8. The space below the MPC lid shall be purged with inert gas prior to, and during MPC lid welding operations to provide additional assurance that flammable gas concentrations will not develop in this space.

- e. Perform combustible gas monitoring and purge the space under the MPC lid with an inert gas to ensure that there is no combustible mixture present in the welding area.
  - f. Perform the MPC lid-to-shell weld and NDE with approved procedures (See 9.1 and Table 2.2.15).
  - g. Deleted.
  - h. Deleted.
  - i. Deleted.
  - j. Deleted.
4. Perform MPC Lid-to-Shell weld pressure testing as follows:

**ALARA Note:**

Testing is performed before the MPC is drained for ALARA reasons. A weld repair is a lower dose activity if water remains inside the MPC.

- a. If performing a hydrostatic test, attach the drain line to the vent port and route the drain line to the spent fuel pool or the plant liquid radwaste system and connect the pressurized water supply to the drain port. If performing a pneumatic test, attach the pressure supply and vent line to the vent port and route the vent line to a suitable radwaste connection. See Figure 8.1.20 for the pressure test arrangement.

**ALARA Warning:**

Water flowing from the MPC may carry activated particles and fuel particles. Apply appropriate ALARA practices around the drain line.

- b. If performing a hydrostatic test, fill the MPC with either spent fuel pool water or plant demineralized water until water is observed flowing out of the vent port drain hose. Refer to Tables 2.1.14 and 2.1.16 for boron concentration requirements.
  - c. Perform the pressure test of the MPC as follows:
    - 1. Close the drain/vent valve and pressurize the MPC to minimum test pressure listed in Table 2.0.1 +5/-0 psig.
    - 2. Close the supply valve and monitor the pressure for a minimum of 10 minutes. The pressure shall not drop below the minimum test pressure during the performance of the test.
    - 3. Following the 10-minute hold period, visually examine the MPC lid-to-shell weld for leakage of water (hydrostatic test) or helium using a bubble test solution (pneumatic test). The acceptance criterion is no observable leakage.
  - d. Release the MPC internal pressure, disconnect the inlet line and drain line from the vent and drain port RVOAs leaving the vent and drain port caps open.
    - 1. Repeat the liquid penetrant examination on the MPC lid final pass.
  - e. Repair any weld defects in accordance with the site's approved weld repair procedures. Re-perform the Ultrasonic (if necessary), PT, and pressure tests if weld repair is performed.
5. Drain the MPC as follows:

**Caution:**

This Caution block is required by the HI-STORM 100 CoC (CoC Appendix B, Section 3.4.10 and Appendix B-100U, Section 3.4.12) and may not be deleted without prior NRC approval via CoC amendment. To prevent the oxidation of the fuel the MPC interior shall be filled with helium or another suitable inert gas to avoid exposing the fuel to oxidizing agents while at elevated temperatures. Exposing fuel at elevated temperatures to oxidizing agents can lead to deleterious oxidation of the fuel.

**Caution:**

For MPCs above a threshold heat load (see Technical Specifications), vacuum drying is subject to a time limit starting at completion of this operational step and ending when helium backfill is initiated. Do not begin this step for such an MPC unless intending to proceed shortly thereafter to vacuum drying. In addition, users should ensure procedures for cycling are in place if time limits are applicable. The procedures should include the required backfilling pressure, hold times, and duration of subsequent vacuum drying cycles, understanding that the number of cycles is limited to ten per ISG-11 Rev. 3.

- a. Attach the drain line to the vent port and route the drain line to the spent fuel pool or the plant liquid radwaste system. See Figure 8.1.20.

**ALARA Warning:**

Water flowing from the MPC may carry activated particles and fuel particles. Apply appropriate ALARA practices around the drain line.

- b. Attach the water fill line to the drain port and fill the MPC with either spent fuel pool water or plant demineralized water until water is observed flowing out of the drain line.
- c. Disconnect the water fill and drain lines from the MPC leaving the vent port valve open to allow for thermal expansion of the MPC water.

**ALARA Warning:**

Dose rates will rise as water is drained from the MPC. Continuous dose rate monitoring is recommended.

- d. Attach a regulated helium or nitrogen supply to the vent port.
- e. Attach a drain line to the drain port shown on Figure 8.1.21.
- f. Deleted
- g. Verify the correct pressure on the gas supply.
- h. Open the gas supply valve and record the time at the start of MPC draining.

**Note:**

An optional warming pad may be placed under the HI-TRAC Transfer Cask to replace the heat lost during the evaporation process of MPC drying. This may be used at the user's discretion for older and colder fuel assemblies to reduce vacuum drying times.

- i. Start the warming pad, if used.

**Note:**

Users may continue to purge the MPC to remove as much water as possible.

- j. Drain the water out of the MPC until water ceases to flow out of the drain line. Shut the gas supply valve. See Figure 8.1.21.
- k. Deleted.

- l. Disconnect the gas supply line from the MPC.
- m. Disconnect the drain line from the MPC.

**Note:**

Vacuum drying or moisture removal using FHD (for high burn-up fuel or high decay heat) is performed to remove moisture and oxidizing gasses from the MPC. This ensures a suitable environment for long-term storage of spent fuel assemblies and ensures that the MPC pressure remains within design limits. The vacuum drying process described herein reduces the MPC internal pressure in stages. Dropping the internal pressure too quickly may cause the formation of ice in the fittings. Ice formation could result in incomplete removal of moisture from the MPC. The moisture removal process limits bulk MPC temperatures by continuously circulating gas through the MPC. Section 8.1.5 Steps 6a through q are used for the vacuum drying method of drying and backfill. Section 8.1.5 Steps 7a through i are used for the FHD method of drying and backfill.

6. Dry and Backfill the MPC as follows (Vacuum Drying Method):

**Note:**

During vacuum drying, the annulus between the MPC and the HI-TRAC must be maintained full of water. Water lost due to evaporation or boiling must be replaced to maintain the water level. For MPCs above a threshold heat load (see Technical Specifications), water must be continuously flowed through the annulus at sufficient rate to ensure a water temperature at the outlet of the annulus below 125°F. Confirmation of water outlet temperature must be confirmed via measurement.

- a. Fill the annulus between the MPC and HI-TRAC with clean water. The water level must be within 6" of the top of the MPC. If required by MPC heat load connect a source of water with sufficient flow to maintain an exit water temperature below 125°F during all vacuum drying operations.
- b. Attach the drying system (VDS) to the vent and drain port RVOAs. See Figure 8.1.22a. Other equipment configurations that achieve the same results may also be used.

**Note:**

The vacuum drying system may be configured with an optional fore-line condenser. Other equipment configurations that achieve the same results may be used.

**Note:**

To prevent freezing of water, the MPC internal pressure should be lowered in incremental steps. The vacuum drying system pressure will remain at about 30 torr until most of the liquid water has been removed from the MPC.

- c. Open the VDS suction valve and reduce the MPC pressure to below 3 torr.
- d. Shut the VDS valves and verify a stable MPC pressure on the vacuum gage.

**Note:**

The MPC pressure may rise due to the presence of water in the MPC. The dryness test may need to be repeated several times until all the water has been removed. Leaks in the vacuum drying system, damage to the vacuum pump, and improper vacuum gauge calibration may cause repeated failure of the dryness verification test. These conditions should be checked as part of the corrective actions if repeated failure of the dryness verification test is occurring.

- e. Perform the MPC drying pressure test in accordance with the technical specifications. If MPC vacuum drying acceptance criteria are not met during allowable time, backfill the MPC cavity with helium to a pressure of  $\geq 0.5$  atm and reset the vacuum drying time (see Technical Specifications).
- f. Close the vent and drain port valves.
- g. Disconnect the VDS from the MPC.
- h. Stop the warming pad, if used.
- i. Close the drain port RVOA cap and remove the drain port RVOA.

**Note:**

Helium backfill shall be in accordance with the Technical Specification using 99.995% (minimum) purity. Other equipment configurations that achieve the same results may be used.

- j. Set the helium bottle regulator pressure to the appropriate pressure.
- k. Purge the Helium Backfill System to remove oxygen from the lines.
- l. Attach the Helium Backfill System to the vent port as shown on Figure 8.1.23 and open the vent port.
- m. Slowly open the helium supply valve while monitoring the pressure rise in the MPC.

**Note:**

If helium bottles need to be replaced, the bottle valve needs to be closed and the entire regulator assembly transferred to the new bottle.

- n. Carefully backfill the MPC in accordance with the technical specifications
  - o. If used, stop the water flow through the annulus between the MPC and HI-TRAC. Drain the water from the annulus
  - p. Disconnect the helium backfill system from the MPC.
  - q. Close the vent port RVOA and disconnect the vent port RVOA.
7. Dry and Backfill the MPC as follows (FHD Method):

**Note:**

Helium backfill shall be in accordance with the Technical Specification using 99.995% (minimum) purity. When using the FHD system to perform the MPC helium backfill, the FHD system shall be evacuated or purged and the system operated with 99.995% (minimum) purity helium.

**Note:**

MPC internal pressure during FHD operation must be  $\leq 75$  psia, to comply with Technical Specification.

**Caution:**

MPC internal pressure during FHD operation may be less than the Technical Specification minimum backfill requirement. In the event of an FHD System failure where the MPC internal pressure is below the Technical Specification limit, the MPC internal pressure must be raised to at least 5 atm (73.5 psia) to place the MPC in an acceptable condition.

- a. Attach the moisture removal system to the vent and drain port RVOAs. See Figure 8.1.22b. Other equipment configurations that achieve the same results may also be used.
  - b. Circulate the drying gas through the MPC while monitoring the circulating gas for moisture. Collect and remove the moisture from the system as necessary.
  - c. Continue the monitoring and moisture removal until LCO 3.1.1 is met for MPC dryness.
  - d. Continue operation of the FHD system with the demister on.
  - e. While monitoring the temperatures into and out of the MPC, adjust the helium pressure in the MPC to provide a fill pressure as required by the technical specifications.
  - f. Open the FHD bypass line.
  - g. Close the vent and drain port RVOAs.
  - h. Shutdown the FHD system and disconnect it from the RVOAs.
  - i. Remove the vent and drain port RVOAs.
8. Weld the vent and drain port cover plates as follows:

**Note:**

The process provided herein may be modified to perform actions in parallel.

- a. Wipe the inside area of the vent and drain port recesses to dry and clean the surfaces.
- b. Place the cover plate over the vent port recess.
- c. Deleted.

**Note:**

ASME Boiler and Pressure Vessel Code [8.1.3], Section V, Article 6 provides the liquid penetrant inspection methods. The acceptance standards for liquid penetrant examination shall be in accordance with ASME Boiler and Pressure Vessel Code, Section III, Subsection NB, Article NB-5350 as specified on the Design Drawings. ASME Code, Section III, Subsection NB, Article NB-4450 provides acceptable requirements for weld repair. NDE personnel shall be qualified per the requirements of Section V of the Code or site-specific program.

- d. Weld cover plate and perform NDE on the cover plate with approved procedures (See 9.1 and Table 2.2.15)
- e. Repair and weld defects in accordance with the site's approved code weld repair procedures.
- f. Perform a helium leakage rate test on the cover plate welds. (See 9.1 and Table 2.2.15). Acceptance Criteria are defined in Technical Specification LCO 3.1.1.
- g. Repair any weld defects in accordance with the site's approved code weld repair procedures.
- h. Deleted.
- i. Repeat for the drain port cover plate.

9. Perform a leakage test of the MPC vent and drain port cover plates as follows:

**Note:**

The leakage detector may detect residual helium in the atmosphere from the helium injection process. If the leakage tests detect a leak, the area should be blown clear with compressed air or nitrogen and the location should be retested.

**Note:**

The following process provides a high concentration of helium gas in the cavity. Other methods that ensure a high concentration of helium gas are also acceptable.

- a. If necessary, remove the cover plate set screws.
- b. Flush the cavity with helium to remove the air and immediately install the set screws recessed ¼ inch below the top of the cover plate.
- c. Plug weld the recess above each set screw to complete the penetration closure welding.

**Note:**

ASME Boiler and Pressure Vessel Code [8.1.3], Section V, Article 6 provides the liquid penetrant inspection methods. The acceptance standards for liquid penetrant examination shall be in accordance with ASME Boiler and Pressure Vessel Code, Section III, Subsection NB, Article NB-5350 as specified on the Design Drawings. ASME Code, Section III, Subsection NB, Article NB-4450 provides acceptable requirements for weld repair. NDE personnel shall be qualified per the requirements of Section V of the Code or site-specific program.

- d. Perform a liquid penetrant examination on the plug weld.

- e. Flush the area around the vent and drain cover plates with compressed air or nitrogen to remove any residual helium gas.
- f. Perform a helium leakage rate test of vent and drain cover plate welds in accordance with the Mass Spectrometer Leak Detector (MSLD) manufacturer's instructions and ANSI N14.5 [8.1.2]. The MPC Helium Leak Rate acceptance criteria is provided in the Technical Specification LCO 3.1.1.
- g. Repair any weld defects in accordance with the site's approved code weld repair procedures. Re-perform the leakage test as required.

10. Weld the MPC closure ring as follows:

**ALARA Note:**

The closure ring is installed by hand. No tools are required. Localized grinding to achieve the desired fit and weld prep are allowed.

- a. Install and align the closure ring. See Figure 8.1.8.
- b. Weld the closure ring to the MPC shell and the MPC lid, and perform NDE with approved procedures (See 9.1 and Table 2.2.15).
- c. Deleted.
- d. Deleted.
- e. Deleted.
- f. Deleted.
- g. Deleted.
- h. Deleted.
- i. Deleted.
- j. If necessary, remove the AWS. See Figure 8.1.7 for rigging.

8.1.6 Preparation for Storage

**ALARA Warning:**

Dose rates will rise around the top of the annulus as water is drained from the annulus. Apply appropriate ALARA practices.

**Caution:**

Limitations for the handling an MPC containing high burn-up fuel in a HI-TRAC are evaluated and established on a canister basis to ensure that acceptable cladding temperatures are not exceeded. Refer to FSAR Section 4.5 for guidance.

**Note:**

For an MPC containing high burn-up fuel assemblies, the Supplemental Cooling System is required to be operated following completion of backfill (see Section 4.5). In the event of a Supplemental Cooling System failure, a HI-TRAC in a horizontal orientation must be placed into a vertical orientation within 24 hours.

1. Remove the annulus shield (if used) and store it in an approved plant storage location
2. If use of the SCS is not required, attach a drain line to the HI-TRAC and drain the remaining water from the annulus to the spent fuel pool or the plant liquid radwaste system.
3. Install HI-TRAC top lid as follows:

**Warning:**

When traversing the MPC with the HI-TRAC top lid using non-single-failure proof (or equivalent safety factors), the lid shall be kept less than 2 feet above the top surface of the MPC. This is performed to protect the MPC lid from a potential lid drop.

- a. Install HI-TRAC top lid. Inspect the bolts for general condition. Replace worn or damaged bolts with new bolts.
  - b. Install and torque the top lid bolts. See Table 8.1.5 for torque requirements.
  - c. Inspect the lift cleat bolts for general condition. Replace worn or damaged bolts with new bolts.
  - d. Install the MPC lift cleats and MPC slings. See Figure 8.1.24 and 8.1.25. See Table 8.1.5 for torque requirements.
  - e. Drain and remove the Temporary Shield Ring, if used.
4. Replace the pool lid with the transfer lid as follows (Not required for HI-TRAC 100D and 125D):

**ALARA Note:**

The transfer slide is used to perform the bottom lid replacement and eliminate the possibility of directly exposing the bottom of the MPC. The transfer slide consists of the guide rails, rollers, transfer step and carriage. The transfer slide carriage and jacks are powered and operated by remote control. The carriage consists of short-stroke hydraulic jacks that raise the carriage to support the weight of the bottom lid. The transfer step produces a tight level seam between the transfer lid and the pool lid to minimize radiation streaming. The transfer slide jacks do not have sufficient lift capability to support the entire weight of the HI-TRAC. This was selected specifically to limit floor loads. Users should designate a specific area that has sufficient room and support for performing this operation.

**Note:**

The following steps are performed to pretension the MPC slings.

- a. Lower the lift yoke and attach the MPC slings to the lift yoke. See Figure 8.1.25.
- b. Raise the lift yoke and engage the lift yoke to the HI-TRAC lifting trunnions.
- c. If necessary, position the transfer step and transfer lid adjacent to one another on the transfer slide carriage. See Figure 8.1.26. See Figure 8.1.9 for transfer step rigging.

- d. Deleted.
- e. Position HI-TRAC with the pool lid centered over the transfer step approximately one inch above the transfer step.
- f. Raise the transfer slide carriage so the transfer step is supporting the pool lid bottom. Remove the bottom lid bolts and store them temporarily.

**ALARA Warning:**

Clear all personnel away from the immediate operations area. The transfer slide carriage and jacks are remotely operated. The carriage has fine adjustment features to allow precise positioning of the lids.

- g. Lower the transfer carriage and position the transfer lid under HI-TRAC.
- h. Raise the transfer slide carriage to place the transfer lid against the HI-TRAC bottom lid bolting flange.
- i. Inspect the transfer lid bolts for general condition. Replace worn or damaged bolts with new bolts.
- j. Install the transfer lid bolts. See Table 8.1.5 for torque requirements.
- k. Raise and remove the HI-TRAC from the transfer slide.
- l. Disconnect the MPC slings and store them in an approved plant storage location.

**Warning:**

HI-TRAC dose rates are measured to ensure they are within expected values. Dose rates exceeding the expected values could indicate that fuel assemblies not meeting the CoC may have been loaded.

- 5. Perform the HI-TRAC surface dose rate measurements in accordance with the technical specifications. Measured dose rates must be compared with calculated dose rates that are consistent with the calculated doses that demonstrate compliance with the dose limits of 10 CFR 72.104(a).

**Note:**

HI-STORM receipt inspection and preparation may be performed independent of procedural sequence.

- 6. Perform a HI-STORM receipt inspection and cleanliness inspection in accordance with a site-approved inspection checklist, if required. See Figure 8.1.27 for HI-STORM lid rigging.

**Note:**

MPC transfer may be performed in the truck bay area, at the ISFSI, or any other location deemed appropriate by the licensee. The following steps describe the general transfer operations (See Figure 8.1.28). The HI-STORM may be positioned on an air pad, roller skid in the cask receiving area or at the ISFSI. The HI-STORM or HI-TRAC may be transferred to the ISFSI using a heavy haul transfer trailer, special transporter or other equipment specifically designed for such a function (See Figure 8.1.29) as long as the HI-TRAC and HI-STORM lifting requirements are not exceeded (See technical specifications). The licensee is responsible for assessing and controlling floor loading conditions during the MPC transfer operations. Installation of the lid, vent screen, and other components may vary according to the cask movement methods and location of MPC transfer.

**8.1.7 Placement of HI-STORM into Storage**

1. Position an empty HI-STORM module at the designated MPC transfer location. The HI-STORM may be positioned on the ground, on a de-energized air pad, on a roller skid, on a flatbed trailer or other special device designed for such purposes. If necessary, remove the exit vent screens and gamma shield cross plates, temperature elements and the HI-STORM lid. See Figure 8.1.28 for some of the various MPC transfer options.
  - a. Rinse off any road dirt with water. Inspect all cavity locations for foreign objects. Remove any foreign objects.
  - b. Transfer the HI-TRAC to the MPC transfer location.
2. De-energize the air pad or chock the vehicle wheels to prevent movement of the HI-STORM during MPC transfer and to maintain level, as required.

**ALARA Note:**

The HI-STORM vent duct shield inserts eliminate the streaming path created when the MPC is transferred past the exit vent ducts. Vent duct shield inserts are not used with the HI-STORM 100S.

3. Install the alignment device (or mating device for HI-TRAC 100D and 125D) and if necessary, install the HI-STORM vent duct shield inserts. See Figure 8.1.30.

**Caution:**

For MPCs with high burn-up fuel requiring supplemental cooling, the time to complete the transfer may be limited to prevent fuel cladding temperatures in excess of ISG-11 Rev. 3 limits. (See Section 4.5) All preparatory work related to the transfer should be completed prior to terminating the supplemental cooling operations.

4. If used, discontinue the supplemental cooling operations and disconnect the SCS. Drain water from the HI-TRAC annulus to an appropriate plant discharge point.
5. Position HI-TRAC above HI-STORM. See Figure 8.1.28.
6. Align HI-TRAC over HI-STORM (See Figure 8.1.31) and mate the overpacks.
7. If necessary, attach the MPC Downloader. See Figure 8.1.32.

8. Attach the MPC slings to the MPC lift cleats.
9. Raise the MPC slightly to remove the weight of the MPC from the transfer lid doors (or pool lid for HI-TRAC 100D and 125D and mating device)
10. If using the HI-TRAC 100D or 125D, unbolt the pool lid from the HI-TRAC.
11. Remove the transfer lid door (or mating device drawer) locking pins and open the doors (or drawer).

**ALARA Warning:**

MPC trim plates are used to eliminate the streaming path above and below the doors (or drawer). If trim plates are not used, personnel should remain clear of the immediate door area during MPC downloading since there may be some radiation streaming during MPC raising and lowering operations.

12. At the user's discretion, install trim plates to cover the gap above and below the door/drawer. The trim plates may be secured using hand clamps or any other method deemed suitable by the user. See Figure 8.1.33.
13. Lower the MPC into HI-STORM.
14. Disconnect the slings from the MPC lifting device and lower them onto the MPC lid.
15. Remove the trim plates (if used), and close the doors (or mating device drawer)

**ALARA Warning:**

Personnel should remain clear (to the maximum extent practicable) of the HI-STORM annulus when HI-TRAC is removed due to radiation streaming.

**Note:**

It may be necessary, due to site-specific circumstances, to move HI-STORM from under the empty HI-TRAC to install the HI-STORM lid, while inside the Part 50 facility. In these cases, users shall evaluate the specifics of their movements within the requirements of their Part 50 license.

16. Remove HI-TRAC from on top of HI-STORM.
17. Remove the MPC lift cleats and MPC slings and install hole plugs in the empty MPC bolt holes. See Table 8.1.5 for torque requirements.
18. Place HI-STORM in storage as follows:
  - a. Remove the alignment device (mating device with HI-TRAC pool lid for HI-TRAC 100D and 125D) and vent duct shield inserts (if used). See Figure 8.1.30.
  - b. Inspect the HI-STORM lid studs and nuts or lid closure bolts for general condition. Replace worn or damaged components with new ones.
  - c. If used, inspect the HI-STORM 100A anchor components for general condition. Replace worn or damaged components with new ones.
  - d. Deleted.

**Warning:**

Unless the lift is single failure proof (or equivalent safety factor) for the HI-STORM Lid, the lid shall be kept less than 2 feet above the top surface of the overpack. This is performed to protect the MPC lid from a potential HI-STORM 100 lid drop.

**Note:**

Shims may be used on the HI-STORM 100 lid studs. If used, the shims shall be positioned to ensure a radial gap of less than 1/8 inch around each stud. The method of cask movement will determine the most effective sequence for vent screen, lid, temperature element, and vent gamma shield cross plate installation.

- e. Install the HI-STORM lid and the lid studs and nuts or lid closure bolts. See Table 8.1.5 for bolting requirements. Install the HI-STORM 100 lid stud shims if necessary. See Figure 8.1.27 for rigging.
- f. Install the HI-STORM exit vent gamma shield cross plates, temperature elements (if used) and vent screens. See Table 8.1.5 for torque requirements. See Figure 8.1.34a.
- g. Remove the HI-STORM lid lifting device and install the hole plugs in the empty holes. Store the lifting device in an approved plant storage location. See Table 8.1.5 for torque requirements.

**Warning:**

HI-STORM dose rates are measured to ensure they are within expected values. Dose rates exceeding the expected values could indicate that fuel assemblies not meeting the CoC may have been loaded.

- h. Perform the HI-STORM surface dose rate measurements in accordance with the technical specifications. Measured dose rates must be compared with calculated dose rates that are consistent with the calculated doses that demonstrate compliance with the dose limits of 10 CFR 72.104(a).
- i. Secure HI-STORM to the transporter device as necessary.

**Note:**

The site-specific transport route conditions must satisfy the requirements of the technical specification.

- 19. Perform a transport route walkdown to ensure that the cask transport conditions are met.
- 20. Transfer the HI-STORM to its designated storage location at the appropriate pitch. See Figure 8.1.35.

**Note:**

Any jacking system shall have the provisions to ensure uniform loading of all four jacks during the lifting operation.

- a. If air pads were used, insert the HI-STORM lifting jacks and raise HI-STORM. See Figure 8.1.36. Remove the air pad.
  - b. Lower and remove the HI-STORM lifting jacks, if used.
  - c. For HI-STORM 100A overpack (anchored), perform the following:
    1. Inspect the anchor stud receptacles and verify that they are clean and ready for receipt of the anchor hardware.
    2. Align the overpack over the anchor location.
    3. Lower the overpack to the ground while adjusting for alignment.
    4. Install the anchor connecting hardware (See Table 8.1.5 for torque requirements).
21. Install the HI-STORM inlet vent gamma shield cross plates and vent screens. See Table 8.1.5 for torque requirements. See Figure 8.1.34.
22. Perform an air temperature rise test as follows for the first HI-STORM 100 System placed in service:

**Note:**

The air temperature rise test shall be performed between 5 and 7 days after installation of the HI-STORM 100 lid to allow thermal conditions to stabilize. The purpose of this test is to confirm the initial performance of the HI-STORM 100 ventilation system.

- a. Measure the inlet air (or screen surface) temperature at the center of each of the four vent screens. Determine the average inlet air (or surface screen) temperature.
  - b. Measure the outlet air (or screen surface) temperature at the center of each of the four vent screens. Determine the average outlet air (or surface screen) temperature.
  - c. Determine the average air temperature rise by subtracting the results of the average inlet screen temperature from the average outlet screen temperature.
  - d. Report the results to the certificate holder.
23. Users who load to CoC Amendment 5 with a heat load greater than 20kW must perform the following annular air flow thermal test or cite a test report that was performed and prepared by another User. This test is required to be performed once per CoC Condition 9.
- a. The annular air flow thermal test shall be conducted at least 7 days after the HI-STORM is loaded in order for the overpack to establish thermal equilibrium.
  - b. The User or other qualified engineer shall calculate and record the actual heat load of the fuel stored in the HI-STORM.
  - c. To minimize the effects on the annular air flow, the test shall be performed when the weather is relatively dry and calm.

- d. The ambient air temperature at the cask shall be recorded
- e. The test data shall be collected for the annular flow as follows:
  - 1. The outlet vent screen and gamma shield shall be removed from one outlet vent.
  - 2. A hot wire anemometer or similar flow measuring instrument shall be inserted into the annular space between the MPC and HI-STORM inner shell.
  - 3. The flow measuring instrument shall be positioned at least 6" below the top of the MPC and shall not significantly block the air flow.
  - 4. The instrument shall not be placed too close to the MPC or HI-STORM shells to avoid edge effects on the flow.
  - 5. The outlet gamma shield and vent screen shall be re-installed.
  - 6. Measurements of the air flow shall be taken and recorded for a minimum of three places radially across the annular gap.
  - 7. The outlet vent screen and gamma shield shall be removed from the outlet vent and the flow measuring instrument removed.
  - 8. The outlet gamma shield and vent screen shall be re-installed.
- f. Air flow in each of the three remaining outlet vents shall be measured and recorded in accordance with step 23.e above.
- g. All test data shall be transmitted to the General Licensee for evaluation and validation of the thermal model.
- h. Users shall forward test and analysis results to the NRC in accordance with 10 CFR 72.4.

Table 8.1.1  
ESTIMATED HANDLING WEIGHTS OF HI-STORM 100 SYSTEM COMPONENTS  
125-TON HI-TRAC\*\*

Component	MPC-24 (Lbs.)	MPC-32 (Lbs.)	MPC-68 (Lbs.)	Case <sup>†</sup> Applicability						
				1	2	3	4	5	6	
Empty HI-STORM 100 overpack (without lid) <sup>††</sup>	245,040	245,040	245,040						1	
HI-STORM 100 lid (without rigging)	23,963	23,963	23,963							1
Empty HI-STORM 100S (Short) overpack (without lid) <sup>††</sup>	275,000	275,000	275,000							1
Empty HI-STORM 100S (Tall) overpack (without lid) <sup>††</sup>	290,000	290,000	290,000							1
HI-STORM 100S lid (without rigging. Add 1,000 lbs for 100S Version B Lid)	28,000	28,000	28,000							1
Empty MPC (without lid or closure ring including drain line)	29,845	24,503	29,302	1	1	1	1	1	1	1
MPC lid (without fuel spacers or drain line)	9,677	9,677	10,194	1	1	1	1	1	1	1
MPC Closure Ring	145	145	145			1	1	1	1	1
Fuel (design basis)	41,280	55,040	49,640	1	1	1	1	1	1	1
Damaged Fuel Container (Dresden 1)	0	0	150							
Damaged Fuel Container (Humboldt Bay)	0	0	120							
MPC water (with fuel in MPC)	17,630	17,630	16,957	1	1					
Annulus Water	256	256	256	1	1					
HI-TRAC Lift Yoke (with slings)	4,200	4,200	4,200	1	1	1				
Annulus Seal	50	50	50	1	1					
Lid Retention System	2,300	2,300	2,300							
Transfer frame	6,700	6,700	6,700							1
Mating Device	15,000	15,000	15,000							
Empty HI-TRAC 125 (without Top Lid, neutron shield jacket water, or bottom lids)	117,803	117,803	117,803	1	1	1				1
Empty HI-TRAC 125D (without Top Lid, neutron shield jacket water, or bottom lids)	122,400	122,400	122,400	1	1	1				1
HI-TRAC 125 Top Lid	2,745	2,745	2,745			1				1
HI-TRAC 125D Top Lid	2,645	2,645	2,645			1				1
Optional HI-TRAC Lid Spacer (weight lbs/in thickness)	400	400	400							
HI-TRAC 125/125D Pool Lid(with bolts)	11,900	11,900	11,900	1	1					
HI-TRAC Transfer Lid (with bolts) (125 Only)	23,437	23,437	23,437			1				1
HI-TRAC 125 Neutron Shield Jacket Water	8,281	8,281	8,281		1	1				1
HI-TRAC 125 D Neutron Shield Jacket Water	9,000	9,000	9,000		1	1				1
MPC Stays (total of 2)	200	200	200							
MPC Lift Cleat	480	480	480			1	1			1

\*\* Actual component weights are dependant upon as-built dimensions. The values provided herein are estimated. FSAR analyses use bounding values provided elsewhere. Users are responsible for ensuring lifted loads meet site capabilities and requirements.

<sup>†</sup> See Table 8.1.2 for a description of each load handling case.

<sup>††</sup> Short refers to both 100S-232 and 100S Version B-219. Tall refers to both 100S-243 and 100S Version B-229. Weights are based on 200 lb/cf concrete. Add an additional 1955 lbs. for the HI-STORM 100A overpack.

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HI-STORM 100 FSAR  
REVISION 10  
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TABLE 8.1.2  
ESTIMATED HANDLING WEIGHTS  
125-TON HI-TRAC\*\*

**Caution:**

The maximum weight supported by the 125-Ton HI-TRAC lifting trunnions cannot exceed 250,000 lbs. Users must take actions to ensure that this limit is not exceeded.

**Note:**

The weight of the fuel spacers and the damaged fuel container are less than the weight of the design basis fuel assembly for each MPC and are therefore not included in the maximum handling weight calculations. Fuel spacers are determined to be the maximum combination weight of fuel + spacer. Users should determine their specific handling weights based on the MPC contents and the expected handling modes.

Case No.	Load Handling Evolution	Weight (lbs)		
		MPC-24	MPC-32	MPC-68
1	Loaded HI-TRAC 125 removal from spent fuel pool (neutron tank empty)	232,641	241,059	240,302
2	Loaded HI-TRAC 125 removal from spent fuel pool (neutron tank full)	240,992	249,340	248,583
3	Loaded HI-TRAC 125 During Movement through Hatchway	237,893	246,311	246,227
1A	Loaded HI-TRAC 125D removal from spent fuel pool (neutron tank empty)	237,238	245,656	244,899
2A	Loaded HI-TRAC 125D removal from spent fuel pool (neutron tank full)	246,238	254,656	253,899
3A	Loaded HI-TRAC 125D During Movement through Hatchway	231,572	239,990	239,906
4	MPC during transfer operations	81,427	89,595	89,761
5A	Loaded HI-STORM 100 in storage (See Second Note to Table 8.1.1)	349,950	358,368	358,284
5B	Loaded HI-STORM 100S (Short) in storage (See Second Note to Table 8.1.1)	383,947	392,365	392,281
5C	Loaded HI-STORM 100S (Tall) in storage (See Second Note to Table 8.1.1)	398,947	407,365	407,281
6	Loaded HI-TRAC and transfer frame during on site handling	240,393	248,811	248,727

\*\* Actual component weights are dependant upon as-built dimensions. The values provided herein are estimated. FSAR analyses use bounding values provided elsewhere. Users are responsible for ensuring lifted loads meet site capabilities and requirements.

Table 8.1.3  
ESTIMATED HANDLING WEIGHTS OF HI-STORM 100 SYSTEM COMPONENTS  
100-TON HI-TRAC\*\*

Component	MPC-24 (Lbs.)	MPC-32 (Lbs.)	MPC-68 (Lbs.)	Case <sup>†</sup> Applicability						
				1	2	3	4	5	6	
Empty HI-STORM 100 overpack (without lid) <sup>††</sup>	245,040	245,040	245,040						1	
HI-STORM 100 lid (without rigging)	23,963	23,963	23,963							1
Empty HI-STORM 100S (Short) overpack (without lid) <sup>††</sup>	275,000	275,000	275,000							1
Empty HI-STORM 100S (Tall) overpack (without lid) <sup>††</sup>	290,000	290,000	290,000							1
HI-STORM 100S lid (without rigging, add 1,000 lbs for 100S Version B Lid)	28,000	28,000	28,000							
Empty MPC (without lid or closure ring including drain line)	29,845	24,503	29,302	1	1	1	1	1	1	1
MPC lid (without fuel spacers or drain line)	9,677	9,677	10,194	1	1	1	1	1	1	1
MPC Closure Ring	145	145	145			1	1	1	1	1
Fuel (design basis)	41,280	55,040	49,640	1	1	1	1	1	1	1
Damaged Fuel Container (Dresden I)	0	0	150							
Damaged Fuel Container (Humboldt Bay)	0	0	120							
MPC water (with fuel in MPC)	17,630	17,630	16,957	1	1					
Annulus Water	256	256	256	1	1					
HI-TRAC Lift Yoke (with slings)	3,200	3,200	3,200	1	1	1				
Annulus Seal	50	50	50	1	1					
Lid Retention System	2,300	2,300	2,300							
Transfer frame	6,700	6,700	6,700							1
Empty HI-TRAC 100 (without Top Lid, neutron shield jacket water, or bottom lids)	84,003	84,003	84,003	1	1	1				1
HI-TRAC 100 Top Lid	1,189	1,189	1,189			1				1
HI-TRAC 100 Pool Lid	7,863	7,863	7,863	1	1					
HI-TRAC Transfer Lid (HI-TRAC 100 only)	16,686	16,686	16,686			1				1
Empty HI-TRAC 100D (without Top Lid, neutron shield jacket water, or pool lid)	84,204	84,204	84,204	1	1	1				1
HI-TRAC 100D Top Lid	1,239	1,239	1,239			1				1
HI-TRAC 100D Pool Lid	7,955	7,955	7,955	1	1	1				
Mating Device (HI-TRAC 100D only)	15,000	15,000	15,000							
HI-TRAC 100 Neutron Shield Jacket Water	7,583	7,583	7,583		1	1				1
HI-TRAC 100D Neutron Shield Jacket Water	7,800	7,800	7,800		1	1				1
MPC Stays (total of 2)	200	200	200							
MPC Lift Cleat	480	480	480				1			1

\*\* Actual component weights are dependant upon as-built dimensions. The values provided herein are estimated. FSAR analyses use bounding values provided elsewhere. Users are responsible for ensuring lifted loads meet site capabilities and requirements.

<sup>†</sup> See Table 8.1.4 for a description of each load handling case.

<sup>††</sup> Short refers to both 100S-232 and 100S Version B-219. Tall refers to both 100S-243 and 100S Version B-229. Weights are based on 200 lb/cf concrete. Add an additional 1955 lbs. for the HI-STORM 100A overpack.

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Table 8.1.4  
ESTIMATED HANDLING WEIGHTS  
100-TON HI-TRAC\*\*

**Caution:**

The maximum weight supported by the 100-Ton HI-TRAC lifting trunnions cannot exceed 200,000 lbs. Users must take actions to ensure that this limit is not exceeded.

**Note:**

The weight of the fuel spacers and the damaged fuel container are less than the weight of the design basis fuel assembly and therefore not included in the maximum handling weight calculations. Fuel spacers are determined to be the maximum combination weight of fuel + spacer. Users should determine the handling weights based on the contents to be loaded and the expected mode of operations.

Case No.	Load Handling Evolution	Weight (lbs)		
		MPC-24	MPC-32	MPC-68
1	Loaded HI-TRAC 100 removal from spent fuel pool (neutron tank empty)	193,804	202,222	201,465
2	Loaded HI-TRAC 100 removal from spent fuel pool (neutron tank full)	201,387	209,805	209,048
3	Loaded HI-TRAC 100 During Movement through Hatchway	193,608	202,026	201,942
1A	Loaded HI-TRAC 100D removal from spent fuel pool (neutron tank empty)	194,097	202,515	201,758
2A	Loaded HI-TRAC 100D removal from spent fuel pool (neutron tank full)	201,897	210,315	209,558
3A	Loaded HI-TRAC 100D During Movement through Hatchway	183,345	193,763	193,679
4	MPC during transfer operations	81,427	89,845	89,761
5A	Loaded HI-STORM 100 in storage (See Second Note to Table 8.1.1)	349,950	358,368	358,284
5B	Loaded HI-STORM 100S (Short) in storage (See Second Note to Table 8.1.1)	383,947	392,365	392,281
5C	Loaded HI-STORM 100S (Tall) in storage (See Second Note to Table 8.1.1)	398,947	407,365	407,281
6	Loaded HI-TRAC 100 and transfer frame during on site handling	197,588	206,006	205,922

\*\* Actual component weights are dependant upon as-built dimensions. The values provided herein are estimated. FSAR analyses use bounding values provided elsewhere. Users are responsible for ensuring lifted loads meet site capabilities and requirements.

Table 8.1.5  
HI-STORM 100 SYSTEM TORQUE REQUIREMENTS

<b>Fastener<sup>†</sup></b>	<b>Torque (ft-lbs)<sup>††</sup></b>	<b>Pattern<sup>†††</sup></b>
HI-TRAC Top Lid Bolts <sup>†</sup>	Hand tight	None
HI-TRAC Pool Lid Bolts (36 Bolt Lid) <sup>†</sup>	Wrench tight	Figure 8.1.37
HI-TRAC Pool Lid Bolts (16 Bolt Lid) <sup>†</sup>	Wrench tight	Figure 8.1.37
100-Ton HI-TRAC Transfer Lid Bolts <sup>†</sup>	Wrench tight	Figure 8.1.37
125-Ton HI-TRAC Transfer Lid Bolts <sup>†</sup>	Wrench tight	Figure 8.1.37
MPC Lift Cleats Stud Nuts <sup>†</sup>	Wrench tight	None
MPC Lift Hole Plugs <sup>†</sup>	Hand tight	None
Threaded Fuel Spacers	Hand Tight	None
HI-STORM Lid Nuts <sup>†</sup>	Hand tight	None
HI-STORM 100S Lid Nuts and Lid Closure Bolts <sup>†</sup> (Temporary and Permanent Lids, Including Version B)	Hand Tight	None
Door Locking Pins	Hand Tight + 1/8 to 1/2 turn	None
HI-STORM 100 Vent Screen/Temperature Element Screws	Hand Tight	None
HI-STORM 100A Anchor Studs	55- 65 ksi tension applied by bolt tensioner (no initial torque)	None

<sup>†</sup> Studs and nuts shall be cleaned and inspected for damage or excessive thread wear (replace if necessary) and coated with a light layer of Fel-Pro Chemical Products, N-5000, Nuclear Grade Lubricant (or equivalent).

<sup>††</sup> Unless specifically specified, torques have a +/- 5% tolerance.

<sup>†††</sup> No detorquing pattern is needed.

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Table 8.1.6  
HI-STORM 100 SYSTEM ANCILLARY EQUIPMENT OPERATIONAL DESCRIPTION

Equipment	Important To Safety Classification	Reference Figure <sup>†</sup>	Description
Air Pads/Rollers	Not Important To Safety	8.1.29	Used for HI-STORM or HI-TRAC cask positioning. May be used in conjunction with the cask transporter or other HI-STORM 100 or HI-TRAC lifting device.
Annulus Overpressure System	Not Important To Safety	8.1.14	The Annulus Overpressure System is used for protection against spent fuel pool water contamination of the external MPC shell and baseplate surfaces by providing a slight annulus overpressure during in-pool operations.
Annulus Shield	Not Important To Safety	8.1.13	A shield that is placed at the top of the HI-TRAC annulus to provide supplemental shielding to the operators performing cask loading and closure operations.
Automated Welding System	Not Important To Safety	8.1.2b	Used for remote field welding of the MPC.
AWS Baseplate Shield	Not Important To Safety	8.1.2b	Provides supplemental shielding to the operators during the cask closure operations.
Bottom Lid Transfer Slide (Not used with HI-TRAC 100D and 125D)	Not Important To Safety	8.1.26	Used to simultaneously replace the pool lid with the transfer lid under the suspended HI-TRAC and MPC. Used in conjunction with the bottom lid transfer step.
Cask Transporter	Not Important to Safety unless used for MPC transfers	8.1.29a and 8.1.29b	Used for handling of the HI-STORM 100 Overpack and/or the HI-TRAC Transfer Cask around the site. The cask transporter may take the form of heavy haul transfer trailer, special transporter or other equipment specifically designed for such a function. May also be used for MPC transfers (examples are shown in Figure 8.1.28).

<sup>†</sup> Figures are representative and may not depict all configurations for all users.

Table 8.1.6  
 HI-STORM 100 SYSTEM ANCILLARY EQUIPMENT OPERATIONAL DESCRIPTION  
 (Continued)

Equipment	Important To Safety Classification	Reference Figure <sup>†</sup>	Description
Lid and empty component lifting rigging	Not Important To Safety, Rigging shall be provided in accordance with NUREG 0612	8.1.9	Used for rigging such components such as the HI-TRAC top lid, pool lid, MPC lid, transfer lid, AWS, HI-STORM Lid and auxiliary shielding and the empty MPC.
Helium Backfill System	Not Important To Safety	8.1.23	Used for controlled insertion of helium into the MPC for pressure testing, blowdown and placement into storage.
HI-STORM 100 Lifting Jacks	Not Important To Safety	8.1.36	Jack system used for lifting the HI-STORM overpack to provide clearance for inserting or removing a device for transportation. .
Alignment Device	Not Important To Safety	8.1.31	Guides HI-TRAC into place on top of HI-STORM for MPC transfers. (Not used for HI-TRAC 100D and 125D)
HI-STORM Lifting Devices	Determined site-specifically based on type, location, and height of lift being performed. Lifting devices shall be provided in accordance with ANSI N14.6.	Not shown.	A special lifting device used for connecting the crane (or other primary lifting device) to the HI-STORM 100 for cask handling. Does not include the crane hook (or other primary lifting device) device.
HI-STORM Vent Duct Shield Inserts	Important to Safety Category C .	8.1.30	Used for prevention of radiation streaming from the HI-STORM 100 exit vents during MPC transfers to and from HI-STORM. Not used with the HI-STORM 100S.
HI-TRAC Lid Spacer	Spacer Ring is Not-Important-To-Safety, Studs or bolts are Important to Safety Category B	Not Shown	Optional ancillary which is used during MPC transfer operations to increase the clearance between the top of the MPC and the underside of the HI-TRAC top lid. Longer threaded studs (or bolts), supplied with the lid spacer, replace the standard threaded studs (or bolts) supplied with the HI-TRAC. The HI-TRAC lid spacer may ONLY be used when the HI-TRAC is handled in the vertical orientation or if HI-TRAC transfer lid is NOT used. The height of the spacer shall be limited to ensure that the weights and C.G. heights in a loaded HI-TRAC with the spacer do not exceed the bounding values found in Section 3.2 of the FSAR.
HI-TRAC Lift Yoke/Lifting Links	Determined site-specifically based on type and location, and height of lift being performed. Lift yoke and lifting devices for loaded HI-TRAC handling shall be provided in accordance with ANSI N14.6.	8.1.3	Used for connecting the crane (or other primary lifting device) to the HI-TRAC for cask handling. Does not include the crane hook (or other primary lifting device).

<sup>†</sup> Figures are representative and may not depict all configurations for all users.

Table 8.1.6  
HI-STORM 100 SYSTEM ANCILLARY EQUIPMENT OPERATIONAL DESCRIPTION (Continued)

Equipment	Important To Safety Classification	Reference Figure <sup>†</sup>	Description
HI-TRAC transfer frame	Not Important To Safety	8.1.4	A steel frame used to support HI-TRAC during delivery, on-site movement and upending/downending operations.
Cask Primary Lifting Device (Cask Transfer Facility)	Important to Safety. Quality classification of subcomponents determined site-specifically.	8.1.28 and 8.1.32	Optional auxiliary (Non-Part 50) cask lifting device(s) used for cask upending and downending and HI-TRAC raising for positioning on top of HI-STORM to allow MPC transfer. The device may consist of a crane, lifting platform, gantry system or any other suitable device used for such purpose.
Inflatable Annulus Seal	Not Important To Safety	8.1.13	Used to prevent spent fuel pool water from contaminating the external MPC shell and baseplate surfaces during in-pool operations.
Lid Retention System	Important to Safety Status determined by each licensee. MPC lid lifting portions of the Lid Retention System shall meet the requirements of ANSI N14.6.	8.1.15, 8.1.17	Optional. The Lid Retention System secures the MPC lid in place during cask handling operations between the pool and decontamination pad.
MPC Lift Cleats	Important To Safety – Category A. MPC Lift Cleats shall be provided in accordance with of ANSI N14.6.	8.1.24	MPC lift cleats consist of the cleats and attachment hardware. The cleats are supplied as solid steel components that contain no welds. The MPC lift cleats are used to secure the MPC inside HI-TRAC during bottom lid replacement and support the MPC during MPC transfer from HI-TRAC into HI-STORM and vice versa. The ITS classification of the lifting device attached to the cleats may be lower than the cleat itself, as determined site-specifically.
Pressure Test System	Not Important to Safety	8.1.20	Used to pressure test the MPC lid-to-shell weld.
MPC Downloader	Important To Safety status determined site-specifically. MPC Downloader Shall meet the requirements of CoC, Appendix B, Section 3.5 for aboveground systems and Appendix A-100U, Section 5.5 for underground systems.	8.1.28 and 8.1.32	A lifting device used to help raise and lower the MPC during MPC transfer operations to limit the lift force of the MPC against the top lid of HI-TRAC. The MPC downloader may take several forms depending on the location of MPC transfer and may be used in conjunction with other lifting devices.

<sup>†</sup> Figures are representative and may not depict all configurations for all users.

Table 8.1.6  
HI-STORM 100 SYSTEM ANCILLARY EQUIPMENT OPERATIONAL DESCRIPTION (Continued)

Equipment	Important To Safety Classification	Reference Figure <sup>†</sup>	Description
Deleted			
Deleted			
Mating Device	Important-To-Safety – Category B	8.1.31	Used to mate HI-TRAC 100D and 125D to HI-STORM during transfer operations. Includes sliding drawer for use in removing HI-TRAC pool lid.
MPC Support Slings	Important To Safety – Category A – Rigging shall be provided in accordance with NUREG 0612.	8.1.25	Used to secure the MPC to the lift yoke during HI-TRAC bottom lid replacement operations. Attaches between the MPC lift cleats and the lift yoke. Can be configured for different crane hook configuration.
MPC Upending Frame	Not Important to Safety	8.1.6	A steel frame used to evenly support the MPC during upending operations, and control the upending process.
Supplemental Cooling System	Important to Safety – Category B	2.C.1	A system used to circulate water or other coolant through the HI-TRAC annulus in order to maintain fuel cladding temperatures below ISG-11 Rev. 3 limits during operations with the MPC in the HI-TRAC. Required only for MPC containing high burn-up fuel as determined in accordance with Section 4.5. Calibration of the temperature instruments used to demonstrate heat removal from the HI-TRAC shall be performed in accordance with the requirements for Important to Safety Category B, the remaining components in the system are NITS.
MSLD (Helium Leakage Detector)	Not Important to Safety	Not shown	Used for helium leakage testing of the vent/drain port cover plate welds.
Deleted			
Temporary Shield Ring	Not Important To Safety	8.1.18	A water-filled tank that fits on the cask neutron shield around the upper forging and provides supplemental shielding to personnel performing cask loading and closure operations.
Vacuum Drying (Moisture Removal) System	Not Important To Safety	8.1.22a	Used for removal of residual moisture from the MPC following water draining.
Forced Helium Dehydration System	Important to Safety – Category B	8.1.22b	Used for removal of residual moisture from the MPC following water draining. Calibration of the instrumentation used to confirm Tech Spec compliance shall be performed in accordance with the requirements for Important to Safety Category B, the remaining components of the system are NITS.
Vent and Drain RVOAs	Not Important To Safety	8.1.16	Used to access the vent and drain ports. The vent and drain RVOAs allow the vent and drain ports to be operated like valves and prevent the need to hot tap into the penetrations during unloading operation.
Deleted			
Weld Removal System	Not Important To Safety	8.3.2b	Semi-automated weld removal system used for removal of the MPC field weld to support unloading operations.

<sup>†</sup> Figures are representative and may not depict all configurations for all users.

Table 8.1.7  
 HI-STORM 100 SYSTEM INSTRUMENTATION SUMMARY FOR LOADING AND  
 UNLOADING OPERATIONS†

Instrument	Function
Contamination Survey Instruments	Monitors fixed and non-fixed contamination levels.
Dose Rate Monitors/Survey Equipment	Monitors dose rate and contamination levels and ensures proper function of shielding. Ensures assembly debris is not inadvertently removed from the spent fuel pool during overpack removal.
Flow Rate Monitor	Monitors fluid flow rate during various loading and unloading operations.
Helium Mass Spectrometer Leakage Detector (MSLD)	Ensures leakage rates of welds are within acceptable limits.
Deleted	
Deleted	
Volumetric Examination Testing Rig	Used to assess the integrity of the MPC lid-to-shell weld.
Pressure Gauges	Ensures correct pressure during loading and unloading operations.
Temperature Gauges	Monitors the state of gas and water temperatures during closure and unloading operations.
Deleted	
Temperature Surface Pyrometer	For HI-STORM vent operability testing.
Vacuum Gages	Used for vacuum drying operations and to prepare an MPC evacuated sample bottle for MPC gas sampling for unloading operations.
Deleted	
Deleted	
Moisture Monitoring Instruments	Used to monitor the MPC moisture levels as part of the moisture removal system.

† All instruments require calibration. See figures at the end of this section for additional instruments, controllers and piping diagrams.

Table 8.1.8  
HI-STORM 100 SYSTEM OVERPACK INSPECTION CHECKLIST

**Note:**

This checklist provides the basis for establishing a site-specific inspection checklist for the HI-STORM 100 overpack. Specific findings shall be brought to the attention of the appropriate site organizations for assessment, evaluation and potential corrective action prior to use.

HI-STORM 100 Overpack Lid:

1. Lid studs and nuts or lid closure bolts shall be inspected for general condition.
2. The painted surfaces shall be inspected for corrosion and chipped, cracked or blistered paint.
3. All lid surfaces shall be relatively free of dents, scratches, gouges or other damage.
4. The lid shall be inspected for the presence or availability of studs and nuts and hole plugs.
5. Lid lifting device/ holes shall be inspected for dirt and debris and thread condition.
6. Lid bolt holes shall be inspected for general condition.

HI-STORM 100 Main Body:

1. Lid bolt holes shall be inspected for dirt, debris, and thread condition.
2. Vents shall be free from obstructions.
3. Vent screens shall be available, intact, and free of holes and tears in the fabric.
4. The interior cavity shall be free of debris, litter, tools, and equipment.
5. Painted surfaces shall be inspected for corrosion, and chipped, cracked or blistered paint.
6. The nameplate shall be inspected for presence, legibility, and general condition and conformance to Quality Assurance records package.
7. Anchor hardware, if used, shall be checked for general condition.

Table 8.1.9  
MPC INSPECTION CHECKLIST

**Note:**

This checklist provides the basis for establishing a site-specific inspection checklist for MPC. Specific findings shall be brought to the attention of the appropriate site organizations for assessment, evaluation and potential corrective action prior to use.

MPC Lid and Closure Ring:

1. The MPC lid and closure ring surfaces shall be relatively free of dents, gouges or other shipping damage.
2. The drain line shall be inspected for straightness, thread condition, and blockage.
3. Vent and Drain attachments shall be inspected for availability, thread condition operability and general condition.
4. Upper fuel spacers (if used) shall be inspected for availability and general condition. Plugs shall be available for non-used spacer locations.
5. Lower fuel spacers (if used) shall be inspected for availability and general condition.
6. Drain and vent port cover plates shall be inspected for availability and general condition.
7. Serial numbers shall be inspected for readability.
8. The MPC lid lift holes shall be inspected for thread condition.

MPC Main Body:

1. All visible MPC body surfaces shall be inspected for dents, gouges or other shipping damage.
2. Fuel cell openings shall be inspected for debris, dents and general condition.
3. Lift lugs shall be inspected for general condition.
4. Verify proper MPC basket type for contents.

Table 8.1.10  
HI-TRAC TRANSFER CASK INSPECTION CHECKLIST

**Note:**

This checklist provides the basis for establishing a site-specific inspection checklist for the HI-TRAC Transfer Cask. Specific findings shall be brought to the attention of the appropriate site organizations for assessment, evaluation and potential corrective action prior to use.

HI-TRAC Top Lid:

1. The painted surfaces shall be inspected for corrosion and chipped, cracked or blistered paint.
2. All Top Lid surfaces shall be relatively free of dents, scratches, gouges or other damage.

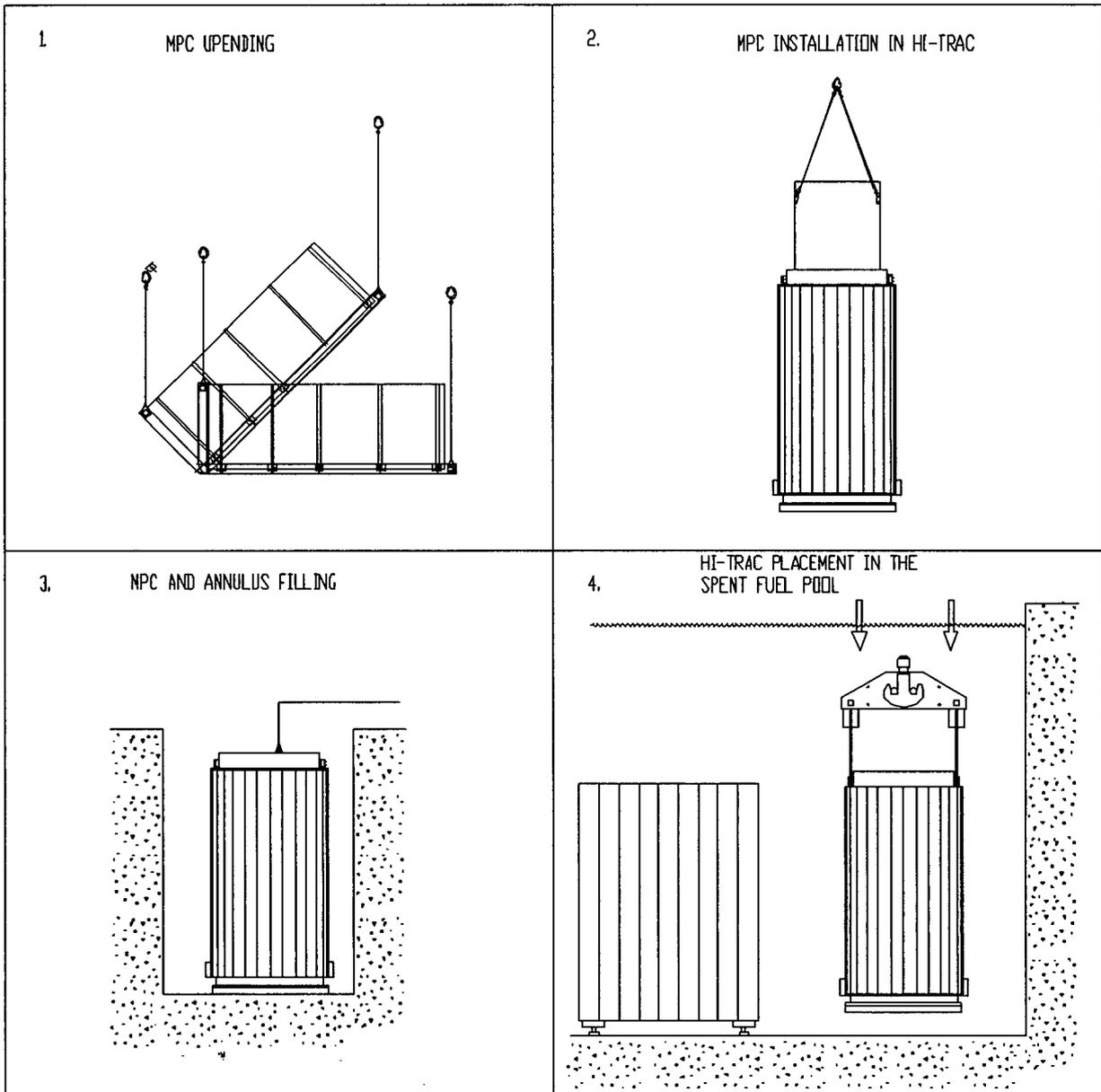
HI-TRAC Main Body:

1. The painted surfaces shall be inspected for corrosion, chipped, cracked or blistered paint.
2. The Top Lid bolt holes shall be inspected for dirt, debris and thread damage.
3. The Top Lid lift holes shall be inspected for thread condition.
4. Lifting trunnions shall be inspected for deformation, cracks, damage, corrosion, excessive galling, and, if applicable, damage to the locking plate and end plate, and presence or availability of locking plate and end plate retention bolts.
5. Pocket trunnion, if used, recesses shall be inspected for indications of overstressing (i.e., cracks, deformation, and excessive wear).
6. Annulus inflatable seal groove shall be inspected for cleanliness, scratches, dents, gouges, sharp corners, burrs or any other condition that may damage the inflatable seal.
7. The nameplate shall be inspected for presence and general condition.
8. The neutron shield jacket shall be inspected for leaks.
9. Neutron shield jacket pressure relief valve shall be inspected for presence, and general condition.
10. The neutron shield jacket fill and drain plugs shall be inspected for presence, leaks, and general condition.
11. Bottom lid flange surface shall be clean and free of large scratches and gouges.

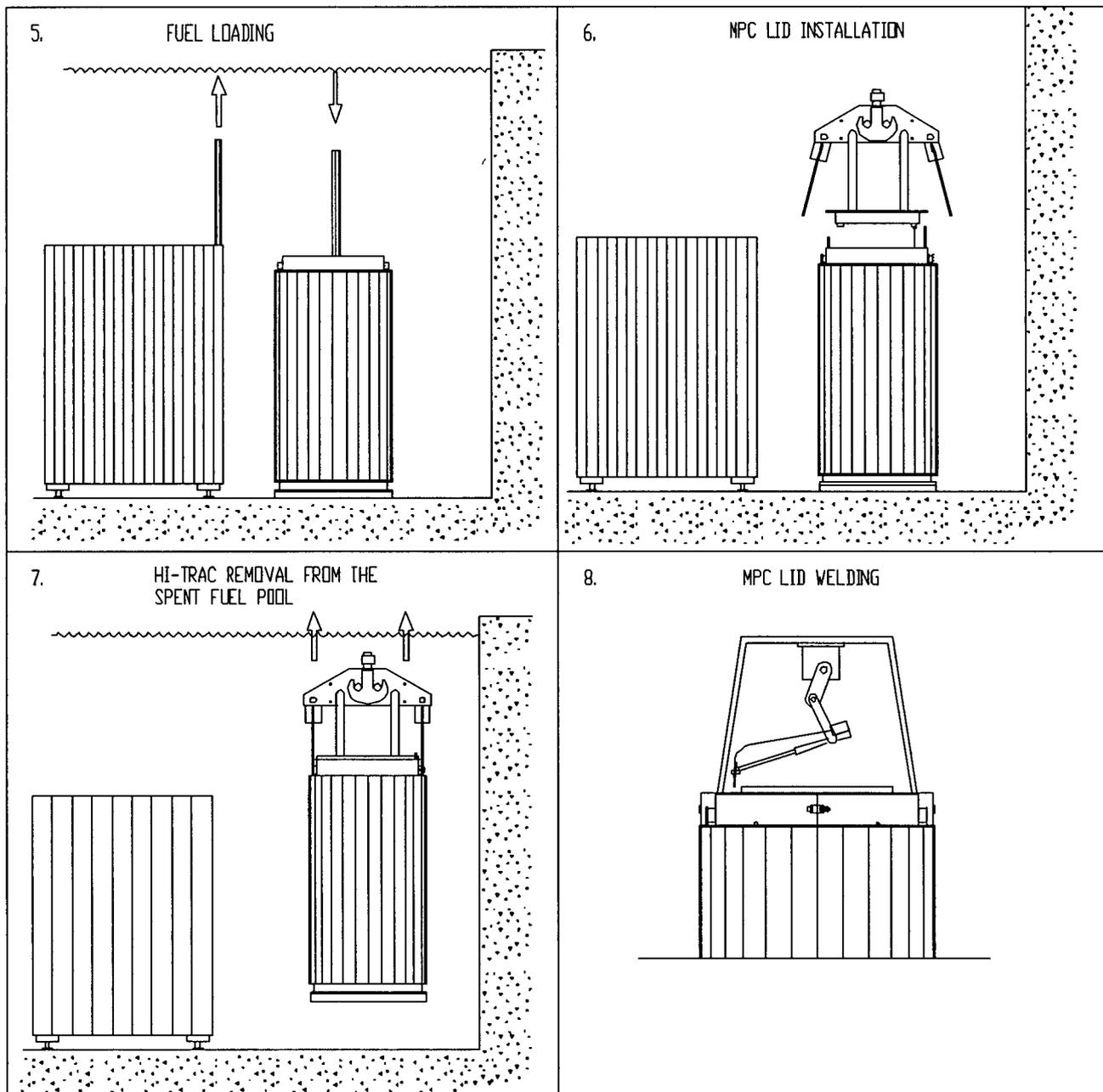
<b>LOCATION: CASK RECEIVING AREA</b>
REMOVE HI-TRAC TOP LID
CONFIGURE HI-TRAC WITH POOL LID
INSTALL MPC IN HI-TRAC
INSTALL UPPER FUEL SPACERS
INSTALL LOWER FUEL SPACERS
FILL MPC AND ANNULUS
INSTALL ANNULUS SEAL
PLACE HI-TRAC IN SPENT FUEL POOL
<b>LOCATION: SPENT FUEL POOL</b>
LOAD FUEL ASSEMBLIES INTO MPC
PERFORM ASSEMBLY IDENTIFICATION VERIFICATION
INSTALL DRAIN LINE TO MPC LID
ALIGN MPC LID AND LIFT YOKE TO DRAIN LINE
INSTALL MPC LID
REMOVE HI-TRAC FROM SPENT FUEL POOL AND PLACE IN PREPARATION AREA
<b>LOCATION: CASK PREPARATION AREA</b>
DECONTAMINATE HI-TRAC BOTTOM
SET HI-TRAC IN CASK PREPARATION AREA
FILL NEUTRON WATER JACKET
MEASURE DOSE RATES AT MPC LID
DECONTAMINATE HI-TRAC AND LIFT YOKE
INSTALL TEMPORARY SHIELD RING
REMOVE INFLATABLE ANNULUS SEAL
LOWER ANNULUS WATER LEVEL SLIGHTLY
SMEAR MPC LID TOP SURFACES
INSTALL ANNULUS SHIELD
LOWER MPC WATER LEVEL
WELD MPC LID & PERFORM NDE
DELETED
RAISE MPC WATER LEVEL
PERFORM MPC LID-TO-SHELL WELD PRESSURE TEST
DELETED
DRAIN MPC
MEASURE VOLUME OF WATER DRAINED
DRY MPC
PERFORM MPC DRYNESS VERIFICATION TEST

BACKFILL MPC
WELD VENT AND DRAIN PORT COVER PLATES & PERFORM NDE
PERFORM LEAKAGE TEST ON CLOSURE PLATES
WELD MPC CLOSURE RING & PERFORM NDE
DRAIN ANNULUS
INSTALL HI-TRAC TOP LID
PERFORM SURVEYS ON HI-TRAC
REMOVE TEMPORARY SHIELD RING
REPLACE POOL LID WITH TRANSFER LID (Not Required for HI-TRAC 100D and 125D)
INSTALL MPC LIFT CLEAT
PERFORM SURVEYS OF POOL LID
PERFORM HI-TRAC SURFACE DOSE RATE MEASUREMENTS (PER TS)
<b>LOCATION: CASK RECEIVING AREA</b>
POSITION HI-STORM FOR MPC TRANSFER
INSTALL ALIGNMENT DEVICE (MATING DEVICE FOR HI-TRAC 100D and 125D) & VENT DUCT SHIELD INSERTS
MATE OVERPACK AND TRANSFER CASK
ATTACH MPC SLINGS
OPEN TRANSFER LID DOORS (Remove pool lid and open mating device drawer for HI-TRAC 100D and 125D)
LOWER MPC INTO HI-STORM
REMOVE HI-TRAC FROM ON TOP OF HI-STORM
REMOVE MPC LIFT CLEAT
REMOVE ALIGNMENT DEVICE (Mating device for HI-TRAC 100D and 125D) & VENT DUCT SHIELD INSERTS
INSTALL HI-STORM LID
PERFORM HI-STORM SURFACE DOSE RATE MEASUREMENTS (PER TS)
<b>LOCATION: ISFSI</b>
PLACE HI-STORM IN STORAGE
INSTALL GAMMA SHIELD CROSS PLATES AND THERMOCOUPLES IN HI-STORM 100 OVERPACK EXIT VENTS
INSTALL HI-STORM VENT SCREENS
PERFORM THERMAL TESTING

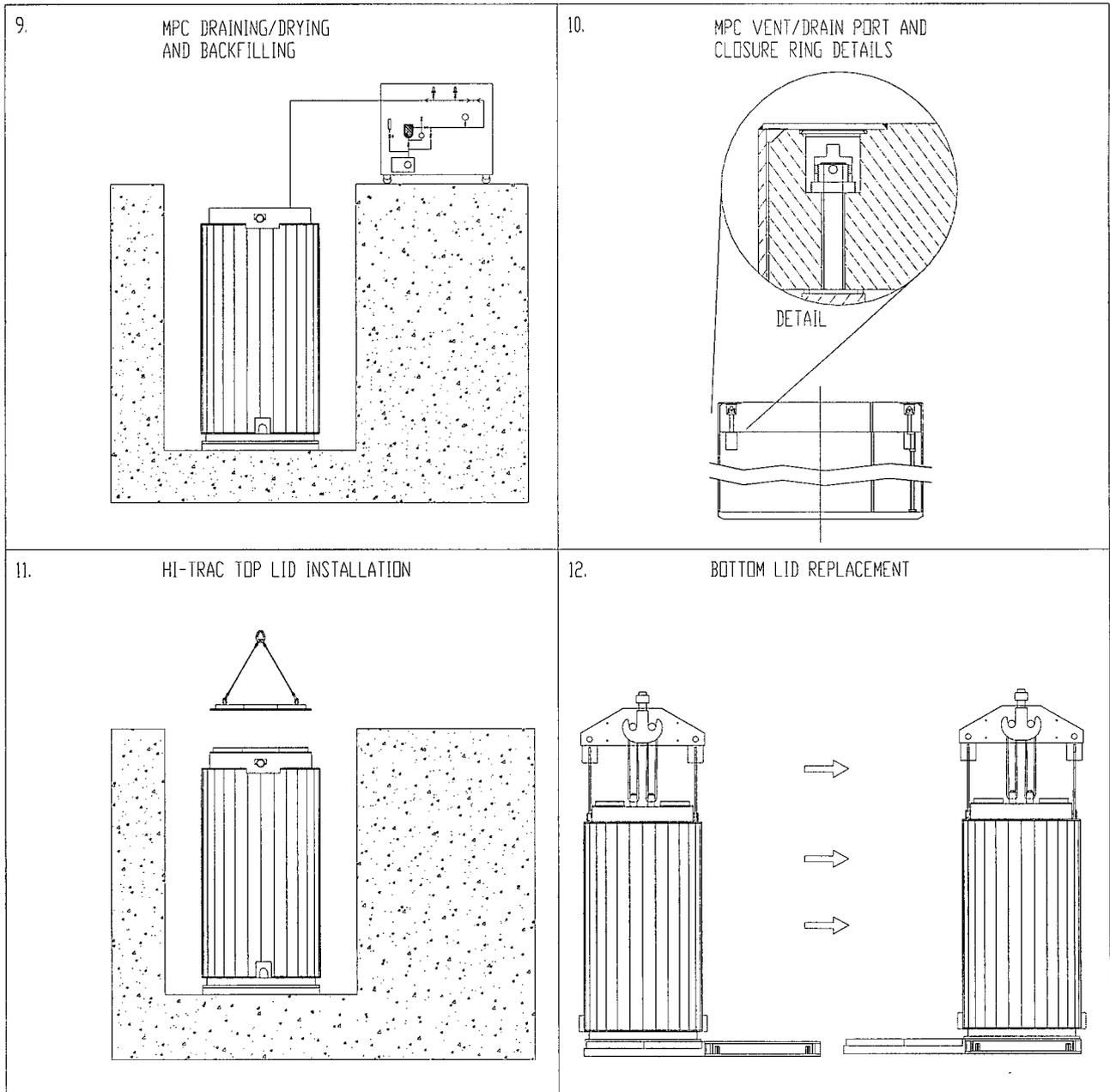
**Figure 8.1.1; Loading Operations Flow Diagram**



**Figure 8.1.2a; Major HI-STORM 100 Loading Operations**



**Figure 8.1.2b; Major HI-STORM 100 Loading Operations**

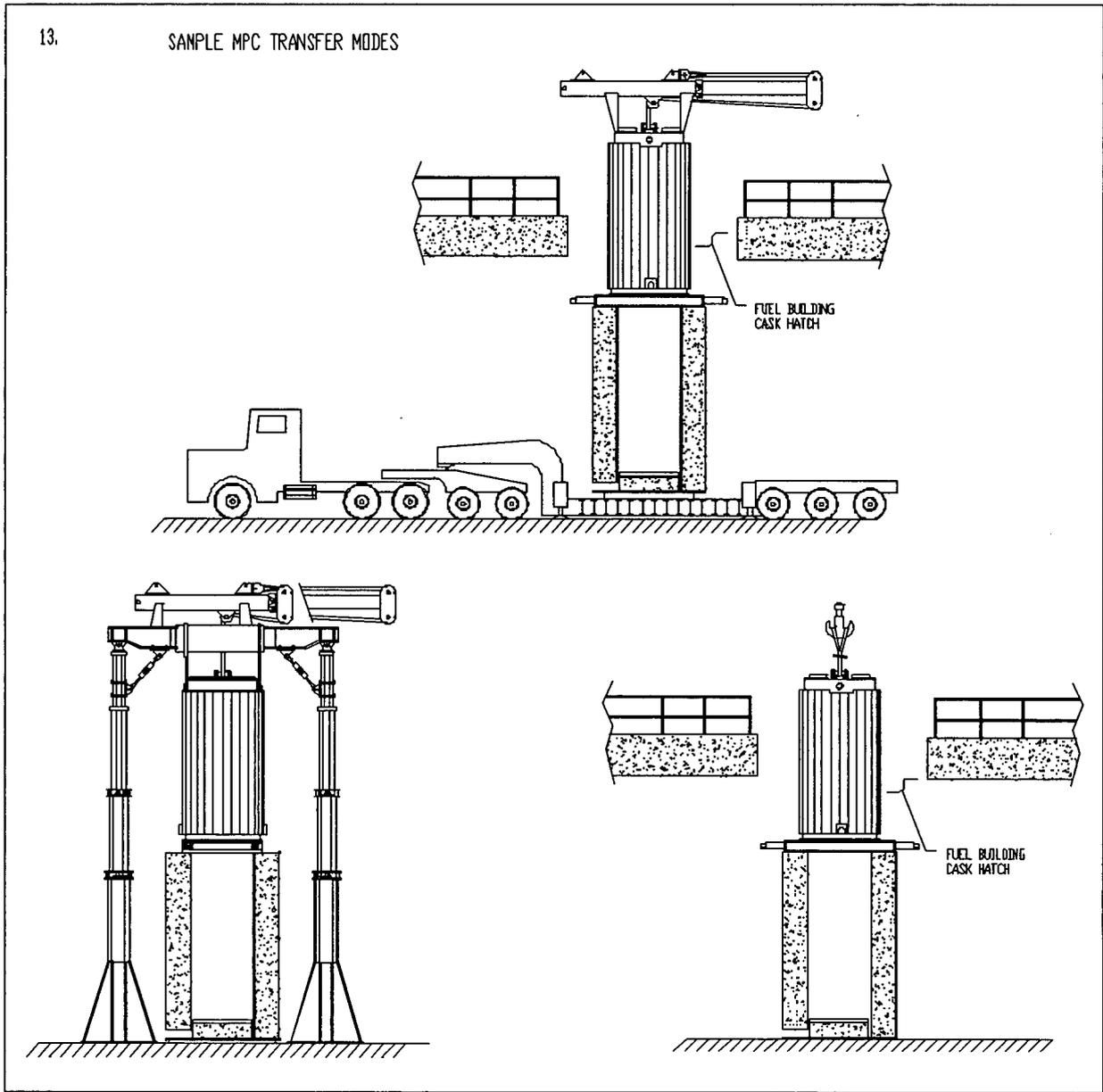


**Note: Bottom Lid Replacement is not required for HI-TRAC 100D and 125D**

**Figure 8.1.2c; Major HI-STORM 100 Loading Operations**

13.

SAMPLE MPC TRANSFER MODES

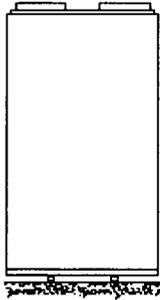


**Figure 8.1.2d; Major HI-STORM 100 Loading Operations(HI-TRAC with Transfer Lid Shown)**

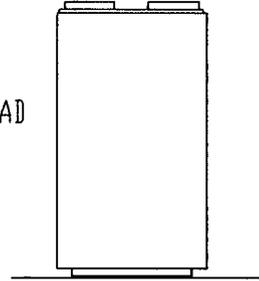
14.

SAMPLE HI-STORM HANDLING METHODS

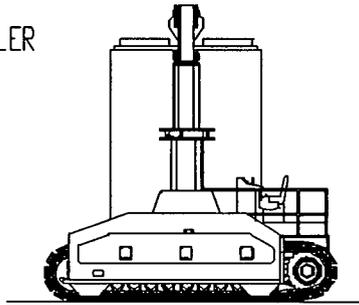
RAIL DOLLY



AIR PAD



CASK CRAWLER



HEAVY-HAUL TRAILER

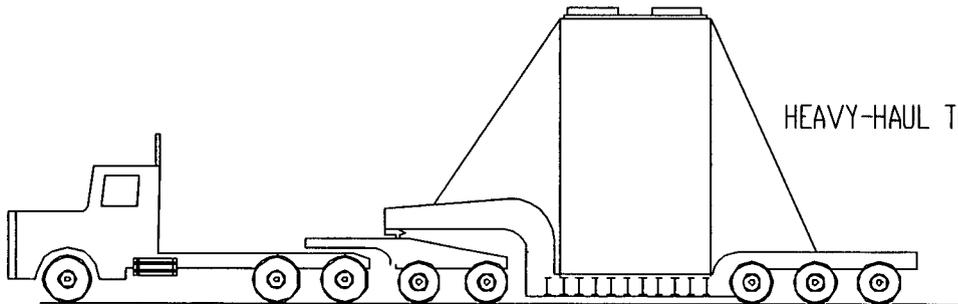
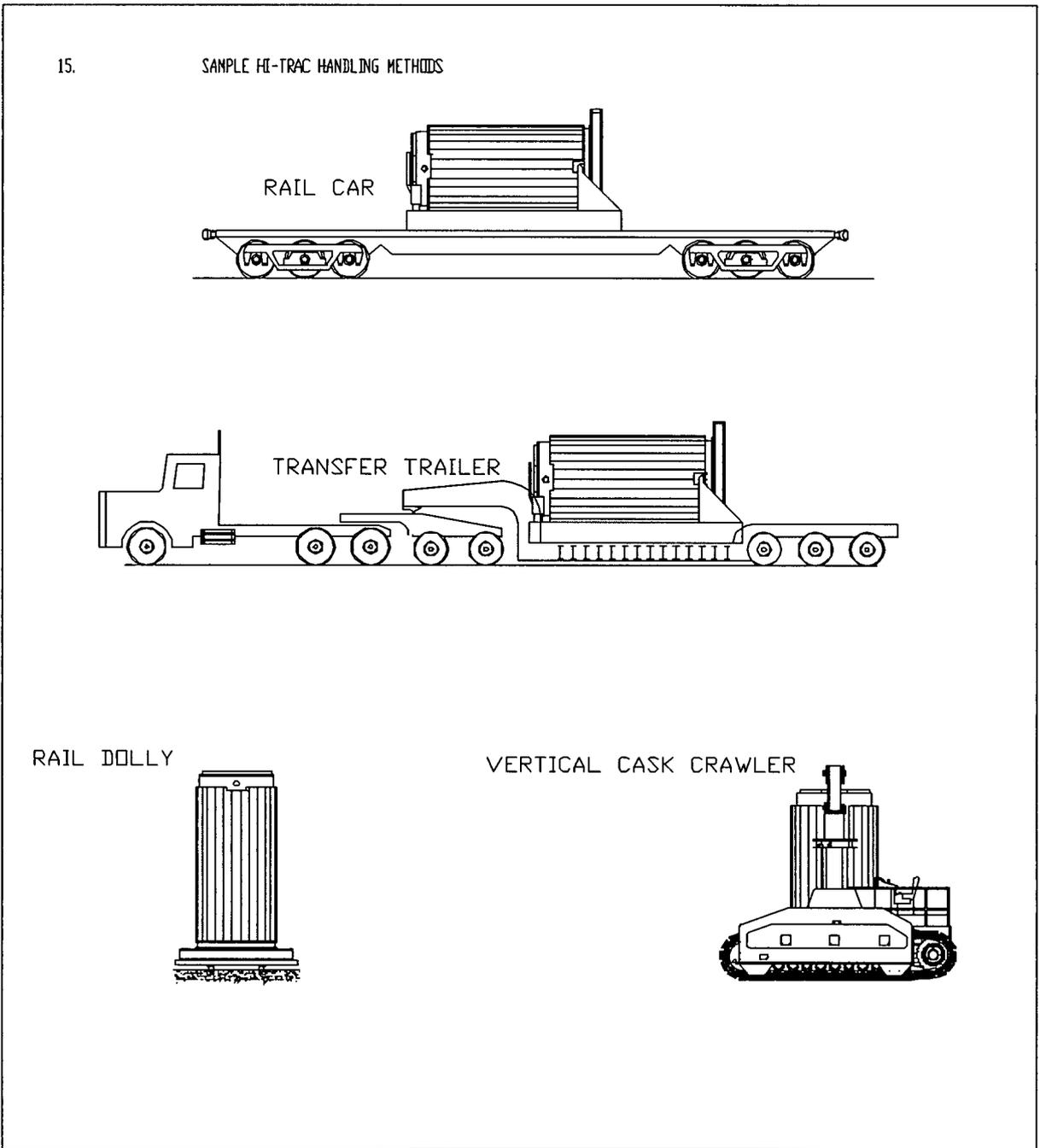


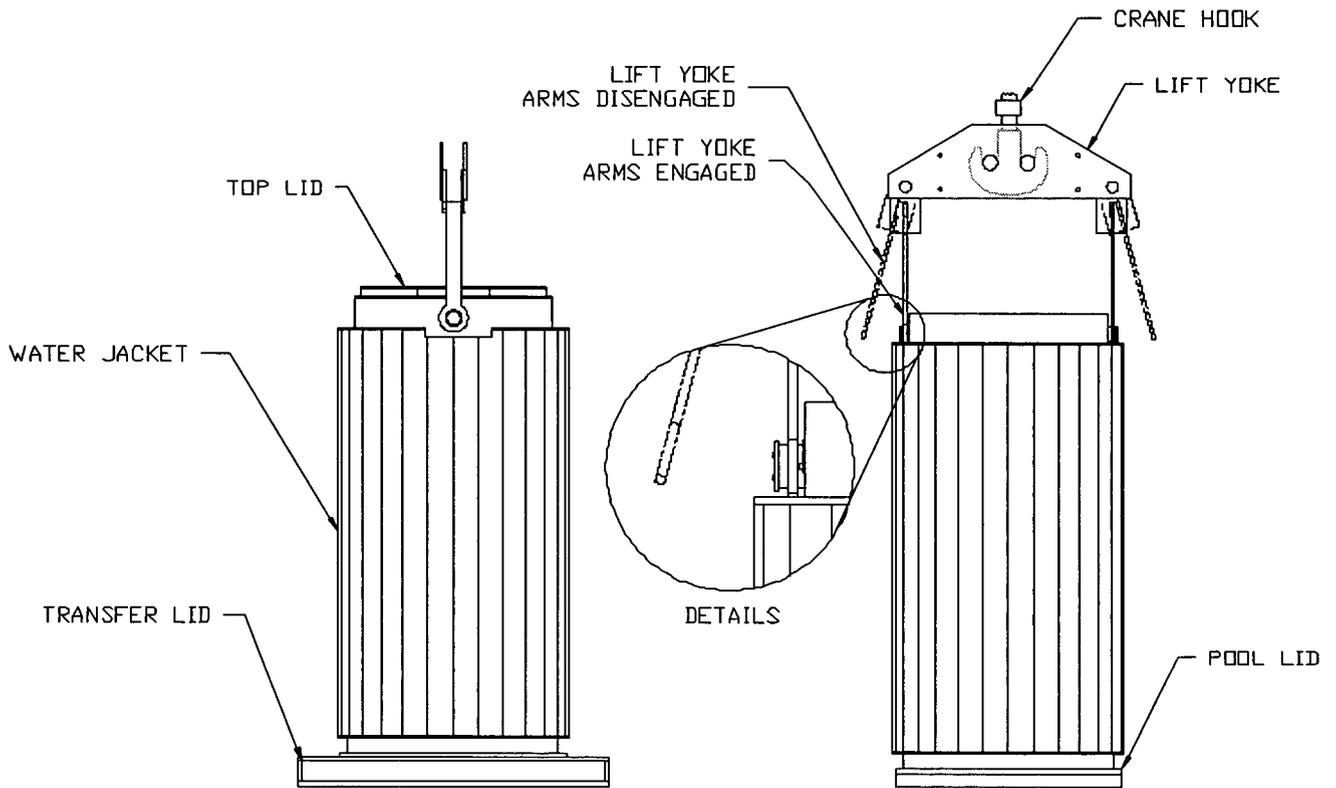
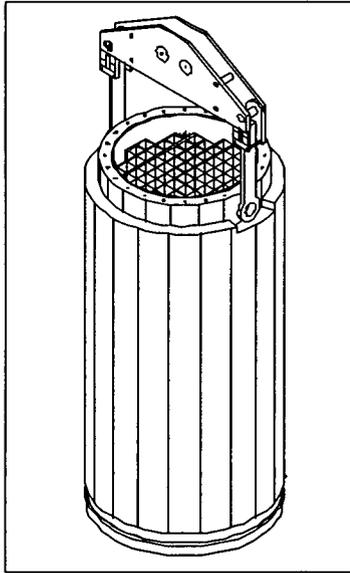
Figure 8.1.2e; Example of HI-STORM 100 Handling Options

15.

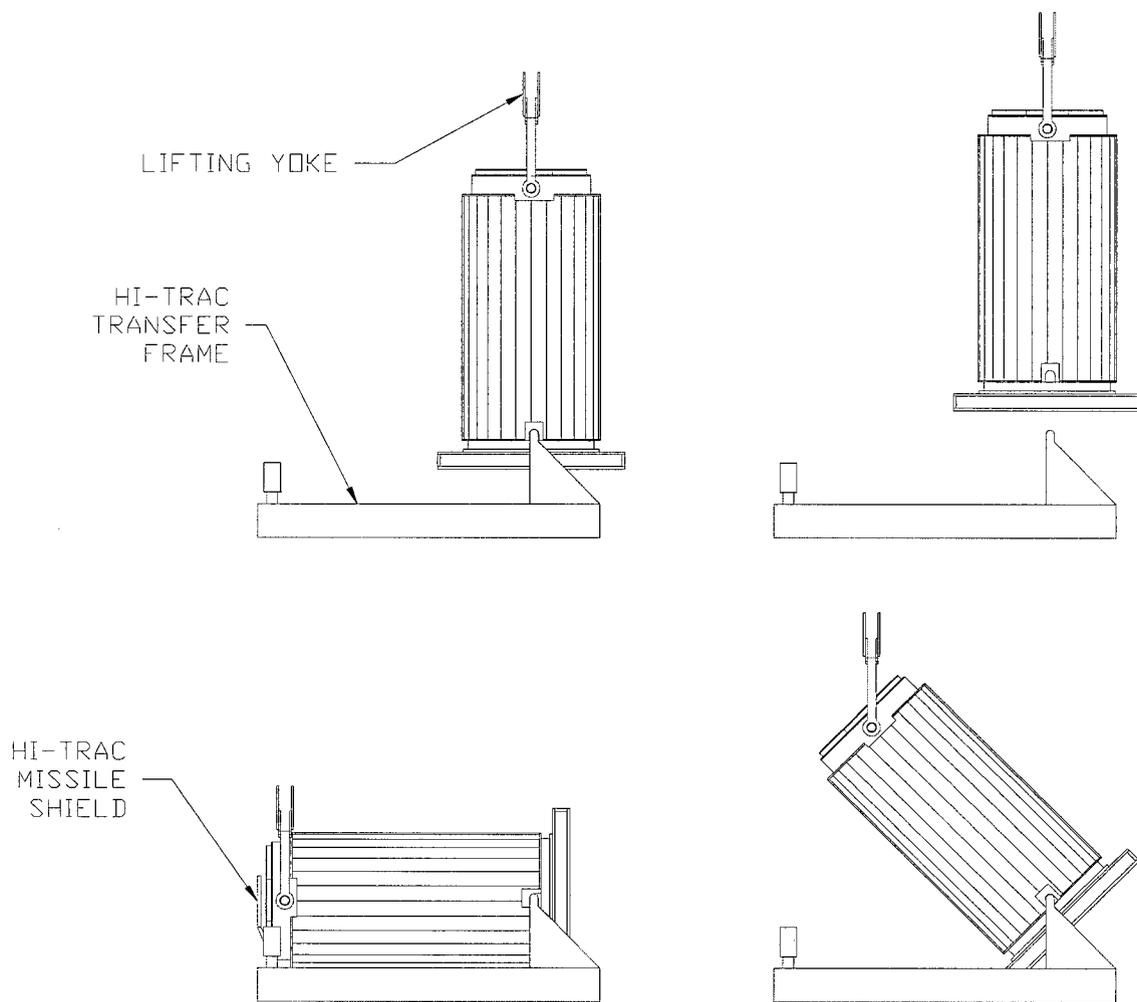
SAMPLE HI-TRAC HANDLING METHODS



**Figure 8.1.2f; Example of HI-TRAC Handling Options (Missile Shields Not Shown For Clarity)**



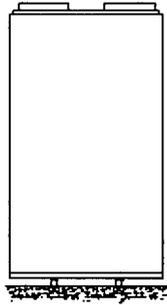
**Figure 8.1.3; Lift Yoke Engagement and Vertical HI-TRAC Handling  
(Shown with the Pool Lid and the Transfer Lid)**



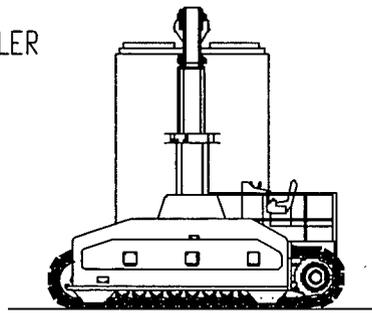
**Figure 8.1.4; HI-TRAC Upending/Downending in the Transfer Frame**

**(HI-TRAC with pocket trunnions shown, HI-TRAC 100D and 125D utilize separate upending frame without pocket trunnions)**

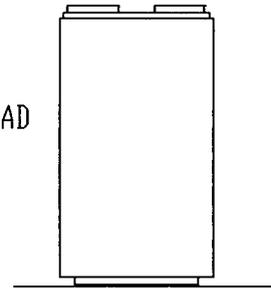
RAIL DOLLY



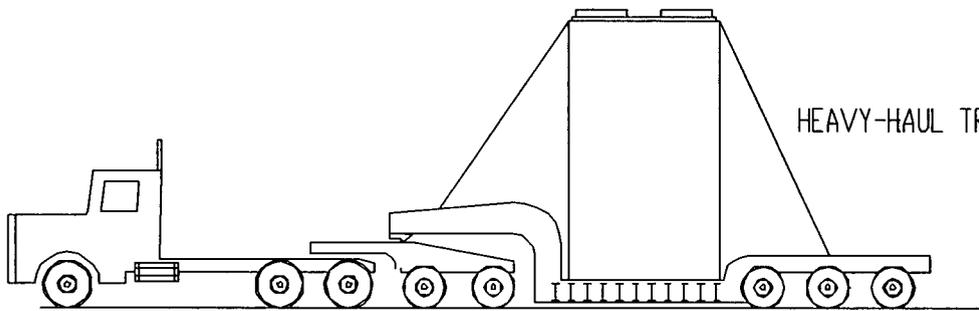
CASK CRAWLER



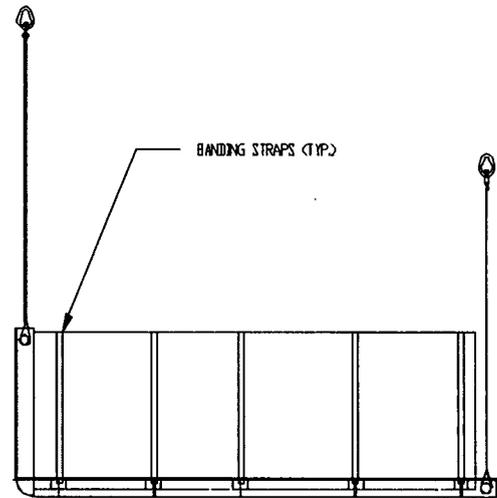
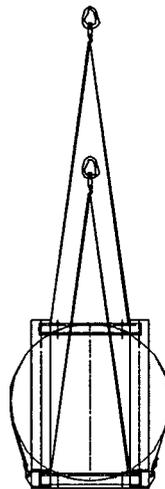
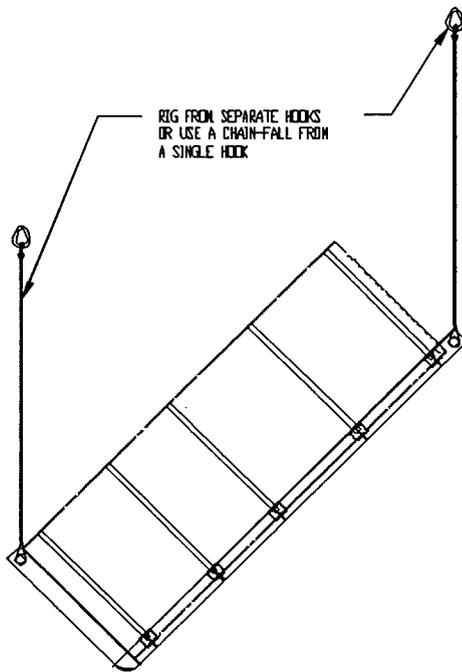
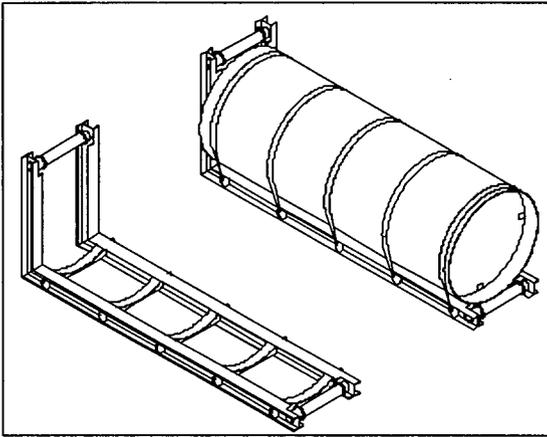
AIR PAD



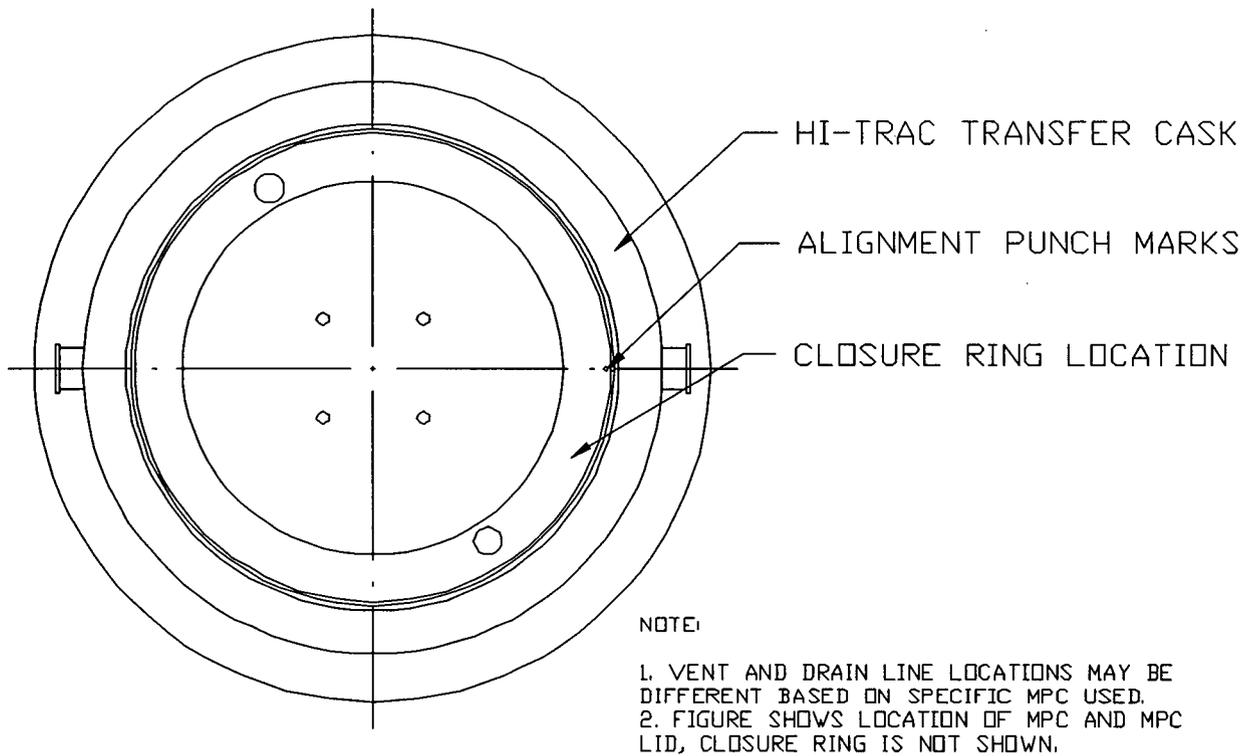
HEAVY-HAUL TRAILER



**Figure 8.1.5; HI-STORM Vertical Handling**

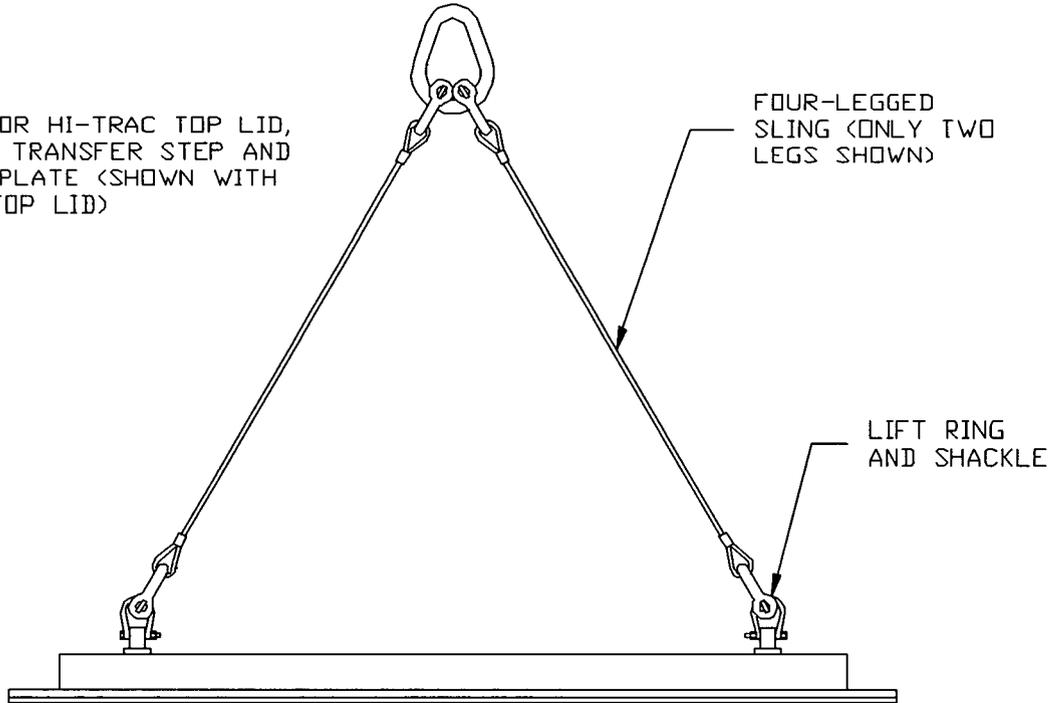


**Figure 8.1.6; MPC Upending in the MPC Upending Frame**

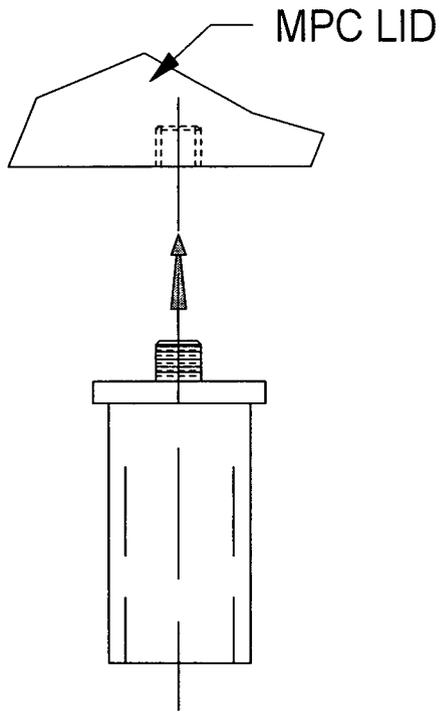


**Figure 8.1.8; MPC Alignment in HI-TRAC**

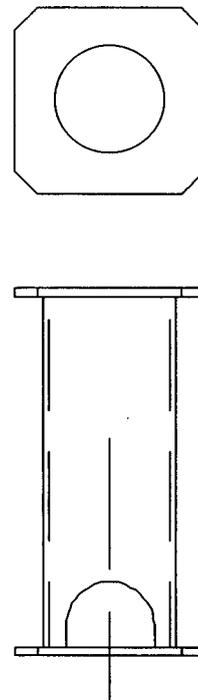
RIGGING FOR HI-TRAC TOP LID,  
POOL LID, TRANSFER STEP AND  
AWS BASEPLATE (SHOWN WITH  
HI-TRAC TOP LID)



**Figure 8.1.9; MPC Lid AND HI-TRAC Accessory Rigging**



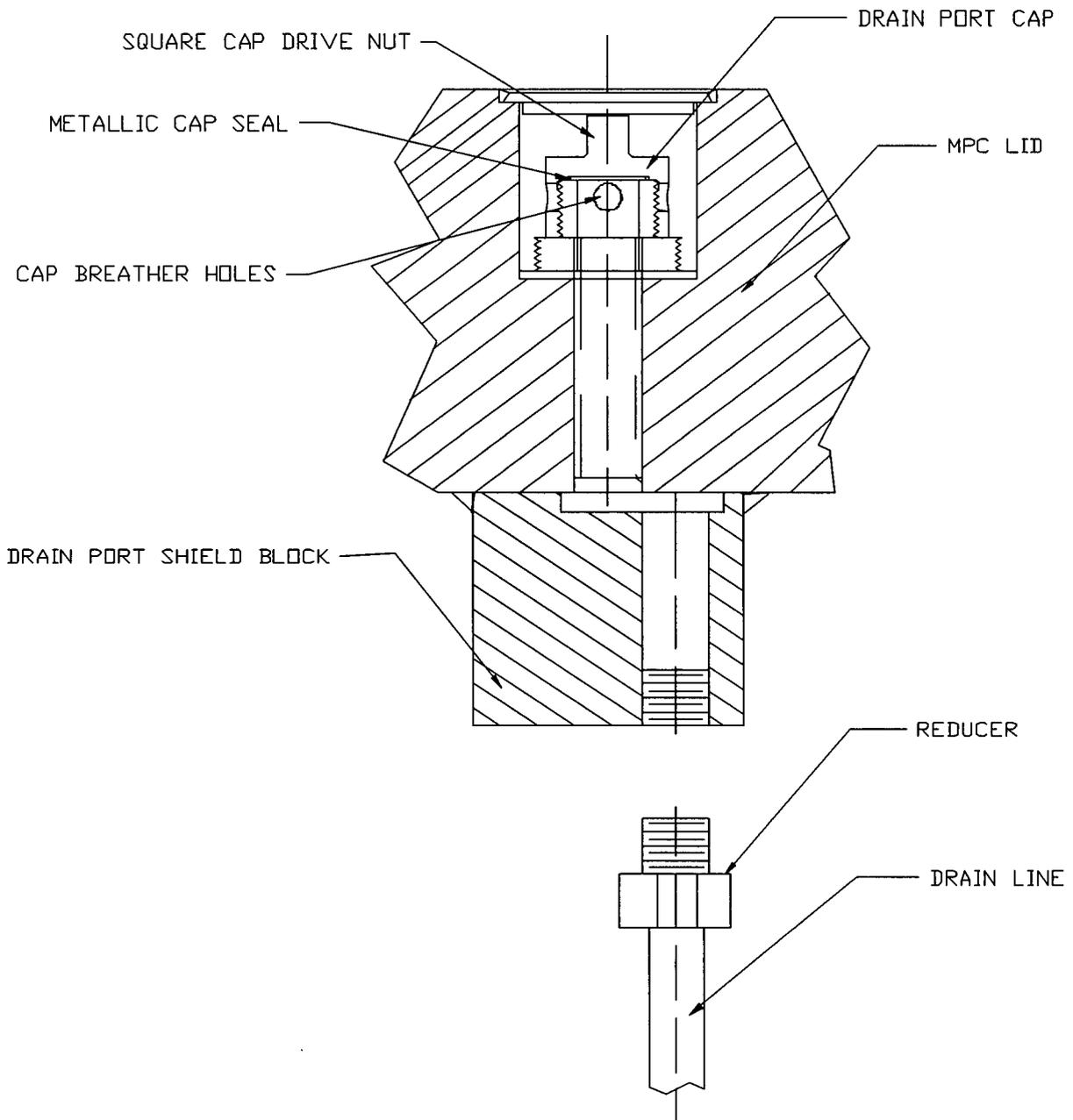
UPPER FUEL SPACER



LOWER FUEL SPACER

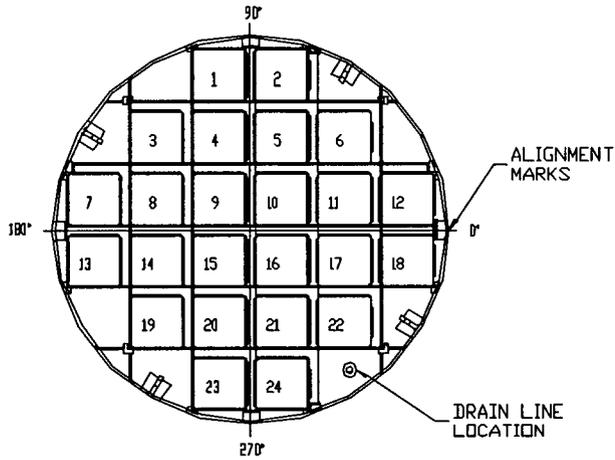
Note: Lengths are based on specific fuel assembly type to be stored.

**Figure 8.1.10; Fuel Spacers**

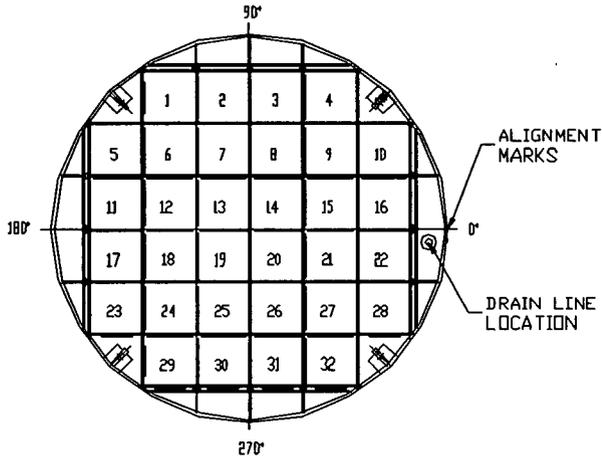


**Figure 8.1.11; Drain Port Details**

MPC-24



MPC-32



MPC-68

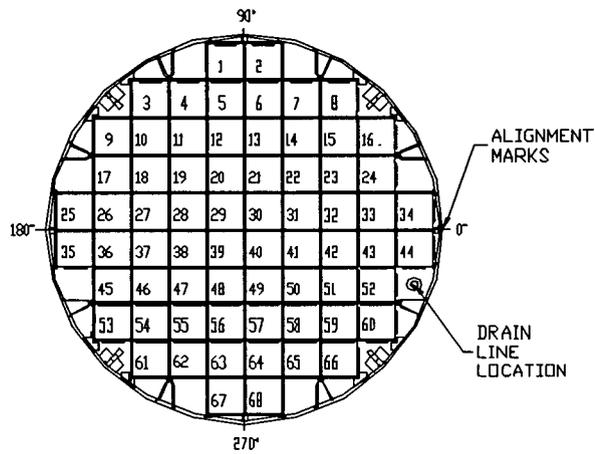
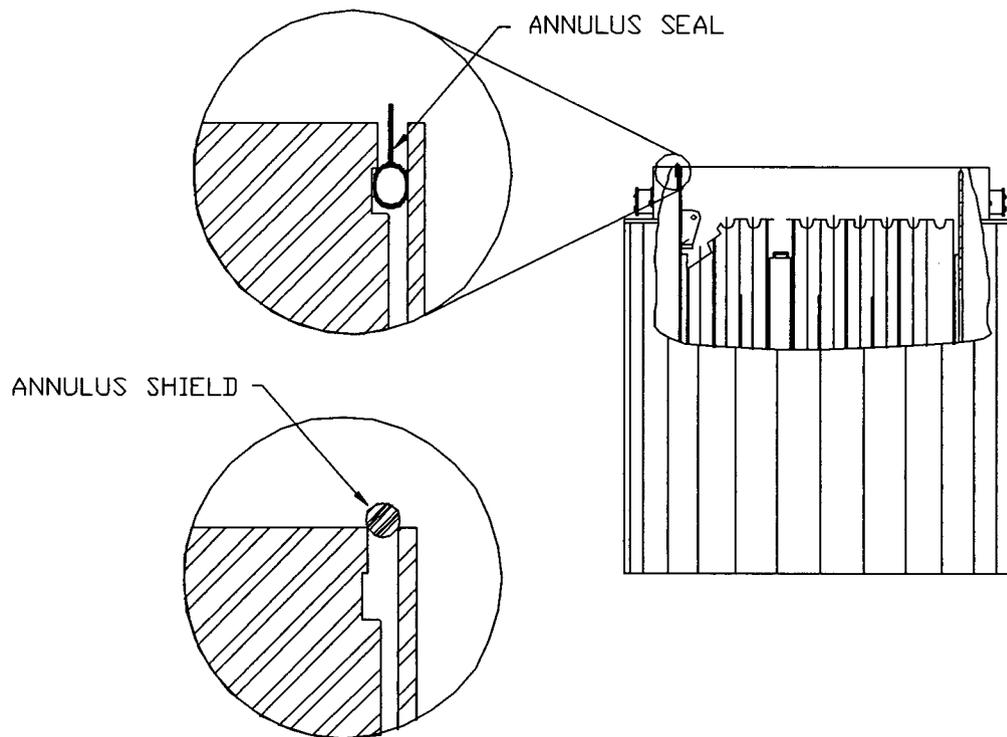
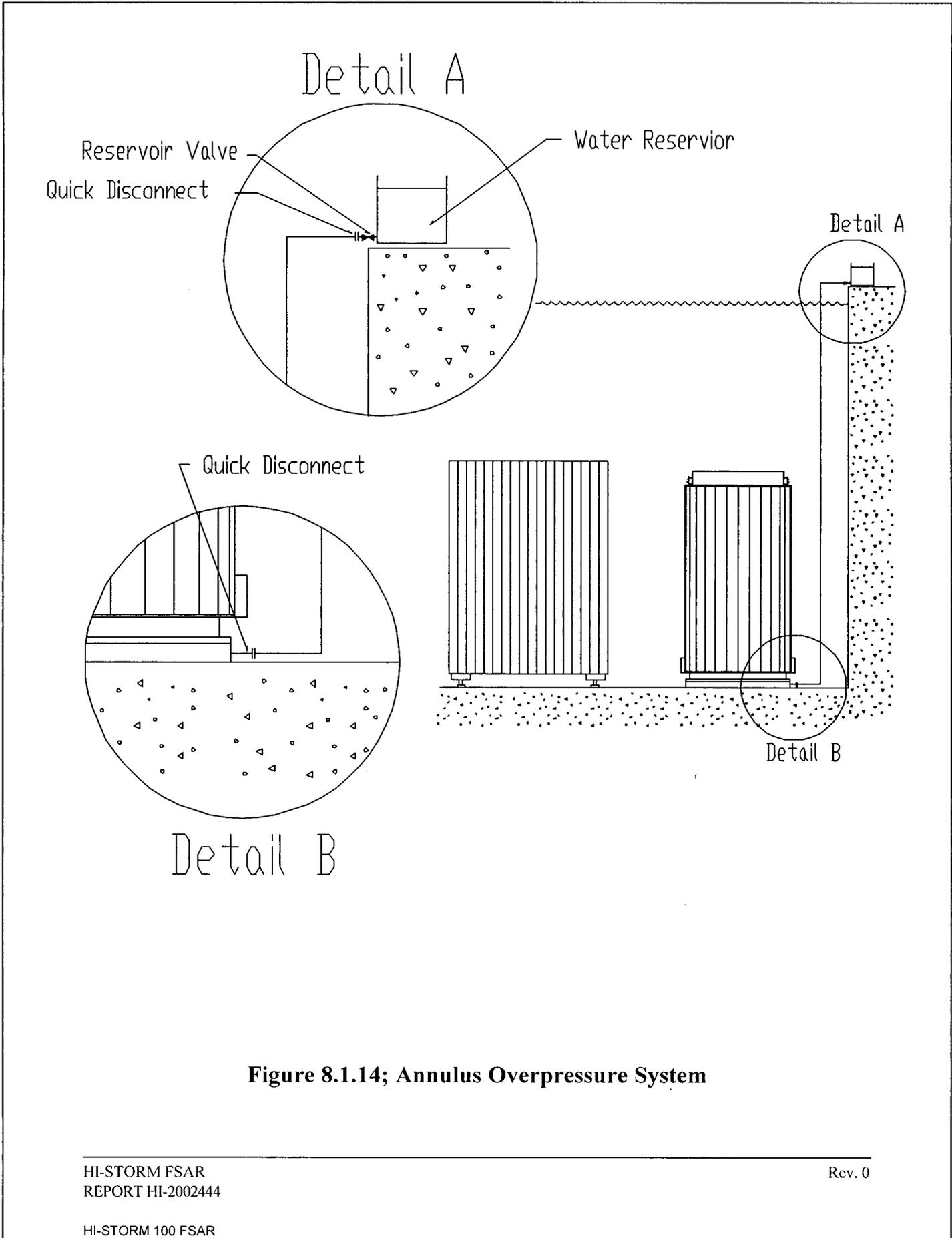


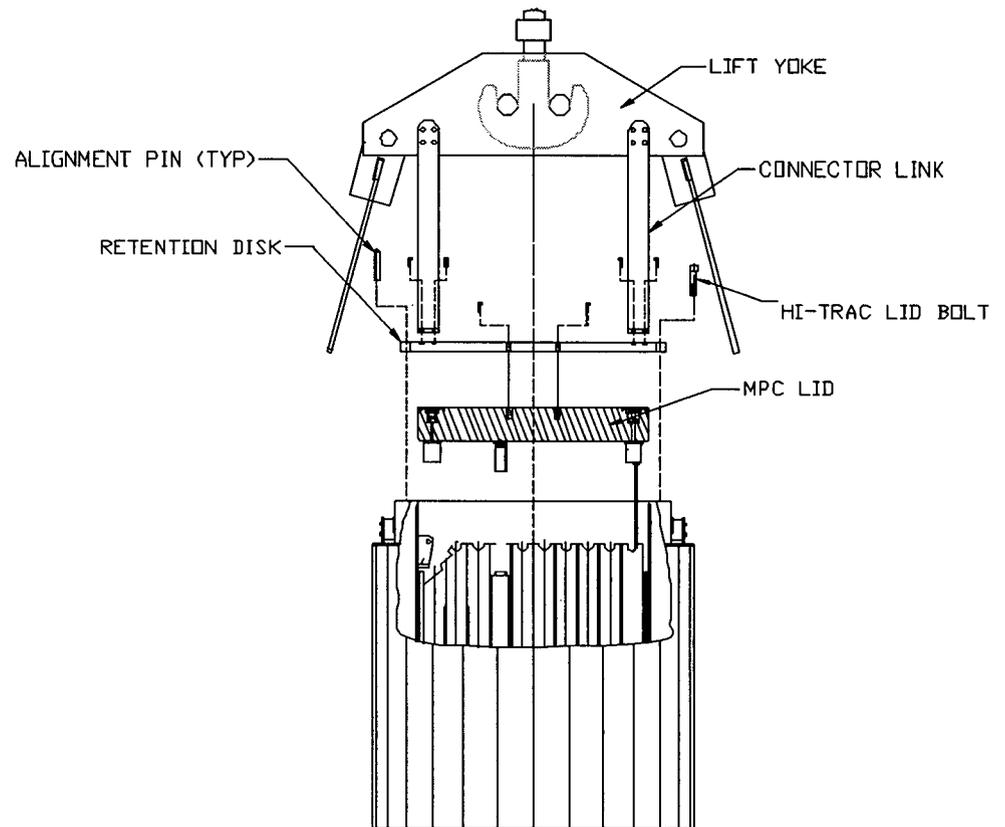
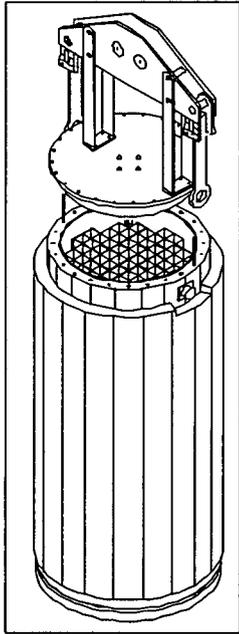
Figure 8.1.12; Drain Line Positioning



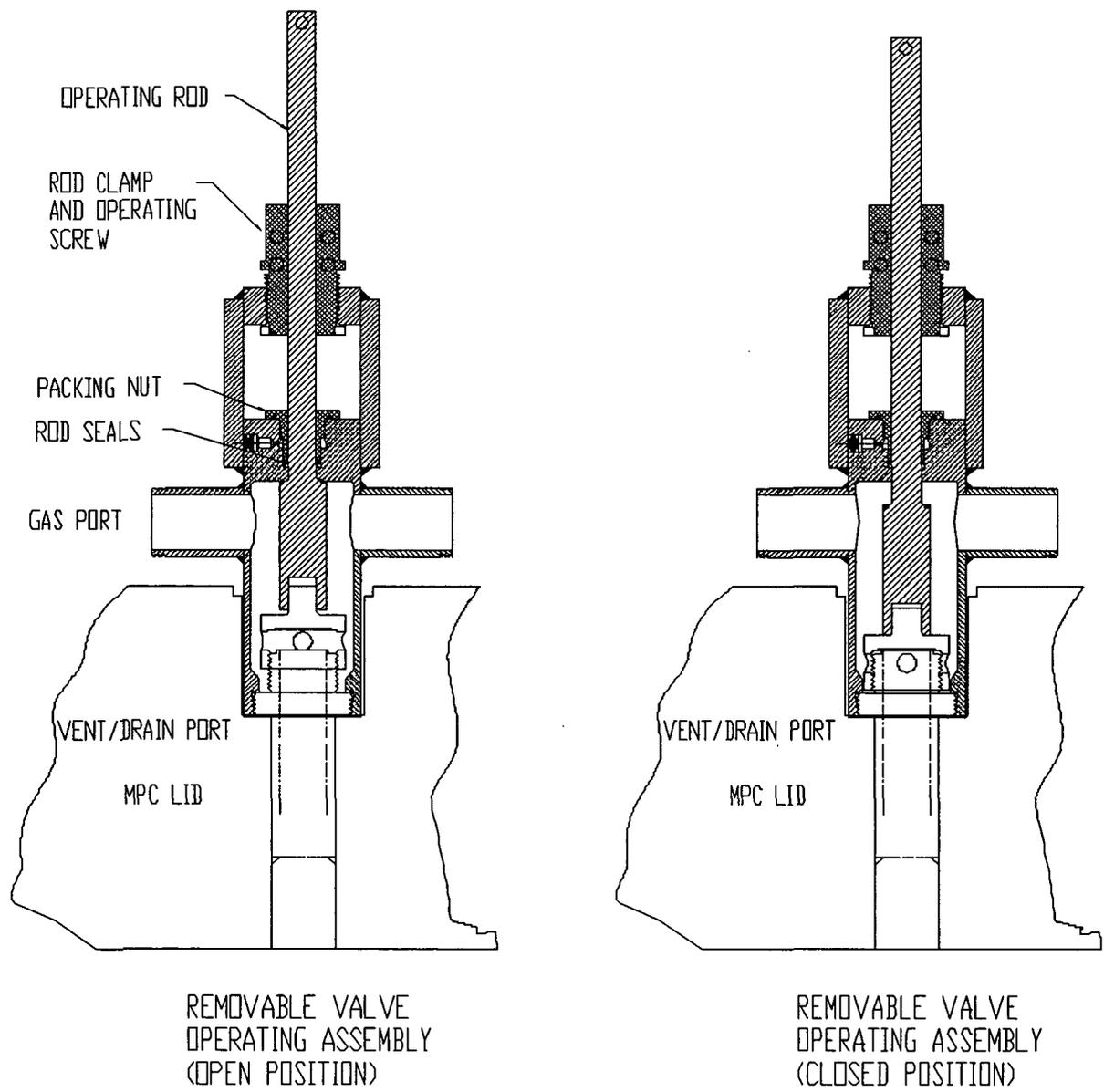
**Figure 8.1.13; Annulus Shield/Annulus Seal**



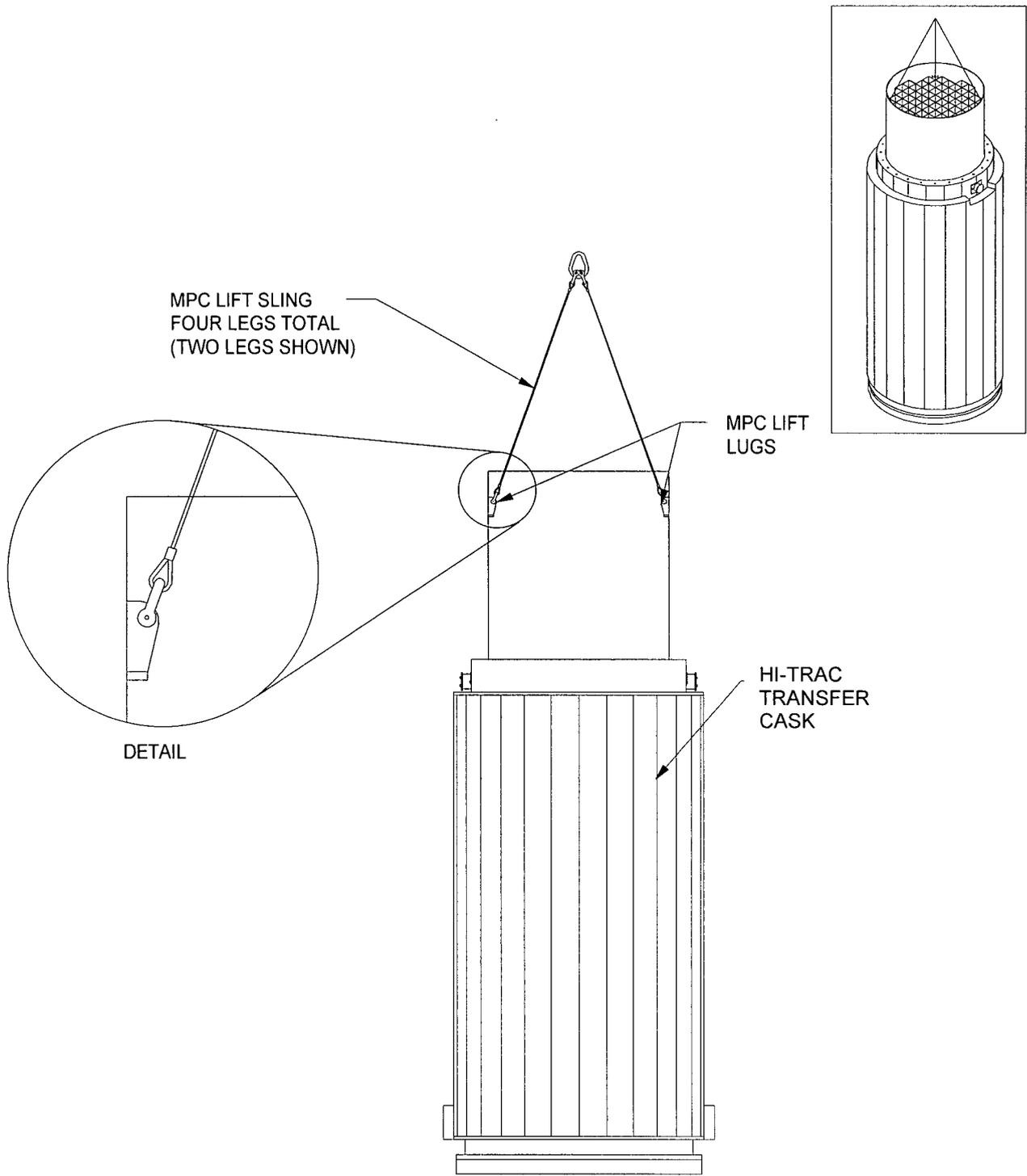
**Figure 8.1.14; Annulus Overpressure System**



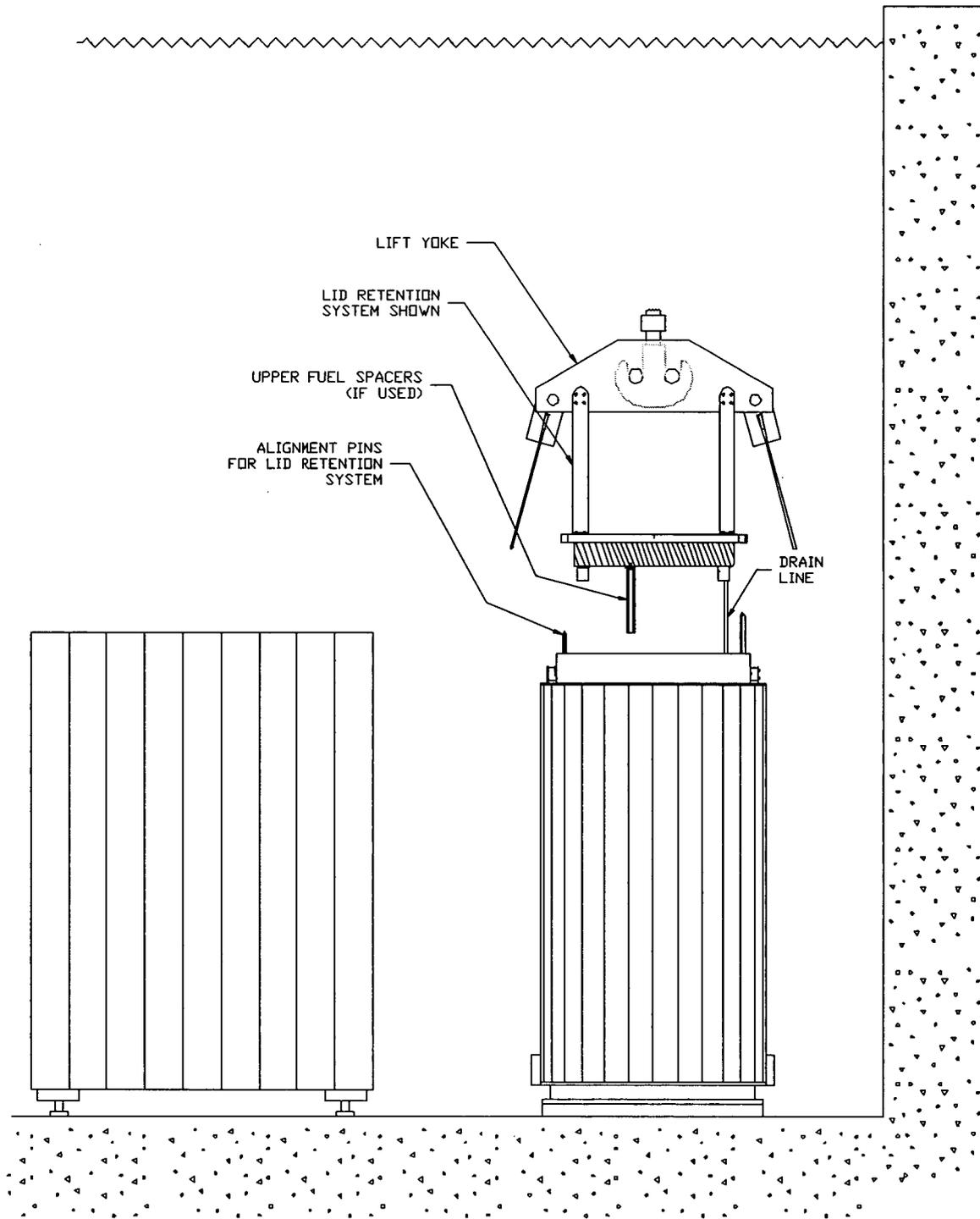
**Figure 8.1.15; HI-TRAC Lid Retention System in Exploded View**



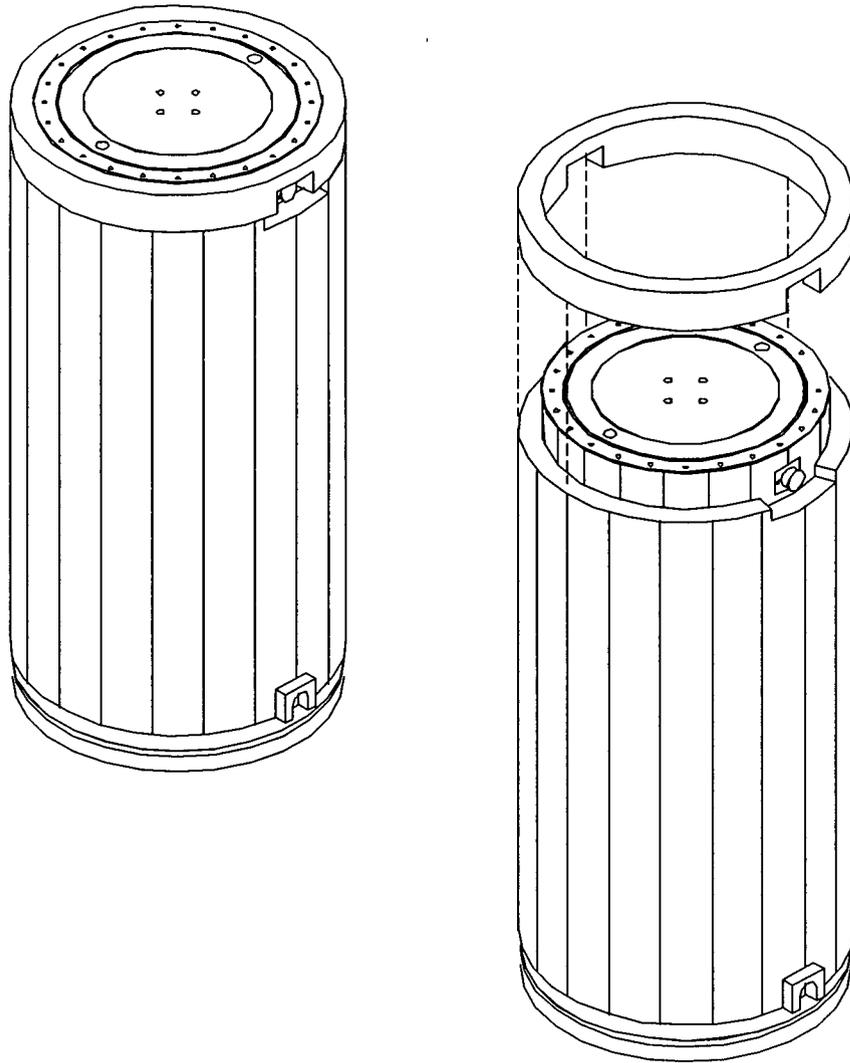
**Figure 8.1.16; MPC Vent and Drain Port RVOA Connector**



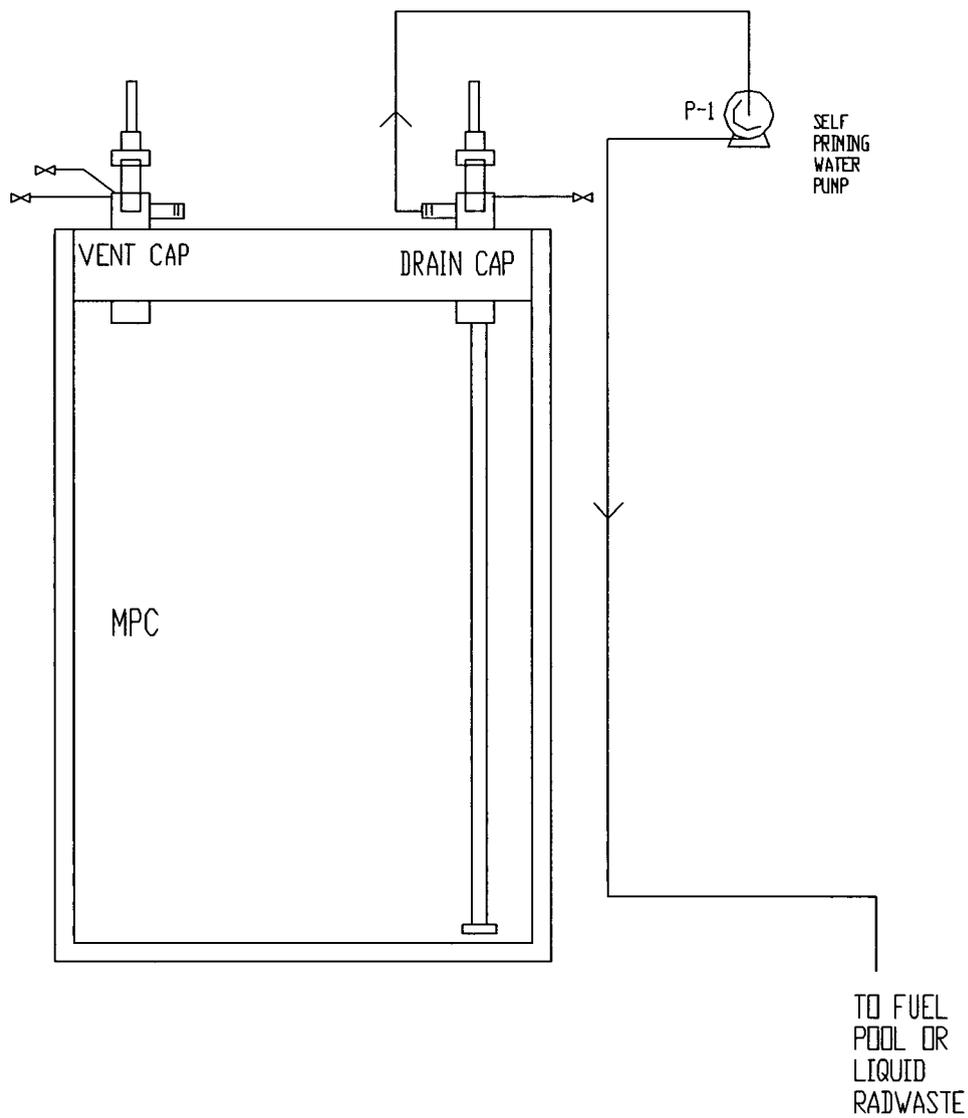
**Figure 8.1.7; MPC Rigging for Vertical Lifts**



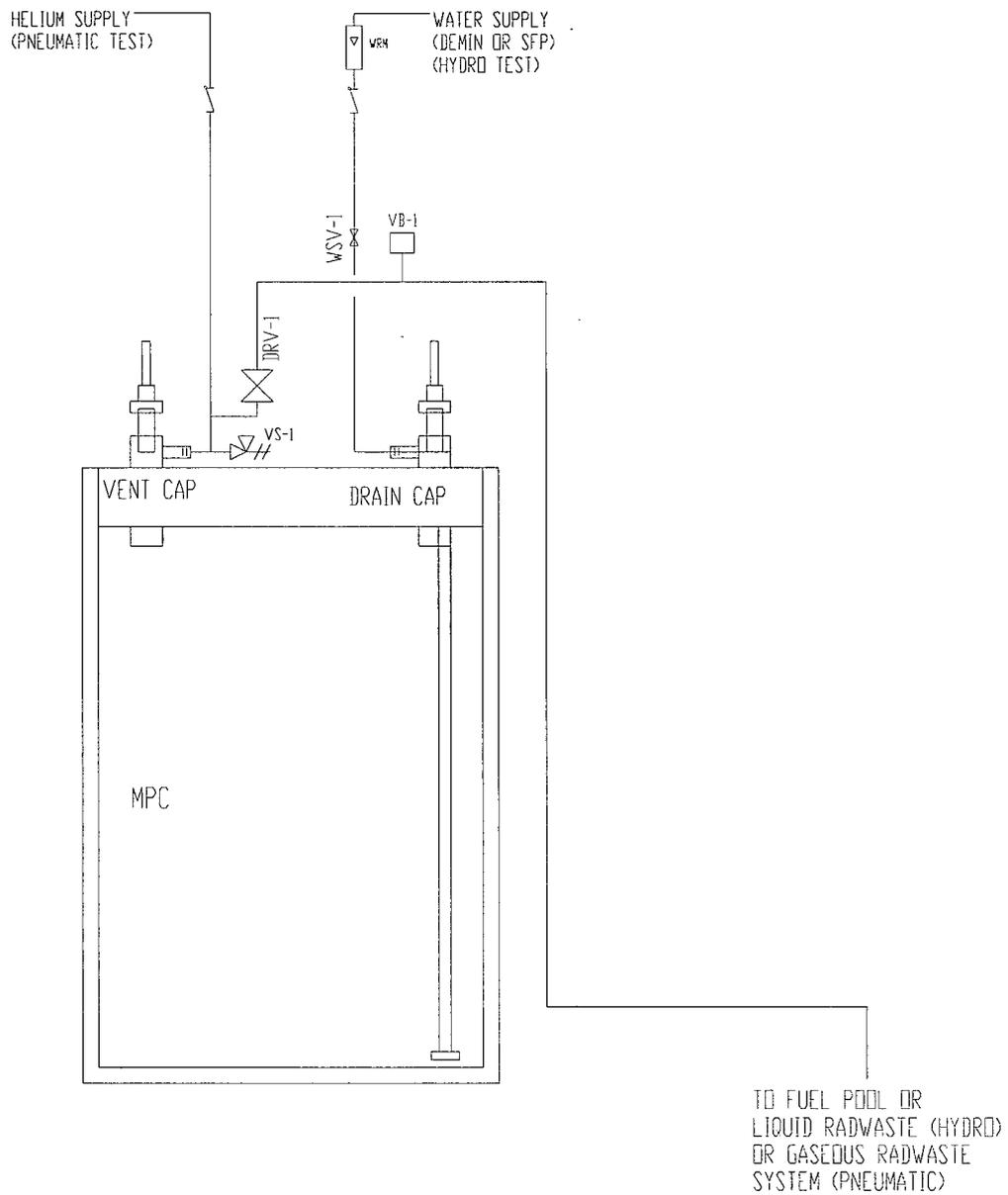
**Figure 8.1.17; Drain Line Installation**



**Figure 8.1.18; Temporary Shield Ring**



**Figure 8.1.19; MPC Water Pump-Down for MPC Lid Welding Operations, Example P&I D**



**Figure 8.1.20; MPC Lid-to-Shell Pressure Testing, Example P&I D**

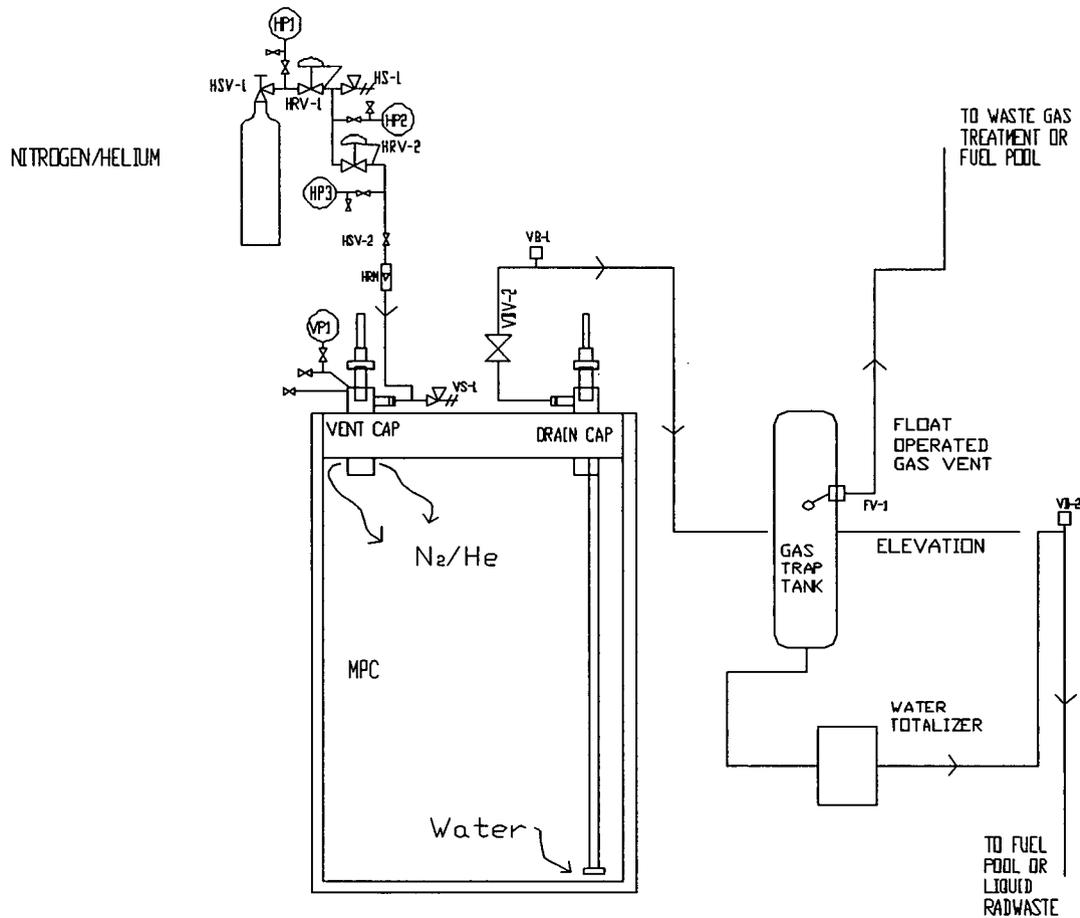
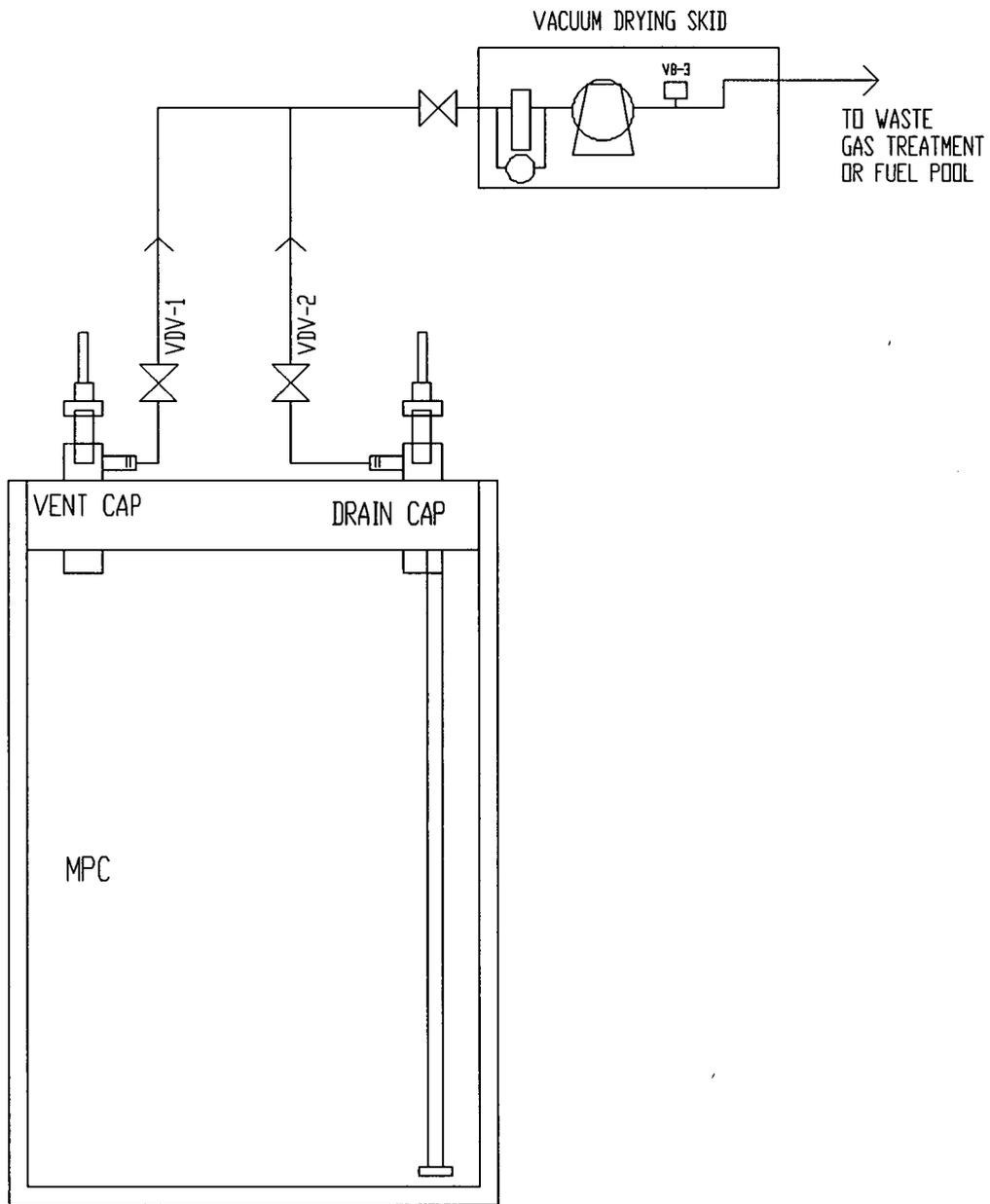
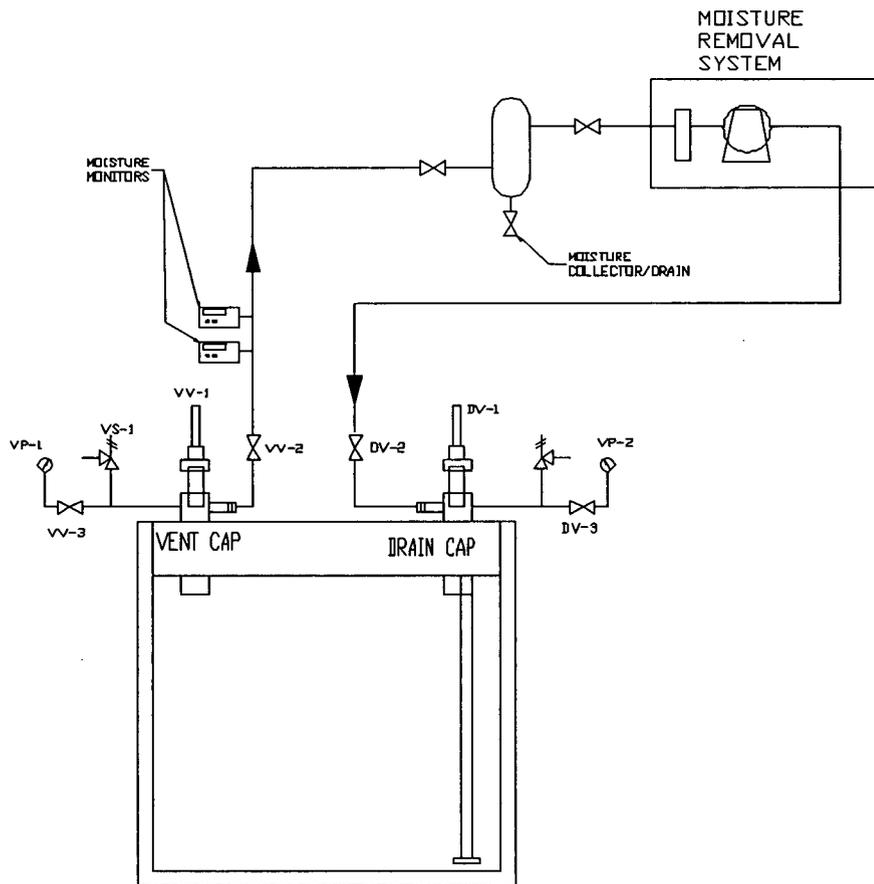


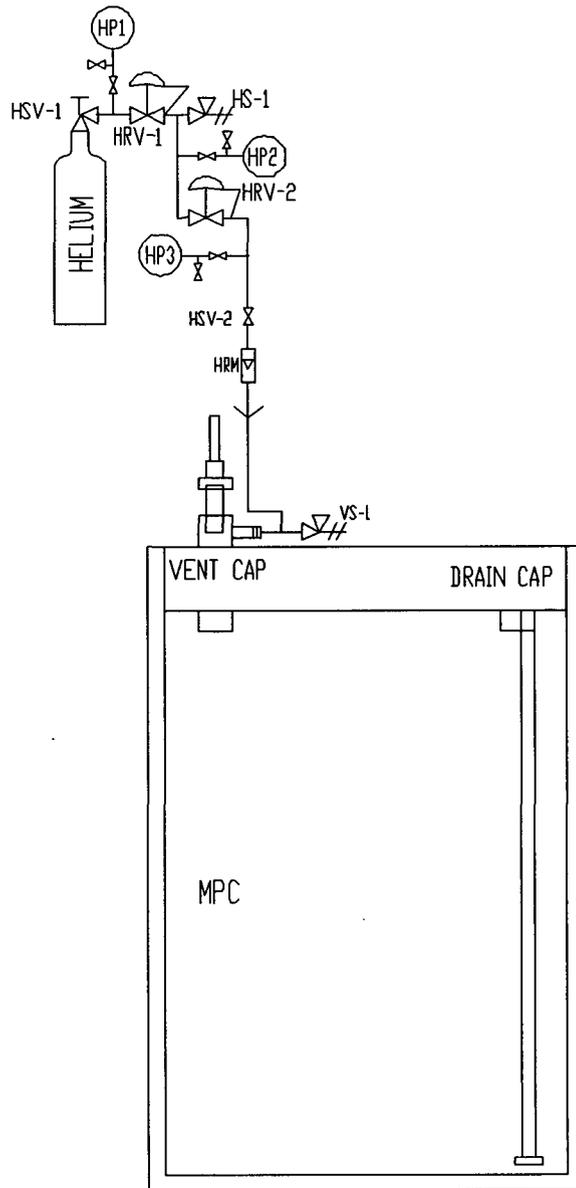
Figure 8.1.21; MPC Blowdown, Example P&I D



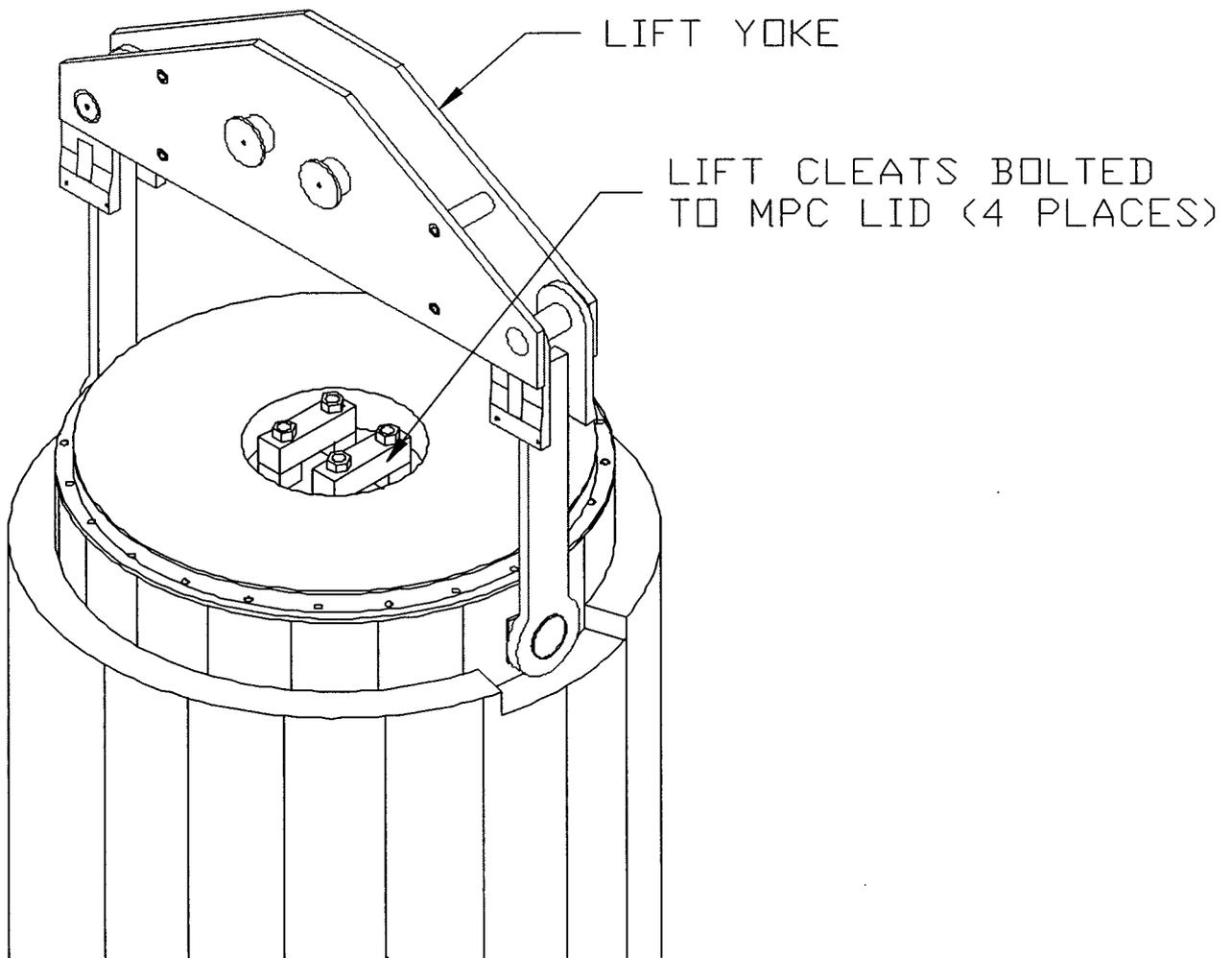
**Figure 8.1.22a; Vacuum Drying System, Example P&I D**



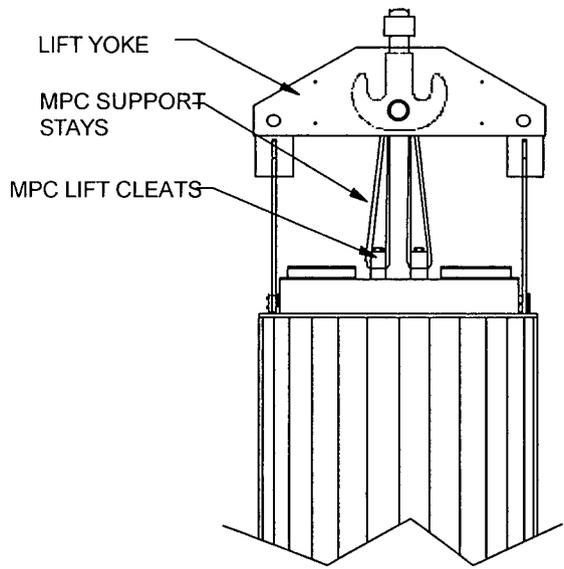
**Figure 8.1.22b; forced Helium Dehydration System, Example P&I D**



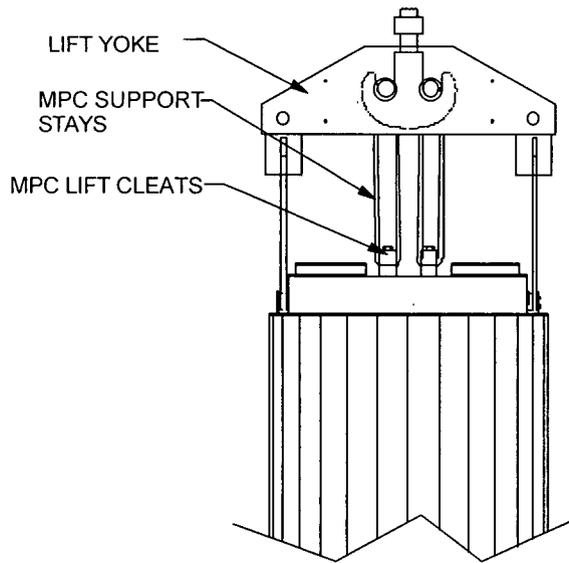
**Figure 8.1.23; Helium Backfill System, Example P&I D**



**Figure 8.1.24; MPC Lift Cleats**

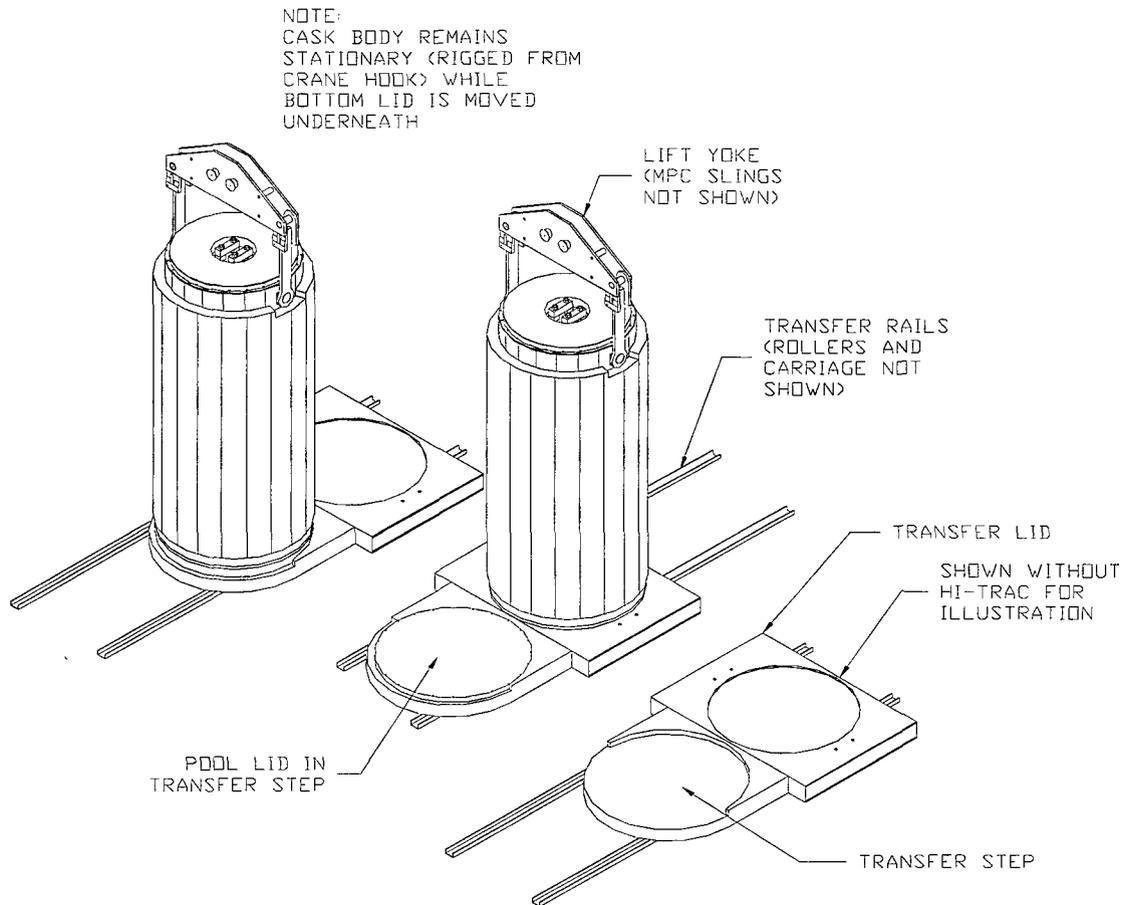


SINGLE-PIN  
ARRANGEMENT



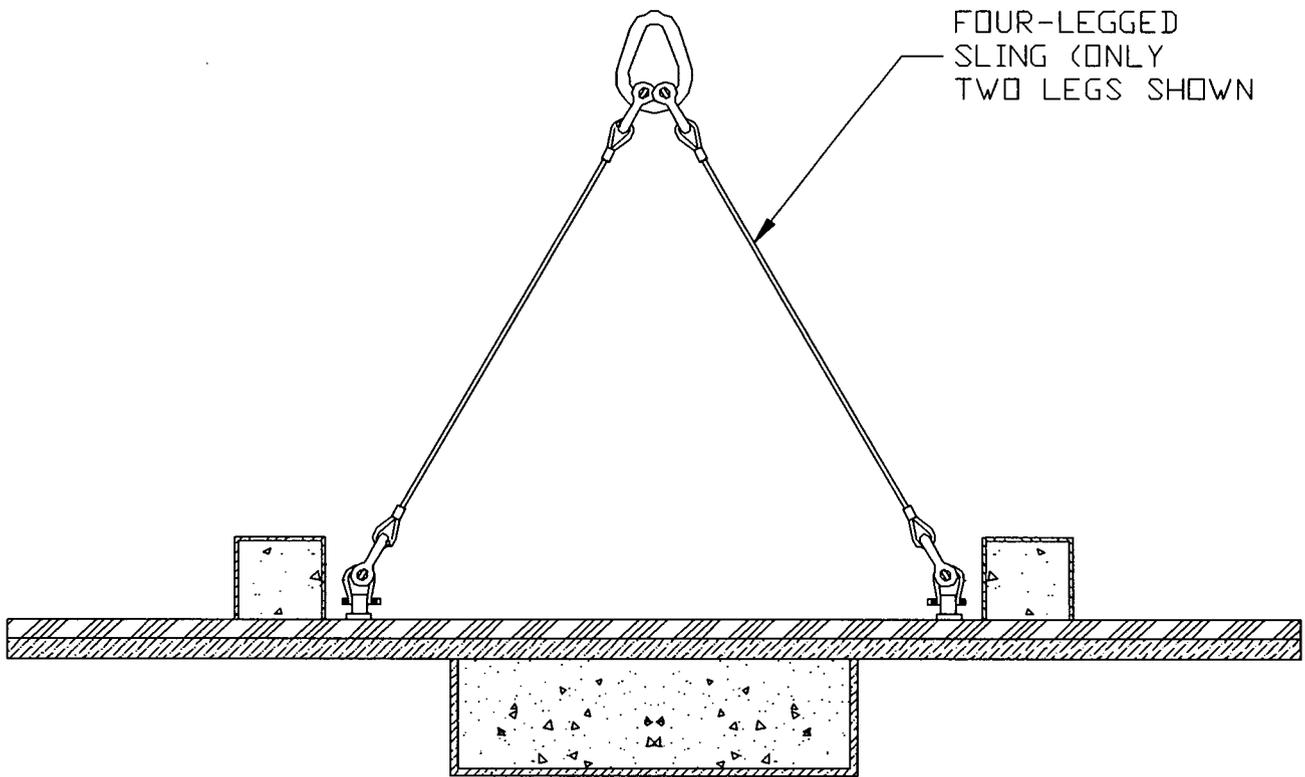
DOUBLE-PIN  
ARRANGEMENT

**Figure 8.1.25; MPC Slings**



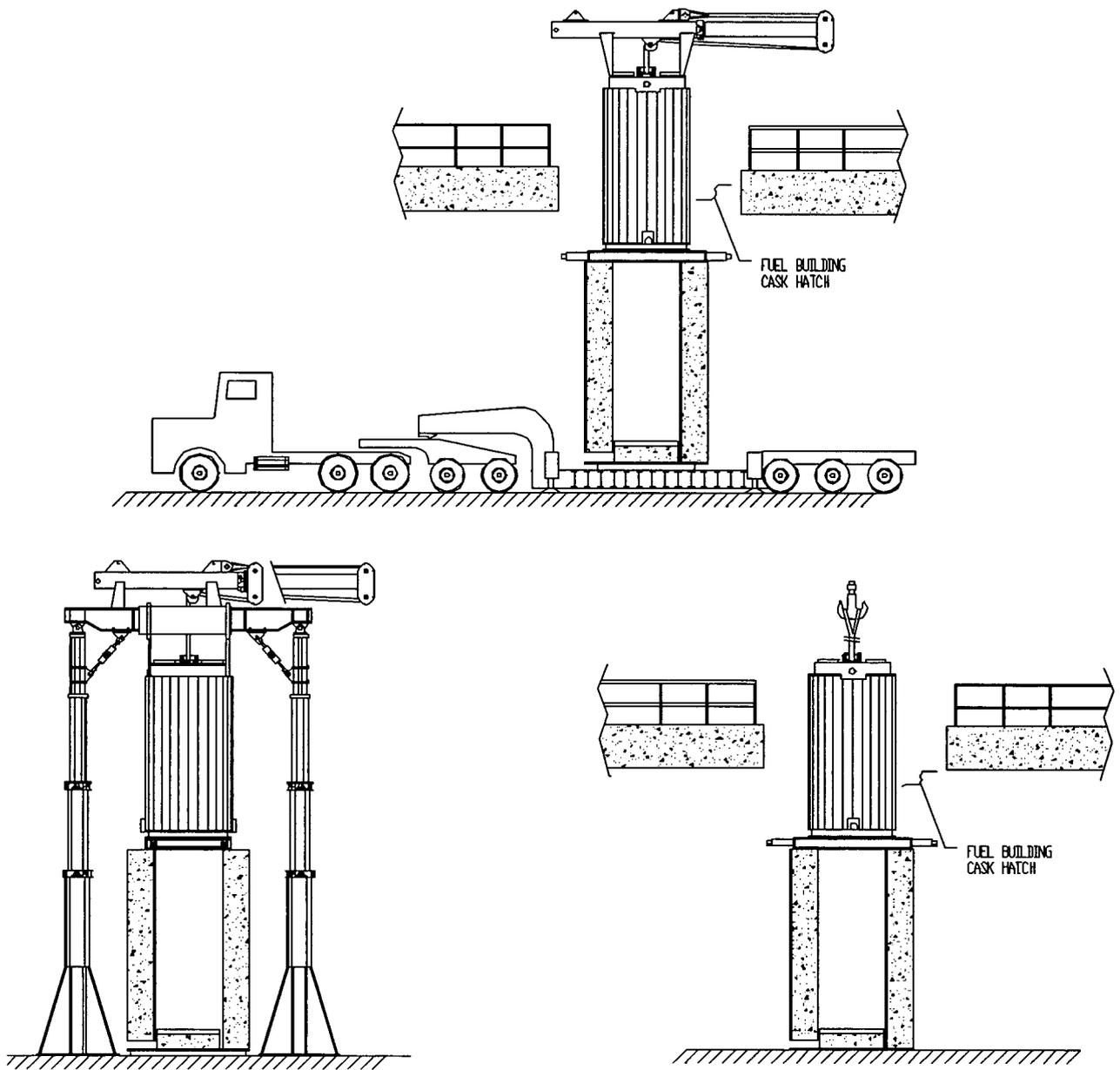
**Figure 8.1.26; HI-TRAC Bottom Lid Replacement**

**(Not Required for HI-TRAC 100D and 125D)**



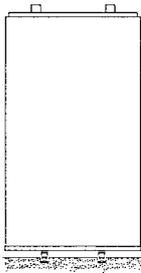
**Figure 8.1.27; HI-STORM Lid Rigging**

**(HI-STORM 100 Lid Shown)**

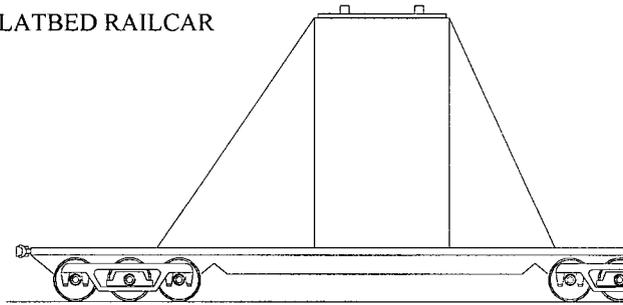


**Figure 8.1.28; Sample MPC Transfer Options  
(HI-TRAC with Transfer Lid Shown)**

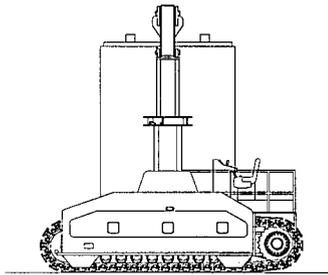
RAIL DOLLY



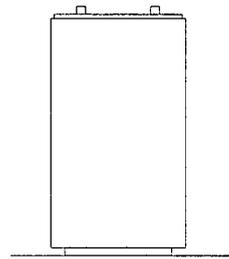
FLATBED RAILCAR



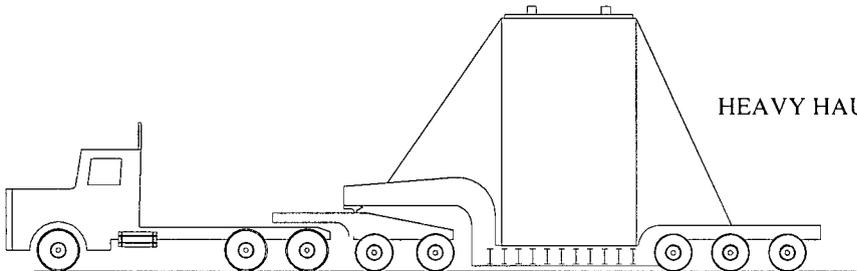
VERTICAL CASK  
TRANSPORTER  
("CRAWLER")



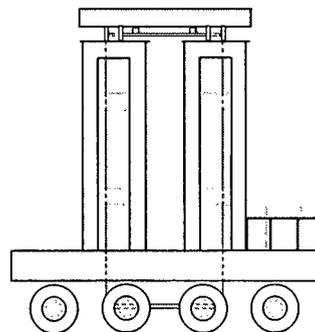
AIR PAD



HEAVY HAUL TRAILER

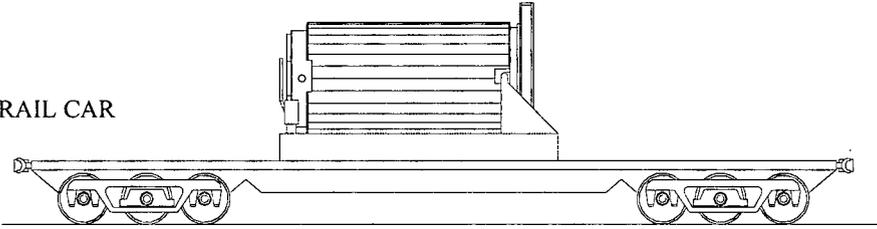


VERTICAL CASK  
TRANSPORTER

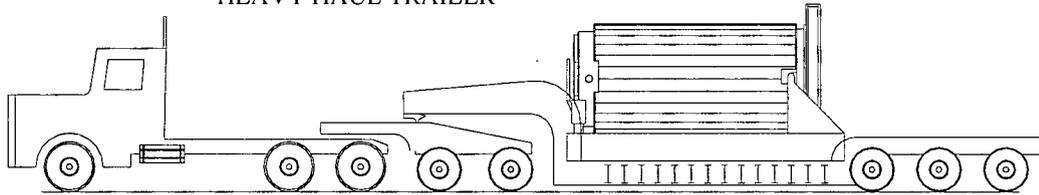


**Figure 8.1.29a; Sample HI-STORM Transfer Options**

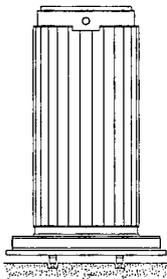
RAIL CAR



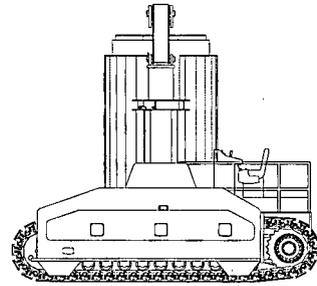
HEAVY HAUL TRAILER



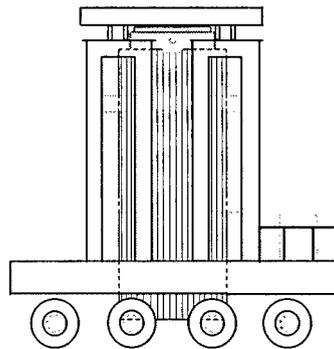
RAIL DOLLY



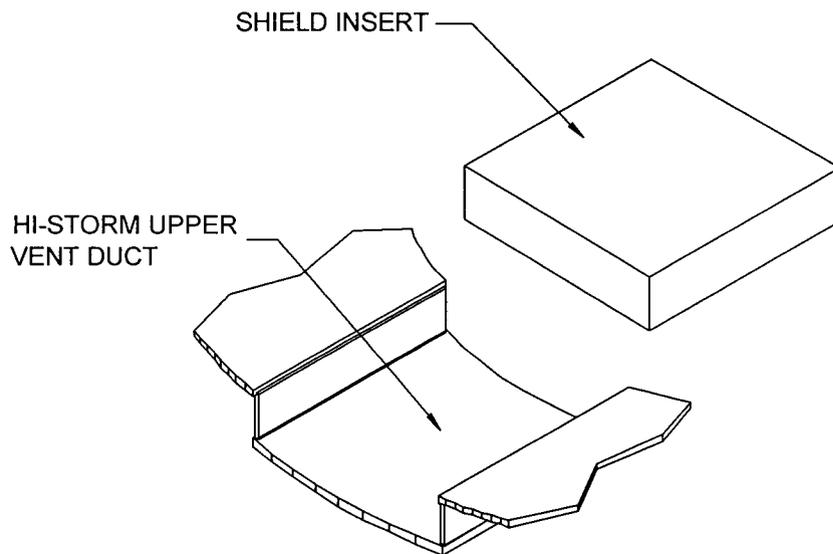
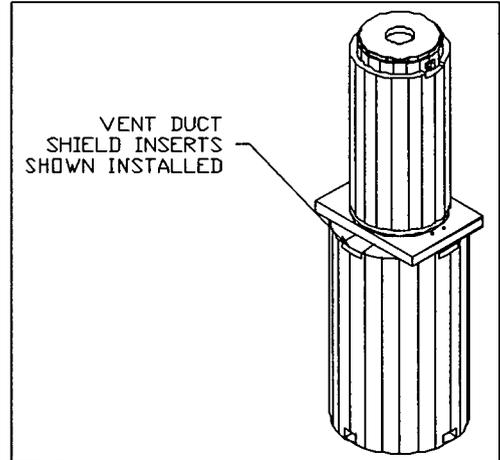
VERTICAL CASK TRANSPORTER  
("CRAWLER")



VERTICAL CASK TRANSPORTER

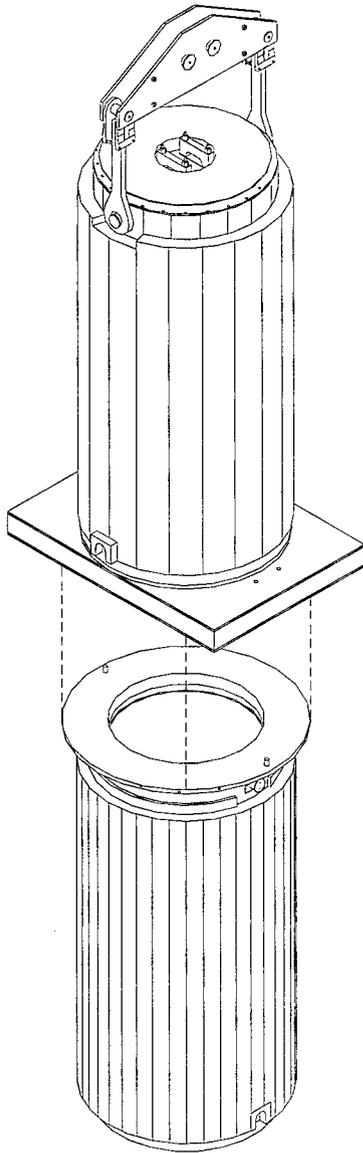


**Figure 8.1.29b; Sample HI-TRAC Transfer Options  
(HI-TRAC 100/125 Shown)**

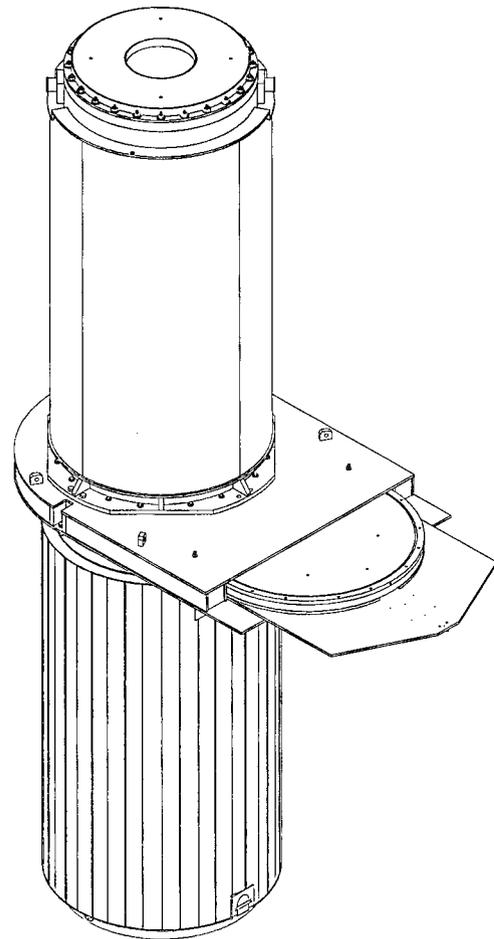


**Figure 8.1.30; Sample HI-STORM Vent Duct Shield Inserts**

**(Not Required for HI-STORM 100S)**

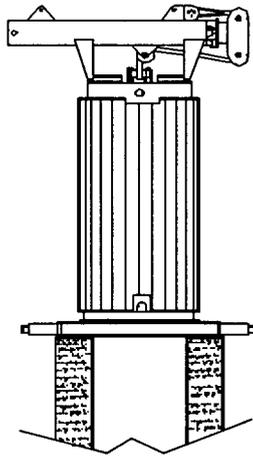


HI-TRAC 100 / 125

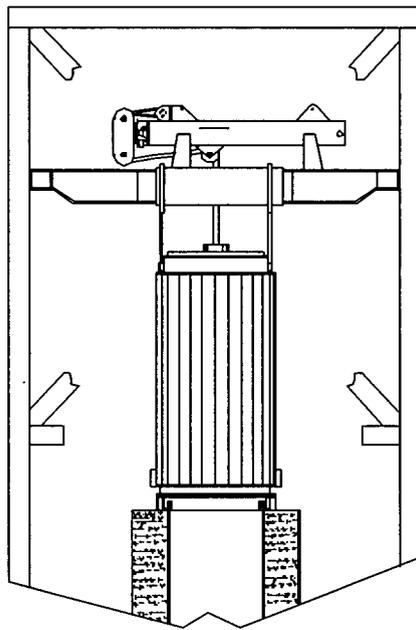


HI-TRAC 100D / 125D with Mating Device

**Figure 8.1.31; HI-TRAC Alignment Over HI-STORM**

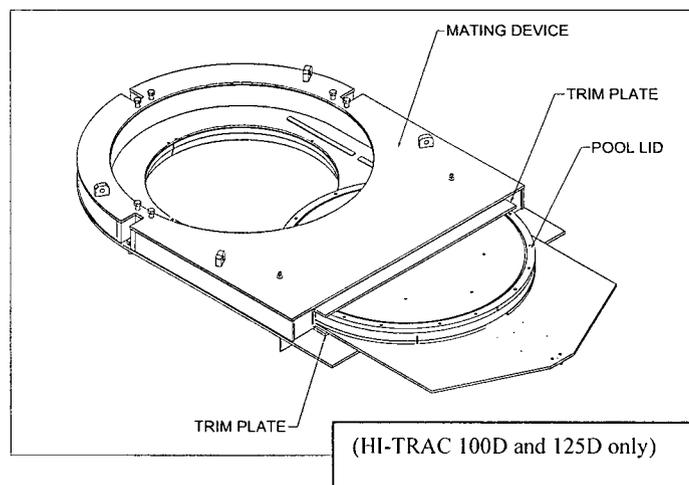
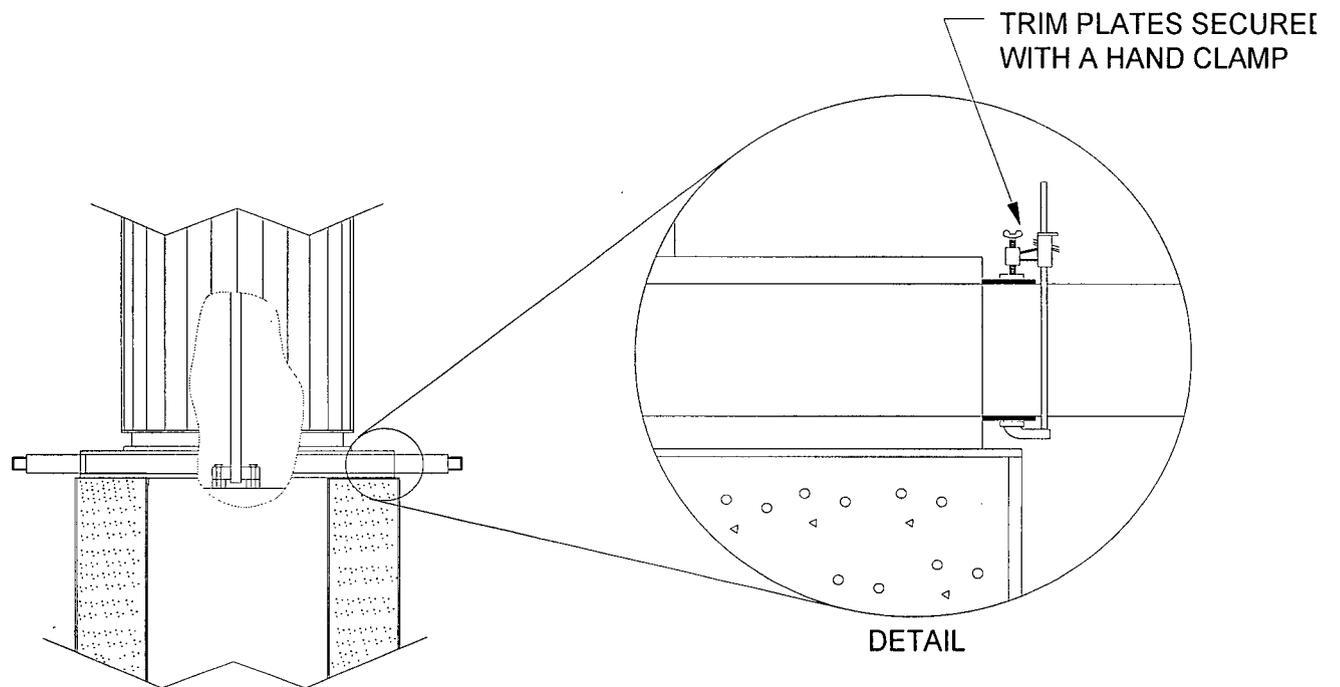


MOUNTED TO THE HI-TRAC LID

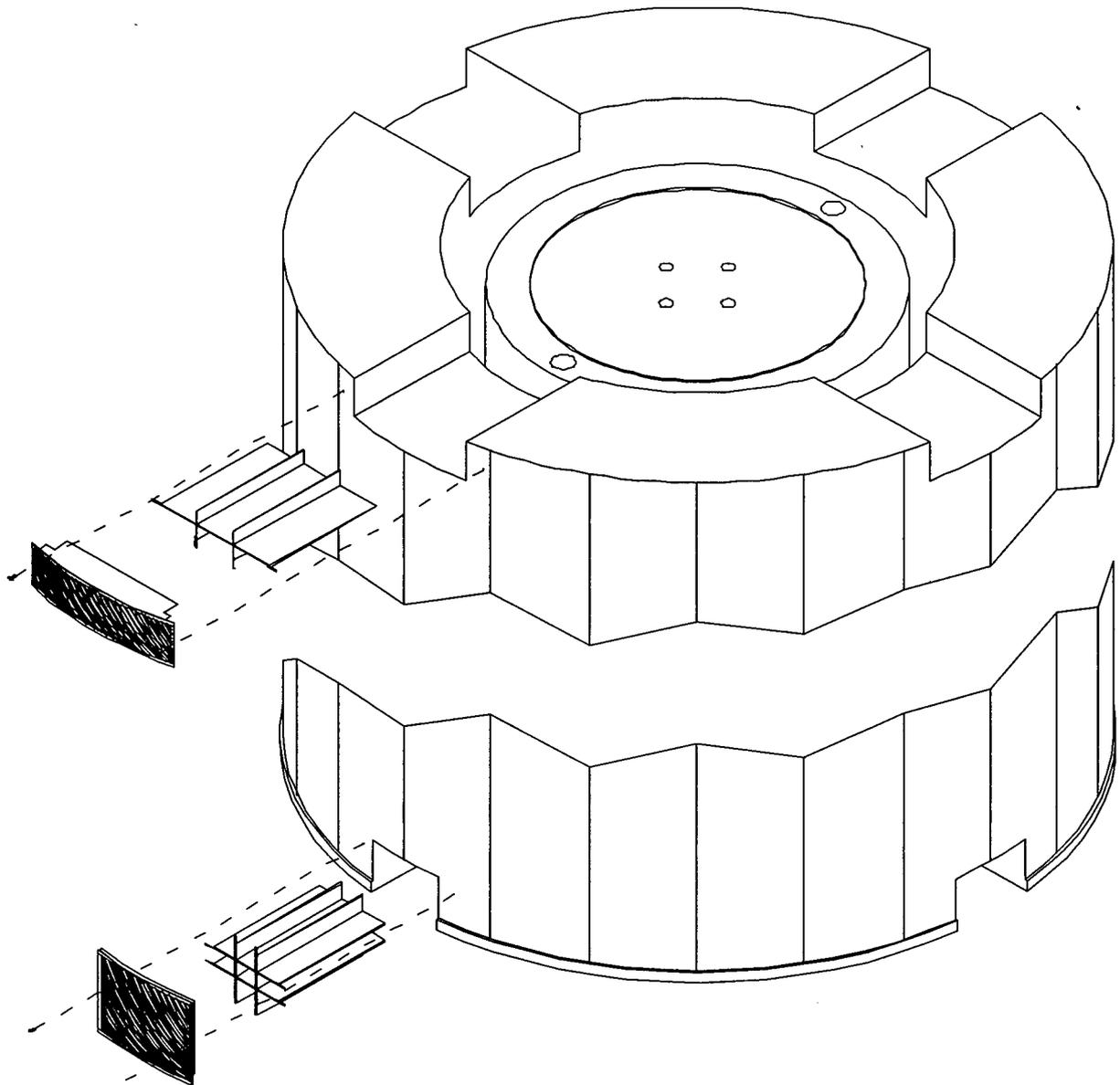


MOUNTED TO A CASK TRANSFER GANTRY

**Figure 8.1.32; Examples of an MPC Downloader**



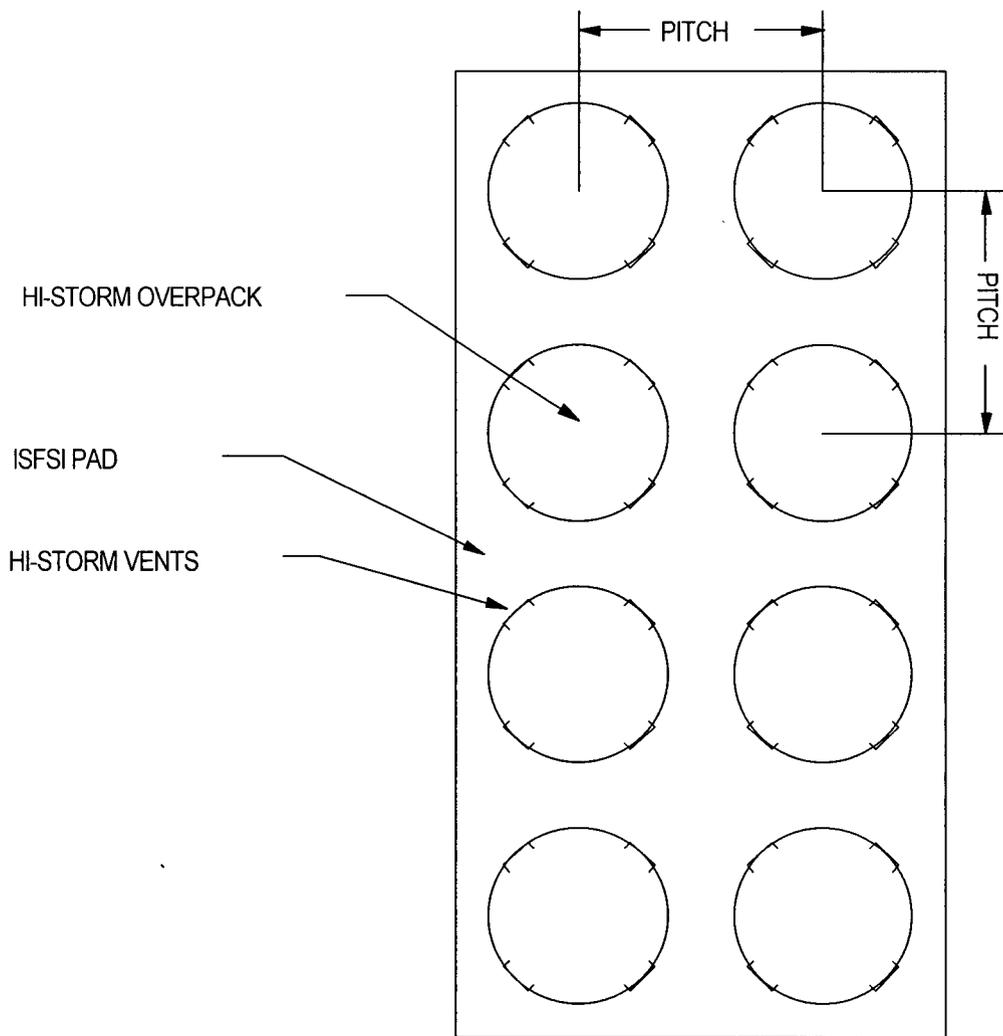
**Figure 8.1.33; Trim Plate Locations**



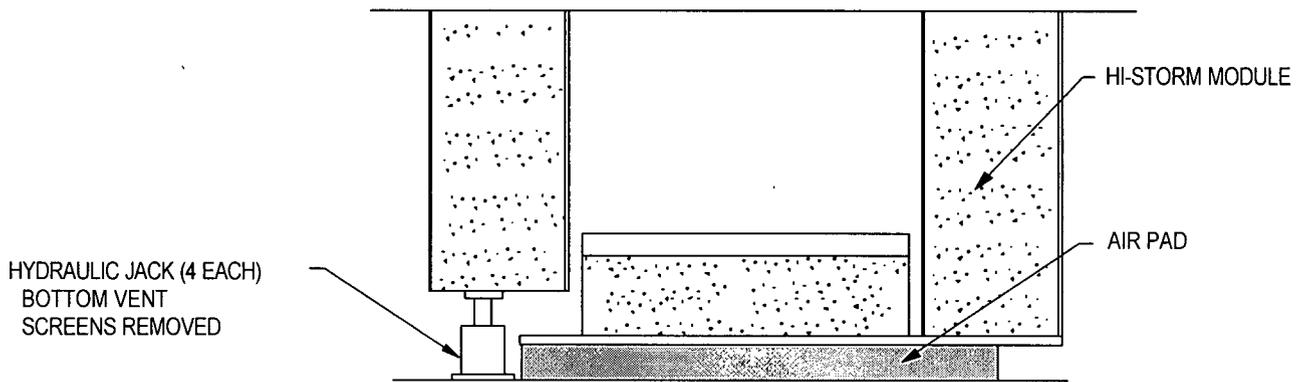
**Figure 8.1.34a; Typical HI-STORM Vent Screen and Gamma Shield Cross Plate Installation**

**Figure 8.1.34b**

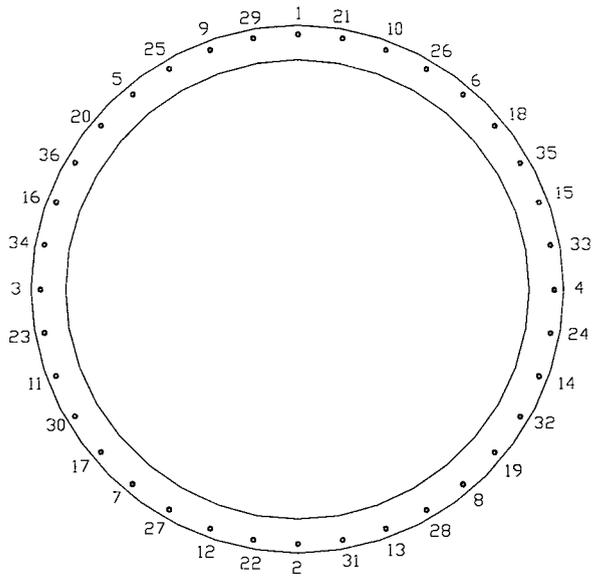
**Intentionally Deleted**



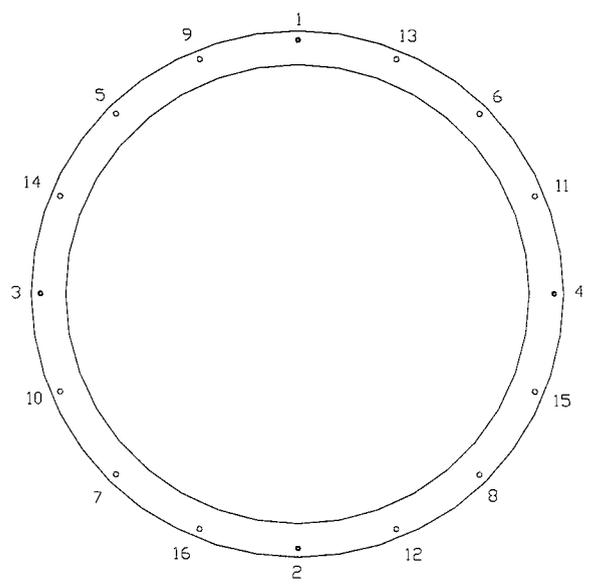
**Figure 8.1.35; HI-STORM Placement of the ISFSI Pad**



**Figure 8.1.36; HI-STORM Jacking**



HI-TRAC 100 / 125  
 BOTTOM LID  
 (POOL LID OR  
 TRANSFER LID)



HI-TRAC  
 100D / 125D  
 POOL LID

**Figure 8.1.37; HI-TRAC Lid Bolt Torquing Pattern**

Table 8.1.10 (Continued)  
HI-TRAC OVERPACK INSPECTION CHECKLIST

HI-TRAC Transfer Lid (Not used with HI-TRAC 100D and 125D):

1. The doors shall be inspected for smooth actuation.
2. The threads shall be inspected for general condition.
3. The bolts shall be inspected for indications of overstressing (i.e., cracks, deformation, thread damage, excessive wear) and replaced as necessary.
4. Door locking pins shall be inspected for indications of overstressing (i.e., cracks, and deformation, thread damage, excessive wear) and replaced as necessary.
5. Painted surfaces shall be inspected for corrosion and chipped, cracked or blistered paint.
6. Lifting holes shall be inspected for thread damage.

HI-TRAC Pool Lid:

1. Seal shall be inspected for cracks, breaks, cuts, excessive wear, flattening, and general condition.
2. Drain line shall be inspected for blockage and thread condition.
3. The lifting holes shall be inspected for thread damage.
4. The bolts shall be inspected for indications of overstressing (i.e., cracks and deformation, thread damage, and excessive wear).
5. Painted surfaces shall be inspected for corrosion and chipped, cracked or blistered paint.
6. Threads shall be inspected for indications of damage.

## 8.2 ISFSI OPERATIONS

The HI-STORM 100 System heat removal system is a totally passive system. Maintenance on the HI-STORM system is typically limited to cleaning and touch-up painting of the overpacks, repair and replacement of damaged vent screens, and removal of vent blockages (e.g., leaves, debris). The heat removal system operability surveillance should be performed after any event that may have an impact on the safe functioning of the HI-STORM system. These include, but are not limited to, wind storms, heavy snow storms, fires inside the ISFSI, seismic activity, flooding of the ISFSI, and/or observed animal or insect infestations. The responses to these conditions involve first assessing the dose impact to perform the corrective action (inspect the HI-STORM overpack, clear the debris, check the cask pitch, and/or replace damaged vent screens), perform the corrective action, verify that the system is operable (check ventilation flow paths and radiation). In the event of significant damage to the HI-STORM, the situation may warrant removal of the MPC, and repair or replacement of the damaged HI-STORM overpack. If necessary, the procedures in Section 8.1 may be used to reposition a HI-STORM overpack for minor repairs and maintenance. In extreme cases, Section 8.3 may be used as guidance for unloading the MPC from the HI-STORM.

**Note:**

The heat removal system operability surveillance involves performing a visual examination on the HI-STORM exit and inlet vent screens to ensure that the vents remain clear or verifying the temperature rise from ambient to outlet is within prescribed limits. The metallic vent screens if damaged may allow leaves, debris or animals to enter the duct and block the flow of air to the MPC.

**ALARA Warning:**

Operators should practice ALARA principals when inspecting the vent screens. In most cases, binoculars allow the operator to perform the surveillance from a low dose area.

- 8.2.1 Perform the heat removal operability surveillance.
- 8.2.2 ISFSI Security Operations shall be performed in accordance with the approved site security program plan.

## 8.3 PROCEDURE FOR UNLOADING THE HI-STORM 100 SYSTEM IN THE SPENT FUEL POOL

### 8.3.1 Overview of HI-STORM 100 System Unloading Operations

**ALARA Note:**

The procedure described below uses the weld removal system to remove the welds necessary to enable the MPC lid to be removed. Users may opt to remove some or all of the welds using hand operated equipment. The decision should be based on dose rates, accessibility, degree of weld removal, and available tooling and equipment.

The HI-STORM 100 System unloading procedures describe the general actions necessary to prepare the MPC for unloading, flood the MPC cavity, remove the lid welds, unload the spent fuel assemblies, and recover the HI-TRAC and empty MPC. Special precautions are outlined to ensure personnel safety during the unloading operations, and to prevent the risk of MPC over pressurization and thermal shock to the stored spent fuel assemblies. Figure 8.3.1 shows a flow diagram of the HI-STORM unloading operations. Figure 8.3.2 illustrates the major HI-STORM unloading operations.

Refer to the boxes of Figure 8.3.2 for the following description. The MPC is recovered from HI-STORM either at the ISFSI or the fuel building using the same methods as described in Section 8.1 (Box 1). The HI-STORM lid is removed, the vent duct shield inserts are installed, the alignment device (or mating device with pool lid for HI-TRAC 100D and 125D) is positioned, and the MPC lift cleats are attached to the MPC. The exit vent screens and gamma shield cross plates are removed as necessary. MPC slings are attached to the MPC lift cleat and positioned on the MPC lid. HI-TRAC is positioned on top of HI-STORM (Box 2) and the slings are brought through the HI-TRAC top lid. The MPC is raised into HI-TRAC, the HI-TRAC doors (or mating device drawer) are closed and the locking pins are installed. If the mating device and HI-TRAC 100D or 125D are used, the pool lid is bolted to the HI-TRAC. The HI-TRAC is removed from on top of HI-STORM. If the HI-TRAC 100D and 125D are not used, the HI-TRAC is positioned in the transfer slide and the transfer lid is replaced with the pool lid (Box 3) using the same method as with the loading operations.

If a Supplemental Cooling System (SCS) is required by the TS, it is connected to the HI-TRAC annulus following transfer from the HI-STORM to the HI-TRAC and used to circulate coolant to maintain fuel cladding temperatures below ISG-11 Rev. 3 limits. HI-TRAC and its enclosed MPC are returned to the designated preparation area and the MPC slings and MPC lift cleats are removed. The temporary shield ring is installed on the HI-TRAC upper section and filled with plant demineralized water. The HI-TRAC top lid is removed<sup>1</sup> (Box 4) and water is added to the annulus. If SCS is not being used, water is fed into the annulus through the drain port to cool the MPC shell. After filling the annulus with water the annulus and HI-TRAC top surfaces are covered to protect them from debris produced when removing the MPC lid. The weld removal system is installed (Box 7) and the MPC vent and drain ports are accessed (Box 5). The vent RVOA is attached to the vent port and an evacuated sample bottle is connected. The vent port is

<sup>1</sup> Users with the optional HI-TRAC Lid Spacer shall modify steps in their procedures to install and remove the spacer together with top lid.

slightly opened to allow the sample bottle to obtain a gas sample from inside the MPC. A gas sample is performed to assess the condition of the fuel assembly cladding. A vent line is attached to the vent port and the MPC is vented to the fuel building ventilation system or spent fuel pool as determined by the site's radiation protection personnel. The MPC is filled with water (borated as required) at a controlled rate to avoid over pressurizing the MPC (Box 6) and the supplemental cooling system, if used, is terminated. The weld removal system then removes the MPC lid-to-shell weld. The weld removal system is removed with the MPC lid left in place (Box 7).

The top surfaces of the HI-TRAC and MPC are cleared of metal shavings. The inflatable annulus seal is installed and pressurized. The MPC lid is rigged to the lift yoke or lid retention system and the lift yoke is engaged to HI-TRAC lifting trunnions. If weight limitations require, the neutron shield jacket is drained of water. HI-TRAC is placed in the spent fuel pool and the MPC lid is removed (Boxes 8 and 9). All fuel assemblies are returned to the spent fuel storage racks and the MPC fuel cells are vacuumed to remove any assembly debris and crud (Box 10). HI-TRAC and MPC are returned to the designated preparation area (Box 11) where the MPC water is pumped back into the spent fuel pool or liquid radwaste facility. The annulus water is drained and the MPC and overpack are decontaminated (Box 12 and 13).

### 8.3.2 HI-STORM Recovery from Storage

**Note:**

The MPC transfer may be performed using the MPC downloader or the overhead crane.

**Note:**

The site-specific transport route conditions must satisfy the requirements of the technical specification.

1. Recover the MPC from HI-STORM as follows:
  - a. If necessary, perform a transport route walkdown to ensure that the cask transport conditions are met.
  - b. Transfer HI-STORM to the fuel building or site designated location for the MPC transfer.
  - c. Position HI-STORM under the lifting device.
  - d. Remove the HI-STORM lid nuts, washers and studs or lid closure bolts.
  - e. Remove the HI-STORM lid lifting hole plugs and install the lid lifting sling. See Figure 8.1.27.

**Note:**

The specific sequence for vent screen, temperature element, and gamma shield cross plate removal may vary based on the mode(s) or transport.

- f. Remove the HI-STORM exit vent screens, temperature elements and gamma shield cross plates. See Figure 8.1.34a.

**Warning:**

Unless the lift is single-failure proof (or equivalent safety factor) for the HI-STORM lid, the lid shall be kept less than 2 feet above the top surface of the overpack. This is performed to protect the MPC lid from a potential HI-STORM 100 lid drop.

- g. Remove the HI-STORM lid. See Figure 8.1.27.
  - h. Install the alignment device (or mating device with pool lid for HI-TRAC 100D and 125D) and vent duct shield inserts (HI-STORM 100 only). See Figure 8.1.30.
  - i. Deleted.
  - j. Remove the MPC lift cleat hole plugs and install the MPC lift cleats and MPC slings to the MPC lid. See Table 8.1.5 for torque requirements.
  - k. If necessary, install the top lid on HI-TRAC. See Figure 8.1.9 for rigging. See Table 8.1.5 for torque requirements.
  - l. Deleted.
2. If necessary, configure HI-TRAC with the transfer lid (Not required for HI-TRAC 100D and 125D):

**ALARA Warning:**

The bottom lid replacement as described below may only be performed on an empty (i.e., no MPC) HI-TRAC.

- a. Position HI-TRAC vertically adjacent to the transfer lid. See Section 8.1.2.
  - b. Remove the bottom lid bolts and plates and store them temporarily.
  - c. Raise the empty HI-TRAC and position it on top of the transfer lid.
  - d. Inspect the pool lid bolts for general condition. Replace worn or damaged bolts with new bolts.
  - e. Install the transfer lid bolts. See Table 8.1.5 for torque requirements.
3. At the site's discretion, perform a HI-TRAC receipt inspection and cleanliness inspection in accordance with a site-specific inspection checklist.

**Note:**

If the HI-TRAC is expected to be operated in an environment below 32 °F, the water jacket shall be filled with an ethylene glycol solution (25% ethylene glycol). Otherwise, the jacket shall be filled with demineralized water.

4. If previously drained, fill the neutron shield jacket with plant demineralized water or an ethylene glycol solution (25% ethylene glycol) as necessary. Ensure that the fill and drain plugs are installed.

5. Engage the lift yoke to the HI-TRAC lifting trunnions.
6. Align HI-TRAC over HI-STORM and mate the overpacks. See Figure 8.1.31.
7. If necessary, install the MPC downloader.
8. Remove the transfer lid (or mating device) locking pins and open the doors (mating device drawer).

**ALARA Warning:**

If trim plates are not used, personnel should remain clear of the immediate door area during MPC downloading since there may be some radiation streaming during MPC raising and lowering operations.

9. At the user's discretion, install trim plates to cover the gap above and below the door (drawer for 100D and 125D). The trim plates may be secured using hand clamps or any other method deemed suitable by the user. See Figure 8.1.33.
10. Attach the ends of the MPC sling to the lifting device or MPC downloader. See Figure 8.1.32.

**Caution:**

Limitations for the handling an MPC containing high burn-up fuel or total MPC heat load greater than 28.74 kW at the time of unloading in a HI-TRAC are evaluated and established on a canister basis to ensure that acceptable cladding temperatures are not exceeded. Refer to FSAR Section 4.5 for guidance. The Supplemental Cooling System (SCS) is used to prevent fuel cladding temperatures from exceeding ISG-11 Rev. 3 limits. Operation of the SCS is initiated in accordance with the TS and continues until MPC re-flooding operations have commenced. Staging and check-out of the SCS shall be completed prior to transferring the MPC to the HI-TRAC.

11. Raise the MPC into HI-TRAC.
12. Verify the MPC is in the full-up position.
13. Close the HI-TRAC doors (or mating device drawer) and install the door locking pins.
14. For the HI-TRAC 100D and 125D, bolt the pool lid to the HI-TRAC. See Table 8.1.5 for torque requirements.
15. Lower the MPC onto the transfer lid doors (or pool lid for 100D and 125D).
16. Disconnect the slings from the MPC lift cleats.
17. If necessary, remove the MPC downloader from the top of HI-TRAC.
18. Remove HI-TRAC from the top of HI-STORM.

**Note:**

For the HI-TRAC 100 and HI-TRAC 125, operation of the SCS may need to be postponed until the pool lid is in place on the HI-TRAC. In any event, the supplemental cooling system shall be initiated in accordance with the TS.

19. Replace the transfer lid with the pool lid as follows (Not required for HI-TRAC 100D and 125D):
- a. Lower the lift yoke and attach the MPC slings between the lift cleats and the lift yoke. See Figure 8.1.25.
  - b. Engage the lift yoke to the HI-TRAC lifting trunnions.
  - c. Deleted.
  - d. Raise HI-TRAC and position the transfer lid approximately one inch above the transfer step. See Figure 8.1.26.
  - e. Raise the transfer slide carriage so the transfer carriage is supporting the transfer lid bottom. Remove the transfer lid bolts and store them temporarily.

**ALARA Warning:**

Clear all personnel away from the immediate operations area. The transfer slide carriage and jacks are remotely operated. The carriage has fine adjustment features to allow precise positioning of the lids.

- f. Lower the transfer carriage and position the pool lid under HI-TRAC.
- g. Raise the transfer slide carriage to place the pool lid against the HI-TRAC bottom lid bolting flange.
- h. Inspect the bottom lid bolts for general condition. Replace worn or damaged bolts with new bolts.
- i. Install the pool lid bolts. See Table 8.1.5 for torque requirements.
- j. If required, attach the SCS to the HI-TRAC annulus and begin circulating coolant. (See Figure 2.C.1) Continue operation of the SCS until MPC re-flooding operations have commenced.
- k. Raise and remove the HI-TRAC from the transfer slide.
- l. Disconnect the MPC slings and lift cleats.

**Warning:**

At the start of SCS operations, annulus fill water may flash to steam due to high MPC shell temperatures. Users may select the location and means of filling the annulus. Water addition should be preformed in a slow and controlled manner until water steam generation has ceased.

20. If required, attach the SCS to the HI-TRAC annulus and begin circulating coolant. (See Figure 2.C.1). Continue operation of the SCS until MPC re-flooding operations have commenced.

### 8.3.3 Preparation for Unloading:

1. Place HI-TRAC in the designated preparation area.

**Warning:**

Unless the lift is single-failure proof (or equivalent safety factor) for the HI-TRAC top lid, the top lid shall be kept less than 2 feet above the top surface of the MPC. This is performed to protect the MPC lid from a potential lid drop.

2. Prepare for MPC cool-down.
3. Remove the top lid bolts and remove HI-TRAC top lid. See Figure 8.1.9 for rigging.

**Warning:**

At the start of annulus filling, the annulus fill water may flash to steam due to high MPC shell temperatures. Water addition should be performed in a slow and controlled manner until water steam generation has ceased.

4. Set the annulus water level to approximately 4 inches below the top of the MPC shell and install the annulus shield. Cover the annulus and HI-TRAC top surfaces to protect them from debris produced when removing the MPC lid.
5. Access the MPC as follows:

**ALARA Note:**

The following procedures describe weld removal using a machine tool head. Other methods may also be used. The metal shavings may need to be periodically vacuumed.

**ALARA Warning:**

Weld removal may create an airborne radiation condition. Weld removal must be performed under the direction of the user's Radiation Protection organization.

- a. Install bolt plugs and/or waterproof tape on the HI-TRAC top bolt holes.
  - b. Using the marked locations of the vent and drain ports, core drill the closure ring and vent and drain port cover plates.
6. Remove the closure ring section and the vent and drain port cover plates.

**ALARA Note:**

The MPC vent and drain ports are equipped with metal-to-metal seals to minimize leakage and withstand the long-term effects of temperature and radiation. The vent and drain port design prevents the need to hot tap into the penetrations during unloading operation and eliminate the risk of a pressurized release of gas from the MPC.

7. Take an MPC gas sample as follows:

**Note:**

Users may select alternate methods of obtaining a gas sample.

- a. Attach the RVOAs (See Figure 8.1.16).
- b. Attach a sample bottle to the vent port RVOA as shown on Figure 8.3.3.
- c. Evacuate the RVOA and Sample Bottle.
- d. Slowly open the vent port cap using the RVOA and gather a gas sample from the MPC internal atmosphere.
- e. Close the vent port cap and disconnect the sample bottle.

**ALARA Note:**

The gas sample analysis is performed to determine the condition of the fuel cladding in the MPC. The gas sample may indicate that fuel with damaged cladding is present in the MPC. The results of the gas sample test may affect personnel protection and how the gas is processed during MPC depressurization.

- f. Turn the sample bottle over to the site's Radiation Protection or Chemistry Department for analysis.
- g. Deleted.

8. Fill the MPC cavity with water as follows:

**Caution:**

This Caution block is required by the HI-STORM 100 CoC (CoC Appendix B, Section 3.4.10 and CoC Appendix B-100U, Section 3.4.12) and may not be deleted without prior NRC approval via CoC amendment. To prevent the oxidation of the fuel the MPC interior shall be filled with helium or another suitable inert gas to avoid exposing the fuel to oxidizing agents while at elevated temperatures. Exposing fuel at elevated temperatures to oxidizing agents can lead to deleterious oxidation of the fuel.

- a. Open the vent and drain port caps using the RVOAs.
- b. Deleted.
- c. Deleted.
- d. Deleted.
- e. Deleted.
- f. Deleted.
- g. Deleted.
- h. Deleted.

**Caution:**

The introduction of water into the MPC may create steam. Re-flooding operations shall be

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closely controlled to insure that the internal pressure in the MPC does not exceed design limits. The water flow rate shall be adjusted to maintain the internal pressure below design limits.

- i. Prepare the MPC fill and vent lines as shown on Figure 8.1.20. Route the vent port line several feet below the spent fuel pool surface or to the radwaste gas facility. Attach the vent line to the MPC vent port and slowly open the vent line valve to depressurize the MPC.

**Note:**

When unloading MPCs requiring soluble boron, the boron concentration of the water shall be checked in accordance with Tables 2.1.14 and 2.1.16 before and during operations with fuel and water in the MPC.

- j. Attach the water fill line to the MPC drain port and slowly open the water supply valve and establish a pressure less than 90 psi. (Refer to Tables 2.1.14 and 2.1.16 for boron concentration requirements). Fill the MPC until bubbling from the vent line has terminated. Close the water supply valve on completion.
- k. If used, cease operation of the SCS and remove the system from the HI-TRAC.

**Caution:**

Combustible gas monitoring as described this Caution block is required by the HI-STORM 100 CoC (CoC Appendix B and B-100U, Section 3.8) and may not be deleted without prior NRC approval via CoC amendment. Oxidation of neutron absorber panels contained in the MPC may create hydrogen gas while the MPC is filled with water. Appropriate monitoring for combustible gas concentrations shall be performed prior to, and during MPC lid cutting operations. The space below the MPC lid shall be purged with inert gas prior to, and during MPC lid cutting operations to provide additional assurance that flammable gas concentrations will not develop in this space.

- l. Disconnect both lines from the drain and vent ports leaving the drain port cap open to allow for thermal expansion of the water during MPC lid weld removal.
- m. Connect a combustible gas monitor to the MPC vent port and check for combustible gas concentrations prior to and periodically during weld removal activities. Purge the gas space under the lid as necessary
- n. Remove the MPC lid-to-shell weld using the weld removal system. See Figure 8.1.9 for rigging.
- o. Vacuum the top surfaces of the MPC and HI-TRAC to remove any metal shavings.

9. Install the inflatable annulus seal as follows:

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**Caution:**

Do not use any sharp tools or instruments to install the inflatable seal.

- a. Remove the annulus shield.
  - b. Manually insert the inflatable seal around the MPC. See Figure 8.1.13.
  - c. Ensure that the seal is uniformly positioned in the annulus area.
  - d. Inflate the seal
  - e. Visually inspect the seal to ensure that it is properly seated in the annulus. Deflate, adjust and inflate the seal as necessary.
10. Place HI-TRAC in the spent fuel pool as follows:
- a. If necessary for plant weight limitations, drain the water from the neutron shield jacket.
  - b. Engage the lift yoke to HI-TRAC lifting trunnions, remove the MPC lid lifting hole plugs and attach the MPC lid slings or lid retention system to the MPC lid.
  - c. If the lid retention system is used, inspect the lid bolts for general condition. Replace worn or damaged bolts with new bolts.
  - d. Install the lid retention system bolts if the lid retention system is used.

**ALARA Note:**

The optional Annulus Overpressure System is used to provide further protection against MPC external shell contamination during in-pool operations.

- e. If used, fill the annulus overpressure system lines and reservoir with demineralized water and close the reservoir valve. Attach the annulus overpressure system to the HI-TRAC. See Figure 8.1.14.
- f. Position HI-TRAC over the cask loading area with the basket aligned to the orientation of the spent fuel racks.

**ALARA Note:**

Wetting the components that enter the spent fuel pool may reduce the amount of decontamination work to be performed later.

- g. Wet the surfaces of HI-TRAC and lift yoke with plant demineralized water while slowly lowering HI-TRAC into the spent fuel pool.
- h. When the top of the HI-TRAC reaches the elevation of the reservoir, open the annulus overpressure system reservoir valve. Maintain the reservoir water level at approximately 3/4 full the entire time the cask is in the spent fuel pool.
- i. If the lid retention system is used, remove the lid retention bolts when the top of HI-TRAC is accessible from the operating floor.

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- j. Place HI-TRAC on the floor of the cask loading area and disengage the lift yoke. Visually verify that the lift yoke is fully disengaged.
- k. Apply slight tension to the lift yoke and visually verify proper disengagement of the lift yoke from the trunnions.
- l. Remove the lift yoke, MPC lid and drain line from the pool in accordance with directions from the site's Radiation Protection personnel. Spray the equipment with demineralized water as they are removed from the pool.
- m. Disconnect the drain line from the MPC lid.
- n. Store the MPC lid components in an approved location. Disengage the lift yoke from MPC lid. Remove any upper fuel spacers using the same process as was used in the installation.
- o. Disconnect the lid retention system if used.

#### 8.3.4 MPC Unloading

- 1. Remove the spent fuel assemblies from the MPC using applicable site procedures.
- 2. Vacuum the cells of the MPC to remove any debris or corrosion products.
- 3. Inspect the open cells for presence of any remaining items. Remove them as appropriate.

#### 8.3.5 Post-Unloading Operations

- 1. Remove HI-TRAC and the unloaded MPC from the spent fuel pool as follows:
  - a. Engage the lift yoke to the top trunnions.
  - b. Apply slight tension to the lift yoke and visually verify proper engagement of the lift yoke to the trunnions.
  - c. Raise HI-TRAC until HI-TRAC flange is at the surface of the spent fuel pool.

**ALARA Warning:**

Activated debris may have settled on the top face of HI-TRAC during fuel unloading.

- d. Measure the dose rates at the top of HI-TRAC in accordance with plant radiological procedures and flush or wash the top surfaces to remove any highly-radioactive particles.
- e. Raise the top of HI-TRAC and MPC to the level of the spent fuel pool deck.
- f. Close the annulus overpressure system reservoir valve.
- g. Using a water pump, lower the water level in the MPC approximately 12 inches to prevent splashing during cask movement.

**ALARA Note:**

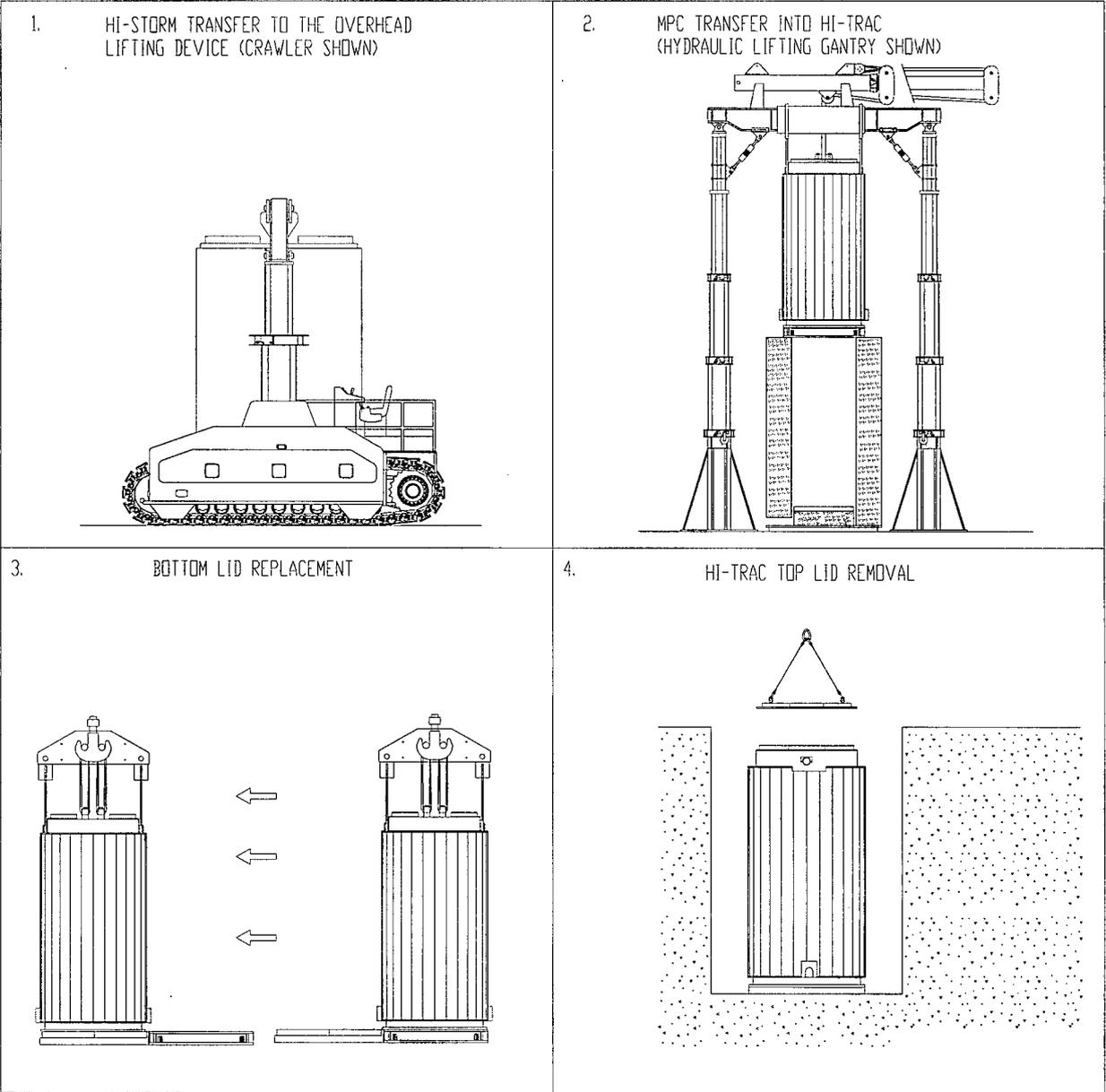
To reduce contamination of HI-TRAC, the surfaces of HI-TRAC and lift yoke should be kept wet until decontamination can begin.

- h. Remove HI-TRAC from the spent fuel pool while spraying the surfaces with plant demineralized water.
  - i. Disconnect the annulus overpressure system from the HI-TRAC via the quick disconnect.
  - j. Place HI-TRAC in the designated preparation area.
  - k. Disengage the lift yoke.
  - l. Perform decontamination on HI-TRAC and the lift yoke.
2. Carefully decontaminate the area above the inflatable seal. Deflate, remove, and store the seal in an approved plant storage location.
3. Using a water pump, pump the remaining water in the MPC to the spent fuel pool or liquid radwaste system.
4. Drain the water in the annulus area by connecting the drain line to the HI-TRAC drain connector.
5. Remove the MPC from HI-TRAC and decontaminate the MPC as necessary.
6. Decontaminate HI-TRAC.
7. Remove the bolt plugs and/or waterproof tape from HI-TRAC top bolt holes.
8. Return any HI-STORM 100 equipment to storage as necessary.

<b>LOCATION: ISFSI</b>
RECOVER HI-STORM FROM STORAGE
<b>LOCATION: CASK RECEIVING AREA</b>
REMOVE HI-STORM EXIT VENT SCREENS AND CROSS PLATES
REMOVE HI-STORM LID
INSTALL HI-STORM ALIGNMENT DEVICE (OR MATING DEVICE) AND VENT DUCT SHIELD INSERTS
INSTALL MPC LIFT CLEATS
ATTACH MPC SLINGS
INSTALL TOP LID ON HI-TRAC
INSTALL MPC LIFT SLINGS
RAISE HI-TRAC AND MATE OVERPACKS
OPEN SHIELD DOORS (OR MATING DEVICE DRAWER)
ATTACH SLINGS TO LIFT DEVICE AND CLEAT
RAISE MPC INTO HI-TRAC
CLOSE HI-TRAC TRANSFER LID DOORS (HI-TRAC 100D and 125D - BOLT UP POOL LID)
REMOVE HI-TRAC FROM TOP OF HI-STORM
DISCONNECT MPC LIFT SLINGS
REPLACE TRANSFER LID WITH POOL LID (NOT FOR HI-TRAC 100D and 125D)
DISCONNECT MPC LIFT CLEAT
PLACE HI-TRAC IN DESIGNATED PREPARATION AREA
<b>LOCATION: CASK PREPARATION AREA</b>

REMOVE HI-TRAC TOP LID
FILL ANNULUS
INSTALL ANNULUS SHIELD
REMOVE MPC CLOSURE RING
REMOVE VENT PORT COVERPLATE WELD AND SAMPLE MPC GAS
FILL MPC CAVITY WITH WATER
REMOVE MPC LID TO SHELL WELD
INSTALL INFLATABLE SEAL
PLACE HI-TRAC IN SPENT FUEL POOL
<b>LOCATION: SPENT FUEL POOL</b>
REMOVE MPC LID
DISCONNECT DRAIN LINE
REMOVE SPENT FUEL ASSEMBLIES WASTE FROM MPC
VACUUM CELLS OF MPC
REMOVE HI-TRAC FROM SPENT FUEL POOL
<b>LOCATION: CASK PREPARATION AREA</b>
LOWER WATER LEVEL IN MPC
PUMP REMAINING WATER IN MPC TO SPENT FUEL POOL
REMOVE MPC FROM HI-TRAC
DECONTAMINATE HI-TRAC

**Figure 8.3.1; Unloading Operations Flow Diagram**

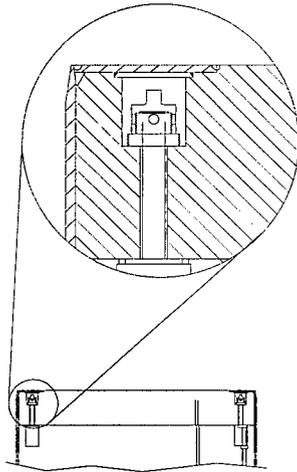


Note: Bottom Lid Replacement Not Required for HI-TRAC 100D and 125D

Figure 8.3.2a; Major HI-STORM 100 Unloading Operations

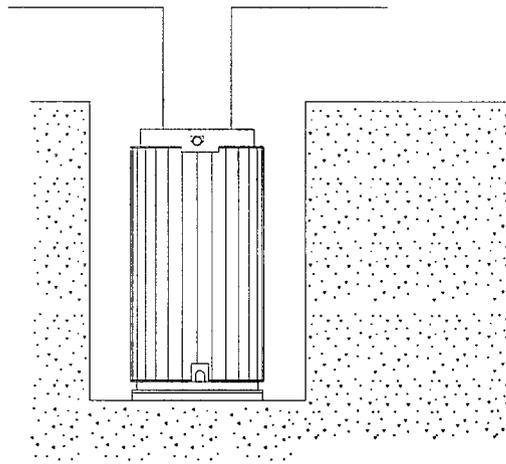
5.

MPC VENT/DRAIN PORT AND  
CLOSURE RING REMOVAL



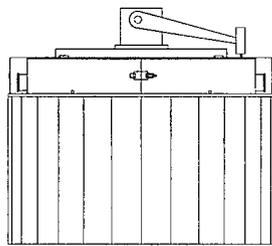
6.

MPC Re-Flooding  
Operations



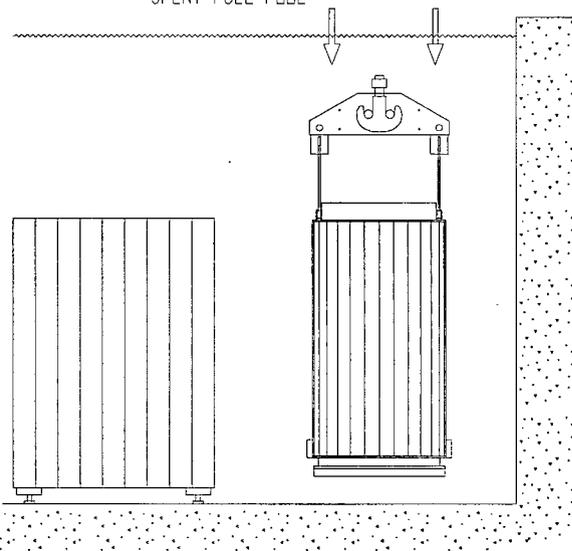
7.

MPC LID WELD REMOVAL

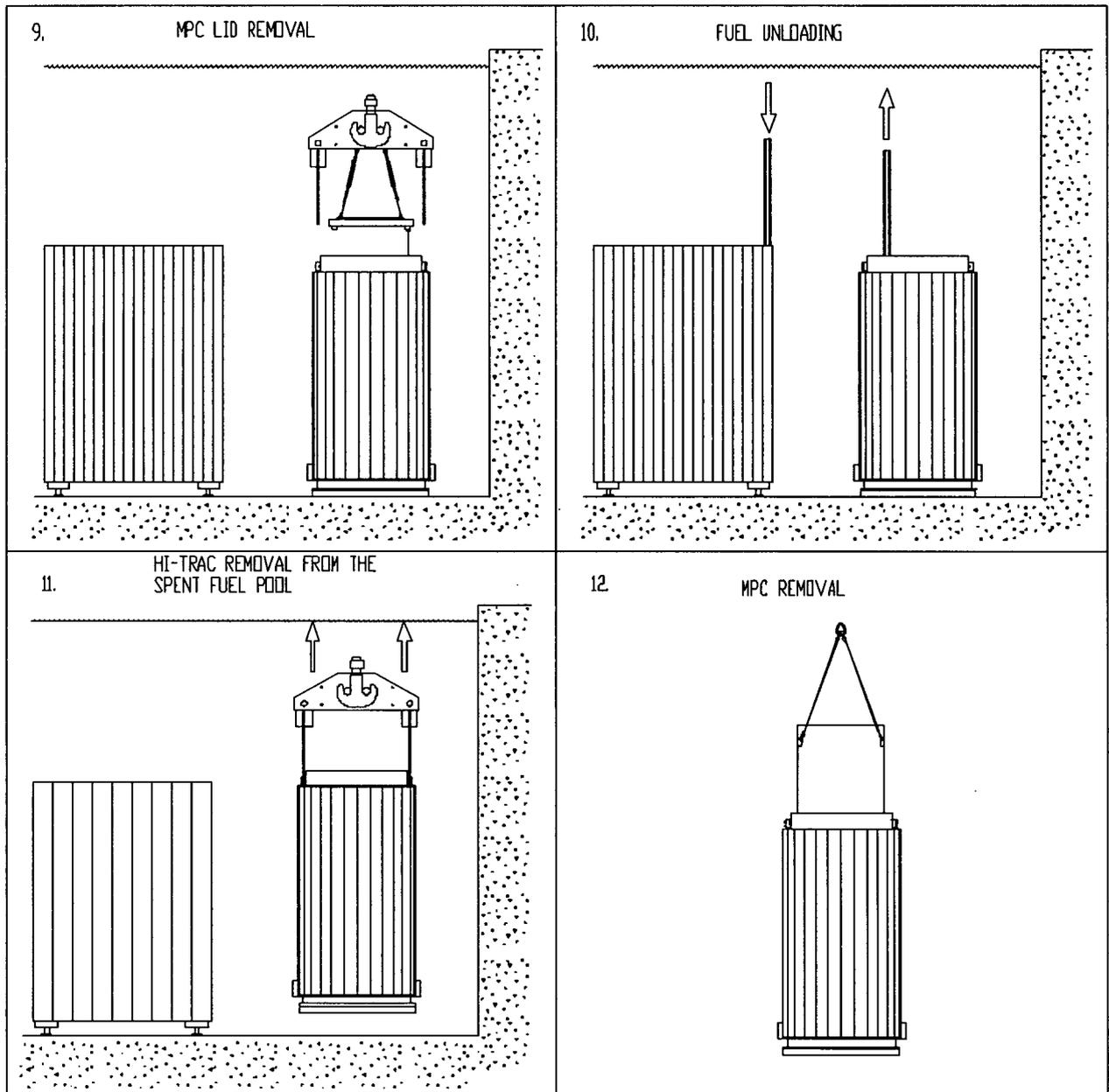


8.

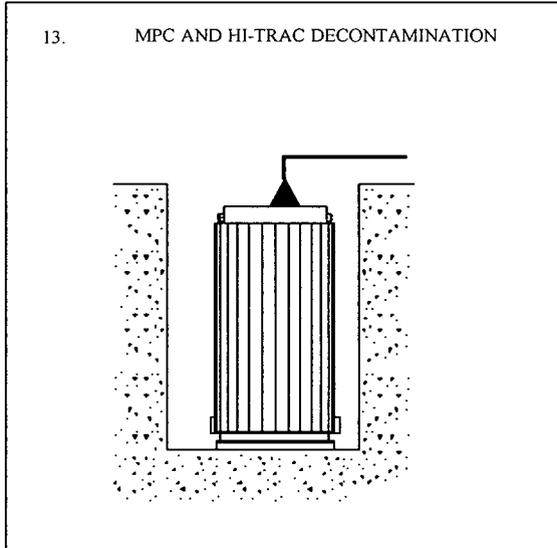
HI-TRAC INSTALLATION IN THE  
SPENT FUEL POOL



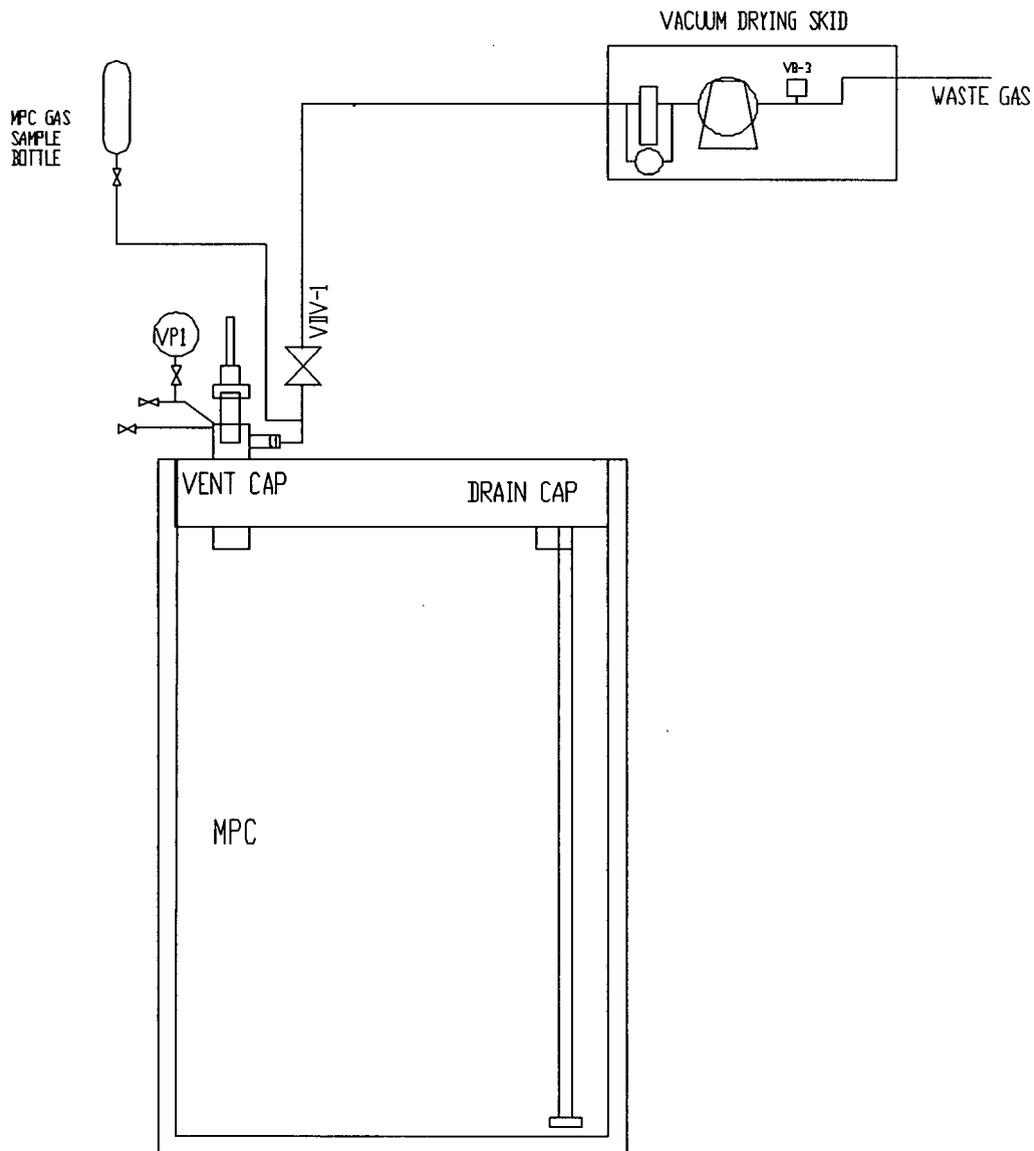
**Figure 8.3.2b; Major HI-STORM 100 Unloading Operations**



**Figure 8.3.2c; Major HI-STORM 100 Unloading Operations**



**Figure 8.3.2d; Major HI-STORM 100 Unloading Operations**



**Figure 8.3.3; MPC Gas Sampling in Preparation for Unloading**

**Figure 8.3.4; Deleted**

## 8.4 MPC TRANSFER TO A HI-STAR 100 OVERPACK FOR TRANSPORT OR STORAGE

### 8.4.1 Overview of Operations

The MPC is recovered from storage and transferred into HI-TRAC using the same or similar method as described in Section 8.3. Once the MPC is inside HI-TRAC, the HI-STAR 100 is brought to the transfer location and positioned for receiving of the MPC. If used, the Temporary Shield Ring is installed and filled with water and the Transfer Collar is installed on the HI-STAR 100 Overpack. The Temporary Shield Ring reduces operator dose rates during MPC transfer operations. The Transfer Collar or mating device adapts the top surface of the HI-STAR 100 Overpack to mate with the bottom of HI-TRAC. The MPC may be lowered using the MPC Downloader, the main crane hook or similar device. The MPC slings and MPC lift cleats are attached to the MPC. The MPC is raised slightly, the transfer lid door (or mating device drawer) locking pins are removed and the doors are (drawer is) opened. The MPC is lowered into the HI-STAR. Following verification that the MPC is fully lowered, the MPC slings are disconnected and lowered onto the MPC lid. HI-TRAC is removed from on top of the HI-STAR 100 Overpack. The MPC lift cleat, slings, and the transfer collar/mating device are removed. Hole plugs are installed in the empty MPC lid bolt holes. The HI-STAR 100 Overpack is prepared for storage or transport in accordance with the Certificate of Compliance for storage or transport, as applicable.

### 8.4.2 Recovery from Storage

**Caution:**

Limitations for the handling an MPC containing high burn-up fuel in a HI-TRAC are evaluated and established on a canister basis to ensure that acceptable cladding temperatures are not exceeded. Refer to FSAR Section 4.5 for guidance.

1. Recover the MPC from storage and position it inside of HI-TRAC in accordance with Section 8.3.2.
2. Deleted.

### 8.4.3 MPC Transfer into the HI-STAR 100 Overpack

**Note:**

The following steps outline the HI-STAR 100 operating steps. Refer to the HI-STAR 100 System Final Safety Analysis Report (Docket No. 72-1008) and the HI-STAR 100 System Safety Analysis Report (Docket No. 71-9261) for HI-STAR 100 Overpack specific operations.

1. If necessary, remove the HI-STAR 100 closure plate and the removable shear ring segments. Perform a radiological survey of the inside of the HI-STAR 100 Overpack to verify there is no residual contamination from previous uses. If contamination levels are above specified limits, the HI-STAR 100 Overpack shall be decontaminated appropriately prior to use.
2. Discard any used metallic seals.
3. Perform a HI-STAR 100 receipt inspection in accordance with site-specific procedures.
4. Install the temporary shield ring on HI-STAR 100 and fill it with water, if used. See Figure 8.1.18.
5. Install the HI-STAR transfer collar (or mating device with the pool lid for HI-TRAC 100D and 125D). See Figure 8.4.1a (or Figure 8.4.1b).
6. Position HI-STAR adjacent to HI-TRAC.

**Note:**

Lifting of the loaded HI-TRAC shall be performed in accordance with the applicable lifting requirements.

7. Raise and align HI-TRAC over HI-STAR and mate the overpacks.

**Note:**

The MPC lift cleats and MPC slings are still installed from the previous operation.

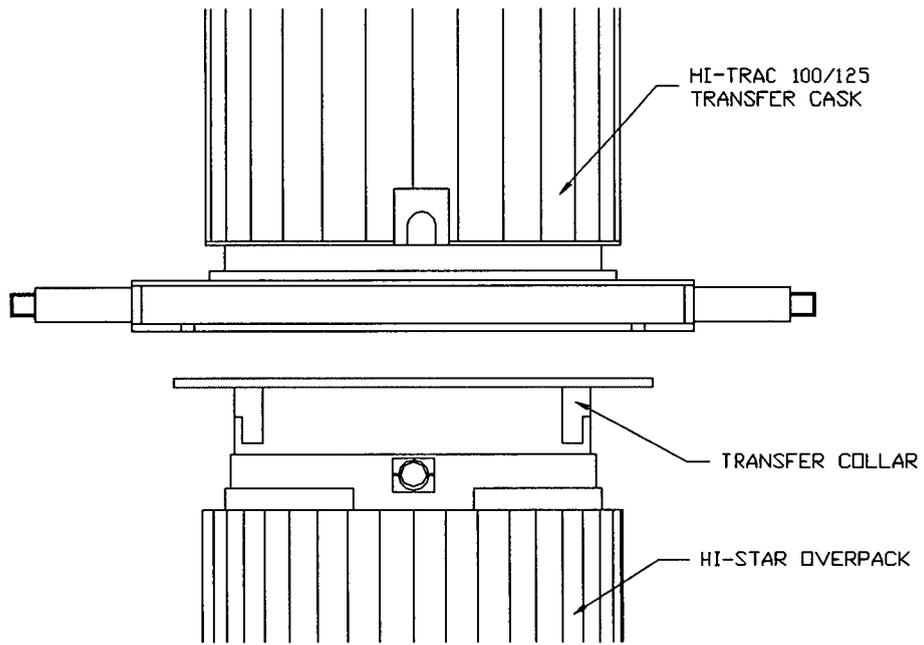
8. Deleted.
9. Remove the transfer lid door (mating device drawer) locking pins and open the doors (drawer).

**ALARA Warning:**

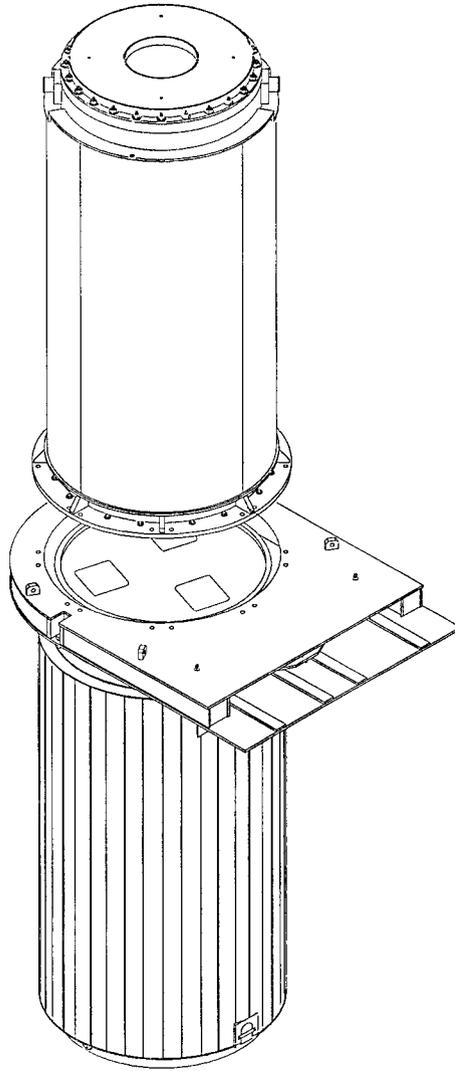
If trim plates are not used, personnel should remain clear of the immediate door/drawer area during MPC downloading since there may be radiation streaming during MPC raising and lowering operations.

10. At the user's discretion, install trim plates to cover the gap above and below the door/drawer. The trim plates may be secured using hand clamps or any other method deemed suitable by the user. See Figure 8.1.33.
11. Lower the MPC into HI-STAR.
12. When the MPC is fully seated, disconnect the slings from the MPC lifting device and lower them on to the MPC lid.
13. Remove HI-TRAC from on top of HI-STAR 100 Overpack.
14. Remove the MPC lift cleat from the MPC and install hole plugs in the empty bolt holes. See Table 8.1.5 for torque requirements.
15. Remove the HI-STAR 100 transfer collar or mating device.

16. Drain and remove the temporary shield ring (if used) and store it in an approved plant storage location.
17. Complete HI-STAR preparation for transport in accordance with the HI-STAR 100 Safety Analysis Report (Docket 71-9261) and the Certificate of Compliance, or complete HI-STAR preparation for storage in accordance with the HI-STAR 100 Final Safety Analysis Report (Docket 72-1008) and the Certificate of Compliance, as applicable.



**Figure 8.4.1a; HI-STAR and HI-TRAC Mating**



**Figure 8.4.1b; HI-STAR and HI-TRAC 100D/125D Mating**

## 8.5 MPC TRANSFER INTO THE HI-STORM 100 OVERPACK DIRECTLY FROM TRANSPORT

### 8.5.1 Overview of Operations

HI-STAR 100 Dual-Purpose Cask System arrives at the receiving location and is surveyed for dose rates and contamination levels. The receiver reviews the shipping paperwork to ensure that the HI-STAR 100 Overpack met the internal contamination limits prior to transportation. The personnel barrier is removed, the impact limiters are removed, the tie-down is removed, and the HI-STAR 100 Overpack is upended. The HI-STAR 100 Overpack is positioned at the designated transfer area and the temporary shield ring is installed. The temporary shield ring reduces operator dose rates during MPC transfer operations. A gas sample is drawn from the annulus and analyzed. The gas sample provides an indication of MPC closure performance. The annulus is depressurized and the closure plate is removed. The transfer collar (mating device with pool lid for HI-TRAC 100 D and 125D) is installed and the MPC lift cleats are attached to the MPC. The transfer collar (mating device) is used to provide the mating surface on top of the HI-STAR 100 Overpack. The MPC slings are attached to the MPC lift cleat.

If the HI-TRAC 100D and 125D are not used, the HI-TRAC is configured with the transfer lid. The top lid<sup>1</sup> is installed, if necessary. HI-TRAC is raised and positioned on top of HI-STAR. The MPC slings are attached to the lifting device. The MPC is raised into HI-TRAC. The HI-TRAC doors/(mating device drawer) are closed and the locking pins are installed. For the HI-TRAC 100D and 125D, the pool lid is bolted on. HI-TRAC is raised and the HI-STAR 100 Overpack is removed from under HI-TRAC. The HI-STAR 100 Overpack is repositioned at the user's discretion.

HI-STORM is positioned for MPC receipt with the lid removed, the *alignment device (or mating device) positioned*, and the vent duct shield inserts installed in the exit vent ducts. HI-TRAC is raised and positioned on top of HI-STORM. For HI-TRAC 100D and 125D, the pool lid is unbolted. The locking pins are removed and the doors are opened (or mating device drawer opened for HI-TRAC 100D and 125D). The MPC is lowered into HI-STORM. The MPC slings are disconnected and lowered onto the MPC lid. HI-TRAC is raised and positioned at the site's discretion. The MPC lift cleat, slings, vent duct shield inserts, and transfer collar (or mating device) are removed and hole plugs are installed in the empty bolt holes. HI-STORM is prepared for storage and transferred to the ISFSI pad in the same manner as described in Section 8.1.

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<sup>1</sup> Users with the optional HI-TRAC Lid Spacer shall modify steps in their procedures to install and remove the spacer together with top lid.

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## 8.5.2 HI-STAR 100 SYSTEM Receipt and Preparation for MPC Transfer

**Note:**

The following provides a general description of the HI-STAR 100 System operations. Refer to the HI-STAR 100 System Topical Safety Analysis Report (Docket 72-1008) and the Safety Analysis Report (Docket 71-9261) for HI-STAR-specific operations.

1. Review the shipping paperwork and verify that the HI-STAR 100 Overpack met the required internal contamination limits prior to transportation.
2. Measure the HI-STAR 100 dose rates in accordance with 10CFR20 [8.5.1].
3. Remove the personnel barrier.
4. Perform removable contamination surveys in accordance with 10CFR20 [8.5.1].
5. Remove the impact limiters.
6. Remove the tie-down.
7. Perform a visual inspection of the overpack for obvious signs of shipping damage.
8. Remove the removable shear ring segments from the overpack. (Approximate weight is 50 lbs each).
9. Transfer the HI-STAR 100 Overpack to the location for MPC transfer and position it vertically.
10. Install the temporary shield ring on the overpack top flange if used.

**ALARA Warning:**

Gas sampling is performed to assess the condition of the MPC confinement boundary. If a leak is discovered in the MPC boundary, the MPC may not be placed into HI-STORM. If no leak is detected, the annulus may be vented directly.

11. Perform gas sampling as follows:
  - a. Remove the overpack vent port cover plate and attach the backfill tool with a sample bottle attached. See Figure 8.5.1. Store the cover plate in a site-approved location.
  - b. Using a vacuum pump, evacuate the sample bottle and backfill tool.

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- c. Slowly open the vent port plug and gather a gas sample from the annulus. Reinstall the overpack vent port plug.
  - d. Evaluate the gas sample and determine the condition of the MPC confinement boundary.
12. If the confinement boundary is intact (i.e., no radioactive gas is measured) then vent the overpack annulus by removing the overpack vent port seal plug (using the backfill tool). Otherwise return the HI-STAR 100 to the spent fuel pool for MPC unloading in accordance with the HI-STAR 100 SAR.
  13. Remove the closure plate bolts and remove the overpack closure plate. Store the closure plate on cribbing to protect the seal seating surfaces. Store the closure plate bolts in a site-approved location.
  14. Install the HI-STAR 100 Seal Surface Protector.
  15. Install the transfer collar (or mating device with pool lid for HI-TRAC 100D and 125D) on HI-STAR. See Figure 8.4.1.

**Note:**  
The location of MPC transfer may be selected at the user's discretion.

16. Remove the MPC lift cleat hole plugs and install the MPC lift cleats. See Figure 8.1.24. See Table 8.1.5 for torque requirements.
17. Attach the MPC slings to the MPC lift cleat and lay them on the MPC lid.

**Warning:**  
Unless the lift is single-failure proof (or equivalent safety factor) for the HI-TRAC top lid, the lid shall be kept less than 2 feet above the top surface of the MPC. This is performed to protect the MPC lid from a potential lid drop.

18. If necessary, install the HI-TRAC top lid. See Figure 8.1.9. See Table 8.1.5 for torque requirements.
19. If necessary, configure HI-TRAC with the transfer lid as follows (Not applicable for HI-TRAC 100D and 125D):

**ALARA Note:**  
The bottom lid replacement as described below may be performed only on an empty HI-TRAC.

- a. Position HI-TRAC vertically adjacent to the transfer lid.

- b. Remove the pool lid bolts and plates and store them in an approved plant storage location.
  - c. Raise the empty HI-TRAC and position it on top of the transfer lid.
  - d. Install the bottom lid bolts. See Table 8.1.5 for torque requirements.
20. Position HI-TRAC adjacent to HI-STAR.
  21. Raise HI-TRAC above HI-STAR.
  22. Align HI-TRAC over HI-STAR 100 and mate the overpacks. See Figure 8.1.31.
  23. Remove the locking pins and open the doors or mating device drawer.

**ALARA Warning:**

If trim plates are not being used, personnel should remain clear of the door/drawer area during MPC downloading since there may be some radiation streaming during MPC raising and lowering operations.

24. At the users discretion, install trim plates to cover the gap above and below the door/drawer. The trim plates may be secured using clamps or any other method deemed suitable by the user. See Figure 8.1.33.

8.5.3 Perform MPC Transfer into HI-STORM 100

**Caution:**

Limitations for the handling an MPC containing high burn-up fuel in a HI-TRAC are evaluated and established on a canister basis to ensure that acceptable cladding temperatures are not exceeded. Refer to FSAR Section 4.5 for guidance.

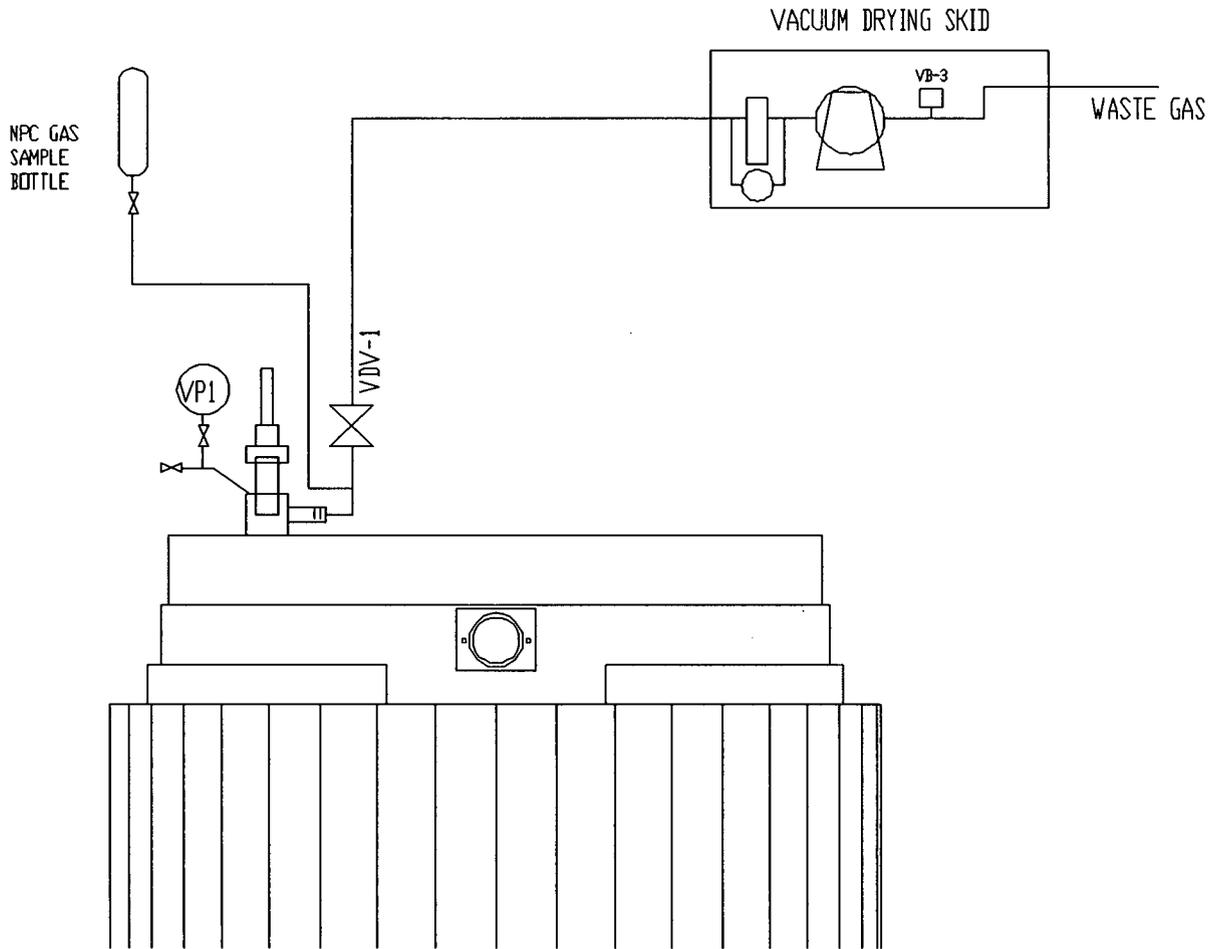
1. Raise the MPC into HI-TRAC by extending the MPC downloader.
2. Verify the MPC is in the full-up position.
3. Remove the trim plates (if used).
4. Close the HI-TRAC doors/drawer and install the locking pins.
5. For the HI-TRAC 100D and 125D, raise the pool lid and bolt it onto the HI-TRAC.
6. Raise HI-TRAC and remove the HI-STAR 100 Overpack from the operations area.

7. Transfer the MPC into HI-STORM in accordance with the steps provided in Section 8.1.

**Warning:**

HI-STORM dose rates are measured to ensure they are within expected values. Dose rates exceeding the expected values could indicate that fuel assemblies not meeting the CoC may have been loaded.

8. Perform the HI-STORM surface dose rate measurements in accordance with the technical specifications. Measured dose rates must be compared with calculated dose rates that are consistent with the calculated doses that demonstrate compliance with the dose limits of 10 CFR 72.104(a).
9. Place HI-STORM in storage in accordance with the steps provided in Section 8.1.
10. Perform an air temperature rise test per Step 8.1.7.23 if required.



**Figure 8.5.1; HI-STAR Annulus Gas Sampling**

## 8.6 REFERENCES

- [8.0.1] U.S. Nuclear Regulatory Commission, "Standard Review Plan for Dry Cask Storage Systems", NUREG-1536, Final Report, January 1997.
- [8.1.1] U.S. Code of Federal Regulations, Title 10 "Energy", Part 72, "Licensing Requirements for Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste,"
- [8.1.2] American National Standards Institute, Institute for Nuclear Materials Management, "American National Standard for Radioactive Materials – Leakage Tests on Packages for Shipment," ANSI N14.5-1997.
- [8.1.3] American Society of Mechanical Engineers "Boiler and Pressure Vessel Code".
- [8.5.1] U.S. Code of Federal Regulations, Title 10 " Energy", Part 20, "Standards for Protection Against Radiation,"

## SUPPLEMENT 8.I

### OPERATING PROCEDURES FOR THE HI-STORM 100U SYSTEM

#### 8.I.0 INTRODUCTION

The operations associated with the use of the HI-STORM 100U System, described in Supplement 1.I, are quite similar to the operations for all other variations of the HI-STORM 100 System. The following sections describe those operations that are, in any respect, unique to the HI-STORM 100U System and thus supplement the information presented in Chapter 8. Where practical, the section number used below directly references the corresponding section in Chapter 8. For example, Subsection 8.I.1.6 supplements or replaces the operations described in Subsection 8.1.6. The guidance provided in this supplement shall be used to develop the site-specific loading procedures for the HI-STORM 100U System, as described in the main body of Chapter 8.

#### 8.I.1 PROCEDURE FOR LOADING THE HI-STORM 100U SYSTEM IN THE SPENT FUEL POOL

##### 8.I.1.1 Overview of Loading Operations

The HI-STORM 100U System differs from the other variations of the HI-STORM 100 System in that the vertical ventilated module (VVM) is an integral part of the ISFSI and cannot be transported on site. The steps required to prepare and load the HI-STORM 100 System up to the point of MPC transfer to the HI-STORM VVM are described in Sections 8.1.2 to 8.1.5 of Chapter 8. For the HI-STORM 100U System, the MPC transfer is performed at the ISFSI after preparation of the MPC for storage operations within the HI-TRAC transfer cask. The loaded HI-TRAC transfer cask may be transported between the ISFSI and the fuel loading facility using a specially designed transporter, heavy haul transfer trailer, or other load handling equipment designed for such applications. The operational steps required to prepare, load the MPC, and transport it to the ISFSI using the HI-TRAC transfer cask are the same for both HI-STORM 100U and the aboveground HI-STORM for the case wherein the MPC transfer for long-term storage occurs at the ISFSI. The detailed operational steps presented in this supplement, therefore, start with the preparation and loading at the ISFSI.

Prior to MPC transfer at the ISFSI, the VVM lid is removed and the empty storage module is inspected. The mating device is positioned on top of the VVM. If used, the Supplemental Cooling System (SCS) is disconnected from the HI-TRAC, the HI-TRAC annulus is drained and the HI-TRAC transfer cask is placed on top of the mating device (Figure 8.I.1). The MPC may be downloaded using the vertical cask crawler, the MPC downloader attached to the transfer cask, or other suitable lifting device. The MPC lifting device is attached to the MPC. The pool lid is removed and the mating device drawer is opened. Optional temporary shielding may be installed, as guided by the licensee's radiation protection program, on or around the mating device. The MPC is lowered into the VVM (Figure 8.I.2). Following verification that the MPC is fully lowered, the MPC slings are disconnected from the lifting device and lowered onto or

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removed from the MPC lid. The temporary shielding is removed, if necessary. The HI-TRAC and pool lid may be reattached while on the VVM or may be removed and then reattached. HI-TRAC is removed from on top of the VVM. The MPC lift cleats are removed. Plugs are installed in the empty MPC lifting holes to fill the voids left by the removal of the lift cleat studs. The mating device is removed and the VVM lid is installed. Finally, the temperature monitoring elements and their instrument connections, if used at the ISFSI, are installed, and post-loading performance verification is performed, as required.

#### 8.I.1.2 HI-STORM 100U Receiving Operations

Because the HI-STORM 100U VVM is cast as part of the ISFSI itself, there is no handling of the VVM. For an example of the rigging required to handle the HI-STORM 100U VVM Closure Lid, see Figure 8.I.3.

#### 8.I.1.3 HI-TRAC and MPC Receipt Inspection and Loading Preparation

For the HI-STORM 100U System, these activities are identical to those described in Subsection 8.1.3.

#### 8.I.1.4 MPC Fuel Loading

For the HI-STORM 100U System, these activities are identical to those described in Subsection 8.1.4.

#### 8.I.1.5 MPC Closure

For the HI-STORM 100U System, these activities are identical to those described in Subsection 8.1.5.

#### 8.I.1.6 Preparation for Storage

For the HI-STORM 100U System, these activities are essentially identical to those described in Subsection 8.1.6. However, for the HI-STORM 100U VVM, the receipt and cleanliness inspection should be carried out in accordance with a CoC Holder-approved inspection checklist and Table 8.I.1

#### 8.I.1.7 Placement of MPC/HI-STORM 100U VVM into Storage

**Note:**  
Because the HI-STORM 100U VVM is an integral part of the ISFSI, MPC transfer must take place at the ISFSI.

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1. Perform a transport route walkdown to ensure that the cask transport conditions are met.
2. Remove the outlet vent cover if necessary. Remove the VVM lid. See Figure 8.I.3 for a lid rigging example and Subsection 3.I.2 for the bounding weight of the lid.
3. Inspect all vent and cavity locations in the VVM cavity for foreign objects. Remove any foreign objects.
4. Install the mating device on the VVM.
5. Transport the HI-TRAC transfer cask to the ISFSI location using a vertical cask crawler or other suitable transportation device.

**Caution:**

For MPCs with heat loads requiring supplemental cooling, all preparatory work related to the transfer should be completed prior to terminating supplemental cooling operations to prevent fuel cladding temperatures from exceeding the limits set forth in Chapter 2 of this FSAR.

6. If used, discontinue the supplemental cooling operations and disconnect the SCS. Drain the water from the HI-TRAC annulus to an appropriate plant discharge point.
7. Position the HI-TRAC transfer cask above the VVM.
8. Align HI-TRAC over the VVM and mate the casks using the mating device. See Figure 8.I.1.
9. Attach the MPC slings to the MPC lift cleats and the cask transporter or other suitable downloading device. See Figure 8.I.2.
10. Raise the MPC slightly to remove the weight of the MPC from the HI-TRAC pool lid.
11. Unbolt the pool lid from the HI-TRAC and lower the lid into the mating device.
12. Open the mating device drawer.

**ALARA Warning:**

Temporary shielding may be used to reduce personnel dose during transfer operations. If ALARA considerations dictate that temporary shielding not be used, personnel must remain clear of the immediate area around the mating device drawer during MPC downloading.

13. At the user's discretion, install temporary shielding to cover the gap above and below the mating device drawer.
14. Lower the MPC into the VVM.
15. Verify that the MPC is fully seated in the VVM
16. Disconnect the MPC slings from the downloading device and lower them onto the MPC lid or remove them from the MPC.
17. Remove the temporary shielding and close the mating device drawer.

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**Note:**

The HI-TRAC pool lid may be reattached while positioned on the VVM or following HI-TRAC and mating device removal from the VVM.

18. Bolt the pool lid back onto the HI-TRAC.

**ALARA Warning:**

Personnel should remain clear (to the maximum extent practicable) of the HI-STORM annulus when HI-TRAC is removed to comply with ALARA requirements.

19. Remove the HI-TRAC transfer cask from on top of the VVM.
20. Open the mating device drawer and remove the MPC lift cleats and, if installed, the MPC slings.
21. Install hole plugs in the empty MPC bolt holes.
22. Close the mating device drawer and remove the mating device from on top of the VVM.

**Warning:**

Unless the lift is single failure proof (or equivalent safety factor) for the VVM lid, the lid shall be preferably kept less than 2 feet above the top surface of the VVM while over the MPC. This lift limit action is purely a defense-in-depth measure: the Closure Lid cannot fall and impact the MPC, as discussed in Supplement 1.I.

23. Install the VVM lid. See Figure 8.I.3 for lid rigging and Subsection 3.I.2 for the bounding lid weight.
24. Remove the VVM lid rigging equipment and re-install the outlet vent cover (if previously removed).
25. Install the HI-STORM temperature monitoring elements (if used).
26. Perform shielding effectiveness testing, as required.

## 8.I.2 ISFSI OPERATIONS

ISFSI operations for the HI-STORM 100U System are identical to the activities identified in Section 8.2. Additional operations related to the HI-STORM 100U System would include any periodic surveillance and maintenance activities required for the site specific cathodic protection system.

## 8.I.3 PROCEDURE FOR UNLOADING THE HI-STORM 100U SYSTEM IN THE SPENT FUEL POOL

### 8.I.3.1 Overview of HI-STORM 100U System Unloading Operations

The MPC is recovered from the HI-STORM 100U VVM at the ISFSI using the same methodologies as described in Subsection 8.I.1, except that the order is basically reversed. The VVM temperature monitoring elements (if used) and lid are removed. The mating device is

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installed and the mating device drawer is opened. The MPC lift cleats are attached to the MPC. The MPC slings are attached to the MPC lift cleats and positioned on the MPC lid. The mating device drawer is closed and the HI-TRAC is positioned on top of the mating device and VVM. The pool lid is unbolted from the HI-TRAC and the mating device drawer is opened. The MPC slings are brought through the HI-TRAC top lid and connected to the lift device. The MPC is raised into HI-TRAC and the mating device drawer is closed. The pool lid is bolted to the HI-TRAC. The HI-TRAC is removed from on top of the VVM and transported to the preparation area. The remainder of the unloading operation is carried out in accordance with the operations for the standard HI-STORM 100 System (See Subsection 8.3.3).

#### 8.1.3.2 Preparing HI-STORM 100U System and HI-TRAC for Recovery from Storage

1. If necessary, perform a transport route walkdown to ensure that the cask transport conditions are met for transporting the loaded HI-TRAC transfer cask.
2. Perform a HI-TRAC receipt inspection and cleanliness inspection in accordance with a written inspection checklist. Transport the HI-TRAC to the ISFSI using the cask transporter or other suitable device.
3. Remove the VVM temperature monitoring equipment (if used).
4. Remove the outlet vent cover if necessary. Remove the VVM lid, preferably keeping its height above the top of the CEC Flange to under 2 feet. See Figure 8.1.3 for a rigging example and Subsection 3.1.2 for the bounding lid weight.
5. Install the mating device on the VVM.
6. Open the mating device drawer.
7. Remove the MPC lift cleat hole plugs and install the MPC lift cleats and MPC slings on the MPC lid. See Table 8.1.5 for torque requirements.
8. Close the mating device drawer.
9. If necessary, install the top lid on HI-TRAC. See Figure 8.1.9 for example rigging and Table 8.1.5 for torque requirements.
10. If previously drained, fill the neutron shield jacket with plant demineralized water or an approved antifreeze solution as necessary. Ensure that the fill and drain plugs are installed.
11. Align HI-TRAC over the mating device and VVM and mate the casks. See Figure 8.1.2.
12. Unbolt the pool lid from the HI-TRAC and lower into the mating device.
13. Open the mating device drawer.
14. At the user's discretion, install temporary shielding to cover the gap above and below the mating device drawer.

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15. Raise the MPC slings up through the HI-TRAC and attach them to the lifting device. See Figure 8.I.1.

**ALARA Warning:**

If temporary shielding is not used, personnel should remain clear of the immediate drawer area during MPC downloading.

**Caution:**

Limitations for the handling of the loaded MPC in HI-TRAC are evaluated and established on a canister basis to ensure that acceptable cladding temperatures are not exceeded. Refer to FSAR Chapter 4 for requirements on the use of the Supplemental Cooling System (SCS) to maintain fuel cladding temperatures below limits when MPCs with greater than threshold limits are transported in the HI-TRAC. Operation of the SCS normally continues until MPC cool-down and re-flooding operations have commenced. Staging and check-out of the SCS shall be completed prior to transferring the MPC to the HI-TRAC to minimize the time required to begin operations.

16. Raise the MPC into HI-TRAC.
17. Verify the MPC is in the full-up position.
18. Close the mating device drawer.
19. Bolt the pool lid to the HI-TRAC. See Table 8.1.5 for torque requirements.
20. Lower the MPC onto the pool lid.
21. Disconnect the slings from the lifting device and the MPC lift cleats.

**Note:**

Operation of the SCS will need to be postponed until the pool lid is in place on the HI-TRAC. Supplemental cooling shall begin, if required, by the provision in Chapter 4.

**Warning:**

At the start of SCS operations, the annulus fill water may flash to steam due to high MPC shell temperatures. Users may select the location and means of filling the annulus. Water addition should be preformed in a slow and controlled manner until water steam generation has ceased.

22. If required, attach the SCS to the HI-TRAC annulus and begin circulating coolant. (See Figure 2.C.1). Continue operation of the SCS until MPC cool-down and re-flooding operations have commenced.
23. Remove HI-TRAC from the top of the VVM.
24. Transport the HI-TRAC to the designated preparation area using the cask transporter or other suitable device.
25. Install the VVM lid and outlet vent cover (if previously removed) to prevent entry of foreign objects into the VVM.

### 8.I.3.3 Preparation for Unloading

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Perform the balance of the unloading operations in accordance with Subsection 8.3.3 beginning at Step 2.

8.1.3.4            MPC Unloading

For the HI-STORM 100U System, these activities are identical to those described in Subsection 8.3.4.

8.1.3.5            Post-Unloading Operations

For the HI-STORM 100U System, these activities are identical to those described in Subsection 8.3.5.

8.1.4            MPC TRANSFER TO A HI-STAR 100 OVERPACK FOR TRANSPORT OR STORAGE

For the HI-STORM 100U System, these activities are identical to those described in Section 8.4. MPC transfer to the HI-TRAC from the HI-STORM 100U VVM is addressed in Subsection 8.1.3 above as noted in Section 8.3.

8.1.5            MPC TRANSFER INTO THE HI-STORM 100U VVM DIRECTLY FROM TRANSPORT

For the HI-STORM 100U System, these activities are identical to those described in Section 8.5. MPC transfer to the HI-STORM 100U VVM from the HI-TRAC is addressed in Subsection 8.1.1 above as noted in Section 8.1.

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Table 8.I.1  
HI-STORM 100U VVM INSPECTION CHECKLIST

**Note:**

This checklist provides the basis for establishing a site-specific inspection checklist for the HI-STORM 100U VVM. Specific findings shall be brought to the attention of the project management for assessment, evaluation and potential corrective action prior to use.

HI-STORM 100U VVM Lid:

1. The painted surfaces shall be inspected for corrosion and chipped, cracked or blistered paint.
2. All lid surfaces shall be relatively free of dents, scratches, gouges or other damage.
3. The lid shall be inspected for the presence or availability of studs, nuts, and hole plugs.
4. Lid lifting points shall be inspected for dirt, debris, and general condition.
5. Vent openings shall be free from obstructions.
6. Vent screens shall be available, intact, and free of holes and tears.
7. Temperature monitoring elements, if used, shall be inspected for availability, function, calibration and provisions for mounting to the VVM outlet air passage.

HI-STORM 100U VVM Main Body:

1. Cooling passages shall be free from obstructions.
2. The interior cavity shall be free of debris, litter, tools, and equipment.
3. Painted surfaces shall be inspected for corrosion, and chipped, cracked or blistered paint.

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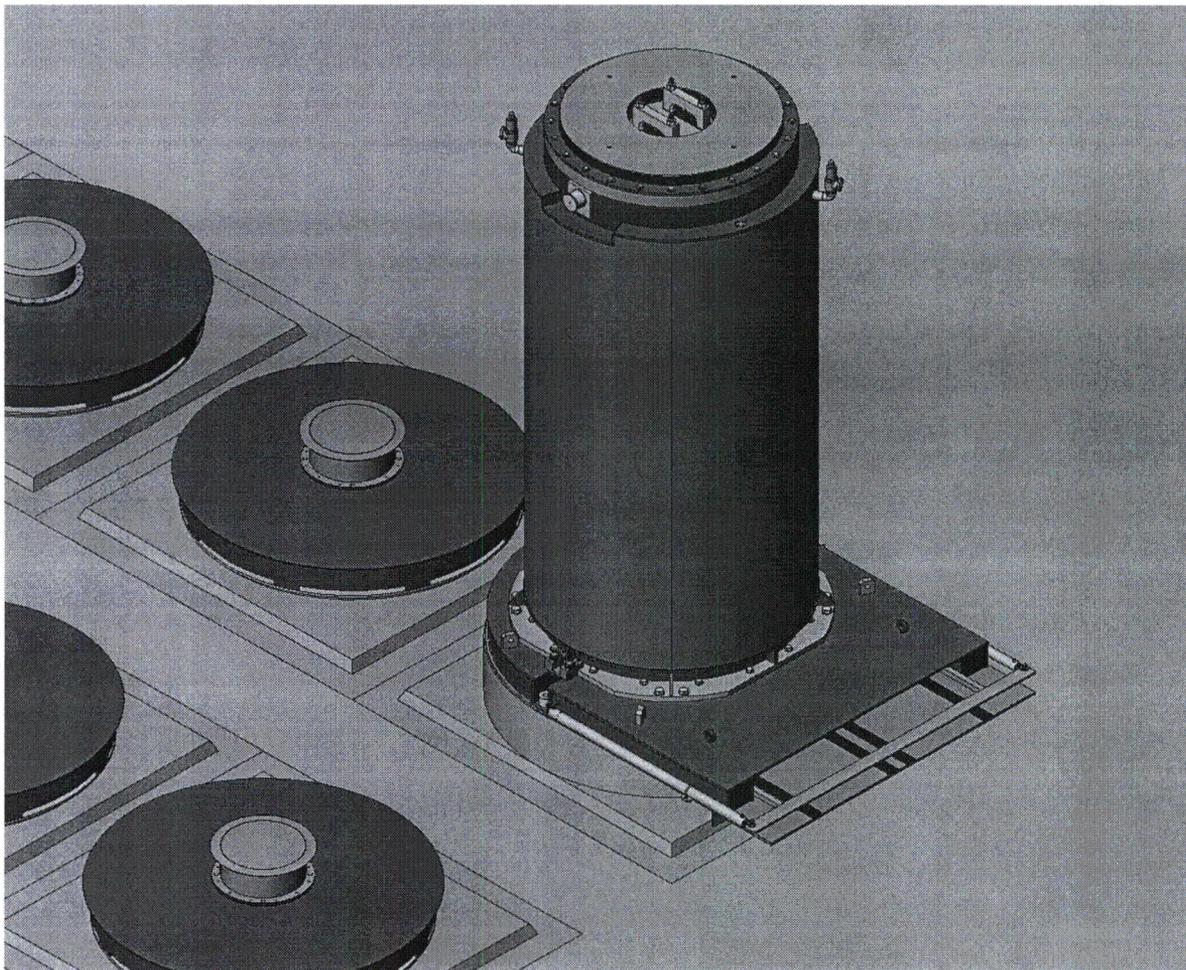


FIGURE 8.I.1: HI-TRAC ALIGNMENT AND PLACEMENT ON MATING  
DEVICE AND HI-STORM 100U\* VVM

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\* The design features of the HI-STORM 100U System are the exclusive intellectual property of Holtec International under U.S. and international patents rights laws. Minor details of the HI-STORM 100U depicted here may vary slightly from the licensing drawings in Subsection 1.I.5.

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HI-STORM FSAR  
REPORT HI-2002444

Rev. 9

HI-STORM 100 FSAR  
REVISION 10  
APRIL 25, 2012

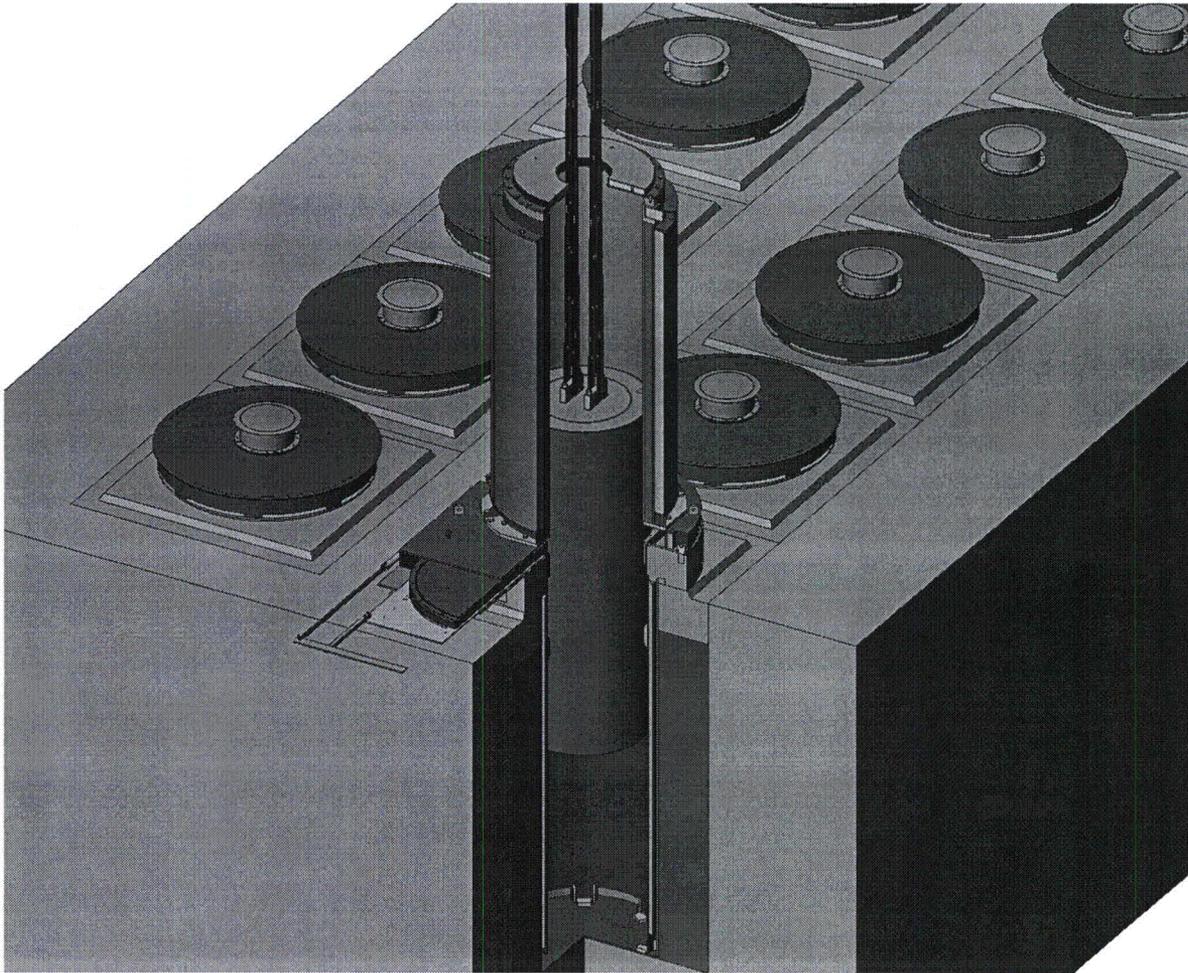


FIGURE 8.I.2: DOWNLOADING MPC INTO HI-STORM 100U\* VVM

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\* The design features of the HI-STORM 100U System are the exclusive intellectual property of Holtec International under U.S. and international patents rights laws. Minor details of the HI-STORM 100U depicted here may vary slightly from the licensing drawings in Subsection 1.I.5.

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REPORT HI-2002444

Rev. 9

HI-STORM 100 FSAR  
REVISION 10  
APRIL 25, 2012



FIGURE 8.I.3: EXAMPLE RIGGING CONFIGURATION FOR THE  
HI-STORM 100U\* VVM LID

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HI-STORM FSAR  
REPORT HI-2002444

Rev. 9

HI-STORM 100 FSAR  
REVISION 10  
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## CHAPTER 9<sup>†</sup>: ACCEPTANCE CRITERIA AND MAINTENANCE PROGRAM

### 9.0 INTRODUCTION

This chapter identifies the fabrication, inspection, test, and maintenance programs to be conducted on the HI-STORM 100 System, including the HI-TRAC transfer cask to verify that the structures, systems and components (SSCs) classified as important to safety have been fabricated, assembled, inspected, tested, accepted, and maintained in accordance with the requirements set forth in this FSAR, the applicable regulatory requirements, and the Certificate of Compliance (CoC). The acceptance criteria and maintenance program requirements specified in this chapter apply to each HI-STORM 100 System fabricated, assembled, inspected, tested, and accepted for use under the scope of the HI-STORM 100 System CoC, except as noted herein.

The controls, inspections, and tests set forth in this chapter, in conjunction with the design requirements described in previous chapters ensure that the HI-STORM 100 System will maintain confinement of radioactive material under normal, off-normal, and hypothetical accident conditions; will maintain subcriticality control; will properly transfer the decay heat of the stored radioactive materials; and that radiation doses will meet regulatory requirements.

Both pre-operational and operational tests and inspections are performed throughout HI-STORM 100 System operations to assure that the HI-STORM 100 System is functioning within its design parameters. These include receipt inspections, nondestructive weld examinations, pressure tests, radiation shielding tests, thermal performance tests, dryness tests, and others. Chapter 8 identifies the tests and inspections. "Pre-operation", as referred to in this section, defines that period of time from receipt inspection of a HI-STORM 100 System until the empty MPC is loaded into a HI-TRAC transfer cask for fuel assembly loading.

The HI-STORM 100 System is classified as important to safety. Therefore, the individual structures, systems, and components (SSCs) that make up the HI-STORM 100 System shall be designed, fabricated, assembled, inspected, tested, accepted, and maintained in accordance with a quality program commensurate with the particular SSC's graded quality category. Tables 2.2.6 and 8.1.6 provide the quality category for each major item or component of the HI-STORM 100 System and its ancillary equipment, respectively.

The acceptance criteria and maintenance program described in this chapter fully comply with the requirements of 10CFR72 [9.0.1] and NUREG-1536 [9.0.2], except as clarified in Table 1.0.3.

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<sup>†</sup> This chapter has been prepared in the format and section organization set forth in Regulatory Guide 3.61. However, the material content of this chapter also fulfills the requirements of NUREG-1536. Pagination and numbering of sections, figures, and tables are consistent with the convention set down in Chapter 1, Section 1.0, herein. Finally, all terms-of-art used in this chapter are consistent with the terminology of the glossary (Table 1.0.1) and component nomenclature of the Bill-of-Materials (Section 1.5).

## 9.1 ACCEPTANCE CRITERIA

This section provides the workmanship inspections and acceptance tests to be performed on the HI-STORM 100 System prior to and during loading of the system. These inspections and tests provide assurance that the HI-STORM 100 System has been fabricated, assembled, inspected, tested, and accepted for use under the conditions specified in this FSAR and the Certificate of Compliance issued by the NRC in accordance with the requirements of 10CFR72 [9.0.1].

Identification and resolution of noncompliances shall be performed in accordance with the Holtec International Quality Assurance Program as described in Chapter 13 of this FSAR, or the licensee's NRC-approved Quality Assurance Program.

The testing and inspection acceptance criteria applicable to the MPCs, the HI-STORM 100 overpack, and the 100-ton HI-TRAC and 125-ton HI-TRAC transfer casks are listed in Tables 9.1.1, 9.1.2, and 9.1.3, respectively, and discussed in more detail in the sections that follow. Chapters 8 and 12 provide operating guidance and the bases for the Technical Specifications, respectively. These inspections and tests are intended to demonstrate that the HI-STORM 100 System has been fabricated, assembled, and examined in accordance with the design criteria contained in Chapter 2 of this FSAR.

This section summarizes the test program required for the HI-STORM 100 System.

### 9.1.1 Fabrication and Nondestructive Examination (NDE)

The design, fabrication, inspection, and testing of the HI-STORM 100 System is performed in accordance with the applicable codes and standards specified in Tables 2.2.6 and 2.2.7 and on the Design Drawings. Additional details on specific codes used are provided below.

The following fabrication controls and required inspections shall be performed on the HI-STORM 100 System, including the MPCs, overpacks, and HI-TRAC transfer casks, in order to assure compliance with this FSAR and the Certificate of Compliance.

1. Materials of construction specified for the HI-STORM 100 System are identified in the drawings in Chapter 1 and shall be procured with certification and supporting documentation as required by ASME Code [9.1.1] Section II (when applicable); the requirements of ASME Section III (when applicable); Holtec procurement specifications; and 10CFR72, Subpart G. Materials and components shall be receipt inspected for visual and dimensional acceptability, material conformance to specification requirements, and traceability markings, as applicable. Controls shall be in place to assure material traceability is maintained throughout fabrication. Materials for the confinement boundary (MPC baseplate, lid, closure ring, port cover plates and shell) shall also be inspected per the requirements of ASME Section III, Article NB-2500.

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2. The MPC confinement boundary shall be fabricated and inspected in accordance with ASME Code, Section III, Subsection NB, with alternatives as noted below. The MPC basket and basket supports shall be fabricated and inspected in accordance with ASME Code, Section III, Subsection NG, with alternatives as noted below. Metal components of the HI-TRAC transfer cask and the HI-STORM overpack, as applicable, shall be fabricated and inspected in accordance with ASME Code, Section III, Subsection NF, Class 3 or AWS D1.1, as shown on the design drawings, with alternatives as noted below.

NOTE: NRC-approved alternatives to these Code requirements are discussed in FSAR Section 2.2.4.

3. ASME Code welding shall be performed using welders and weld procedures that have been qualified in accordance with ASME Code Section IX and the applicable ASME Section III Subsections (e.g., NB, NG, or NF, as applicable to the SSC). AWS code welding may be performed using welders and weld procedures that have been qualified in accordance with applicable AWS requirements or in accordance with ASME Code Section IX
4. Welds shall be visually examined in accordance with ASME Code, Section V, Article 9 with acceptance criteria per ASME Code, Section III, Subsection NF, Article NF-5360, except the MPC fuel basket cell plate-to-cell plate welds and fuel basket support-to-canister welds which shall have acceptance criteria to ASME Code Section III, Subsection NG, Article NG-5360, (as modified by the design drawings). Table 9.1.4 identifies additional nondestructive examination (NDE) requirements to be performed on specific welds, and the applicable codes and acceptance criteria to be used in order to meet the inspection requirements of the applicable ASME Code, Section III. Acceptance criteria for NDE shall be in accordance with the applicable Code for which the item was fabricated. These additional NDE criteria are also specified on the design drawings for the specific welds. Weld inspections shall be detailed in a weld inspection plan which shall identify the weld and the examination requirements, the sequence of examination, and the acceptance criteria. The inspection plan shall be reviewed and approved by Holtec in accordance with its QA program. NDE inspections shall be performed in accordance with written and approved procedures by personnel qualified in accordance with SNT-TC-1A [9.1.2] or other site-specific, NRC-approved program for personnel qualification.

5. The MPC confinement boundary shall be examined and tested by a combination of methods (including helium leak test, pressure test, UT, MT and/or PT, as applicable) to verify that it is free of cracks, pinholes, uncontrolled voids or other defects that could significantly reduce its confinement effectiveness.
6. ASME Code welds requiring weld repair shall be repaired in accordance with the requirements of the ASME Code, Section III, Article NB-4450, NG-4450, or NF-4450, as applicable to the SSC, and examined after repair in the same manner as the original weld.
7. Base metal repairs shall be performed and examined in accordance with the applicable fabrication Code.
8. Grinding and machining operations on the MPC confinement boundary shall be controlled through written and approved procedures and quality assurance oversight to ensure grinding and machining operations do not reduce base metal wall thicknesses of the confinement boundary beyond that allowed per the design drawings. The thicknesses of base metals shall be ultrasonically tested, as necessary, in accordance with written and approved procedures to verify base metal thickness meets Design Drawing requirements. A nonconformance shall be written for areas found to be below allowable base metal thickness and shall be evaluated and repaired per the applicable ASME Code, Subsection NB requirements.
9. Dimensional inspections of the HI-STORM 100 System shall be performed in accordance with written and approved procedures in order to verify compliance to design drawings and fit-up of individual components. All dimensional inspections and functional fit-up tests shall be documented.
10. Required inspections shall be documented. The inspection documentation shall become part of the final quality documentation package.
11. The HI-STORM 100 System shall be inspected for cleanliness and proper packaging for shipping in accordance with written and approved procedures.
12. Each cask shall be durably marked with the appropriate model number, a unique identification number, and its empty weight per 10CFR72.236(k) at the completion of the acceptance test program.

13. A documentation package shall be prepared and maintained during fabrication of each HI-STORM 100 System to include detailed records and evidence that the required inspections and tests have been performed. The completed documentation package shall be reviewed to verify that the HI-STORM 100 System or component has been properly fabricated and inspected in accordance with the design and Code construction requirements. The documentation package shall include, but not be limited to:

- Completed Shop Weld Records
- Inspection Records
- Nonconformance Reports
- Material Test Reports
- NDE Reports
- Dimensional Inspection Report

#### 9.1.1.1 MPC Lid-to-Shell Weld Volumetric Inspection

1. The MPC lid-to-shell (LTS) weld shall be volumetrically or multi-layer liquid penetrant (PT) examined following completion of welding. If volumetric examination is used, the ultrasonic testing (UT) method shall be employed. Ultrasonic techniques (including, as appropriate, Time-of-Flight Diffraction, Focussed Phased Array, and conventional pulse-echo) shall be supplemented, as necessary, to ensure substantially complete coverage of the examination volume.
2. If volumetric examination is used, then a PT examination of the root and final pass of the LTS weld shall also be performed and unacceptable indications shall be documented, repaired and re-examined.
3. If volumetric examination is not used, a multi-layer PT examination shall be employed. The multi-layer PT must, at a minimum, include the root and final weld layers and one intermediate PT after each approximately 3/8 inch weld depth has been completed. The 3/8 inch weld depth corresponds to the maximum allowable flaw size determined in Holtec Position Paper DS-213 [9.1.6].
4. The overall minimum thickness of the LTS weld has been increased by 0.125 inch over the size credited in the structural analyses, to provide additional structural capacity. A 0.625-inch J-groove weld was assumed in structural analyses in Chapter 3.
5. For either UT or PT, the maximum undetectable flaw size must be demonstrated to be less than the critical flaw size. The critical flaw size must be determined in accordance with ASME Section XI methods. The critical flaw size shall not cause the primary stress limits of NB-3000 to be exceeded. The inspection results,

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including relevant findings (indications) shall be made a permanent part of the cask user's records by video, photographic, or other means which provide an equivalent retrievable record of weld integrity. The video or photographic records should be taken during the final interpretation period described in ASME Section V, Article 6, T-676. The inspection of the weld shall be performed by qualified personnel and shall meet the acceptance requirements of ASME Section III, NB-5350 for PT and NB-5332 for UT.

6. Evaluation of any indications shall include consideration of any active flaw mechanisms. However, cyclic loading on the LTS weld is not significant, so fatigue is not a factor. The LTS weld is protected from the external environment by the closure ring and the root of the LTS weld is dry and inert (He atmosphere), so stress corrosion cracking is not a concern for the LTS weld.
7. The volumetric or multi-layer PT examination of the LTS weld, in conjunction with other examinations and tests performed on this weld (PT of root and final layer, and pressure test); the use of ASME Section III acceptance criteria, and the additional weld material added to account for potential defects in the root pass of the weld, in total, provide reasonable assurance that the LTS weld is sound and will perform its design function under all loading conditions. The volumetric (or multi-layer PT) examination and evaluation of indications provides reasonable assurance that leakage of the weld or structural failure under the design basis normal, off-normal, and accident loading conditions will not occur.

#### 9.1.2 Structural and Pressure Tests

##### 9.1.2.1 Lifting Trunnions

Two trunnions (located near the top of the HI-TRAC transfer cask) are provided for vertical lifting and handling. The trunnions are designed in accordance with ANSI N14.6 [9.1.3] using a high-strength and high-ductility material (see Chapter 1). The trunnions contain no welded components. The maximum design lifting load of 250,000 pounds for the HI-TRAC 125 and HI-TRAC 125D and 200,000 pounds for the HI-TRAC 100 and HI-TRAC 100D will occur during the removal of the HI-TRAC from the spent fuel pool after the MPC has been loaded, flooded with water, and the MPC lid is installed. The high-material ductility, absence of materials vulnerable to brittle fracture, large stress margins, and a carefully engineered design to eliminate local stress risers in the highly-stressed regions (during the lift operations) ensure that the lifting trunnions will work reliably. However, pursuant to the defense-in-depth approach of NUREG-0612 [9.1.4], the acceptance criteria for the lifting trunnions must be established in conjunction with other considerations applicable to heavy load handling.

Section 5 of NUREG-0612 calls for measures to "provide an adequate defense-in-depth for handling of heavy loads...". The NUREG-0612 guidelines cite four major causes of load handling accidents, of which rigging failure (including trunnion failure) is one:

- i. operator errors
- ii. rigging failure
- iii. lack of adequate inspection
- iv. inadequate procedures

The cask loading and handling operations program shall ensure maximum emphasis to mitigate the potential load drop accidents by implementing measures to eliminate shortcomings in all aspects of the operation including the four aforementioned areas.

In order to ensure that the lifting trunnions do not have any hidden material flaws, the trunnions shall be tested at 300% of the maximum design (service) lifting load. The load (750,000 lbs for the HI-TRAC 125 and HI-TRAC 125D and 600,000 lbs for the HI-TRAC 100 and 100D) shall be applied for a minimum of 10 minutes. The accessible parts of the trunnions (areas outside the HI-TRAC cask), and the adjacent HI-TRAC cask trunnion attachment area shall then be visually examined to verify no deformation, distortion, or cracking occurred. Any evidence of deformation, distortion or cracking of the trunnion or adjacent HI-TRAC cask trunnion attachment areas shall require replacement of the trunnion and/or repair of the HI-TRAC cask. Following any replacements and/or repair, the load testing shall be performed and the components re-examined in accordance with the original procedure and acceptance criteria. Testing shall be performed in accordance with written and approved procedures. Certified material test reports verifying trunnion material mechanical properties meet ASME Code Section II requirements will provide further verification of the trunnion load capabilities. Test results shall be documented. The documentation shall become part of the final quality documentation package.

The acceptance testing of the trunnions in the manner described above will provide adequate assurance against handling accidents.

#### 9.1.2.2 Pressure Testing

##### 9.1.2.2.1 HI-TRAC Transfer Cask Water Jacket

All 125-ton and 100-ton HI-TRAC transfer cask water jackets shall be hydrostatically tested to 75 psig +3, -0 psig, and 71 psig +3, -0 psig, respectively, in accordance with written and approved procedures. The water jacket fill port will be used for filling the cavity with water and the vent port for venting the cavity. The approved test procedure shall clearly define the test equipment arrangement.

The hydrostatic test shall be performed after the water jacket has been welded together. The test pressure gage installed on the water jacket shall be graduated over a range not less than 1.5 times nor more than 4 times the test pressure. Digital type pressure gages may be used without range

restriction provided the combined error due to calibration and readability does not exceed 1% of the test pressure. The hydrostatic test pressure shall be maintained for ten minutes. During this time period, the pressure gage shall not fall below the applicable minimum test pressure. At the end of ten minutes, and while the pressure is being maintained at the minimum pressure, weld joints shall be visually examined for leakage. If a leak is discovered, the cavity shall be emptied and an examination to determine the cause of the leakage shall be made. Repairs and retest shall be performed until the hydrostatic test criteria are met.

After completion of the hydrostatic testing, the water jacket exterior surfaces shall be visually examined for cracking or deformation. Evidence of cracking or deformation shall be cause for rejection, or repair and retest, as applicable. Liquid penetrant (PT) or magnetic particle (MT) examination of accessible welds shall be performed in accordance with ASME Code, Section V, Articles 6 and 7, respectively, with acceptance criteria per ASME Code, Section III, Subsection NF, Articles NF-5350 and NF-5340, respectively. Unacceptable areas shall require repair and re-examination per the applicable ASME Code. The HI-TRAC water jacket hydrostatic test shall be repeated until all examinations are found to be acceptable.

If a hydrostatic retest is required and fails, a nonconformance report shall be issued and a root cause evaluation and appropriate corrective actions taken before further repairs and retests are performed.

Test results shall be documented. The documentation shall become part of the final quality documentation package.

#### 9.1.2.2.2 MPC Confinement Boundary

Pressure testing (hydrostatic or pneumatic) of the MPC confinement boundary shall be performed in accordance with the requirements of the ASME Code Section III, Subsection NB, Article NB-6000 and applicable sub-articles, when field welding of the MPC lid-to-shell weld is completed. If hydrostatic testing is used, the MPC shall be pressure tested to 125% of design pressure. If pneumatic testing is used, the MPC shall be pressure tested to 120% of design pressure. The MPC vent and drain ports will be used for pressurizing the MPC cavity. The loading procedures in FSAR Chapter 8 define the test equipment arrangement. The calibrated test pressure gage installed on the MPC confinement boundary shall have an upper limit of approximately twice that of the test pressure. Following completion of the required hold period at the test pressure, the surface of the MPC lid-to-shell weld shall be re-examined by liquid penetrant examination in accordance with ASME Code, Section III, Subsection NB, Article NB-5350 acceptance criteria. Any evidence of cracking or deformation shall be cause for rejection, or repair and retest, as applicable. The performance and sequence of the test is described in FSAR Section 8.1 (loading procedures).

If a leak is discovered, the test pressure shall be reduced, the MPC cavity water level lowered, if applicable, the MPC cavity vented, and the weld shall be examined to determine the cause of the leakage and/or cracking. Repairs to the weld shall be performed in accordance with written and approved procedures prepared in accordance with the ASME Code, Section III, Article NB-4450.

The MPC confinement boundary pressure test shall be repeated until all required examinations are found to be acceptable. Test results shall be documented and maintained as part of the loaded MPC quality documentation package.

#### 9.1.2.3 Materials Testing

The majority of materials used in the HI-TRAC transfer cask and a portion of the material in the HI-STORM overpack are ferritic steels. ASME Code, Section II and Section III require that certain materials be tested in order to assure that these materials are not subject to brittle fracture failures.

Materials of the HI-TRAC transfer cask and HI-STORM overpack, as required, shall be Charpy V-notch tested in accordance with ASME Section IIA and/or ASME Section III, Subsection NF, Articles NF-2300, and NF-2430. The materials to be tested include the components identified in Table 3.1.18 and applicable weld materials. Table 3.1.18 provides the test temperatures and test acceptance criteria to be used when performing the material testing specified above.

The concrete utilized in the construction of the HI-STORM overpack shall be mixed, poured, and tested as described in FSAR Appendix 1.D in accordance with written and approved procedures. Testing shall verify the composition, compressive strength, and density meet design requirements.

Concrete testing shall be performed for each lot of concrete. Concrete testing shall comply with Appendix 1.D.

Test results shall be documented and become part of the final quality documentation package.

#### 9.1.3 Leakage Testing

Leakage testing shall be performed in accordance with the requirements of ANSI N14.5 [9.1.5]. Testing shall be performed in accordance with written and approved procedures.

Helium leakage testing of the MPC shell and MPC shell to baseplate welds is performed on the unloaded MPC.

The helium leakage test of the vent and drain port cover plate welds shall be performed using a helium mass spectrometer leak detector (MSLD). If a leakage rate exceeding the acceptance criterion is detected, then the area of leakage shall be determined and the area repaired per ASME Code Section III, Subsection NB, Article NB-4450 requirements. Re-testing shall be performed until the leakage rate acceptance criteria is met.

Leakage testing of the field welded MPC lid-to-shell weld and closure ring welds are not required.

Leak testing results for the MPC shall be documented and shall become part of the quality record documentation package.

Leakage testing of the vent and drain port cover plates shall be performed after welding of the cover plates and subsequent NDE. The description and procedures for these field leakage tests are provided in FSAR Section 8.1 and the acceptance criteria are defined in the Technical Specifications in Appendix A to CoC 72-1014

#### 9.1.4 Component Tests

##### 9.1.4.1 Valves, Rupture Discs, and Fluid Transport Devices

There are no fluid transport devices or rupture discs associated with the HI-STORM 100 System. The only valve-like components in the HI-STORM 100 System are the specially designed caps installed in the MPC lid for the drain and vent ports. These caps are recessed inside the MPC lid and covered by the fully-welded vent and drain port cover plates. No credit is taken for the caps' ability to confine helium or radioactivity. After completion of drying and backfill operations, the drain and vent port cover plates are welded in place on the MPC lid and are liquid penetrant examined and leakage tested to verify the MPC confinement boundary.

There are two pressure relief valves installed in the upper ledge surface of the HI-TRAC transfer cask water jacket. These pressure relief valves are provided for venting of the neutron shield jacket fluid under hypothetical fire accident conditions in which the design pressure of the water jacket may be exceeded. The pressure relief valves shall relieve at 60 psig and 65 psig.

##### 9.1.4.2 Seals and Gaskets

There are no confinement seals or gaskets included in the HI-STORM 100 System.

#### 9.1.5 Shielding Integrity

The HI-STORM overpack and MPC have two designed shields for neutron and gamma ray attenuation. The HI-STORM overpack concrete provides both neutron and gamma shielding. Additional neutron shielding is provided by the encased neutron absorber attached to the fuel basket cell surfaces inside the MPCs. The overpack's inner and outer steel shells, and the steel shield shell<sup>†</sup> provide radial gamma shielding. Concrete and steel plates provide axial neutron and gamma shielding. A concrete ring attached to the top of the overpack lid provides additional gamma and neutron shielding in the axial direction. Steel gamma shield cross plates, installed in the overpack air inlet and outlet vents, provide additional shielding for radiation through the vent openings.

The HI-TRAC transfer cask uses three different materials for primary shielding. All HI-TRAC

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<sup>†</sup> The shield shell design feature was deleted in June, 2001 after overpack serial number 7 was fabricated. Those overpacks without the shield shell are required to have a higher concrete density in the overpack body to provide compensatory shielding. See Table 1.D.1.

transfer cask designs include a radial steel-lead-steel shield and a steel-lead-steel pool lid design. The top lid in the HI-TRAC 125 and HI-TRAC 125D designs includes Holtite neutron shielding inside a steel enclosure. The HI-TRAC 100 and 100D top lids include only steel shielding. The HI-TRAC 125 transfer lid includes steel, lead, and Holtite, while the HI-TRAC 100 includes only steel and lead. The HI-TRAC 100D and 125D designs do not include a transfer lid. The water jacket, included in all transfer cask designs, provides radial neutron shielding. Testing requirements for the shielding items are described below.

#### 9.1.5.1 Fabrication Testing and Control

##### Holtite-A:

Neutron shield properties of Holtite-A are provided in Chapter 1, Section 1.2.1.3.2. Each manufactured lot of neutron shield material shall be tested to verify the material composition (aluminum and hydrogen), boron concentration and neutron shield density (or specific gravity) meet the requirements specified in Chapter 1 and the Bill-of-Material. A manufactured lot is defined as the total amount of material used to make any number of mixed batches comprised of constituent ingredients from the same lot/batch identification numbers supplied by the constituent manufacturer. Testing shall be performed in accordance with written and approved procedures and/or standards. Material composition, boron concentration and density (or specific gravity) data for each manufactured lot of neutron shield material shall become part of the quality documentation package.

The installation of the neutron shielding material shall be performed in accordance with written and qualified procedures. The procedures shall ensure that mix ratios and mixing methods are controlled in order to achieve proper material composition, boron concentration and distribution, and that pours are controlled in order to prevent gaps from occurring in the material. Samples of each manufactured lot of neutron shield material shall be maintained by Holtec International as part of the quality record documentation package.

##### Concrete:

The dimensions of the HI-STORM overpack steel shells and the density of the concrete shall be verified to be in accordance with FSAR Appendix 1.D and the design drawings prior to concrete installation. The dimensional inspection and density measurements shall be documented. Also, see Subsection 9.1.2.3 for concrete material testing requirements.

##### Lead:

The installation of the lead in the HI-TRAC transfer cask shall be performed using written and qualified procedures in order to ensure voids are minimized. The lead shall be tested for chemical composition.

As an alternative to pouring molten lead, the HI-TRAC lead shielding may be installed as pre-cast sections, or lead sheets. If pre-cast sections or sheets are used, the design of the sections and the

installations instructions shall minimize the gaps between adjacent lead sections and between the lead and the transfer cask walls to the extent practicable.

Steel:

Steel plates utilized in the construction of the HI-STORM 100 System shall be dimensionally inspected to assure compliance with the requirements specified on the Design Drawings.

General Requirements for Shield Materials:

1. Test results shall be documented and become part of the quality documentation package.
2. Dimensional inspections of the cavities containing the shielding materials shall assure that the design required amount of shielding material is being incorporated into the fabricated item.

Shielding effectiveness tests shall be performed during fabrication and again after initial loading operations in accordance with Section 9.1.5.2 below and the operating procedures in Chapter 8.

#### 9.1.5.2 Shielding Effectiveness Tests

The effectiveness of the lead pours in the HI-TRAC transfer cask body shall be verified during fabrication by performing gamma scanning on all accessible surfaces of the cask in the lead pour region. The gamma scanning may be performed prior to, or after installation of the water jacket. The purpose of the gamma scanning test is to demonstrate that the gamma shielding of the transfer cask body is at least as effective as that of a lead and steel test block. For the test block, the steel thickness shall be equivalent to the minimum design thickness of steel in the transfer cask component and the lead thickness shall be 5 percent lower than the minimum design thickness of lead in the transfer cask component (see the Design Drawings for the design values). Data shall be recorded on a 6-inch by 6-inch (nominal) grid pattern over the surfaces to be scanned. Should the measured gamma dose rates exceed those established with the test block, the shielding of that transfer cask component shall be deemed unacceptable. Corrective actions should be taken, if practicable, and the testing re-performed until successful results are achieved. If physical corrective actions are not practicable, the degraded condition may be dispositioned with a written evaluation in accordance with applicable procedures to determine the acceptability of the transfer cask for service. Gamma scanning shall be performed in accordance with written and approved procedures. Dose rate measurements shall be documented and shall become part of the quality documentation package.

As an alternative to poured lead, the lead shielding inside the HI-TRAC transfer cask body may be made of individual lead sheets layered together. The minimum total thickness of lead sheets installed in the cask body shall be verified to meet the licensing drawing including tolerance. The effectiveness of each lead sheet shall be verified by visual examination. The visual examination includes absence of cracks, pores, inclusions, scratches, grooves, or other types of defects that could

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impair the gamma shielding function of the lead. Defects which exceed a depth of 10% of the plate thickness and an area greater than one square inch shall be rejected. Lead sheets thicker than 3/16" (nominal) shall be subject to UT testing. The UT testing will take place before the installation of the plates. The UT testing ensures that the plates are uniform internally. This is an accepted industry procedure for locating voids within the lead sheets in order to verify the shielding effectiveness of the sheets.

The effectiveness of the lead plates in the HI-TRAC pool lid (all transfer cask designs) and transfer lid (HI-TRAC 125 and 100 only) shall be verified during fabrication by performing a UT test of the lead plates. The UT testing will take place before the installation of the plates. The UT testing ensures that the plates are uniform internally. This is an accepted industry procedure for locating voids within the lead plate in order to verify the shielding effectiveness of the plate.

Following the first fuel loading of each HI-STORM 100 System (HI-TRAC transfer cask and HI-STORM storage overpack), a shielding effectiveness test shall be performed at the loading facility site to verify the effectiveness of the radiation shield. This test shall be performed after the HI-STORM overpack and HI-TRAC transfer cask have been loaded with an MPC containing spent fuel assemblies and the MPC has been drained, moisture removed, and backfilled with helium.

Operational neutron and gamma shielding effectiveness tests shall be performed after fuel loading using written and approved procedures. Calibrated neutron and gamma dose rate meters shall be used to measure the actual neutron and gamma dose rates at the surface of the HI-STORM overpack and HI-TRAC. Measurements shall be taken at the locations specified in the Radiation Protection Program for comparison against the prescribed limits. The test is considered acceptable if the dose rate readings are less than or equal to the calculated limits. If dose rates are higher than the limits, the required actions provided in the Radiation Protection Program shall be completed. Dose rate measurements shall be documented and shall become part of the quality documentation package.

NOTE

Section 9.1.5.3 below (including Subsections 9.1.5.3.1 through 9.1.5.3.3) is incorporated into the HI-STORM 100 CoC by reference (CoC Appendix B, Section 3.2.8) and may not be deleted or altered in any way without prior NRC approval via CoC amendment. The text of this section is, therefore, shown in bold type to distinguish it from other text.

**9.1.5.3      Neutron Absorber Tests**

**Each plate of neutron absorber shall be visually inspected for damage such as scratches, cracks, burrs, peeled cladding, foreign material embedded in the surfaces, voids, delamination, and surface finish, as applicable.**

**9.1.5.3.1      Boral (75% Credit)**

**After manufacturing, a statistical sample of each lot of neutron absorber shall be tested using**

wet chemistry and/or neutron attenuation testing to verify a minimum  $^{10}\text{B}$  content (areal density) in samples taken from the ends of the panel. The minimum  $^{10}\text{B}$  loading of the neutron absorber panels for each MPC model is provided in Table 2.1.15. Any panel in which  $^{10}\text{B}$  loading is less than the minimum allowed shall be rejected. Testing shall be performed using written and approved procedures. Results shall be documented and become part of the cask quality records documentation package.

#### 9.1.5.3.2 METAMIC<sup>®</sup> (90% Credit)

NUREG/CR-5661 identifies the main reason for a penalty in the neutron absorber B-10 density as the potential of neutron streaming due to non-uniformities in the neutron absorber, and recommends comprehensive acceptance tests to verify the presence and uniformity of the neutron absorber for credits more than 75%. Since a 90% credit is taken for METAMIC<sup>®</sup>, the following criteria must be satisfied:

- The boron carbide powder used in the manufacturing of METAMIC<sup>®</sup> must have small particle sizes to preclude neutron streaming
- The  $^{10}\text{B}$  areal density must comply with the limits of Table 2.1.15.
- The  $\text{B}_4\text{C}$  powder must be uniformly dispersed locally, i.e. must not show any particle agglomeration. This precludes neutron streaming.
- The  $\text{B}_4\text{C}$  powder must be uniformly dispersed macroscopically, i.e. must have a consistent concentration throughout the entire neutron absorber panel.
- The maximum  $\text{B}_4\text{C}$  content in METAMIC<sup>®</sup> shall be less than or equal to 33.0 weight percent.

To ensure that the above requirements are met the following tests shall be performed:

- All lots of boron carbide powder are analyzed to meet particle size distribution requirements.
- The following qualification testing shall be performed on the first production run of METAMIC<sup>®</sup> panels for the MPCs in order to validate the acceptability and consistency of the manufacturing process and verify the acceptability of the METAMIC<sup>®</sup> panels for neutron absorbing capabilities:
  - 1) The boron carbide powder weight percent shall be verified by testing a sample from forty different mixed batches. (A mixed batch is defined as a single mixture of aluminum powder and boron carbide powder used to make one or more billets. Each billet will produce several panels.) The samples shall be drawn from the mixing

containers after mixing operations have been completed. Testing shall be performed using the wet chemistry method.

- 2) The  $^{10}\text{B}$  areal density shall be verified by testing a sample from one panel from each of forty different mixed batches. The samples shall be drawn from areas contiguous to the manufactured panels of METAMIC<sup>®</sup> and shall be tested using the wet chemistry method. Alternatively, or in addition to the wet chemistry tests, neutron attenuation tests on the samples may be performed to quantify the actual  $^{10}\text{B}$  areal density.
  - 3) To verify the local uniformity of the boron particle dispersal, neutron attenuation measurements of random test coupons shall be performed. These test coupons may come from the production run or from pre-production trial runs.
  - 4) To verify the macroscopic uniformity of the boron particle distribution, test samples shall be taken from the sides of one panel from five different mixed batches before the panels are cut to their final sizes. The sample locations shall be chosen to be representative of the final product. Wet chemistry or neutron attenuation shall be performed on each of the samples.
- During production runs, testing of mixed batches shall be performed on a statistical basis to verify the correct boron carbide weight percent is being mixed.
  - During production runs, samples from random METAMIC<sup>®</sup> panels taken from areas contiguous to the manufactured panels shall be tested via wet chemistry and/or neutron attenuation testing to verify the  $^{10}\text{B}$  areal density. This test shall be performed to verify the continued acceptability of the manufacturing process.

The measurements of  $\text{B}_4\text{C}$  particle size,  $^{10}\text{B}$  isotopic assay, uniformity of  $\text{B}_4\text{C}$  distribution and  $^{10}\text{B}$  areal density shall be made using written and approved procedures. Results shall be documented.

#### 9.1.5.3.3 Installation of the Neutron Absorber Panels

Installation of neutron absorber panels into the fuel basket shall be performed in accordance with written and approved instructions. Travelers and quality control procedures shall be in place to assure each required cell wall of the MPC basket contains a neutron absorber panel in accordance with drawings in Chapter 1. These quality control processes, in conjunction with in-process manufacturing testing, provide the necessary assurances that the neutron absorber will perform its intended function. No additional testing or in-service monitoring of the neutron absorber material will be required.

#### 9.1.6 Thermal Acceptance Tests

The thermal performance of the HI-STORM 100 System, including the MPCs and HI-TRAC transfer casks, is demonstrated through analysis in Chapter 4 of the FSAR. Dimensional inspections to verify the item has been fabricated to the dimensions provided in the drawings shall be performed prior to system loading. Following the loading and placement on the storage pad of the first HI-STORM System placed in service, the operability of the natural convective cooling of the HI-STORM 100 System shall be verified by the performance of an air temperature rise test. A description of the test is described in FSAR Chapter 8.

In addition, the technical specifications require periodic surveillance of the overpack air inlet and outlet vents or, optionally, implementation of an overpack air temperature monitoring program to provide continued assurance of the operability of the HI-STORM 100 heat removal system.

#### 9.1.7 Cask Identification

Each MPC, HI-STORM overpack, and HI-TRAC transfer cask shall be marked with a model number, identification number (to provide traceability back to documentation), and the empty weight of the item in accordance with the marking requirements specified in 10 CFR 72.236(k).

Table 9.1.1  
MPC INSPECTION AND TEST ACCEPTANCE CRITERIA

Function	Fabrication	Pre-operation	Maintenance and Operations
Visual Inspection and Nondestructive Examination (NDE)	<ul style="list-style-type: none"> <li>a) Examination of MPC components per ASME Code Section III, Subsections NB and NG, as defined on design drawings, per NB-5300 and NG-5300, as applicable.</li> <li>b) A dimensional inspection of the internal basket assembly and canister shall be performed to verify compliance with design requirements.</li> <li>c) A dimensional inspection of the MPC lid and MPC closure ring shall be performed prior to inserting into the canister shell to verify compliance with design requirements.</li> <li>d) NDE of weldments are defined on the design drawings using standard American Welding Society NDE symbols and/or notations.</li> <li>e) Cleanliness of the MPC shall be verified upon completion of fabrication.</li> <li>f) The packaging of the MPC at the completion of fabrication shall be verified prior to shipment.</li> </ul>	<ul style="list-style-type: none"> <li>a) The MPC shall be visually inspected prior to placement in service at the licensee's facility.</li> <li>b) MPC protection at the licensee's facility shall be verified.</li> <li>c) MPC cleanliness and exclusion of foreign material shall be verified prior to placing in the spent fuel pool.</li> </ul>	<ul style="list-style-type: none"> <li>a) None.</li> </ul>

Table 9.1.1 (continued)  
MPC INSPECTION AND TEST ACCEPTANCE CRITERIA

Function	Fabrication	Pre-operation	Maintenance and Operations
Structural	<p>a) Assembly and welding of MPC components shall be performed per ASME Code Section IX and III, Subsections NB and NG, as applicable.</p> <p>b) Materials analysis (steel, neutron absorber, etc.), shall be performed and records shall be kept in a manner commensurate with "important to safety" classifications.</p>	<p>a) None.</p>	<p>a) An ultrasonic (UT) examination or multi-layer liquid penetrant (PT) examination of the MPC lid-to-shell weld shall be performed per ASME Section V, Article 5 (or ASME Section V, Article 2). Acceptance criteria for the examination are defined in Subsection 9.1.1.1 and in the Design Drawings.</p> <p>b) ASME Code NB-6000 pressure test shall be performed after MPC closure welding. Acceptance criteria are defined in the Code.</p>
Leak Tests	<p>a) Helium leakage testing of the MPC shell and MPC shell to baseplate welds is performed on the unloaded MPC.</p>	<p>a) None.</p>	<p>a) Helium leak rate testing shall be performed on the vent and drain port cover plate to MPC lid field welds. See Technical Specification Bases in Chapter 12 for guidance on acceptance criteria.</p>

Table 9.1.1 (continued)  
MPC INSPECTION AND TEST ACCEPTANCE CRITERIA

<b>Function</b>	<b>Fabrication</b>	<b>Pre-operation</b>	<b>Maintenance and Operations</b>
Criticality Safety	<p>a) The boron content shall be verified at the time of neutron absorber material manufacture.</p> <p>b) The installation of neutron absorber panels into MPC basket plates shall be verified by inspection.</p>	a) None.	a) None.
Shielding Integrity	<p>a) Material compliance shall be verified through CMTRs.</p> <p>b) Dimensional verification of MPC lid thickness shall be performed.</p>	a) None.	a) None.
Thermal Acceptance	a) None.	a) None.	a) None.
Fit-Up Tests	<p>a) Fit-up of the following components is to be tested during fabrication.</p> <ul style="list-style-type: none"> <li>- MPC lid</li> <li>- vent/drain port cover plates</li> <li>- MPC closure ring</li> </ul> <p>b) A gauge test of all basket fuel compartments.</p>	<p>a) Fit-up of the following components shall be verified during pre-operation.</p> <ul style="list-style-type: none"> <li>- MPC lid</li> <li>- MPC closure ring</li> <li>- vent/drain cover plates</li> </ul>	a) None.
Canister Identification Inspections	a) Verification of identification marking applied at completion of fabrication.	a) Identification marking shall be checked for legibility during pre-operation.	a) None.

Table 9.1.2  
 HI-STORM STORAGE OVERPACK INSPECTION AND TEST ACCEPTANCE CRITERIA

Function	Fabrication	Pre-operation	Maintenance and Operations
Visual Inspection and Nondestructive Examination (NDE)	<p>Structural Steel Components:</p> <p>a) All ASME and AWS welds shall be visually examined per ASME Section V, Article 9 with acceptance criteria per ASME Section III, Subsection NF, NF-5360.</p> <p>b) All welds requiring PT examination as shown on the Design Drawings shall be PT examined per ASME Section V, Article 6 with acceptance criteria per ASME Section III, Subsection NF, NF-5350.</p> <p>c) All welds requiring MT examination as shown on the drawings shall be MT examined per ASME Section V, Article 7 with acceptance criteria per ASME Section III, Subsection NF, NF-5340.</p> <p>d) NDE of weldments shall be defined on design drawings using standard AWS NDE symbols and/or notations.</p> <p>Concrete Components:                      The following processes related to concrete components shall be implemented per ACI 349 as clarified in FSAR Appendix I.D. Concrete testing shall be in accordance with Table I.D.2. Activities shall be conducted in accordance with written and approved procedures.</p> <p>a) Assembly and examination.                      b) Materials verification.                      c) Mixing, pouring, and testing.</p>	<p>a) The overpack shall be visually inspected prior to placement in service.</p> <p>b) Fit-up with mating components (e.g., lid) shall be performed directly whenever practical or using templates or other means.</p> <p>c) Overpack protection at the licensee's facility shall be verified.</p> <p>d) Exclusion of foreign material shall be verified prior to placing the overpack in service at the licensee's facility.</p>	<p>a) Indications identified during visual inspection shall be corrected, reconciled, or otherwise dispositioned .</p> <p>b) Exposed surfaces shall be monitored for coating deterioration and repair/recoat as necessary.</p>

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Table 9.1.2 (continued)  
HI-STORM STORAGE OVERPACK INSPECTION AND TEST ACCEPTANCE CRITERIA

Function	Fabrication	Pre-operation	Maintenance and Operations
Visual Inspection and Nondestructive Examination (NDE) (continued)	General: a) Cleanliness of the overpack shall be verified upon completion of fabrication. b) Packaging of the overpack at the completion of shop fabrication shall be verified prior to shipment.		
Structural	a) No structural or pressure tests are required for the overpack during fabrication. b) Concrete compressive strength tests shall be performed per Appendix I.D.	a) No structural or pressure tests are required for the overpack during pre-operation.	a) No structural or pressure tests are required for the overpack during operation.
Leak Tests	a) None.	a) None.	a) None.
Criticality Safety	a) No neutron absorber tests of the overpack are required for criticality safety during fabrication.	a) None.	a) None.
Shielding Integrity	a) Concrete density shall be verified per ACI-349 as clarified by FSAR Appendix I.D, at time of placement. b) Shell thicknesses and dimensions between inner and outer shells shall be verified as conforming to design drawings prior to concrete placement. c) Verification of material composition shall be performed.	a) None	a) A shielding effectiveness test shall be performed after the initial fuel loading.

Table 9.1.2 (continued)  
 HI-STORM STORAGE OVERPACK INSPECTION AND TEST ACCEPTANCE CRITERIA

Function	Fabrication	Pre-operation	Maintenance and Operations
Thermal Acceptance	a) Inner shell I.D. and vent size, configuration and placement shall be verified.	a) No pre-operational testing related to the thermal characteristics of the overpack is required.	a) Air temperature rise test(s) shall be performed after initial loading of the first HI-STORM 100 System in accordance with the operating procedures in Chapter 8.  b) Periodic surveillance shall be performed by either (1) or (2) below, at the licensee's discretion.  (1) Inspection of overpack inlet and outlet air vent openings for debris and other obstructions. (2) Temperature monitoring.
Cask Identification	a) Verification that the overpack identification is present in accordance with the drawings shall be performed upon completion of assembly.	a) The overpack identification shall be checked prior to loading.	a) The overpack identification shall be periodically inspected per licensee procedures and repaired or replaced if damaged.
Fit-up Tests	a) Lid fit-up with the overpack shall be verified following fabrication.	a) None.	a) None.

Table 9.1.3  
HI-TRAC TRANSFER CASK INSPECTION AND TEST ACCEPTANCE CRITERIA

Function	Fabrication	Pre-operation	Maintenance and Operations
Visual Inspection and Nondestructive Examination (NDE)	<p>a) All ASME and AWS welds shall be visually examined per ASME Section V, Article 9 with acceptance criteria per ASME Section III, Subsection NF, NF-5360.</p> <p>b) All welds requiring PT examination as shown on the Design Drawings shall be PT examined per ASME Section V, Article 6 with acceptance criteria per ASME Section III, Subsection NF, NF-5350.</p> <p>c) All welds requiring MT examination as shown on the Design Drawings shall be MT examined per ASME Section V, Article 7 with acceptance criteria per ASME Section III, Subsection NF, NF-5340.</p> <p>d) NDE of weldments shall be defined on design drawings using standard AWS NDE symbols and/or notations</p> <p>e) Cleanliness of the transfer cask shall be verified upon completion of fabrication.</p> <p>f) Packaging of the transfer cask at the completion of fabrication shall be verified prior to shipment.</p>	<p>a) The transfer cask shall be visually inspected prior to placement in service.</p> <p>b) Transfer cask protection at the licensee's facility shall be verified.</p> <p>c) Transfer cask cleanliness and exclusion of foreign material shall be verified prior to use.</p>	<p>a) Annual visual inspections of the transfer cask shall be performed to assure continued compliance with drawing requirements. (See footnote for Table 9.2.1).</p>

Table 9.1.3 (continued)			
HI-TRAC TRANSFER CASK INSPECTION AND TEST ACCEPTANCE CRITERIA			
Function	Fabrication	Pre-operation	Maintenance and Operations
Structural	a) Verification of structural materials shall be performed through receipt inspection and review of certified material test reports (CMTRs) obtained in accordance with the item's quality category.  a) A load test of the lifting trunnions shall be performed during fabrication per ANSI N14.6. b) A pressure test of the neutron shield water jacket shall be performed during fabrication.	a) None.	a) Testing to verify continuing compliance of the lifting trunnions shall be performed per ANSI N14.6. (See footnote to Table 9.2.1).  b) The set pressure of the relief valve on the neutron shield water jacket shall be verified by calibration annually. (See footnote to Table 9.2.1)
Leak Tests	a) None.	a) None.	a) None.
Criticality Safety	a) None.	a) None.	a) None.

Table 9.1.3 (continued)  
TRANSFER CASK INSPECTION AND TEST ACCEPTANCE CRITERIA

Function	Fabrication	Pre-operation	Maintenance and Operations
Thermal Acceptance	a) The thermal properties of the transfer cask are established by calculation and inspection, and are not tested during fabrication.	a) None.	a) None
Cask Identification	a) Verification that the transfer cask identification is present in accordance with the drawings shall be performed upon completion of assembly.	a) The transfer cask identification shall be checked prior to loading..	a) The transfer cask identification shall be periodically inspected per licensee procedures and repaired or replaced if damaged.
Fit-up Tests	a) Fit-up tests of the transfer cask components (top, in-pool, and transfer lids) shall be performed during fabrication.	a) Fit-up test of the transfer cask lifting trunnions with the transfer cask lifting yoke shall be performed.  b) Fit-up test of the transfer cask pocket trunnions with the horizontal transfer skid shall be performed.	a) Fit-up of the top, in-pool, and transfer lids shall be verified prior to use.

Table 9.1.4  
HI-STORM 100 NDE REQUIREMENTS

MPC			
Weld Location	NDE Requirement	Applicable Code	Acceptance Criteria (Applicable Code)
Shell longitudinal seam	RT	ASME Section V, Article 2 (RT)	RT: ASME Section III, Subsection NB, Article NB-5320
	PT (surface)	ASME Section V, Article 6 (PT)	PT: ASME Section III, Subsection NB, Article NB-5350
Shell circumferential seam	RT	ASME Section V, Article 2 (RT)	RT: ASME Section III, Subsection NB, Article NB-5320
	PT (surface)	ASME Section V, Article 6 (PT)	PT: ASME Section III, Subsection NB, Article NB-5350
Baseplate-to-shell	RT or UT	ASME Section V, Article 2 (RT) ASME Section V, Article 5 (UT)	RT: ASME Section III, Subsection NB, Article NB-5320 UT: ASME Section III, Subsection NB, Article NB-5330
	PT (surface)	ASME Section V, Article 6 (PT)	PT: ASME Section III, Subsection NB, Article NB-5350

Table 9.1.4 (continued)  
HI-STORM 100 NDE REQUIREMENTS

MPC			
Weld Location	NDE Requirement	Applicable Code	Acceptance Criteria (Applicable Code)
Lid-to-shell	PT (root and final pass) and multi-layer PT (if UT is not performed).	ASME Section V, Article 6 (PT)	PT: ASME Section III, Subsection NB, Article NB-5350
	PT (surface following pressure test)  UT (if multi-layer PT is not performed)	ASME Section V, Article 5 (UT)	UT: ASME Section III, Subsection NB, Article NB-5332
Closure ring-to-shell	PT (final pass)	ASME Section V, Article 6 (PT)	PT: ASME Section III, Subsection NB, Article NB-5350
Closure ring-to-lid	PT (final pass)	ASME Section V, Article 6 (PT)	PT: ASME Section III, Subsection NB, Article NB-5350
Closure ring radial welds	PT (final pass)	ASME Section V, Article 6 (PT)	PT: ASME Section III, Subsection NB, Article NB-5350
Port cover plates-to-lid	PT (root and final pass)	ASME Section V, Article 6 (PT)	PT: ASME Section III, Subsection NB, Article NB-5350
Lift lug and lift lug baseplate	PT (surface)	ASME Section V, Article 6 (PT)	PT: ASME Section III, Subsection NG, Article NG-5350
Vent and drain port cover plate plug welds	PT (surface)	ASME Section V, Article 6 (PT)	PT: ASME Section III, Subsection NG, Article NG-5350

Table 9.1.4 (continued)  
HI-STORM 100 NDE REQUIREMENTS

<b>HI-STORM OVERPACK</b>			
Weld Location	NDE Requirement	Applicable Code	Acceptance Criteria (Applicable Code)
N/A	N/A	N/A	N/A
<b>HI-TRAC TRANSFER CASK</b>			
Weld Location	NDE Requirement	Applicable Code	Acceptance Criteria (Applicable Code)
HI-TRAC Body: Radial ribs and short ribs to outer shell	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
HI-TRAC Body: Water jacket end plate-to-radial channel or enclosure shell panel	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
Pool Lid: Pool lid top plate-to-pool lid outer ring	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
Pool Lid: Pool lid bottom plate-to-pool lid outer ring	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340

Table 9.1.4 (continued)  
 HI-STORM 100 NDE REQUIREMENTS  
 HI-TRAC TRANSFER CASK

Weld Location	NDE Requirement	Applicable Code	Acceptance Criteria (Applicable Code)
HI-TRAC Body: Water jacket end plate-to-outer shell	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
HI-TRAC Body: Outer shell-to-outer shell longitudinal and circumferential welds	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
HI-TRAC Body: Radial ribs and short ribs –to-enclosure shell panel	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
HI-TRAC Body: Jacket drain pipe and couplings	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
HI-TRAC Body: Outer shell-to-bottom flange	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340

Table 9.1.4 (continued)  
HI-STORM 100 NDE REQUIREMENTS

<b>HI-TRAC TRANSFER CASK</b>			
Weld Location	NDE Requirement	Applicable Code	Acceptance Criteria (Applicable Code)
HI-TRAC Body: Outer shell-to-top flange	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
HI-TRAC Body: Lifting trunnion block-to-top flange	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
HI-TRAC Body: Lifting trunnion block-to-outer and inner shells	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
HI-TRAC Body: Pocket trunnion-to-outer shell (HI-TRAC 125 and 100 only)	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
HI-TRAC Body: Top lid welds except as noted on applicable drawings	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
HI-TRAC Body: Pocket trunnion-to-enclosure shell panel and radial rib (HI-TRAC 125 and 100 only)	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340

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Table 9.1.4 (continued)  
HI-STORM 100 NDE REQUIREMENTS

HI-TRAC TRANSFER CASK			
Weld Location	NDE Requirement	Applicable Code	Acceptance Criteria (Applicable Code)
HI-TRAC Body: Lower water jacket welds	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
HI-TRAC Body: Gusset-to-baseplate, outer shell and water jacket bottom plate (HI-TRAC 100D and 125D only)	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
Transfer Lid: Lid intermediate plate and lead cover plate-to-lid top plate & lid bottom plate	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
Transfer Lid: Door top plate-to-door wheel housing	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
Transfer Lid: Door side plate-to-door wheel housing	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
Transfer Lid: Door side plate-to-door end plate	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340
Transfer Lid: Lead cover plate-to-lead cover side plate	PT (surface) or MT	ASME Section V, Article 6 (PT) ASME Section V, Article 7 (MT)	PT: ASME Section III, Subsection NF, Article NF-5350 MT: ASME Section III, Subsection NF, Article NF-5340

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## 9.2 MAINTENANCE PROGRAM

An ongoing maintenance program shall be defined and incorporated into the HI-STORM 100 System Operations Manual, which shall be prepared and issued prior to the delivery and first use of the system to each user. This document shall delineate the detailed inspections, testing, and parts replacement necessary to ensure continued structural, thermal, and confinement performance; radiological safety, and proper handling of the system in accordance with 10CFR72 regulations, the conditions in the Certificate of Compliance, and the design requirements and criteria contained in this FSAR.

The HI-STORM 100 System is totally passive by design. There are no active components or monitoring systems required to assure the performance of its safety functions. As a result, only minimal maintenance will be required over its lifetime, and this maintenance would primarily result from weathering effects in storage. Typical of such maintenance would be the reapplication of corrosion inhibiting materials on accessible external surfaces. Visual inspection of the vent screens is required to ensure the air inlets and outlets are free from obstruction (or alternatively, temperature monitoring may be utilized). Such maintenance requires methods and procedures no more demanding than those currently in use at power plants.

Maintenance activities shall be performed under the licensee's NRC-approved quality assurance program. Maintenance activities shall be administratively controlled and the results documented. The maintenance program schedule for the HI-STORM 100 System is provided in Table 9.2.1.

### 9.2.1 Structural and Pressure Parts

Prior to each fuel loading, a visual examination in accordance with a written procedure shall be required of the HI-TRAC lifting trunnions and pocket trunnion recesses. The examination shall inspect for indications of overstress such as cracking, deformation, or wear marks. Repairs or replacement in accordance with written and approved procedures shall be required if unacceptable conditions are identified.

Testing to verify continuing compliance of the transfer cask trunnions shall be performed in accordance with ANSI N14.6-1993.

As described in FSAR Chapters 7 and 11, there are no credible normal, off-normal, or accident events which can cause the structural failure of the MPC. Therefore, periodic structural or pressure tests on the MPCs following the initial acceptance tests are not required as part of the storage maintenance program.

### 9.2.2 Leakage Tests

There are no seals or gaskets used on the fully-welded MPC confinement system. As described in Chapters 7 and 11, there are no credible normal, off-normal, or accident events which can cause the failure of the MPC confinement boundary welds. Therefore, leakage tests are not required as part of the storage maintenance program.

### 9.2.3 Subsystem Maintenance

The HI-STORM 100 System does not include any subsystems, which provide auxiliary cooling. Normal maintenance and calibration testing will be required on the vacuum drying, helium backfill, and leakage testing systems. Rigging, remote welders, cranes, and lifting beams shall also be inspected prior to each loading campaign to ensure proper maintenance and continued performance is achieved. Auxiliary shielding provided during on-site transfer operations with the HI-STORM 100 require no maintenance. If the cask user chooses to use an air temperature monitoring system in lieu of visual inspection of the air inlet and outlet vents, the thermocouples and associated temperature monitoring instrumentation shall be maintained and calibrated in accordance with the user's QA program commensurate with the equipment's safety classification and designated QA category. See also FSAR Section 9.2.6.

### 9.2.4 Pressure Relief Valves

The pressure relief valves used on the water jackets for the HI-TRAC transfer cask shall be calibrated on an annual basis (or prior to the next HI-TRAC use if the period the HI-TRAC is out of use exceeds one year) to ensure pressure relief settings are 60 +2/-0 psig and 65 +2/-0 psig, or replaced with factory-set relief valves.

### 9.2.5 Shielding

The gamma and neutron shielding materials in the HI-STORM overpack, HI-TRAC, and MPC degrade negligibly over time or as a result of usage.

Radiation monitoring of the ISFSI by the licensee in accordance with 10CFR72.104(c) provides ongoing evidence and confirmation of shielding integrity and performance. If increased radiation doses are indicated by the facility monitoring program, additional surveys of overpacks shall be performed to determine the cause of the increased dose rates.

The water level in the HI-TRAC water jacket shall be verified during each loading campaign in accordance with the licensee's approved operations procedures.

The neutron absorber panels installed in the MPC baskets are not expected to degrade under normal long-term storage conditions. The use of Boral in similar nuclear applications is discussed in Chapter 1, and the long-term performance in a dry, inert gas atmosphere is evaluated in Chapter 3. A similar discussion is provided for METAMIC<sup>®</sup> neutron absorber material. Therefore, no periodic verification testing of neutron poison material is required on the HI-STORM 100 System.

9.2.6            Thermal

In order to assure that the HI-STORM 100 System continues to provide effective thermal performance during storage operations, surveillance of the air vents (or alternatively, by temperature monitoring) shall be performed in accordance with written procedures.

For those licensees choosing to implement temperature monitoring as the means to verify overpack heat transfer system operability, a maintenance and calibration program shall be established in accordance with the plant-specific Quality Assurance Program, the equipment's quality category, and manufacturer's recommendations.

Table 9.2.1

HI-STORM SYSTEM MAINTENANCE PROGRAM SCHEDULE

Task	Frequency
Overpack cavity visual inspection	Prior to fuel loading
Overpack bolt visual inspection	Prior to installation during each use
Overpack external surface (accessible) visual examination	Annually, during storage operation
Overpack vent screen visual inspection for damage, holes, etc.	Monthly
HI-STORM 100 Shielding Effectiveness Test	In accordance with Technical Specifications after initial fuel loading
HI-TRAC cavity visual inspection	Prior to each handling campaign
HI-TRAC lifting trunnion and pocket trunnion recess visual inspection	Prior to each handling campaign
Testing to verify continuing compliance of HI-TRAC Lifting Trunnions	In accordance with ANSI N14.6-1993
HI-TRAC pressure relief valve calibration	Annually <sup>†</sup>
HI-TRAC internal and external visual inspection for compliance to design drawings	Annually <sup>†</sup>
HI-TRAC water jacket water level visual examination	During each handling campaign in accordance with licensee approved operations procedures
Overpack visual inspection of identification markings	Annually
Overpack Air Temperature Monitoring System	Per licensee's QA program and manufacturer's recommendations

<sup>†</sup> Or prior to next HI-TRAC use if the period the HI-TRAC is out of use exceeds one year.

### 9.3 REGULATORY COMPLIANCE

Chapter 9 of this FSAR has been prepared to summarize the commitments of Holtec International to design, construct, and test the HI-STORM 100 System in accordance with the Codes and Standards identified in Chapter 2. Completion of the defined acceptance test program for each HI-STORM 100 System will provide assurance that the SSCs important to safety will perform their design function. The performance of the maintenance program by the licensee for each loaded HI-STORM 100 System will provide assurance for the continued safe long-term storage of the stored SNF.

The described acceptance criteria and maintenance programs can be summarized in the following evaluation statements:

1. Section 9.1 of this FSAR describes Holtec International's proposed program for pre-operational testing and initial operations of the HI-STORM 100 System. Section 9.2 describes the proposed HI-STORM 100 maintenance program.
2. Structures, systems, and components (SSCs) of the HI-STORM 100 System designated as important to safety will be designed, fabricated, erected, assembled, inspected, tested, and maintained to quality standards commensurate with the importance to safety of the function they are intended to perform. Tables 2.2.6 and 8.1.6 of this FSAR identify the safety importance and quality classifications of SSCs of the HI-STORM 100 System and its ancillary equipment, respectively. Tables 2.2.6 and 2.2.7 present the applicable standards for their design, fabrication, and inspection of the HI-STORM 100 System components.
3. Holtec International will examine and test the HI-STORM 100 System to ensure that it does not exhibit any defects that could significantly reduce its confinement effectiveness. Section 9.1 of this FSAR describes the MPC confinement boundary assembly, inspection, and testing.
4. Holtec International will mark the cask with a data plate indicating its model number, unique identification number, and empty weight.
5. It can be concluded that the acceptance tests and maintenance program for the HI-STORM 100 System are in compliance with 10CFR72 [9.0.1], and that the applicable acceptance criteria have been satisfied. The acceptance tests and maintenance program will provide reasonable assurance that the HI-STORM 100 System will allow safe storage of spent fuel throughout its certified term. This can be concluded based on a review that considers the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted practices.

#### 9.4 REFERENCES

- [9.0.1] U.S. Code of Federal Regulations, Title 10, "Energy", Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste".
- [9.0.2] NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems", January 1997.
- [9.1.1] American Society of Mechanical Engineers, "Boiler and Pressure Vessel Code," Sections II, III, V, IX, and XI, 1995 Edition, including Addenda through 1997.
- [9.1.2] American Society for Nondestructive Testing, "Personnel Qualification and Certification in Nondestructive Testing," Recommended Practice No. SNT-TC-1A, December 1992.
- [9.1.3] American National Standards Institute, Institute for Nuclear Materials Management, "American National Standard for Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kilograms) or More", ANSI N14.6, September 1993.
- [9.1.4] NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants", U.S. Nuclear Regulatory Commission, Washington, D.C., July 1980.
- [9.1.5] American National Standards Institute, Institute for Nuclear Materials Management, "American National Standard for Radioactive Materials Leakage Tests on Packages for Shipment", ANSI N14.5, January 1997.
- [9.1.6] Holtec International Position Paper DS-213, "Acceptable Flaw Size in MPC Lid-to-Shell Welds", Revision 2.

## SUPPLEMENT 9.I

### ACCEPTANCE CRITERIA AND MAINTENANCE PROGRAM FOR THE HI-STORM 100U SYSTEM

#### 9.1.0 INTRODUCTION

This supplement addresses fabrication, inspection, test, and maintenance program for the HI-STORM 100U VVM. The HI-STORM 100U System does not require any changes to the acceptance criteria or maintenance requirements for the MPC or the HI-TRAC transfer cask. Therefore, the material on the fabrication, maintenance, testing, and inspection of all components contained in the main body of this chapter remains unchanged and applicable.

The VVM consists of a shop-fabricated CEC (Cavity Enclosure Container) installed below grade and a removable Closure Lid. The CEC is a welded shell-type structure made of low carbon steel plate and bar (or forging) stock. Likewise, the Closure Lid is made of welded and formed steel plates. However, unlike the CEC, the Closure Lid also contains shielding concrete.

By virtue of its underground configuration, the CEC is interfaced by the subgrade along its lateral surface by the top surface pad near its flanged upper region and by the support foundation along its bottom surface. The requirements on these interfacing bodies to the extent they are needed to enable the CEC to render its intended function are provided in Supplement 2.I. All requirements pertaining to the manufacturing, inspection, testing, and maintenance of the VVM SSCs are presented in this supplement to comply with the provisions of 10CFR71.24(p).

#### 9.1.I ACCEPTANCE CRITERIA

The design, fabrication, inspection, and testing of the VVM is performed in accordance with the applicable codes and standards specified in Supplement 2.I and on the drawing. Acceptance criteria described in FSAR Section 9.1 for the overpack are also implemented for the HI-STORM 100U VVM, as applicable, and as further particularized below.

##### 9.1.1.1 Manufacturing of VVM Components

The manufacturing of VVM components shall be carried out in accordance with the CoC holder's NRC-approved QA program. All elements of the manufacturing cycle will be established to accord with the Important-to-Safety (ITS) designation of the specific part and the applicable provisions of the referenced codes and standards. The acceptance criteria for the manufactured components apply to each step of the manufacturing evolution, namely (a) supplier selection, (b) preparation of material procurement specifications, (c) preparation of the shop traveler and fabrication procedures, (d) fabrication activities such as forming, bending, plasma cutting, and welding, (e) in-process inspections, (f) final inspection, (g) packaging for shipment, and (h) assembling of the documentation package to serve as the archival evidence of adherence to the quality requirements.

### 9.I.1.2 Site Construction

Like the aboveground HI-STORM overpacks, the site construction activities on the VVM and its interfacing SSCs (namely, the foundation, the subgrade, and the top surface pad) shall be carried out to demonstrate compliance with the technical criteria set forth in this FSAR. The specific requirements, to ensure that the required *critical characteristics*\* of the VVM and the interfacing SSCs are realized, are summarized below.

- a. All site construction processes shall be procedurized, reviewed, and approved in accordance with the CoC holder's NRC-approved QA program.
- b. Although the ITS designations apply to VVM components only, all interfacing SSCs (except for concrete encasement and cathodic protection system) shall also be designated as ITS Category C to ensure that the construction materials and processes will be subject to the necessary quality assurance regimen.
- c. Compliance with the requirements in this FSAR shall be demonstrated by appropriate testing and the results documented for archival reference. For example, the strength properties of the subgrade can be established using the classical "plate test".
- d. The shielding concrete shall comply with the applicable provisions of Appendix 1.D.
- e. The insulation installed on the Divider Shell shall be subject to visual examination to ensure that it is undamaged and properly secured.
- f. The coating on the exterior surface of the CEC shall be inspected for absence of damage before the surface becomes inaccessible.
- g. The impressed current cathodic protection system (ICCPs), if used, shall be installed in accordance with the applicable guidelines referenced in Supplement 3.I, Subsection 3.I.4.
- h. The concrete encasement, if used, shall be installed in accordance with the requirements of Supplement 3.I, Subsection 3.I.4.
- i. The dimensional compliance of the CEC, including its verticality, shall be inspected to establish compliance with the governing construction documents.

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\* See Glossary for definition.

- j. The installation of the corrosion barriers shall be in accordance with written procedures.
- k. All VVM surfaces that become inaccessible shall be photographed with sufficient resolution to provide a clear archive of their in-situ state at installation.

The governing processes for manufacturing control shall be prepared to be in complete compliance with this FSAR. For example, the dimensions of the HI-STORM 100U VVM steel components and the properties of the shielding concrete shall be verified to be in accordance with FSAR Supplement 2.I, Appendix 1.D (as applicable), and the drawings prior to concrete placement. The dimensional inspection and density measurements shall be documented.

The governing NDE references provided for the aboveground HI-STORM overpack in Table 9.1.4 also apply to the VVM, as do the requirements on the documentation package contents specified in paragraph 9.1.1(13).

In order to receive the Certificate-of-Compliance under the CoC holder's QA program, the manufacturing of the VVM components must meet all of the technical, quality control, procedural (quality assurance) and administrative requirements set forth in the manufacturing program.

Similarly, the low carbon steel plates, bars, and forgings, as applicable, used in the construction of the HI-STORM 100U VVM shall be dimensionally inspected to assure compliance with the requirements on the drawings. Test results shall be documented and become part of the quality documentation package. Dimensional inspections of the Closure Lid and its weight measurement after placement in the shielding concrete shall assure that the required amount of shielding material has been incorporated in the lid.

#### 9.1.1.3 Inspections and Testing

##### i. Post-Construction Inspection:

Each as-built VVM shall be inspected for final acceptance before it is loaded with fuel. The following inspections define minimum acceptance requirements:

- a. The as-installed Divider Shell shall be inspected to ensure that it sits on the Bottom Plate and is flanked by lateral and circumferential guides located in the bottom region of the CEC. The top surface elevation and roundness of the Divider Shell shall be inspected to ensure it will not hinder installation of the Closure Lid.
- b. The Container Flange and Divider Shell gasket/seal bearing surfaces shall be inspected for their horizontal alignment (within specified tolerance).

- c. The Restraint Ring welded to the underside of the Closure Lid shall be checked for fitup with the Container Flange.
- d. The inlet and outlet air passages in the Closure Lid shall be inspected for absence of obstruction such as debris and extensive weld spatter.
- e. The results of the post-construction inspection shall be incorporated in the VVM's Documentation Package.
- f. The impressed current cathodic protection system (ICCP), if used, shall be tested in accordance with the applicable guidelines referenced in Supplement 3.I, Subsection 3.I.4.

ii. Shielding Integrity and Effectiveness Test

The effectiveness tests performed during fabrication and operation of the HI-TRAC remains the same as in the aboveground system, as described in 9.1.5.2. The 100U VVM is unique however since the gamma and neutron shielding are provided by the concrete and steel components of the VVM as well by as by the surrounding subgrade and the top surface pad.

As shown in Supplement 5.I, the shielding performance of the HI-STORM 100U system is significantly better than its aboveground counterparts. Further, the long-term shielding effectiveness in the HI-STORM 100U system is also assured to an extremely high level of confidence by virtue of its physical configuration, choice of materials, and design embodiment, as described below:

- a. Absence of penetrations in the VVM body: The CEC has no penetrations and thus has no path that can serve as a conduit for radiation streaming. All penetrations are in the lid and are configured to maximize scattering of photons and neutrons.
- b. Axisymmetric penetrations in the lid: As shown in the drawings, all penetrations in the lid are axisymmetric. In particular, the air inlet passage is formed by narrowly separated steel plates that girdle the lid, allowing only infinitesimal amounts of neutrons and gamma radiation to the outside. Likewise, the outlet air passage is formed by a set of formed surfaces of revolution that preclude a direct "line-of-sight" from the fuel to the outside. Because these air passages are formed by welded steel shapes, they will remain invariant over time, making their shielding performance reliably constant over years of use.
- c. Aging of foundation, subgrade: Even though a very stiff support foundation is specified, some settlement of the foundation is expected. However, any settlement of the foundation would have no deleterious effect on the extent of shielding to the environment.

Second, while the subgrade is unloaded, except when a transporter is passing over it, some settlement of the subgrade and the above top surface pad is expected. Any subgrade settlement, however, will result in a corresponding compaction of its material, which will improve the subgrade's shielding capability. The settlement of the subgrade will not result in any new loading on the CEC structure (which is autonomously supported on the foundation) or the Closure Lid, which is autonomously supported on the CEC structure. Any visible gap or crevice between the Container Flange and the surface pad should be filled with grout or caulking for both aesthetic purposes and enhancement of degradation and corrosion mitigation.

- d. **Effect of Corrosion:** It can be readily deduced from the VVM's design that the only surfaces that are not accessible for corrosion monitoring are the bottom face and outer surface of the CEC. As discussed in Supplement 3.I, corrosion mitigation measures for these surfaces are prescribed and expected to provide adequate corrosion mitigation for decades beyond the Design Life of the VVM. These corrosion mitigation measures, however, are chiefly required to preserve long-term structural, not shielding, integrity of the CEC because the effect of the CEC shell or Bottom Plate corrosion on the dose to the environment is ostensibly miniscule.

Thus, the potential for reduction in the shielding effectiveness of the HI-STORM 100U system due to corrosion is not a concern.

- e. **Water Intrusion:** Because the underground portion of the HI-STORM 100U VVM contains a thick steel shell structure without any penetrations, intrusion of ground water in the MPC storage cavity is not credible. At some sites, ground water may saturate the surrounding subgrade. A water-saturated subgrade, however, will be more effective (not less) in radiation attenuation and, therefore, seepage of ground water around the HI-STORM 100U vertical space will not threaten loss in its shielding integrity.
- f. **Materials of Construction:** The sole material of construction in the underground portion of the CEC is carbon steel (the optional concrete encasement is not credited in the shielding evaluation), which is a proven material of long-term shielding endurance under fluence levels that are orders of magnitude greater than those present in the CEC. The Closure Lid is comprised of low carbon steel that encases plain concrete. Concrete, like steel, is a proven durable material in a radiation environment that suffers negligible change in its shielding capability over long periods of use in a radiation environment. Therefore, material degradation induced reduction in the shielding effectiveness of the VVM is not a credible concern.

The long-term shielding effectiveness of the HI-STORM 100U is assured by virtue of its design configuration and its constituent materials.

However, to verify the VVM's shielding capability, operational neutron and gamma shielding effectiveness tests, (i.e. radiation surveys), shall be performed similar to those described in Subsection 9.1.5.2 for the aboveground systems. The tests will be performed after fuel loading using written and approved procedures. Calibrated neutron and gamma dose rate meters shall be used to measure the dose rates at the top of the VVM and at the vents, consistent with the Radiation Protection Program. The tests are considered acceptable if the dose rates are less than or equal to the calculated limits. If dose rates are higher than the limits, the required actions provided in the Radiation Protection Program shall be completed. Dose rate measurements shall be documented and become a part of the quality documentation package.

iii. Thermal Acceptance Test

The thermal acceptance test is performed as described in Subsection 9.1.6 for the aboveground systems.

9.1.1.4 Cask Identification

The MPC and HI-TRAC transfer cask are identified as described in Subsection 9.1.7. See Subsection 9.1.3 for discussion of identification requirements for the VVM.

9.1.1.5 Storm Water Control Test

The VVM is designed to direct storm water and snow/ice melt-off away from the Closure Lid where the air passages are located. Any minor amount of moisture that may intrude into the MPC cavity due to wind-driven rain will evaporate in a short period of time due to the movement of heated air in the MPC storage cavity. To verify the effectiveness of the storm water drainage design, a one-time test shall be performed after construction of the first VVM to ensure that the design is effective in directing storm water away from the VVM to the ISFSI's drainage system. The VVM shall be subjected to a water spray that simulates exposure to rainfall of at least 2 inches per hour for at least one hour. At the conclusion of the water spray, the depth of the water (if any) in the bottom of the module cavity shall be measured. Any amount of water accumulation beyond wetting of the Bottom Plate indicates an inadequacy in rain diversion features of the VVM and shall be appropriately corrected. It should be noted that, as stated in Supplement 4.1, any amount of accumulated water in the CEC will not cause any component of the HI-STORM 100U System to exceed its regulatory limit as supported by Supplement 4.1. The only deleterious effect of water is the potential for increased preservative degradation (on the wetted surface of the Bottom Plate, CEC shell and other interfacing components) from prolonged exposure.

9.1.1.6 Inspection Criteria

The inspection and test criteria specified in FSAR Table 9.1.2 shall be implemented for the VVM to the extent they are applicable. No additional inspections or tests other than those specified in this supplement are required. Consistent with Table 9.1.4, no non-destructive examination (NDE) beyond visual examination is required for the VVM steel components.

## 9.1.2 MAINTENANCE PROGRAM

### 9.1.2.1 HI-STORM 100U System

The HI-STORM 100U System is totally passive by design and requires minimal normal maintenance to ensure it can perform its design functions. Periodic surveillance (via temperature monitoring or visual or camera-aided inspection of air passages) is required to ensure that the air passages in the lid are not blocked. Preventive or remedial painting of the exposed steel surfaces as part of the user's preventive maintenance program is recommended to mitigate corrosion. Such preventive maintenance activities are typical in scope and complexity to other standard maintenance activities at nuclear power plants. Maintenance activities described in FSAR Section 9.2 and Table 9.2.1 shall be implemented for other HI-STORM 100U System components, namely, the MPC and the HI-TRAC transfer cask, without any change.

The maintenance requirements on the VVM also parallel those for the aboveground HI-STORM overpack, but are slightly different. In the following, the essentials of the maintenance program for VVM are specified. Because the VVM is a passive structure and is largely protected from the weather due to its underground configuration, the maintenance requirements on it are rather minimal. Nevertheless, a carefully articulated preventive maintenance program is essential for a satisfactory service life.

In-service inspection for long-term interior and below-grade degradation shall be performed on a site-specific basis in accordance with Holtec prepared long-term maintenance guidelines and the licensee's preventive maintenance program. At most potential ISFSI sites, visual inspection of accessible areas of the VVM is expected to be sufficient to evaluate long-term degradation. The frequency of this visual in-service inspection should be in performed in accordance with Table 9.1.1. Additional in-service inspection activities may include more thorough inspections for foreign material accumulation, corrosion (CEC wall thinning) and insulation degradation as warranted by site-specific conditions. One example is ultrasonic inspection of the CEC using a remotely operated device to check for wall thinning. VVM Closure Lid removal or even MPC transfer into a HI-TRAC may be necessary for certain inspections. For certain inspections such as evaluating CEC wall thinning, a sampling of VVMs at a given ISFSI array may be used but should be commensurate with previous inspection results. The frequencies for the additional in-service inspection activities will be determined on a site-specific basis and may include allowance to increase or decrease the frequency commensurate with the results of previous inspections. In-service inspections for evaluating foreign material accumulation, corrosion (CEC wall thinning) and/or insulation degradation are not required if it is determined that the applicable degradation mechanisms do not exist. For defense in depth, VVM ISFSIs not employing impressed current cathodic protection shall be subject to a mandatory visual and UT

inspection of at least one representative VVM to check for wall thinning and pitting of the CEC at an interval not to exceed 20 years. The inspections are performed on the inside surface of the CEC. The VVM chosen for inspection is not required to be in use or to have previously contained a loaded MPC. A VVM with a loaded MPC may be inspected using remote devices with the VVM lid removed. The oldest VVM or VVM considered to be most vulnerable to corrosion degradation shall be selected for inspection.

As is true for all components certified pursuant to this FSAR, the maintenance activities on the HI-STORM 100U VVM shall be performed in accordance with a written program that fulfills the requirements of the CoC holder's 10CFR72 Subpart G compliant QA program, the owner site's Safety Plan and corrective action program; and the system's Technical Specification.

Among the QA commitments are performance of maintenance by trained personnel by written procedures; and, written documentation of the maintenance work performed and of the results obtained. Table 9.I.1 provides a listing of the minimum maintenance activities on the HI-STORM 100U VVM.

#### 9.I.2.2 Subsystem Maintenance

No new ancillary equipment or sub-systems requiring periodic maintenance are required for use of the HI-STORM 100U System.

#### 9.I.2.3 Shielding

As discussed in the foregoing, the radiation shielding capacity of the HI-STORM 100U System is expected to degrade negligibly over time. Therefore, unless the VVM is subjected to an extreme environmental event that imparts stresses or temperatures beyond the design basis limits for the system (i.e., prolonged fire or impact from a beyond-the-design basis large energetic projectile) such that this event could potentially degrade the shielding effectiveness of the VVM, no shielding effectiveness tests beyond that required by the Radiation Protection Program are required over the life of the HI-STORM 100U System.

#### 9.I.3 REGULATORY COMPLIANCE

The information presented in this supplement augments the material in the main body of the chapter to fulfill the regulatory requirements pertaining to the testing and maintenance of the HI-STORM 100U System, resolution of issues concerning adequacy and reliability, and cask identification. Section 9.3 of this FSAR provides the necessary information on all HI-STORM system components except the VVM. This section demonstrates the corresponding compliance information on the VVM.

- a. The program for pre-operational testing and initial operations, as required by 10CFR72.24(p) for the VVM, is provided in Section 9.I.1 herein.

- b. The maintenance protocol for the VVM, as specified in §72.236(g), is provided in Section 9.I.2 herein.
- c. The quality assurance requirements on the design, fabrication, on-site construction of the VVM commensurate with its ITS designation are invoked through Chapter 13 of this FSAR and are summarized in Section 9.I.1 herein, as called for in §72.122(a), §72.122(f), §72.128(a)(1) and §72.24(c).
- d. The provisions of §72.82(c) with respect to acceptance criteria and the appropriate test program to ensure compliance with the acceptance criterion are fulfilled by Section 9.I.1 herein.
- e. The quality requirements with respect to inspection, testing, and documentation, as set down in §72.212(b)(8), are provided in Section 9.I.1 herein.
- f. The VVM, except for its Closure Lid, does not require unique marking other than that required for fuel ISFSI configuration management because it is not a transportable structure. The module is essentially an integral portion of the ISFSI, not a separate cask structure that can be moved by the user. As such, the markings provided on the MPC alone are sufficient to meet the requirements of 10CFR72.236(k). Nevertheless, it is required that each VVM cavity be labeled with an identifier that is unique for the specific site. Further, because the Closure Lid will be subject to handling, consistent with defense-in-depth guidelines for handling heavy loads at nuclear plants, its unique identifier and its bounding weight shall be permanently marked on a readily visible location.

<b>Table 9.I.1: Maintenance Activities for the HI-STORM 100U VVM*</b>			
	<b>Activity</b>	<b>Frequency</b>	<b>Comment</b>
1.	CEC cavity is visually inspected	Prior to MPC installation	To ensure that VVM internal components are properly aligned, the surface preservatives on all exposed surfaces are undamaged, the insulation on the Divider Shell is undamaged and the cavity is free of visible foreign material.
2.	Lid Examination	Prior to MPC installation	Ensure that the preservatives on the external surfaces are in good condition and the lid is free of dents and rust stains.
3.	Screen Inspection	Prior to installation of the flanged screen assembly and monthly when in use	Ensure that the screen is undamaged.
4.	Interfacing SSCs	Annually	Ensure that the top surface pad is free of visible cracks, the interface between the top surface pad and the Container Flange is grouted (or caulked) if necessary, the ISFSI drain system is functional, the ground water system (if used) is in working order, and that subgrade settlement counter measures are implemented. The cathodic protection system is routinely verified as operable in accordance with the Bases in Chapter 12 for guidance on acceptance criteria.
5.	Shielding Effectiveness Test	As required by the Radiation Protection Program	—

\* This table provides maintenance activities for the “100U” VVM that parallel those for HI-STORM overpacks in Table 9.2.1.

<b>Table 9.I.1: Maintenance Activities for the HI-STORM 100U VVM*</b>			
	<b>Activity</b>	<b>Frequency</b>	<b>Comment</b>
6.	ISFSI Settlement	Every five years	Confirm that the VVM settlement is within the range of the Plant's "best estimate". Implement countermeasures if the settlement is determined to be excessive by the CoC holder.
7.	VVM Air Temperature Monitoring System (if used)	Per Licensee's QA Program and manufacturer's recommendations	—
8.	VVM In-Service Inspection	Annually	Ensure that the vent screen assembly fasteners remain coated with preservative, the screen is undamaged, all visible external surfaces are corrosion free, and the air passages are not degraded.
9.	<p>Additional VVM In-Service Inspection for Long-Term Interior and Below-grade Degradation:</p> <p>a) Visual inspection of accessible areas for long-term degradation.</p> <p>b) Additional in-service inspection activities include inspection for foreign material accumulation, corrosion (CEC thinning) and insulation degradation</p> <p>c) Visual and UT inspection for VVMs <u>not</u> employing impressed current cathodic protection</p>	<p>a) Monthly visual inspection of accessible areas.</p> <p>b) Frequencies for additional in-service inspections are determined on a site-specific basis.</p> <p>c) Visual and UT inspection at an interval not to exceed 20 years</p>	<p>Inspection activities shall be commensurate with site-specific conditions. Under site conditions existing at most ISFSI sites, visual inspection of accessible areas is sufficient to determine the general condition of the system.</p> <p>See Subsection 9.I.2.1 and Technical Specifications for more information.</p>

## CHAPTER 10: RADIATION PROTECTION<sup>†</sup>

This chapter discusses the design considerations and operational features that are incorporated in the HI-STORM 100 Storage System design to protect plant personnel and the public from exposure to radioactive contamination and ionizing radiation during canister loading, closure, transfer, and on-site dry storage. Occupational exposure estimates for typical canister loading, closure, transfer operations, and ISFSI inspections are provided. An off-site dose assessment for a typical ISFSI is also discussed. Since the determination of off-site doses is necessarily site-specific, similar dose assessments are to be prepared by the licensee, as part of implementing the HI-STORM 100 Storage System in accordance with 10CFR72.212 [10.0.1]. The information provided in this chapter meets all requirements of NUREG-1536.

### 10.1 ENSURING THAT OCCUPATIONAL RADIATION EXPOSURES ARE AS-LOW-AS-REASONABLY-ACHIEVABLE (ALARA)

#### 10.1.1 Policy Considerations

The HI-STORM 100 has been designed in accordance with 10CFR72 [10.0.1] and maintains radiation exposures ALARA consistent with 10CFR20 [10.1.1] and the guidance provided in Regulatory Guides 8.8 [10.1.2] and 8.10 [10.1.3]. Licensees using the HI-STORM 100 System will utilize and apply their existing site ALARA policies, procedures and practices for ISFSI activities to ensure that personnel exposure requirements of 10CFR20 [10.1.1] are met. Personnel performing ISFSI operations shall be trained on the operation of the HI-STORM 100 System, and be familiarized with the expected dose rates around the MPC, HI-STORM and HI-TRAC during all phases of loading, storage, and unloading operations. Chapter 12 provides dose rate limits at the HI-TRAC and HI-STORM surfaces to ensure that the HI-STORM 100 System is operated within design basis conditions and that ALARA goals will be met. Pre-job ALARA briefings should be held with workers and radiological protection personnel prior to work on or around the system. Worker dose rate monitoring, in conjunction with trained personnel and well-planned activities, will significantly reduce the overall dose received by the workers. When preparing or making changes to site-specific procedures for ISFSI activities, users shall ensure that ALARA practices are implemented and the 10CFR20 [10.1.1] standards for radiation protection are met in accordance with the site's written commitments. Users can further reduce dose rates around the HI-STORM 100 System by preferentially loading longer-cooled and lower-burnup spent fuel assemblies in the periphery fuel storage cells of the MPC, and loading assemblies with shorter cooling times and higher burnups in the inner MPC fuel storage cell locations. Users can also further reduce the dose rates around the HI-TRAC by the use of temporary shielding. In some cases, users may opt to upgrade their existing crane to take advantage of the increased shielding capabilities of the 125-Ton HI-TRAC transfer cask (versus

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<sup>†</sup> This chapter has been prepared in the format and section organization set forth in Regulatory Guide 3.61. However, the material content of this chapter also fulfills the requirements of NUREG 1536. Pagination and numbering of sections, figures, and tables are consistent with the convention set down in Chapter 1, Section 1.0, herein. Finally, all terms-of-art used in this chapter are consistent with the terminology of the glossary (Table 1.0.1) and component nomenclature of the Bill-of-Materials (Section 1.5).

the 100-Ton HI-TRAC transfer cask). This decision should be based on a cost-benefit analysis. Temporary shielding and use of special tools to reduce dose is discussed in Section 10.1.4.

#### 10.1.2 Design Considerations

Consistent with the design criteria defined in Section 2.3.5, the radiological protection criteria that limit exposure to radioactive effluents and direct radiation from an ISFSI using the HI-STORM 100 Storage System are as follows:

1. 10CFR72.104 [10.0.1] requires that for normal operation and anticipated occurrences, the annual dose equivalent to any real individual located beyond the owner-controlled area boundary must not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other critical organ. This dose would be a result of planned discharges, direct radiation from the ISFSI, and any other radiation from uranium fuel cycle operations in the area. The licensee is responsible for demonstrating site-specific compliance with these requirements.
2. 10CFR72.106 [10.0.1] requires that any individual located on or beyond the nearest owner-controlled area boundary may not receive from any design basis accident the more limiting of a total effective dose equivalent of 5 rem, or the sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue (other than the lens of the eye) of 50 rem. The lens dose equivalent shall not exceed 15 rem and the shallow dose equivalent to skin or to any extremity shall not exceed 50 rem. The licensee is responsible for demonstrating site-specific compliance with this requirement.
3. 10CFR20 [10.1.1], Subparts C and D, limit occupational exposure and exposure to individual members of the public. The licensee is responsible for demonstrating site-specific compliance with this requirement.
4. Regulatory Position 2 of Regulatory Guide 8.8 [10.1.2] provides guidance regarding facility and equipment design features. This guidance has been followed in the design of the HI-STORM 100 Storage System as described below:
  - Regulatory Position 2a, regarding access control, is met by locating the ISFSI in a Protected Area in accordance with 10CFR72.212(b)(5)(ii) [10.0.1]. Depending on the site-specific ISFSI design, other equivalent measures may be used. Unauthorized access is prevented once a loaded HI-STORM 100 Storage cask is placed in an ISFSI. Due to the nature of the system, only limited monitoring is required, thus reducing occupational exposure and supporting ALARA considerations. The licensee is responsible for site-specific compliance with these criteria.
  - Regulatory Position 2b, regarding radiation shielding, is met by the storage cask and transfer cask biological shielding that minimizes personnel exposure, as described in Chapter 5 or later in this chapter. Fundamental design considerations that most directly influence occupational exposures with dry storage systems in general and which have been incorporated into the HI-STORM 100 System design include:

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- system designs that reduce or minimize the number of handling and transfer operations for each spent fuel assembly;
- system designs that reduce or minimize the number of handling and transfer operations for each MPC loading;
- system designs that maximize fuel capacity, thereby taking advantage of the self-shielding characteristics of the fuel and the reduction in the number of MPCs that must be loaded and handled;
- system designs that minimize planned maintenance requirements;
- system designs that minimize decontamination requirements at ISFSI decommissioning;
- system designs that optimize the placement of shielding with respect to anticipated worker locations and fuel placement;
- thick walled overpack that provides gamma and neutron shielding;
- thick MPC lid which provides effective shielding for operators during MPC loading and unloading operations;
- multiple welded barriers to confine radionuclides;
- smooth surfaces to reduce decontamination time;
- minimization of potential crud traps on the handling equipment to reduce decontamination requirements;
- capability of maintaining water in the MPC during welding to reduce dose rates;
- capability of maintaining water in the transfer cask annulus space and water jacket to reduce dose rates during closure operations;
- MPC penetrations located and configured to reduce streaming paths;
- HI-STORM and HI-TRAC designed to reduce streaming paths;
- MPC vent and drain ports with resealable caps to prevent the release of radionuclides during loading and unloading operations and facilitate draining, drying, and backfill operations;
- use of a pool lid, annulus seal, and Annulus Overpressure System to prevent contamination of the MPC shell outer surfaces during in-pool activities;
- temporary and auxiliary shielding to reduce dose rates around the HI-TRAC; and
- low-maintenance design to reduce doses during storage operation.

- Regulatory Position 2c, regarding process instrumentation and controls, is met since there are no radioactive systems at an ISFSI.
- Regulatory Position 2d, regarding control of airborne contaminants, is met since the HI-STORM 100 Storage System is designed to withstand all design basis conditions without loss of confinement function, as described in Chapter 7 of this FSAR, and no gaseous releases are anticipated. No significant surface contamination is expected since the exterior of the MPC is kept clean by using clean water in the HI-TRAC transfer cask-MPC annulus and by using an inflatable annulus seal.
- Regulatory Position 2e, regarding crud control, is not applicable to a HI-STORM 100 Storage System ISFSI since there are no radioactive systems at an ISFSI that could transport crud.
- Regulatory Position 2f, regarding decontamination, is met since the exterior of the loaded transfer cask is decontaminated prior to being removed from the plant's fuel building. The exterior surface of the HI-TRAC transfer cask is designed for ease of decontamination. In addition, an inflatable annulus seal is used to prevent fuel pool water from contacting and contaminating the exterior surface of the MPC.
- Regulatory Position 2g, regarding monitoring of airborne radioactivity, is met since the MPC provides confinement for all design basis conditions. There is no need for monitoring since no airborne radioactivity is anticipated to be released from the casks at an ISFSI.
- Regulatory Position 2h, regarding resin treatment systems, is not applicable to an ISFSI since there are no treatment systems containing radioactive resins.
- Regulatory Position 2i, regarding other miscellaneous ALARA items, is met since stainless steel is used in the MPC shell, the primary confinement boundary. This material is resistant to the damaging effects of radiation and is well proven in the SNF cask service. Use of this material quantitatively reduces or eliminates the need to perform maintenance (or replacement) on the primary confinement system.

### 10.1.3 Operational Considerations

Operational considerations that most directly influence occupational exposures with dry storage systems in general and that have been incorporated into the design of the HI-STORM 100 System include:

- totally-passive design requiring minimal maintenance and monitoring (other than security monitoring) during storage;

- remotely operated welding system, lift yoke, transfer slide or mating device and moisture removal systems to reduce time operators spend in the vicinity of the loaded MPC;
- maintaining water in the MPC and the annulus region during MPC closure activities to reduce dose rates;
- low fuel assembly lift-over height of the HI-TRAC maximizes water coverage over assemblies during fuel assembly loading;
- a water-filled neutron shield jacket allows filling after removal of the HI-TRAC from the spent fuel pool. This maximizes the shielding on the HI-TRAC without exceeding the crane capacity;
- descriptive operating procedures that provide guidance to reduce equipment contamination, obtain survey information, minimize dose and alert workers to possible changing radiological conditions;
- preparation and inspection of the HI-STORM and HI-TRAC in low-dose areas;
- MPC lid fit tests and inspections prior to actual loading to ensure smooth operation during loading;
- gas sampling of the MPC and HI-STAR 100 annulus (receiving from transport) to assess the condition of the cladding and MPC confinement boundary;
- HI-STORM vent temperature elements (See Chapter 12) allow remote monitoring of the vent operability surveillance;
- wetting of component surfaces prior to placement in the spent fuel pool to reduce the need for decontamination;
- decontamination practices which consider the effects of weeping during HI-TRAC transfer cask heat up and surveying of HI-TRAC prior to removal from the fuel handling building;
- a sequence of operations based on ALARA considerations; and
- use of mock-ups and dry run training to prepare personnel for actual work situations.

#### 10.1.4 Auxiliary/Temporary Shielding

To minimize occupational dose during loading and unloading operations, a specially-designed set of auxiliary shielding is available. The HI-STORM 100 auxiliary shielding consists of the Automated Welding System Baseplate, the HI-TRAC Temporary Shield Ring, the annulus shield, HI-STORM vent shield insert, the HI-TRAC transfer step or mating device, and the shield panel trim plates. Additional supplemental shielding such as lead blankets and bricks or other such shielding may also be used to help reduce dose rates. Each auxiliary shield is described in Table 10.1.1, shown on Figure 10.1.1 and the procedures for utilization are provided in Chapter 8. Other embodiments of the temporary shielding may also be used. Table 10.1.2

provides the minimum requirements for use of the temporary shielding indicating optional and required shielding. Users shall evaluate the need for auxiliary and temporary shielding and use of special tooling to reduce the overall exposure based on an ALARA review of cask loading operations and the MPC contents.

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Table 10.1.1  
HI-STORM 100 AUXILIARY AND TEMPORARY SHIELDS

Temporary Shield	Description	Utilization
Automated Welding System Baseplate	Thick gamma and neutron shield circular plate that sits on the MPC lid. Plate is set directly on the MPC. Threaded lift holes are provided to assist in rigging.	Used during MPC closure and unloading operations in the cask preparation area to reduce the dose rates around the MPC lid. The design of the closure ring allows the baseplate shield to remain in place during the entire closure operation.
HI-TRAC Temporary Shield Ring	A water-filled tank that is placed atop of the HI-STAR or HI-TRAC neutron shield.	Used during MPC and HI-TRAC closure operations and MPC transfers into HI-STAR to reduce dose rates to the operators around the top flange of the HI-TRAC.
Annulus Shield	A shield that is seated between the MPC shell and the HI-TRAC.	Used during MPC closure operations to reduce streaming from the annulus.
HI-TRAC Transfer Step	A stepped block used to position the pool lid and transfer lid at the same elevation. The transfer step creates a tight seam between the two lids to eliminate streaming during bottom lid replacement.	Used during HI-TRAC 100 or 125 bottom lid replacement.
HI-TRAC Mating Device	Device used to remove HI-TRAC pool lid and to provide shielding during MPC transfer to HI-STORM..	Used during MPC transfer to the HI-STORM when used with HI-TRAC 100D or 125D
Shield Panel Trim Plates	Four steel plates approximately 0.25 inch by 3 inch by 80 inch that are placed at the ends of the transfer lid top and bottom plate and secured by clamps or other method deemed suitable by the user.	Used during MPC transfer to and from HI-TRAC to shield the small gap above and below the sliding doors on the transfer lid.
HI-STORM Vent Shield Inserts	Devices shaped to fit into the HI-STORM exit vents.	Used during MPC transfer to and from HI-STORM to eliminate the streaming path from the exit vents during MPC transfer operations.

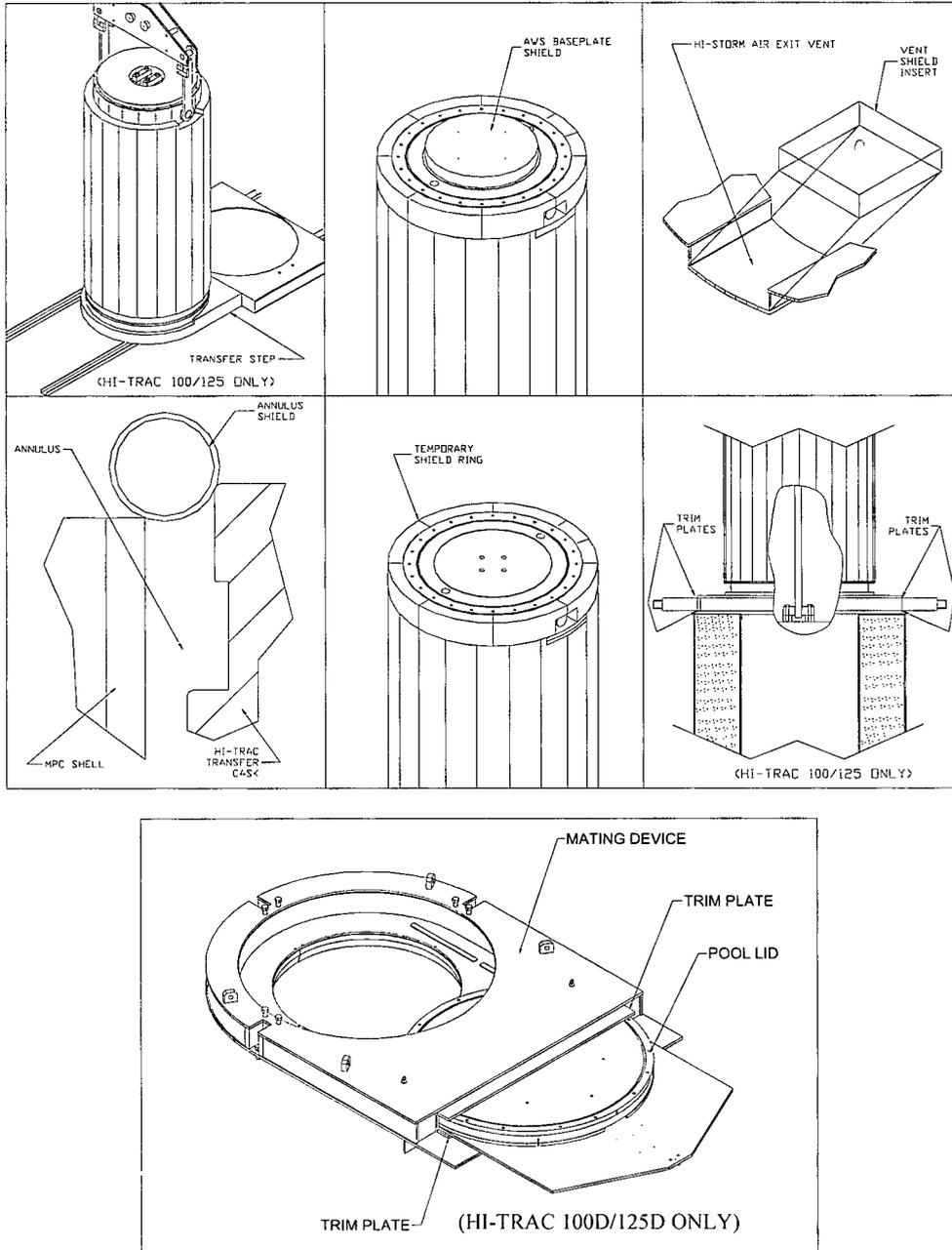
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Table 10.1.2  
 HI-STORM 100 AUXILIARY AND TEMPORARY SHIELD REQUIREMENTS

<b>Auxiliary Shielding</b>	<b>Required for the 100-Ton HI-TRAC and HI-TRAC 100D</b>	<b>Required for the 125-ton HI-TRAC and HI-TRAC 125D</b>
<b>Temporary Shield Ring</b>	Note 1	Note 1
<b>Automated Welding System Baseplate Shield</b>	No	No
<b>Annulus Shield</b>	Note 1	Note 1
<b>Vent Duct Shield Inserts</b>	Note 2	Note 2
<b>Transfer Step</b>	Yes (Note 3)	Yes (Note 3)
<b>Trim Plates</b>	No	No
<b>Mating Device</b>	Yes (Note 4)	Yes (Note 4)

Notes:

1. Users shall determine the need for this temporary shielding based on the specific operations and the MPC contents.
2. Not required for the HI-STORM 100S Overpack.
3. Not used with the HI-TRAC 100D or 125D.
4. Used only with HI-TRAC 100D or 125D



**Figure 10.1.1; HI-STORM 100 System Auxiliary/Temporary Shielding**

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## 10.2 RADIATION PROTECTION DESIGN FEATURES

The development of the HI-STORM 100 System has focused on design provisions to address the considerations summarized in Sections 10.1.2 and 10.1.3. The intent has been to improve on past concrete-based dry storage system designs by developing HI-STORM 100 as a hybrid of current metal and concrete storage system technologies. The design is, therefore, an evolution in storage systems, which incorporates preferred features from concrete storage, canister-based systems while retaining several of the advantages of metal casks as well. This approach results in a reduction in the need for maintenance, in overall radiation levels, and in the time spent on maintenance, when compared with current concrete-based dry storage systems. The following specific design features ensure a high degree of confinement integrity and radiation protection:

- HI-STORM 100 has been designed to meet storage condition dose rates required by 10CFR72 [10.0.1] for three-year cooled fuel;
- HI-STORM 100 has been designed to accommodate a maximum number of PWR or BWR fuel assemblies to minimize the number of cask systems that must be handled and stored at the storage facility and later transported off-site;
- HI-STORM 100 overpack structure is virtually maintenance free, especially over the years following its initial loading, because of the outer metal shell. The metal shell and its protective coating provide a high level of resistance to corrosion and other forms of degradation (e.g., erosion);
- HI-STORM 100 has been designed for redundant, multi-pass welded closures on the MPC; consequently, no monitoring of the confinement boundary is necessary and no gaseous or particulate releases occur for normal, off-normal or credible accident conditions;
- HI-TRAC transfer cask utilizes a mating device or transfer step and other auxiliary shielding devices which reduce streaming paths and simplify operations;
- The pool lid maximizes available fuel assembly water coverage in the spent fuel pool.
- The transfer lid and mating device are designed for quick alignment with HI-STORM; and
- HI-STORM 100 has been designed to allow close positioning (pitch) on the ISFSI storage pad, thereby increasing the ISFSI self-shielding by decreasing the view factors and reducing exposures to on-site and off-site personnel.

### 10.3 ESTIMATED ON-SITE COLLECTIVE DOSE ASSESSMENT

This section provides the estimates of the cumulative exposure to personnel performing loading, unloading and transfer operations using the HI-STORM system. This section uses the shielding analysis provided in Chapter 5 and the operations procedures provided in Chapter 8 to develop a dose assessment. The dose assessment is provided in Tables 10.3.1, 10.3.2, and 10.3.3.

The dose rates from the HI-STORM 100 overpack, MPC lid, HI-TRAC transfer cask, and HI-STAR 100 overpack are calculated to determine the dose to personnel during the various loading and unloading operations. The dose rates are also calculated for the various conditions of the cask that may affect the dose rates to the operators (e.g., MPC water level, HI-TRAC annulus water level, neutron shield water level, presence of temporary shielding). The dose rates around the 100-Ton HI-TRAC transfer cask are based on 24 PWR fuel assemblies with a burnup of 60,000 MWD/MTU and cooling of 3 years including BPRAs. The dose rates around the 125-Ton HI-TRAC transfer cask are based on 24 PWR fuel assemblies with a burnup of 75,000 MWD/MTU and cooling of 5 years including BPRAs. The dose rates around the HI-STORM 100 overpack are based on 24 PWR fuel assemblies with a burnup of 60,000 MWD/MTU and cooling of 3 years. The selection of these fuel assembly types in all fuel cell locations bound all possible PWR and BWR loading scenarios for the HI-STORM System from a dose-rate perspective. The HI-STORM dose rates used in this chapter were calculated for the HI-STORM 100 S Version B. No assessment is made with respect to background radiation since background radiation can vary significantly by site. In addition, exposures are based on work being performed with the temporary shielding described in Table 10.1.2.

The choice of burnup and cooling times used in this chapter is extremely conservative. The bounding burnup and cooling time that resulted in the highest dose rates around the 100-ton, 125-ton HI-TRACs, and HI-STORM 100S Version B were used. In addition, including the source term from BPRAs increases the level of conservatism. The maximum dose rate due to BPRAs was used in this analysis. As stated in Chapter 5, using the maximum source for the BPRAs in conjunction with the bounding burnup and cooling time for fuel assemblies is very conservative as it is not expected that burnup and cooling times of the BPRAs and fuel assemblies would be such that they are both at the maximum design basis values. This combined with the already conservative dose rates for the HI-TRACs and HI-STORMs results in an upper bound estimate of the occupational exposure. Users' radiation protection programs will assure appropriate temporary shielding is used based on actual fuel to be loaded and resulting dose rates in the field.

For each step in Tables 10.3.1 through 10.3.3, the operator work location is identified. These correspond to the locations identified in Figure 10.3.1. The relative locations refer to all HI-STORM Overpacks. The dose rate location points around the transfer cask and overpack were selected to model actual worker locations and cask conditions during the operation. Cask operators typically work at an arms-reach distance from the cask. To account for this, an 18-inch

distance was used to estimate the dose rate for the worker. This assessment addresses only the operators that perform work on or immediately adjacent to the cask.

Justification for the duration of operations along with the corresponding procedure Sections from Chapter 8 are also provided in the tables. The assumptions used in developing time durations are based on mockups of the MPC, review of design drawings, walk-downs using other equipment to represent the HI-TRAC transfer cask and HI-STORM 100 overpack the HI-STAR 100 overpack and MPC-68 prototype, consultation with UST&D (weld examination) and consultation with cask operations personnel from Calvert Cliffs Nuclear Power Plant (for items such as lid installation and decontamination). In addition, for the shielding calculations, only the Temporary Shield Ring was assumed to be in place for applicable portions of the operations.

Tables 10.3.1a, 10.3.1b, and 10.3.1c provide a summary of the dose assessment for a HI-STORM 100 System loading operation using the 125-ton HI-TRAC, the 100-ton HI-TRAC, and the HI-TRAC 125D respectively. Tables 10.3.2a, 2b, and 2c provide a summary of the dose assessment for HI-STORM 100 System unloading operations using the 125-ton HI-TRAC, the 100-ton HI-TRAC, and HI-TRAC 125D respectively. Tables 10.3.3a, 3b, and 3c provide a summary of the dose assessment for transferring the MPC to a HI-STAR 100 overpack as described in Section 8.5 of the operating procedures using the 125-ton HI-TRAC, the 100-ton HI-TRAC, and 125-ton HI-TRAC 125D, respectively. The HI-TRAC 100D was not specifically analyzed since, as stated in Section 5.4, the dose rates from the HI-TRAC 100 and 100D are similar at 1 meter from the overpack. In addition, the results for the HI-TRAC 125 and 125D indicate that there is only a small difference in the occupational exposure from using a mating device (HI-TRAC 125D) rather than transfer doors. Therefore, the use of the mating device in the HI-TRAC 100D does not result in occupational exposures significantly different than those presented for the 100-ton HI-TRAC.

#### 10.3.1 Estimated Exposures for Loading and Unloading Operations

The assumptions used to estimate personnel exposures are conservative by design. The main factors attributed to actual personnel exposures are the age and burnup of the spent fuel assemblies and good ALARA practices. To estimate the dose received by a single worker, it should be understood that a canister-based system requires a diverse range of disciplines to perform all the necessary functions. The high visibility and often critical path nature of fuel movement activities have prompted utilities to load canister systems in a round-the-clock mode in most cases. This results in the exposure being spread out over several shifts of operators and technicians with no single shift receiving a majority of the exposure.

The total person-rem exposure from operation of the HI-STORM 100 System is proportional to the number of systems loaded. A typical utility will load approximately four MPCs per reactor cycle to maintain the current available spent fuel pool capacity. Utilities requiring dry storage of spent fuel assemblies typically have a large inventory of spent fuel assemblies that date back to the reactor's first cycle. The older fuel assemblies will have a significantly lower dose rate than the design basis fuel assemblies due to the extended cooling time (i.e., much greater than the

values used to compute the dose rates). Users shall assess the cask loading for their particular fuel types (burnup, cooling time) to satisfy the requirements of 10CFR20 [10.1.1].

For licensees using the 100-Ton HI-TRAC transfer cask, design basis dose rates will be higher (than a corresponding 125-Ton HI-TRAC) due to the decreased mass of shielding. Due to the higher expected dose rates from the 100-Ton HI-TRAC, users may need to use the auxiliary shielding (See Table 10.1.2), and should consider preferential loading, and increased precautions (e.g., additional temporary or auxiliary shielding, remotely operated equipment, additional contamination prevention measures). Actual use of optional dose reduction measures must be decided by each user based on the fuel to be loaded.

### 10.3.2 Estimated Exposures for Surveillance and Maintenance

Table 10.3.4 provides an estimate of the occupational exposure required for security surveillance and maintenance of an ISFSI. Security surveillance time is based on a daily security patrol around the perimeter of the ISFSI security fence. Users may opt to utilize electronic temperature monitoring of the HI-STORM modules or remote viewing methods instead of performing direct visual observation of the modules. Since security surveillances can be performed from outside the ISFSI, and since the ISFSI fence is typically positioned such that the area outside the fence is not a radiation area, a dose rate of 3 mrem/hour is estimated. Although the HI-STORM 100 System requires only minimal maintenance during storage (e.g. touch-up paint), maintenance will be required around the ISFSI for items such as security equipment maintenance, grass cutting, snow removal, vent system surveillance, drainage system maintenance, and lighting, telephone, and intercom repair. Since most of the maintenance is expected to occur outside the actual cask array, a dose rate of 10 mrem/hour is estimated

**Table 10.3.1a**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
<b>Section 8.1.4</b>							
LOAD PRE-SELECTED FUEL ASSEMBLIES INTO MPC	1020	1	2	1	17.0	34.0	15 MINUTES PER ASSEMBLY/68 ASSY
PERFORM POST-LOADING VISUAL VERIFICATION OF ASSEMBLY IDENTIFICATION	68	1	2	1	1.1	2.3	1 MINUTES PER ASSY/68 ASSY
<b>Section 8.1.5</b>							
INSTALL MPC LID AND ATTACH LIFT YOKE	45	2	2	2.0	1.5	3.0	CONSULTATION WITH CALVERT CLIFFS
RAISE HI-TRAC TO SURFACE OF SPENT FUEL POOL	20	2	2	2.0	0.7	1.3	40 FEET @ 2 FT/MINUTE (CRANE SPEED)
SURVEY MPC LID FOR HOT PARTICLES	3	3A	1	31.1	1.6	1.6	TELESCOPING DETECTOR USED
VERIFY MPC LID IS SEATED	0.5	3A	1	31.1	0.3	0.3	VISUAL VERIFICATION FROM 3 METERS
INSTALL LID RETENTION SYSTEM BOLTS	6	3B	2	46.4	4.6	9.3	24 BOLTS @ 2/PERSON-MINUTE
REMOVE HI-TRAC FROM SPENT FUEL POOL	8.5	3C	1	117.8	16.7	16.7	17 FEET @ 2 FT/MIN (CRANE SPEED)
DECONTAMINATE HI-TRAC BOTTOM	10	3D	1	142.0	23.7	23.7	LONG HANDLED TOOLS, PRELIMINARY DECON
TAKE SMEARS OF HI-TRAC EXTERIOR SURFACES	5	5B	1	185.3	15.4	15.4	50 SMEARS @ 10 SMEARS/MINUTE
DISCONNECT ANNULUS OVERPRESSURE SYSTEM	0.5	5C	1	82.7	0.7	0.7	QUICK DISCONNECT COUPLING
SET HI-TRAC IN CASK PREPARATION AREA	10	4A	1	46.4	7.7	7.7	100 FT @ 10 FT/MIN (CRANE SPEED)
REMOVE NEUTRON SHIELD JACKET FILL PLUG	2	4A	1	46.4	1.5	1.5	SINGLE PLUG, NO SPECIAL TOOLS
INSTALL NEUTRON SHIELD JACKET FILL PLUG	2	5B	1	185.3	6.2	6.2	SINGLE PLUG, NO SPECIAL TOOLS
DISCONNECT LID RETENTION SYSTEM	6	5A	2	37.3	3.7	7.5	24 BOLTS @ 2 BOLT/PERSON MINUTES
MEASURE DOSE RATES AT MPC LID	3	5A	1	37.3	1.9	1.9	TELESCOPING DETECTOR USED

<sup>†</sup> See notes at bottom of Table 10.3.4.

**Table 10.3.1a**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
DECONTAMINATE AND SURVEY HI-TRAC	103	5B	1	185.3	318.1	318.1	490 SQ-FT@5 SQ-FT/PERSON-MINUTE+50 SMEARS@10 SMEARS/MINUTE
INSTALL TEMPORARY SHIELD	16	6A	2	18.7	5.0	10.0	8 SEGMENTS @ 1 SEGMENT/PERSON MIN
FILL TEMPORARY SHIELD RING	25	6A	1	18.7	7.8	7.8	230 GAL @10GPM, LONG HANDLED SPRAY WAND
ATTACH DRAIN LINE TO HI-TRAC DRAIN PORT	0.5	5C	1	82.7	0.7	0.7	QUICK DISCONNECT COUPLING
INSTALL RVOAs	2	6A	1	18.7	0.6	0.6	SINGLE THREADED CONNECTION X 2 RVOAs
ATTACH WATER PUMP TO DRAIN PORT	2	6A	1	18.7	0.6	0.6	POSITION PUMP SELF PRIMING
DISCONNECT WATER PUMP	5	6A	1	18.7	1.6	1.6	DRAIN HOSES MOVE PUMP
DECONTAMINATE MPC LID TOP SURFACE AND SHELL AREA ABOVE INFLATABLE ANNULUS SEAL	6	6A	1	18.7	1.9	1.9	30 SQ-FT @5 SQ-FT/MINUTE+10 SMEARS@10 SMEARS/MINUTE
REMOVE INFLATABLE ANNULUS SEAL	3	6A	1	18.7	0.9	0.9	SEAL PULLS OUT DIRECTLY
SURVEY MPC LID TOP SURFACES AND ACCESSIBLE AREAS OF TOP THREE INCHES OF MPC SHELL	1	6A	1	18.7	0.3	0.3	10 SMEARS@10 SMEARS/MINUTE
INSTALL ANNULUS SHIELD	2	6A	1	18.7	0.6	0.6	SHIELD PLACED BY HAND
CENTER LID IN MPC SHELL	20	6A	3	18.7	6.2	18.7	CONSULTATION WITH CALVERT CLIFFS
INSTALL MPC LID SHIMS	12	6A	2	18.7	3.7	7.5	MEASURED DURING WELD MOCKUP TESTING
POSITION AWS BASEPLATE SHIELD ON MPC LID	20	7A	2	18.7	6.2	12.5	ALIGN AND REMOVE 4 SHACKLES
INSTALL AUTOMATED WELDING SYSTEM ROBOT	8	7A	2	18.7	2.5	5.0	ALIGN AND REMOVE 4 SHACKLES/4 QUICK CONNECTS@1/MIN
PERFORM NDE ON LID WELD	230	7A	1	18.7	71.7	71.7	MEASURED DURING WELD MOCKUP TESTING
ATTACH DRAIN LINE TO VENT PORT	1	7A	1	18.7	0.3	0.3	1" THREADED FITTING NO TOOLS
VISUALLY EXAMINE MPC LID-TO-SHELL WELD FOR LEAKAGE OF WATER	10	7A	1	18.7	3.1	3.1	10 MIN TEST DURATION
DISCONNECT WATER FILL LINE AND DRAIN LINE	2	7A	1	18.7	0.6	0.6	1" THREADED FITTING NO TOOLS X 2

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**Table 10.3.1a**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
REPEAT LIQUID PENETRANT EXAMINATION ON MPC LID FINAL PASS	45	7A	1	18.7	14.0	14.0	5 MIN TO APPLY, 7 MIN TO WIPE, 5 APPLY DEV, INSP (24 IN/MIN)
ATTACH GAS SUPPLY TO VENT PORT	1	7A	1	18.7	0.3	0.3	1" THREADED FITTING NO TOOLS
ATTACH DRAIN LINE TO DRAIN PORT	1	7A	1	18.7	0.3	0.3	1" THREADED FITTING NO TOOLS
Deleted							
Deleted							SIMPLE ATTACHMENT NO TOOLS
ATTACH DRAIN LINE TO VENT PORT	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
ATTACH WATER FILL LINE TO DRAIN PORT	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
DISCONNECT WATER FILL DRAIN LINES FROM MPC	2	8A	1	37.9	1.3	1.3	1" THREADED FITTING NO TOOLS X 2
ATTACH HELIUM SUPPLY TO VENT PORT	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
ATTACH DRAIN LINE TO DRAIN PORT	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
DISCONNECT GAS SUPPLY LINE FROM MPC	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
DISCONNECT DRAIN LINE FROM MPC	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
ATTACH MOISTURE REMOVAL SYSTEM TO VENT AND DRAIN PORT RVOAs	2	8A	1	37.9	1.3	1.3	1" THREADED FITTING NO TOOLS
DISCONNECT MOISTURE REMOVAL SYSTEM FROM MPC	2	8A	1	37.9	1.3	1.3	1" THREADED FITTING NO TOOLS X 2
CLOSE DRAIN PORT RVOA CAP AND REMOVE DRAIN PORT RVOA	1.5	8A	1	37.9	0.9	0.9	SINGLE THREADED CONNECTION (1 RVOA)
ATTACH HELIUM BACKFILL SYSTEM TO VENT PORT	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
DISCONNECT HBS FROM MPC	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
CLOSE VENT PORT RVOA AND DISCONNECT VENT PORT RVOA	1.5	8A	1	37.9	0.9	0.9	SINGLE THREADED CONNECTION (1 RVOA)
WIPE INSIDE AREA OF VENT AND DRAIN PORT RECESSES	2	8A	1	37.9	1.3	1.3	2 PORTS, 1 MIN/PORT
PLACE COVER PLATE OVER VENT PORT RECESS	1	8A	1	37.9	0.6	0.6	INSTALLED BY HAND NO TOOLS (2/MIN)
PERFORM NDE ON VENT AND DRAIN COVER PLATE WELD	100	8A	1	37.9	63.2	63.2	MEASURED DURING WELD MOCKUP TESTING

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**Table 10.3.1a**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
FLUSH CAVITY WITH HELIUM AND INSTALL SET SCREWS	2	8A	1	37.9	1.3	1.3	4 SET SCREWS @2/MINUTE
PLUG WELD OVER SET SCREWS	8	8A	1	37.9	5.1	5.1	FOUR SINGLE SPOT WELDS @ 1 PER 2 MINTES
INSTALL MSLD OVER VENT PORT COVER PLATE	2	8A	1	37.9	1.3	1.3	INSTALLED BY HAND, NO TOOLS
INSTALL MSLD OVER DRAIN PORT COVER PLATE	2	8A	1	37.9	1.3	1.3	INSTALLED BY HAND, NO TOOLS
INSTALL AND ALIGN CLOSURE RING	5	8A	1	37.9	3.2	3.2	INSTALLED BY HAND NO TOOLS
PERFORM NDE ON CLOSURE RING WELDS	185	8A	1	37.9	116.9	116.9	MEASURED DURING WELD MOCKUP TESTING
RIG AWS TO CRANE	12	8A	1	37.9	7.6	7.6	10 MIN TO DISCONNECT LINES, 4 SHACKLES@2/MIN
<b>Section 8.1.6</b>							
REMOVE ANNULUS SHIELD	1	8A	1	37.9	0.6	0.6	SHIELD PLACED BY HAND
ATTACH DRAIN LINE TO HI-TRAC	1	9D	1	354.2	5.9	5.9	1" THREADED FITTING NO TOOLS
POSITION HI-TRAC TOP LID	10	9B	2	37.9	6.3	12.6	VERTICAL FLANGED CONNECTION
TORQUE TOP LID BOLTS	12	9B	1	37.9	7.6	7.6	24 BOLTS AT 2/MIN (INSTALL AND TORQUE, 1 PASS)
INSTALL MPC LIFT CLEATS AND MPC SLINGS	25	9A	2	158.5	66.0	132.1	INSTALL CLEATS AND HYDRO TORQUE 4 BOLTS
REMOVE TEMPORARY SHIELD RING DRAIN PLUGS	1	9B	1	37.9	0.6	0.6	8 PLUGS @ 8/MIN
REMOVE TEMPORARY SHIELD RING SEGMENTS	4	9A	1	158.5	10.6	10.6	REMOVED BY HAND NO TOOLS (8 SEGS@2/MIN)
ATTACH MPC SLINGS TO LIFT YOKE	4	9A	2	158.5	10.6	21.1	INSTALLED BY HAND NO TOOLS
POSITION HI-TRAC ABOVE TRANSFER STEP	15	9C	1	117.8	29.5	29.5	100 FT @ 10 FT/MIN (CRANE SPEED)+ 5MIN TO ALIGN
REMOVE BOTTOM LID BOLTS	6	10A	1	354.2	35.4	35.4	36 BOLTS@6 BOLTS/MIN IMPACT TOOLS USED
INSTALL TRANSFER LID BOLTS	18	11B	1	354.2	106.3	106.3	36 BOLTS @ 2/MIN IMPACT TOOLS USED 1 PASS
DISCONNECT MPC SLINGS	4	9A	2	158.5	10.6	21.1	INSTALLED BY HAND NO TOOLS
<b>Section 8.1.7</b>							
POSITION HI-TRAC ON TRANSPORT DEVICE	20	11A	2	117.8	39.3	78.5	ALIGN TRUNNIONS, DISCONNECT LIFT YOKE
TRANSPORT HI-TRAC TO OUTSIDE TRANSFER LOCATION	90	12A	3	26.4	39.6	118.8	DRIVER AND 2 SPOTTERS

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**Table 10.3.1a**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
ATTACH OUTSIDE LIFTING DEVICE LIFT LINKS	2	12A	2	26.4	0.9	1.8	2 LINKS@1/MIN
MATE OVERPACKS	10	13B	2	118.5	19.8	39.5	ALIGNMENT GUIDES USED
ATTACH MPC SLINGS TO MPC LIFT CLEATS	10	13A	2	158.5	26.4	52.8	2 SLINGS@5MIN/SLING NO TOOLS
REMOVE TRANSFER LID DOOR LOCKING PINS AND OPEN DOORS	4	13B	2	118.5	7.9	15.8	2 PINS@2MIN/PIN
INSTALL TRIM PLATES	4	13B	2	118.5	7.9	15.8	INSTALLED BY HAND
DISCONNECT SLINGS FROM MPC LIFTING DEVICE	10	13A	2	158.5	26.4	52.8	2 SLINGS@5MIN/SLING
REMOVE MPC LIFT CLEATS AND MPC SLINGS	10	14A	1	487.4	81.2	81.2	4 BOLTS,NO TORQUING
INSTALL HOLE PLUGS IN EMPTY MPC BOLT HOLES	2	14A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING
REMOVE HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	43.9	1.5	1.5	4 SHACKLES@2/MIN
REMOVE ALIGNMENT DEVICE	4	15A	1	43.9	2.9	2.9	REMOVED BY HAND NO TOOLS (4 PCS@1/MIN)
INSTALL HI-STORM LID AND INSTALL LID STUDS/NUTS	25	16A	2	11.7	4.9	9.8	INSTALL LID AND HYDRO TORQUE 4 BOLTS
INSTALL HI-STORM EXIT VENT GAMMA SHIELD CROSS PLATES	4	16B	1	205.5	13.7	13.7	4 PCS @ 1/MIN INSTALL BY HAND NO TOOLS
INSTALL TEMPERATURE ELEMENTS	20	16B	1	205.5	68.5	68.5	4@5MIN/TEMPERATURE ELEMENT
INSTALL EXIT VENT SCREENS	20	16B	1	205.5	68.5	68.5	4 SCREENS@5MIN/SCREEN
REMOVE HI-STORM LID LIFTING DEVICE	2	16A	1	11.7	0.4	0.4	4 SHACKLES@2/MIN
INSTALL HOLE PLUGS IN EMPTY HOLES	2	16A	1	11.7	0.4	0.4	4 PLUGS AT 2/MIN NO TORQUING
PERFORM SHIELDING EFFECTIVENESS TESTING	16	16D	2	122.7	32.7	65.4	16 POINTS@1 MIN
SECURE HI-STORM TO TRANSPORT DEVICE	10	16A	2	11.7	2.0	3.9	ASSUMES AIR PAD
TRANSFER HI-STORM TO ITS DESIGNATED STORAGE LOCATION	40	16C	1	69.7	46.5	46.5	200 FEET @ 4FT/MIN
INSERT HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
REMOVE AIR PAD	5	16D	2	122.7	10.2	20.5	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
INSTALL INLET VENT SCREENS/CROSS PLATES	20	16D	1	122.7	40.9	40.9	4 SCREENS@5MIN/SCREEN

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**Table 10.3.1a**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
PERFORM AIR TEMPERATURE RISE TEST	8	16B	1	205.5	27.4	27.4	8 MEASUREMENTS@1/MIN
<b>TOTAL</b>						<b>2063.1 PERSON-MREM</b>	

**Table 10.3.1b**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (60,000 MWD/MTU, 3-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
<b>Section 8.1.4</b>							
LOAD PRE-SELECTED FUEL ASSEMBLIES INTO MPC	1020	1	2	3	51.0	102.0	15 MINUTES PER ASSEMBLY/68 ASSY
PERFORM POST-LOADING VISUAL VERIFICATION OF ASSEMBLY IDENTIFICATION	68	1	2	3	3.4	6.8	1 MINUTES PER ASSY/68 ASSY
<b>Section 8.1.5</b>							
INSTALL MPC LID AND ATTACH LIFT YOKE	45	2	2	3	2.3	4.5	CONSULTATION WITH CALVERT CLIFFS
RAISE HI-TRAC TO SURFACE OF SPENT FUEL POOL	20	2	2	3	1.0	2.0	40 FEET @ 2 FT/MINUTE (CRANE SPEED)
SURVEY MPC LID FOR HOT PARTICLES	3	3A	1	37.6	1.9	1.9	TELESCOPING DETECTOR USED
VERIFY MPC LID IS SEATED	0.5	3A	1	37.6	0.3	0.3	VISUAL VERIFICATION FROM 3 METERS
INSTALL LID RETENTION SYSTEM BOLTS	6	3B	2	90.3	9.0	18.1	24 BOLTS @ 2/PERSON-MINUTE
REMOVE HI-TRAC FROM SPENT FUEL POOL	8.5	3C	1	837.0	118.6	118.6	17 FEET @ 2 FT/MIN (CRANE SPEED)
DECONTAMINATE HI-TRAC BOTTOM	10	3D	1	554.8	92.5	92.5	LONG HANDLED TOOLS, PRELIMINARY DECON
TAKE SMEARS OF HI-TRAC EXTERIOR SURFACES	5	5B	1	1091.9	91.0	91.0	50 SMEARS @ 10 SMEARS/MINUTE
DISCONNECT ANNULUS OVERPRESSURE SYSTEM	0.5	5C	1	282.1	2.4	2.4	QUICK DISCONNECT COUPLING
SET HI-TRAC IN CASK PREPARATION AREA	10	4A	1	90.3	15.1	15.1	100 FT @ 10 FT/MIN (CRANE SPEED)
REMOVE NEUTRON SHIELD JACKET FILL PLUG	2	4A	1	90.3	3.0	3.0	SINGLE PLUG, NO SPECIAL TOOLS
INSTALL NEUTRON SHIELD JACKET FILL PLUG	2	5B	1	1091.9	36.4	36.4	SINGLE PLUG, NO SPECIAL TOOLS
DISCONNECT LID RETENTION SYSTEM	6	5A	2	69.8	7.0	14.0	24 BOLTS @ 2 BOLT/PERSON MINUTES

<sup>†</sup> See notes at bottom of Table 10.3.4.

**Table 10.3.1b**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (60,000 MWD/MTU, 3-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
MEASURE DOSE RATES AT MPC LID	3	5A	1	69.8	3.5	3.5	TELESCOPING DETECTOR USED
DECONTAMINATE AND SURVEY HI-TRAC	103	5B	1	1091.9	1874.4	1874.4	490 SQ-FT@5 SQ-FT/PERSON-MINUTE+50 SMEARS@10 SMEARS/MINUTE
INSTALL TEMPORARY SHIELD	16	6A	2	34.2	9.1	18.2	8 SEGMENTS @ 1 SEGMENT/PERSON MIN
FILL TEMPORARY SHIELD RING	25	6A	1	34.2	14.3	14.3	230 GAL @10GPM, LONG HANDLED SPRAY WAND
ATTACH DRAIN LINE TO HI-TRAC DRAIN PORT	0.5	5C	1	282.1	2.4	2.4	QUICK DISCONNECT COUPLING
INSTALL RVOAs	2	6A	1	34.2	1.1	1.1	SINGLE THREADED CONNECTION X 2 RVOAs
ATTACH WATER PUMP TO DRAIN PORT	2	6A	1	34.2	1.1	1.1	POSITION PUMP SELF PRIMING
DISCONNECT WATER PUMP	5	6A	1	34.2	2.9	2.9	DRAIN HOSES MOVE PUMP
DECONTAMINATE MPC LID TOP SURFACE AND SHELL AREA ABOVE INFLATABLE ANNULUS SEAL	6	6A	1	34.2	3.4	3.4	30 SQ-FT @5 SQ-FT/MINUTE+10 SMEARS@10 SMEARS/MINUTE
REMOVE INFLATABLE ANNULUS SEAL	3	6A	1	34.2	1.7	1.7	SEAL PULLS OUT DIRECTLY
SURVEY MPC LID TOP SURFACES AND ACCESSIBLE AREAS OF TOP THREE INCHES OF MPC SHELL	1	6A	1	34.2	0.6	0.6	10 SMEARS@10 SMEARS/MINUTE
INSTALL ANNULUS SHIELD	2	6A	1	34.2	1.1	1.1	SHIELD PLACED BY HAND
CENTER LID IN MPC SHELL	20	6A	3	34.2	11.4	34.2	CONSULTATION WITH CALVERT CLIFFS
INSTALL MPC LID SHIMS	12	6A	2	34.2	6.8	13.7	MEASURED DURING WELD MOCKUP TESTING
POSITION AWS BASEPLATE SHIELD ON MPC LID	20	7A	2	34.2	11.4	22.8	ALIGN AND REMOVE 4 SHACKLES
INSTALL AUTOMATED WELDING SYSTEM ROBOT	8	7A	2	34.2	4.6	9.1	ALIGN AND REMOVE 4 SHACKLES/4 QUICK CONNECTS@1/MIN
PERFORM NDE ON LID WELD	230	7A	1	34.2	131.1	131.1	MEASURED DURING WELD MOCKUP TESTING

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**Table 10.3.1b**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (60,000 MWD/MTU, 3-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
ATTACH DRAIN LINE TO VENT PORT	1	7A	1	34.2	0.6	0.6	1" THREADED FITTING NO TOOLS
VISUALLY EXAMINE MPC LID-TO-SHELL WELD FOR LEAKAGE OF WATER	10	7A	1	34.2	5.7	5.7	10 MIN TEST DURATION
DISCONNECT WATER FILL LINE AND DRAIN LINE	2	7A	1	34.2	1.1	1.1	1" THREADED FITTING NO TOOLS X 2
REPEAT LIQUID PENETRANT EXAMINATION ON MPC LID FINAL PASS	45	7A	1	34.2	25.7	25.7	5 MIN TO APPLY, 7 MIN TO WIPE, 5 APPLY DEV, INSP (24 IN/MIN)
ATTACH GAS SUPPLY TO VENT PORT	1	7A	1	34.2	0.6	0.6	1" THREADED FITTING NO TOOLS
ATTACH DRAIN LINE TO DRAIN PORT	1	7A	1	34.2	0.6	0.6	1" THREADED FITTING NO TOOLS
Deleted							
Deleted							
ATTACH DRAIN LINE TO VENT PORT	1	8A	1	79.5	1.3	1.3	1" THREADED FITTING NO TOOLS
ATTACH WATER FILL LINE TO DRAIN PORT	1	8A	1	79.5	1.3	1.3	1" THREADED FITTING NO TOOLS
DISCONNECT WATER FILL DRAIN LINES FROM MPC	2	8A	1	79.5	2.7	2.7	1" THREADED FITTING NO TOOLS X 2
ATTACH HELIUM SUPPLY TO VENT PORT	1	8A	1	79.5	1.3	1.3	1" THREADED FITTING NO TOOLS
ATTACH DRAIN LINE TO DRAIN PORT	1	8A	1	79.5	1.3	1.3	1" THREADED FITTING NO TOOLS
DISCONNECT GAS SUPPLY LINE FROM MPC	1	8A	1	79.5	1.3	1.3	1" THREADED FITTING NO TOOLS
DISCONNECT DRAIN LINE FROM MPC	1	8A	1	79.5	1.3	1.3	1" THREADED FITTING NO TOOLS
ATTACH MOISTURE REMOVAL SYSTEM ( ) TO VENT AND DRAIN PORT RVOAs	2	8A	1	79.5	2.7	2.7	1" THREADED FITTING NO TOOLS
DISCONNECT MOISTURE REMOVAL SYSTEM FROM MPC	2	8A	1	79.5	2.7	2.7	1" THREADED FITTING NO TOOLS X 2
CLOSE DRAIN PORT RVOA CAP AND REMOVE DRAIN PORT RVOA	1.5	8A	1	79.5	2.0	2.0	SINGLE THREADED CONNECTION (1 RVOA)

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**Table 10.3.1b**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (60,000 MWD/MTU, 3-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
ATTACH HELIUM BACKFILL SYSTEM TO VENT PORT	1	8A	1	79.5	1.3	1.3	1" THREADED FITTING NO TOOLS
DISCONNECT HBS FROM MPC	1	8A	1	79.5	1.3	1.3	1" THREADED FITTING NO TOOLS
CLOSE VENT PORT RVOA AND DISCONNECT VENT PORT RVOA	1.5	8A	1	79.5	2.0	2.0	SINGLE THREADED CONNECTION (1 RVOA)
WIPE INSIDE AREA OF VENT AND DRAIN PORT RECESSES	2	8A	1	79.5	2.7	2.7	2 PORTS, 1 MIN/PORT
PLACE COVER PLATE OVER VENT PORT RECESS	1	8A	1	79.5	1.3	1.3	INSTALLED BY HAND NO TOOLS (2/MIN)
PERFORM NDE VENT AND DRAIN COVER PLATE WELD	100	8A	1	79.5	132.5	132.5	MEASURED DURING WELD MOCKUP TESTING
FLUSH CAVITY WITH HELIUM AND INSTALL SET SCREWS	2	8A	1	79.5	2.7	2.7	4 SET SCREWS @2/MINUTE
PLUG WELD OVER ET SCREWS	8	8A	1	79.5	10.6	10.6	FOUR SINGLE SPOT WELDS @ 1 PER 2 MINTES
INSTALL MSLD OVER VENT PORT COVER PLATE	2	8A	1				INSTALLED BY HAND, NO TOOLS
INSTALL MSLD OVER DRAIN PORT COVER PLATE	2	8A	1				INSTALLED BY HAND, NO TOOLS
INSTALL AND ALIGN CLOSURE RING	5	8A	1	79.5	6.6	6.6	INSTALLED BY HAND NO TOOLS
PERFORM NDE ON CLOSURE RING WELDS	185	8A	1	79.5	245.1	245.1	MEASURED DURING WELD MOCKUP TESTING
RIG AWS TO CRANE	12	8A	1	79.5	15.9	15.9	10 MIN TO DISCONNECT LINES, 4 SHACKLES@2/MIN
<b>Section 8.1.6</b>							
REMOVE ANNULUS SHIELD	1	8A	1	79.5	1.3	1.3	SHIELD PLACED BY HAND
ATTACH DRAIN LINE TO HI-TRAC	1	9D	1	2190.1	36.5	36.5	1" THREADED FITTING NO TOOLS
POSITION HI-TRAC TOP LID	10	9B	2	79.5	13.3	26.5	VERTICAL FLANGED CONNECTION
TORQUE TOP LID BOLTS	12	9B	1	79.5	15.9	15.9	24 BOLTS AT 2/MIN (INSTALL AND TORQUE, 1 PASS)
INSTALL MPC LIFT CLEATS AND MPC SLINGS	25	9A	2	363.8	151.6	303.2	INSTALL CLEATS AND HYDRO TORQUE 4 BOLTS
REMOVE TEMPORARY SHIELD RING DRAIN PLUGS	1	9B	1	79.5	1.3	1.3	8 PLUGS @ 8/MIN
REMOVE TEMPORARY SHIELD RING SEGMENTS	4	9A	1	363.8	24.3	24.3	REMOVED BY HAND NO TOOLS (8 SEGS@2/MIN)

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**Table 10.3.1b**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (60,000 MWD/MTU, 3-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
ATTACH MPC SLINGS TO LIFT YOKE	4	9A	2	363.8	24.3	48.5	INSTALLED BY HAND NO TOOLS
POSITION HI-TRAC ABOVE TRANSFER STEP	15	9C	1	900.9	225.2	225.2	100 FT @ 10 FT/MIN (CRANE SPEED)+ 5MIN TO ALIGN
REMOVE BOTTOM LID BOLTS	6	10A	1	2190.1	219.0	219.0	36 BOLTS@6 BOLTS/MIN IMPACT TOOLS USED
INSTALL TRANSFER LID BOLTS	18	11B	1	2190.1	657.0	657.0	36 BOLTS @ 2/MIN IMPACT TOOLS USED 1 PASS
DISCONNECT MPC SLINGS	4	9A	2	363.8	24.3	48.5	INSTALLED BY HAND NO TOOLS
<b>Section 8.1.7</b>							
POSITION HI-TRAC ON TRANSPORT DEVICE	20	11A	2	900.9	300.3	600.6	ALIGN TRUNNIONS, DISCONNECT LIFT YOKE
TRANSPORT HI-TRAC TO OUTSIDE TRANSFER LOCATION	90	12A	3	35.2	52.8	158.4	DRIVER AND 2 SPOTTERS
ATTACH OUTSIDE LIFTING DEVICE LIFT LINKS	2	12A	2	35.2	1.2	2.3	2 LINKS@1/MIN
MATE OVERPACKS	10	13B	2	692.0	115.3	230.7	ALIGNMENT GUIDES USED
ATTACH MPC SLINGS TO MPC LIFT CLEATS	10	13A	2	363.8	60.6	121.3	2 SLINGS@5MIN/SLING NO TOOLS
REMOVE TRANSFER LID DOOR LOCKING PINS AND OPEN DOORS	4	13B	2	692.0	46.1	92.3	2 PINS@2MIN/PIN
INSTALL TRIM PLATES	4	13B	2	692.0	46.1	92.3	INSTALLED BY HAND
DISCONNECT SLINGS FROM MPC LIFTING DEVICE	10	13A	2	363.8	60.6	121.3	2 SLINGS@5MIN/SLING
REMOVE MPC LIFT CLEATS AND MPC SLINGS	10	14A	1	487.4	81.2	81.2	4 BOLTS,NO TORQUING
INSTALL HOLE PLUGS IN EMPTY MPC BOLT HOLES	2	14A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING
REMOVE HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	43.9	1.5	1.5	4 SHACKLES@2/MIN
REMOVE ALIGNMENT DEVICE	4	15A	1	43.9	2.9	2.9	REMOVED BY HAND NO TOOLS (4 PCS@1/MIN)
INSTALL HI-STORM LID AND INSTALL LID STUDS/NUTS	25	16A	2	11.7	4.9	9.8	INSTALL LID AND HYDRO TORQUE 4 BOLTS
INSTALL HI-STORM EXIT VENT GAMMA SHIELD CROSS PLATES	4	16B	1	205.5	13.7	13.7	4 PCS @ 1/MIN INSTALL BY HAND NO TOOLS

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**Table 10.3.1b**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (60,000 MWD/MTU, 3-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
INSTALL TEMPERATURE ELEMENTS	20	16B	1	205.5	68.5	68.5	4@5MIN/TEMPERATURE ELEMENT
INSTALL EXIT VENT SCREENS	20	16B	1	205.5	68.5	68.5	4 SCREENS@5MIN/SCREEN
REMOVE HI-STORM LID LIFTING DEVICE	2	16A	1	11.7	0.4	0.4	4 SHACKLES@2/MIN
INSTALL HOLE PLUGS IN EMPTY HOLES	2	16A	1	11.7	0.4	0.4	4 PLUGS AT 2/MIN NO TORQUING
PERFORM SHIELDING EFFECTIVENESS TESTING	16	16D	2	122.7	32.7	65.4	16 POINTS@1 MIN
SECURE HI-STORM TO TRANSPORT DEVICE	10	16A	2	11.7	2.0	3.9	ASSUMES AIR PAD
TRANSFER HI-STORM TO ITS DESIGNATED STORAGE LOCATION	40	16C	1	69.7	46.5	46.5	200 FEET @ 4FT/MIN
INSERT HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
REMOVE AIR PAD	5	16D	2	122.7	10.2	20.5	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
INSTALL INLET VENT SCREENS/CROSS PLATES	20	16D	1	122.7	40.9	40.9	4 SCREENS@5MIN/SCREEN
PERFORM AIR TEMPERATURE RISE TEST	8	16B	1	205.5	27.4	27.4	8 MEASUREMENTS@1/MIN
<b>TOTAL</b>						<b>6628.4 PERSON-MREM</b>	

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**Table 10.3.1c**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
Section 8.1.4							
LOAD PRE-SELECTED FUEL ASSEMBLIES INTO MPC	1020	1	2	1.0	17.0	34.0	15 MINUTES PER ASSEMBLY/68 ASSY
PERFORM POST-LOADING VISUAL VERIFICATION OF ASSEMBLY IDENTIFICATION	68	1	2	1.0	1.1	2.3	1 MINUTES PER ASSY/68 ASSY
Section 8.1.5							
INSTALL MPC LID AND ATTACH LIFT YOKE	45	2	2	2.0	1.5	3.0	CONSULTATION WITH CALVERT CLIFFS
RAISE HI-TRAC TO SURFACE OF SPENT FUEL POOL	20	2	2	2.0	0.7	1.3	40 FEET @ 2 FT/MINUTE (CRANE SPEED)
SURVEY MPC LID FOR HOT PARTICLES	3	3A	1	31.1	1.6	1.6	TELESCOPING DETECTOR USED
VERIFY MPC LID IS SEATED	0.5	3A	1	31.1	0.3	0.3	VISUAL VERIFICATION FROM 3 METERS
INSTALL LID RETENTION SYSTEM BOLTS	6	3B	2	46.4	4.6	9.3	24 BOLTS @ 2/PERSON-MINUTE
REMOVE HI-TRAC FROM SPENT FUEL POOL	8.5	3C	1	117.8	16.7	16.7	17 FEET @ 2 FT/MIN (CRANE SPEED)
DECONTAMINATE HI-TRAC BOTTOM	10	3D	1	142.0	23.7	23.7	LONG HANDLED TOOLS, PRELIMINARY DECON
TAKE SMEARS OF HI-TRAC EXTERIOR SURFACES	5	5B	1	185.3	15.4	15.4	50 SMEARS @ 10 SMEARS/MINUTE
DISCONNECT ANNULUS OVERPRESSURE SYSTEM	0.5	5C	1	82.7	0.7	0.7	QUICK DISCONNECT COUPLING
SET HI-TRAC IN CASK PREPARATION AREA	10	4A	1	46.4	7.7	7.7	100 FT @ 10 FT/MIN (CRANE SPEED)
REMOVE NEUTRON SHIELD JACKET FILL PLUG	2	4A	1	46.4	1.5	1.5	SINGLE PLUG, NO SPECIAL TOOLS
INSTALL NEUTRON SHIELD JACKET FILL PLUG	2	5B	1	185.3	6.2	6.2	SINGLE PLUG, NO SPECIAL TOOLS
DISCONNECT LID RETENTION SYSTEM	6	5A	2	37.3	3.7	7.5	24 BOLTS @ 2 BOLT/PERSON MINUTES

<sup>†</sup> See notes at bottom of Table 10.3.4.

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**Table 10.3.1c**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
MEASURE DOSE RATES AT MPC LID	3	5A	1	37.3	1.9	1.9	TELESCOPING DETECTOR USED
DECONTAMINATE AND SURVEY HI-TRAC	103	5B	1	185.3	318.1	318.1	490 SQ-FT@5 SQ-FT/PERSON-MINUTE+50 SMEARS@10 SMEARS/MINUTE
INSTALL TEMPORARY SHIELD	16	6A	2	18.7	5.0	10.0	8 SEGMENTS @ 1 SEGMENT/PERSON MIN
FILL TEMPORARY SHIELD RING	25	6A	1	18.7	7.8	7.8	230 GAL @10GPM, LONG HANDLED SPRAY WAND
ATTACH DRAIN LINE TO HI-TRAC DRAIN PORT	0.5	5C	1	82.7	0.7	0.7	QUICK DISCONNECT COUPLING
INSTALL RVOAs	2	6A	1	18.7	0.6	0.6	SINGLE THREADED CONNECTION X 2 RVOAs
ATTACH WATER PUMP TO DRAIN PORT	2	6A	1	18.7	0.6	0.6	POSITION PUMP SELF PRIMING
DISCONNECT WATER PUMP	5	6A	1	18.7	1.6	1.6	DRAIN HOSES MOVE PUMP
DECONTAMINATE MPC LID TOP SURFACE AND SHELL AREA ABOVE INFLATABLE ANNULUS SEAL	6	6A	1	18.7	1.9	1.9	30 SQ-FT @5 SQ-FT/MINUTE+10 SMEARS@10 SMEARS/MINUTE
REMOVE INFLATABLE ANNULUS SEAL	3	6A	1	18.7	0.9	0.9	SEAL PULLS OUT DIRECTLY
SURVEY MPC LID TOP SURFACES AND ACCESSIBLE AREAS OF TOP THREE INCHES OF MPC SHELL	1	6A	1	18.7	0.3	0.3	10 SMEARS@10 SMEARS/MINUTE
INSTALL ANNULUS SHIELD	2	6A	1	18.7	0.6	0.6	SHIELD PLACED BY HAND
CENTER LID IN MPC SHELL	20	6A	3	18.7	6.2	18.7	CONSULTATION WITH CALVERT CLIFFS
INSTALL MPC LID SHIMS	12	6A	2	18.7	3.7	7.5	MEASURED DURING WELD MOCKUP TESTING
POSITION AWS BASEPLATE SHIELD ON MPC LID	20	7A	2	18.7	6.2	12.5	ALIGN AND REMOVE 4 SHACKLES
INSTALL AUTOMATED WELDING SYSTEM ROBOT	8	7A	2	18.7	2.5	5.0	ALIGN AND REMOVE 4 SHACKLES/4 QUICK CONNECTS@1/MIN
PERFORM NDE OF LID WELD	230	7A	1	18.7	71.7	71.7	MEASURED DURING WELD MOCKUP TESTING
ATTACH DRAIN LINE TO VENT PORT	1	7A	1	18.7	0.3	0.3	1" THREADED FITTING NO TOOLS

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**Table 10.3.1c**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
VISUALLY EXAMINE MPC LID-TO-SHELL WELD FOR LEAKAGE OF WATER	10	7A	1	18.7	3.1	3.1	10 MIN TEST DURATION
DISCONNECT WATER FILL LINE AND DRAIN LINE	2	7A	1	18.7	0.6	0.6	1" THREADED FITTING NO TOOLS X 2
REPEAT LIQUID PENETRANT EXAMINATION ON MPC LID FINAL PASS	45	7A	1	18.7	14.0	14.0	5 MIN TO APPLY, 7 MIN TO WIPE, 5 APPLY DEV, INSP (24 IN/MIN)
ATTACH GAS SUPPLY TO VENT PORT	1	7A	1	18.7	0.3	0.3	1" THREADED FITTING NO TOOLS
ATTACH DRAIN LINE TO DRAIN PORT	1	7A	1	18.7	0.3	0.3	1" THREADED FITTING NO TOOLS
Deleted							
Deleted							
ATTACH DRAIN LINE TO VENT PORT	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
ATTACH WATER FILL LINE TO DRAIN PORT	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
DISCONNECT WATER FILL DRAIN LINES FROM MPC	2	8A	1	37.9	1.3	1.3	1" THREADED FITTING NO TOOLS X 2
ATTACH HELIUM SUPPLY TO VENT PORT	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
ATTACH DRAIN LINE TO DRAIN PORT	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
DISCONNECT GAS SUPPLY LINE FROM MPC	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
DISCONNECT DRAIN LINE FROM MPC	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
ATTACH MOISTURE REMOVAL SYSTEM TO VENT AND DRAIN PORT RVOAs	2	8A	1	37.9	1.3	1.3	1" THREADED FITTING NO TOOLS
DISCONNECT MOISTURE REMOVAL SYSTEM FROM MPC	2	8A	1	37.9	1.3	1.3	1" THREADED FITTING NO TOOLS X 2

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**Table 10.3.1c**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
CLOSE DRAIN PORT RVOA CAP AND REMOVE DRAIN PORT RVOA	1.5	8A	1	37.9	0.9	0.9	SINGLE THREADED CONNECTION (1 RVOA)
ATTACH HELIUM BACKFILL SYSTEM TO VENT PORT	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
DISCONNECT HBS FROM MPC	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
CLOSE VENT PORT RVOA AND DISCONNECT VENT PORT RVOA	1.5	8A	1	37.9	0.9	0.9	SINGLE THREADED CONNECTION (1 RVOA)
WIPE INSIDE AREA OF VENT AND DRAIN PORT RECESSES	2	8A	1	37.9	1.3	1.3	2 PORTS, 1 MIN/PORT
PLACE COVER PLATE OVER VENT PORT RECESS	1	8A	1	37.9	0.6	0.6	INSTALLED BY HAND NO TOOLS (2/MIN)
PERFORM NDE ON VENT AND DRAIN COVER PLATE WELD	100	8A	1	37.9	63.2	63.2	MEASURED DURING WELD MOCKUP TESTING
INSTALL SET SCREWS	2	8A	1	37.9	1.3	1.3	4 SET SCREWS @2/MINUTE
PLUG WELD OVER SET SCREWS	8	8A	1	37.9	5.1	5.1	FOUR SINGLE SPOT WELDS @ 1 PER 2 MINTES
Deleted							
Deleted							
INSTALL AND ALIGN CLOSURE RING	5	8A	1	37.9	3.2	3.2	INSTALLED BY HAND NO TOOLS
PERFORM A NDE ON CLOSURE RING WELDS	185	8A	1	37.9	116.9	116.9	MEASURED DURING WELD MOCKUP TESTING
RIG AWS TO CRANE	12	8A	1	37.9	7.6	7.6	10 MIN TO DISCONNECT LINES, 4 SHACKLES@2/MIN
<b>Section 8.1.6</b>							
REMOVE ANNULUS SHIELD	1	8A	1	37.9	0.6	0.6	SHIELD PLACED BY HAND
ATTACH DRAIN LINE TO HI-TRAC	1	9D	1	354.2	5.9	5.9	1" THREADED FITTING NO TOOLS
POSITION HI-TRAC TOP LID	10	9B	2	37.9	6.3	12.6	VERTICAL FLANGED CONNECTION
TORQUE TOP LID BOLTS	12	9B	1	37.9	7.6	7.6	24 BOLTS AT 2/MIN (INSTALL AND TORQUE, 1 PASS)

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**Table 10.3.1c**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
INSTALL MPC LIFT CLEATS AND MPC SLINGS	25	9A	2	158.5	66.0	132.1	INSTALL CLEATS AND HYDRO TORQUE 4 BOLTS
REMOVE TEMPORARY SHIELD RING DRAIN PLUGS	1	9B	1	37.9	0.6	0.6	8 PLUGS @ 8/MIN
REMOVE TEMPORARY SHIELD RING SEGMENTS	4	9A	1	158.5	10.6	10.6	REMOVED BY HAND NO TOOLS (8 SEGS@2/MIN)
ATTACH MPC SLINGS TO LIFT YOKE	4	9A	2	158.5	10.6	21.1	INSTALLED BY HAND, NO TOOLS
<b>Section 8.1.7</b>							
POSITION HI-TRAC ON TRANSPORT DEVICE	20	11A	2	117.8	39.3	78.5	ALIGN TRUNNIONS, DISCONNECT LIFT YOKE
TRANSPORT HI-TRAC TO OUTSIDE TRANSFER LOCATION	90	12A	3	26.4	39.6	118.8	DRIVER AND 2 SPOTTERS
ATTACH OUTSIDE LIFTING DEVICE LIFT LINKS	2	12A	2	26.4	0.9	1.8	2 LINKS@1/MIN
MATE OVERPACKS	10	13B	2	118.5	19.8	39.5	ALIGNMENT GUIDES USED
ATTACH MPC LIFT SLINGS TO MPC LIFT CLEATS	10	13A	2	158.5	26.4	52.8	2 SLINGS@5MIN/SLING NO TOOLS
REMOVE MATING DEVICE LOCKING PINS AND OPEN DRAWER	40	13B	2	118.5	79.0	158.0	2 PINS@2MIN/PIN
INSTALL TRIM PLATES	4	13B	2	118.5	7.9	15.8	INSTALLED BY HAND
DISCONNECT SLINGS FROM MPC LIFTING DEVICE	10	13A	2	158.5	26.4	52.8	2 SLINGS@5MIN/SLING
REMOVE MPC LIFT CLEATS AND MPC LIFT SLINGS	10	14A	1	487.4	81.2	81.2	4 BOLTS,NO TORQUING
INSTALL HOLE PLUGS IN EMPTY MPC BOLT HOLES	2	14A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING
REMOVE HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	43.9	1.5	1.5	4 SHACKLES@2/MIN
REMOVE MATING DEVICE	10	15A	1	43.9	7.3	7.3	3 BOLTS @ 2 MINUTES PER BOLT
INSTALL HI-STORM LID AND INSTALL LID STUDS/NUTS	25	16A	2	11.7	4.9	9.8	INSTALL LID AND HYDRO TORQUE 4 BOLTS

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**Table 10.3.1c**  
**HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
INSTALL HI-STORM EXIT VENT GAMMA SHIELD CROSS PLATES	4	16B	1	205.5	13.7	13.7	4 PCS @ 1/MIN INSTALL BY HAND NO TOOLS
INSTALL TEMPERATURE ELEMENTS	20	16B	1	205.5	68.5	68.5	4@5MIN/TEMPERATURE ELEMENT
INSTALL EXIT VENT SCREENS	20	16B	1	205.5	68.5	68.5	4 SCREENS@5MIN/SCREEN
REMOVE HI-STORM LID LIFTING DEVICE	2	16A	1	11.7	0.4	0.4	4 SHACKLES@2/MIN
INSTALL HOLE PLUGS IN EMPTY HOLES	2	16A	1	11.7	0.4	0.4	4 PLUGS AT 2/MIN NO TORQUING
PERFORM SHIELDING EFFECTIVENESS TESTING	16	16D	2	122.7	32.7	65.4	16 POINTS@1 MIN
SECURE HI-STORM TO TRANSPORT DEVICE	10	16A	2	11.7	2.0	3.9	ASSUMES AIR PAD
TRANSFER HI-STORM TO ITS DESIGNATED STORAGE LOCATION	40	16C	1	69.7	46.5	46.5	200 FEET @ 4FT/MIN
INSERT HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
REMOVE AIR PAD	5	16D	2	122.7	10.2	20.5	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
INSTALL INLET VENT SCREENS/CROSS PLATES	20	16D	1	122.7	40.9	40.9	4 SCREENS@5MIN/SCREEN
PERFORM AIR TEMPERATURE RISE TEST	8	16B	1	205.5	27.4	27.4	8 MEASUREMENTS@1/MIN
<b>TOTAL</b>							<b>2017.4 PERSON-MREM</b>

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**Table 10.3.2a**  
**HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
Section 8.3.2 (Step Sequence Varies By Site and Mode of Transport)							
REMOVE INLET VENT SCREENS	20	16D	1	122.7	40.9	40.9	4 SCREENS@5MIN/SCREEN
INSERT HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
INSERT AIR PAD	5	16D	2	122.7	10.2	20.5	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
TRANSFER HI-STORM TO MPC TRANSFER LOCATION	40	16C	1	69.7	46.5	46.5	200 FEET @ 4FT/MIN
REMOVE HI-STORM LID STUDS/NUTS	10	16A	1	11.7	2.0	2.0	4 BOLTS NO TORQUE
REMOVE HI-STORM LID LIFTING HOLE PLUGS AND INSTALL LID LIFTING SLING	2	16A	1	11.7	0.4	0.4	4 PLUGS AT 2/MIN NO TORQUING
REMOVE GAMMA SHIELD CROSS PLATES	4	16B	1	205.5	13.7	13.7	4 PLATES@1/MIN
REMOVE TEMPERATURE ELEMENTS	8	16B	1	205.5	27.4	27.4	4 TEMP. ELEMENTS @ 2MIN/TEMP. ELEMENT NO TORQUE
REMOVE HI-STORM LID	2	16A	1	11.7	0.4	0.4	4 SHACKLES@2/MIN
INSTALL HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	43.9	1.5	1.5	4 SHACKLES@2/MIN
INSTALL ALIGNMENT DEVICE	4	15A	1	43.9	2.9	2.9	REMOVED BY HAND NO TOOLS (4 PCS@1/MIN)
REMOVE MPC LIFT CLEAT HOLE PLUGS	2	14A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING
INSTALL MPC LIFT CLEATS AND MPC SLINGS	2	14A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING
ALIGN HI-TRAC OVER HI-STORM AND MATE OVERPACKS	10	13B	2	118.5	19.8	39.5	ALIGNMENT GUIDES USED
PULL MPC SLINGS THROUGH TOP LID HOLE	10	13A	2	158.5	26.4	52.8	2 SLINGS@5MIN/SLING
INSTALL TRIM PLATES	4	13B	2	118.5	7.9	15.8	INSTALLED BY HAND NO FASTENERS

<sup>†</sup> See notes at bottom of Table 10.3.4.

**Table 10.3.2a**  
**HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
ATTACH MPC SLING TO LIFTING DEVICE	10	13A	1	158.5	26.4	26.4	2 SLINGS@5MIN/SLING NO BOLTING
CLOSE HI-TRAC DOORS AND INSTALL DOOR LOCKING PINS	4	13B	2	118.5	7.9	15.8	2 PINS@2MIN/PIN
DISCONNECT SLINGS FROM MPC LIFT CLEATS	10	13A	2	158.5	26.4	52.8	2 SLINGS@5MIN/SLING
DOWNEND HI-TRAC ON TRANSPORT FRAME	20	12A	2	26.4	8.8	17.6	ALIGN TRUNNIONS, DISCONNECT LIFT YOKE
TRANSPORT HI-TRAC TO FUEL BUILDING	90	12A	1	26.4	39.6	39.6	DRIVER RECEIVES MOST DOSE
UPEND HI-TRAC	20	12A	2	26.4	8.8	17.6	ALIGN TRUNNIONS, DISCONNECT LIFT YOKE
<b>Section 8.3.3</b>							
MOVE HI-TRAC TO TRANSFER SLIDE	20	11A	2	117.8	39.3	78.5	ALIGN TRUNNIONS, DISCONNECT LIFT YOKE
ATTACH MPC SLINGS	4	9A	2	158.5	10.6	21.1	INSTALLED BY HAND NO TOOLS
REMOVE TRANSFER LID BOLTS	6	11B	1	354.2	35.4	35.4	36 BOLTS@6 BOLTS/MIN IMPACT TOOLS USED
INSTALL POOL LID BOLTS	18	10A	1	354.2	106.3	106.3	36 BOLTS @ 2/MIN IMPACT TOOLS USED 1 PASS
DISCONNECT MPC SLINGS AND LIFT CLEATS	10	9A	1	158.5	26.4	26.4	4 BOLTS,NO TORQUING
PLACE HI-TRAC IN PREPARATION AREA	15	9C	1	117.8	29.5	29.5	100 FT @ 10 FT/MIN (CRANE SPEED)+ 5MIN TO ALIGN
REMOVE TOP LID BOLTS	6	9B	1	37.9	3.8	3.8	24 BOLTS AT 4/MIN (NO TORQUE IMPACT TOOLS)
REMOVE HI-TRAC TOP LID	2	6A	1	18.7	0.6	0.6	4 SHACKLES@2/MIN
ATTACH WATER FILL LINE TO HI-TRAC DRAIN PORT	0.5	9D	1	354.2	3.0	3.0	QUICK DISCONNECT NO TOOLS
INSTALL BOLT PLUGS OR WATERPROOF TAPE FROM HI-TRAC TOP BOLT HOLES	9	8A	1	37.9	5.7	5.7	18 HOLES@2/MIN
CORE DRILL CLOSURE RING AND VENT AND DRAIN PORT COVER PLATES	40	7A	2	18.7	12.5	24.9	20 MINUTES TO INSTALL/ALIGN +10 MIN/COVER

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**Table 10.3.2a**  
**HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
REMOVE CLOSURE RING SECTION AND VENT AND DRAIN PORT COVER PLATES	1	8A	1	37.9	0.6	0.6	2 COVERS@2/MIN NO TOOLS
ATTACH RVOAS	2	8A	1	37.9	1.3	1.3	SINGLE THREADED CONNECTION (1 RVOA)
ATTACH A SAMPLE BOTTLE TO VENT PORT RVOA	0.5	8A	1	37.9	0.3	0.3	1" THREADED FITTING NO TOOLS
GATHER A GAS SAMPLE FROM MPC	0.5	8A	1	37.9	0.3	0.3	SMALL BALL VALVE
CLOSE VENT PORT CAP AND DISCONNECT SAMPLE BOTTLE	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
ATTACH RE-FLOOD SYSTEM TO RVOAs	2	8A	1	37.9	1.3	1.3	1" THREADED FITTING NO TOOLS X 2
DISCONNECT RE-FLOOD LINES TO VENT AND DRAIN PORT RVOAs	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
VACUUM TOP SURFACES OF MPC AND HI-TRAC	10	6A	1	18.7	3.1	3.1	SHOP VACUUM WITH WAND + HAND WIPE
REMOVE ANNULUS SHIELD	1	8A	1	37.9	0.6	0.6	SHIELD PLACED BY HAND
MANUALLY INSTALL INFLATABLE SEAL	10	6A	2	18.7	3.1	6.2	CONSULTATION WITH CALVERT CLIFFS
OPEN NEUTRON SHIELD JACKET DRAIN VALVE	2	5C	1	82.7	2.8	2.8	SINGLE THREADED CONNECTION
CLOSE NEUTRON SHIELD JACKET DRAIN VALVE	2	5C	1	82.7	2.8	2.8	SINGLE THREADED CONNECTION
REMOVE MPC LID LIFTING HOLE PLUGS	2	5A	1	37.3	1.2	1.2	4 PLUGS AT 2/MIN NO TORQUING
ATTACH LID RETENTION SYSTEM	12	5A	1	37.3	7.5	7.5	24 BOLTS @ 2 MINUTES/BOLT
ATTACH ANNULUS OVERPRESSURE SYSTEM	0.5	5C	1	82.7	0.7	0.7	QUICK DISCONNECT NO TOOLS
POSITION HI-TRAC OVER CASK LOADING AREA	10	5C	1	82.7	13.8	13.8	100 FT @ 10 FT/MIN (CRANE SPEED)
LOWER HI-TRAC INTO SPENT FUEL POOL	8.5	3C	1	117.8	16.7	16.7	17 FEET @ 2 FT/MIN (CRANE SPEED)
REMOVE LID RETENTION BOLTS	12	3B	1	46.4	9.3	9.3	24 BOLTS @ 2/MINUTE
PLACE HI-TRAC ON FLOOR	20	2	2	2.0	0.7	1.3	40 FEET @ 2 FT/MINUTE (CRANE SPEED)

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**Table 10.3.2a**  
**HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
REMOVE MPC LID	20	2	2	2.0	0.7	1.3	CONSULTATION WITH CALVERT CLIFFS
<b>Section 8.3.4</b>							
REMOVE SPENT FUEL ASSEMBLIES FROM MPC	1020	1	2	1.0	17.0	34.0	15 MINUTES PER ASSEMBLY/68 ASSY
<b>TOTAL</b>						<b>924.4 PERSON-MREM</b>	

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**Table 10.3.2b**  
**HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (60,000 MWD/MTU, 3-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
<b>Section 8.3.2 (Step Sequence Varies By Site and Mode of Transport)</b>							
REMOVE INLET VENT SCREENS	20	16D	1	122.7	40.9	40.9	4 SCREENS@5MIN/SCREEN
INSERT HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
INSERT AIR PAD	5	16D	2	122.7	10.2	20.5	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
TRANSFER HI-STORM TO MPC TRANSFER LOCATION	40	16C	1	69.7	46.5	46.5	200 FEET @ 4FT/MIN
REMOVE HI-STORM LID STUDS/NUTS	10	16A	1	11.7	2.0	2.0	4 BOLTS NO TORQUE
REMOVE HI-STORM LID LIFTING HOLE PLUGS AND INSTALL LID LIFTING SLING	2	16A	1	11.7	0.4	0.4	4 PLUGS AT 2/MIN NO TORQUING
REMOVE GAMMA SHIELD CROSS PLATES	4	16B	1	205.5	13.7	13.7	4 PLATES@1/MIN
REMOVE TEMPERATURE ELEMENTS	8	16B	1	205.5	27.4	27.4	4 TEMP. ELEMENTS @ 2MIN/TEMP. ELEMENT NO TORQUE
REMOVE HI-STORM LID	2	16A	1	11.7	0.4	0.4	4 SHACKLES@2/MIN
INSTALL HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	43.9	1.5	1.5	4 SHACKLES@2/MIN
INSTALL ALIGNMENT DEVICE	4	15A	1	43.9	2.9	2.9	REMOVED BY HAND NO TOOLS (4 PCS@1/MIN)
REMOVE MPC LIFT CLEAT HOLE PLUGS	2	14A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING
INSTALL MPC LIFT CLEATS AND MPC SLINGS	2	14A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING
ALIGN HI-TRAC OVER HI-STORM AND MATE OVERPACKS	10	13B	2	692.0	115.3	230.7	ALIGNMENT GUIDES USED
PULL MPC SLINGS THROUGH TOP LID HOLE	10	13A	2	363.8	60.6	121.3	2 SLINGS@5MIN/SLING
INSTALL TRIM PLATES	4	13B	2	692.0	46.1	92.3	INSTALLED BY HAND NO FASTENERS

<sup>†</sup> See notes at bottom of Table 10.3.4.

**Table 10.3.2b**  
**HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (60,000 MWD/MTU, 3-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
ATTACH MPC SLING TO LIFTING DEVICE	10	13A	1	363.8	60.6	60.6	2 SLINGS@5MIN/SLING NO BOLTING
CLOSE HI-TRAC DOORS AND INSTALL DOOR LOCKING PINS	4	13B	2	692.0	46.1	92.3	2 PINS@2MIN/PIN
DISCONNECT SLINGS FROM MPC LIFT CLEATS	10	13A	2	363.8	60.6	121.3	2 SLINGS@5MIN/SLING
DOWNEND HI-TRAC ON TRANSPORT FRAME	20	12A	2	35.2	11.7	23.5	ALIGN TRUNNIONS, DISCONNECT LIFT YOKE
TRANSPORT HI-TRAC TO FUEL BUILDING	90	12A	1	35.2	52.8	52.8	DRIVER RECEIVES MOST DOSE
UPEND HI-TRAC	20	12A	2	35.2	11.7	23.5	ALIGN TRUNNIONS, DISCONNECT LIFT YOKE
<b>Section 8.3.3</b>							
MOVE HI-TRAC TO TRANSFER SLIDE	20	11A	2	900.9	300.3	600.6	ALIGN TRUNNIONS, DISCONNECT LIFT YOKE
ATTACH MPC SLINGS	4	9A	2	363.8	24.3	48.5	INSTALLED BY HAND NO TOOLS
REMOVE TRANSFER LID BOLTS	6	11B	1	2190.1	219.0	219.0	36 BOLTS@6 BOLTS/MIN IMPACT TOOLS USED
INSTALL POOL LID BOLTS	18	10A	1	2190.1	657.0	657.0	36 BOLTS @ 2/MIN IMPACT TOOLS USED 1 PASS
DISCONNECT MPC SLINGS AND LIFT CLEATS	10	9A	1	363.8	60.6	60.6	4 BOLTS,NO TORQUING
PLACE HI-TRAC IN PREPARATION AREA	15	9C	1	900.9	225.2	225.2	100 FT @ 10 FT/MIN (CRANE SPEED)+ 5MIN TO ALIGN
REMOVE TOP LID BOLTS	6	9B	1	79.5	8.0	8.0	24 BOLTS AT 4/MIN (NO TORQUE IMPACT TOOLS)
REMOVE HI-TRAC TOP LID	2	6A	1	34.2	1.1	1.1	4 SHACKLES@2/MIN
ATTACH WATER FILL LINE TO HI-TRAC DRAIN PORT	0.5	9D	1	2190.1	18.3	18.3	QUICK DISCONNECT NO TOOLS
INSTALL BOLT PLUGS OR WATERPROOF TAPE FROM HI-TRAC TOP BOLT HOLES	9	8A	1	79.5	11.9	11.9	18 HOLES@2/MIN
CORE DRILL CLOSURE RING AND VENT AND DRAIN PORT COVER PLATES	40	7A	2	34.2	22.8	45.6	20 MINUTES TO INSTALL/ALIGN +10 MIN/COVER

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**Table 10.3.2b**  
**HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (60,000 MWD/MTU, 3-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
REMOVE CLOSURE RING SECTION AND VENT AND DRAIN PORT COVER PLATES	1	8A	1	79.5	1.3	1.3	2 COVERS@2/MIN NO TOOLS
ATTACH RVOAS	2	8A	1	79.5	2.7	2.7	SINGLE THREADED CONNECTION (1 RVOA)
ATTACH A SAMPLE BOTTLE TO VENT PORT RVOA	0.5	8A	1	79.5	0.7	0.7	1" THREADED FITTING NO TOOLS
GATHER A GAS SAMPLE FROM MPC	0.5	8A	1	79.5	0.7	0.7	SMALL BALL VALVE
CLOSE VENT PORT CAP AND DISCONNECT SAMPLE BOTTLE	1	8A	1	79.5	1.3	1.3	1" THREADED FITTING NO TOOLS
ATTACH RE-FLOOD SYSTEM TO RVOAs	2	8A	1	79.5	2.7	2.7	1" THREADED FITTING NO TOOLS X 2
DISCONNECT RE-FLOOD LINES TO VENT AND DRAIN PORT RVOAs	1	8A	1	79.5	1.3	1.3	1" THREADED FITTING NO TOOLS
VACUUM TOP SURFACES OF MPC AND HI-TRAC	10	6A	1	34.2	5.7	5.7	SHOP VACUUM WITH WAND + HAND WIPE
REMOVE ANNULUS SHIELD	1	8A	1	79.5	1.3	1.3	SHIELD PLACED BY HAND
MANUALLY INSTALL INFLATABLE SEAL	10	6A	2	34.2	5.7	11.4	CONSULTATION WITH CALVERT CLIFFS
OPEN NEUTRON SHIELD JACKET DRAIN VALVE	2	5C	1	282.1	9.4	9.4	SINGLE THREADED CONNECTION
CLOSE NEUTRON SHIELD JACKET DRAIN VALVE	2	5C	1	282.1	9.4	9.4	SINGLE THREADED CONNECTION
REMOVE MPC LID LIFTING HOLE PLUGS	2	5A	1	69.8	2.3	2.3	4 PLUGS AT 2/MIN NO TORQUING
ATTACH LID RETENTION SYSTEM	12	5A	1	69.8	14.0	14.0	24 BOLTS @ 2 MINUTES/BOLT
ATTACH ANNULUS OVERPRESSURE SYSTEM	0.5	5C	1	282.1	2.4	2.4	QUICK DISCONNECT NO TOOLS
POSITION HI-TRAC OVER CASK LOADING AREA	10	5C	1	282.1	47.0	47.0	100 FT @ 10 FT/MIN (CRANE SPEED)
LOWER HI-TRAC INTO SPENT FUEL POOL	8.5	3C	1	837.0	118.6	118.6	17 FEET @ 2 FT/MIN (CRANE SPEED)
REMOVE LID RETENTION BOLTS	12	3B	1	90.3	18.1	18.1	24 BOLTS @ 2/MINUTE
PLACE HI-TRAC ON FLOOR	20	2	2	3	1.0	2.0	40 FEET @ 2 FT/MINUTE (CRANE SPEED)

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**Table 10.3.2b**  
**HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (60,000 MWD/MTU, 3-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
REMOVE MPC LID	20	2	2	3	1.0	2.0	CONSULTATION WITH CALVERT CLIFFS
<b>Section 8.3.4</b>							
REMOVE SPENT FUEL ASSEMBLIES FROM MPC	1020	1	2	3	51.0	102.0	15 MINUTES PER ASSEMBLY/68 ASSY
<b>TOTAL</b>						<b>3275.0 PERSON-MREM</b>	

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**Table 10.3.2c**  
**HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
<b>Section 8.3.2 (Step Sequence Varies By Site and Mode of Transport)</b>							
REMOVE INLET VENT SCREENS	20	16D	1	122.7	40.9	40.9	4 SCREENS@5MIN/SCREEN
INSERT HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
INSERT AIR PAD	5	16D	2	122.7	10.2	20.5	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
TRANSFER HI-STORM TO MPC TRANSFER LOCATION	40	16C	1	69.7	46.5	46.5	200 FEET @ 4FT/MIN
REMOVE HI-STORM LID STUDS/NUTS	10	16A	1	11.7	2.0	2.0	4 BOLTS NO TORQUE
REMOVE HI-STORM LID LIFTING HOLE PLUGS AND INSTALL LID LIFTING SLING	2	16A	1	11.7	0.4	0.4	4 PLUGS AT 2/MIN NO TORQUING
REMOVE GAMMA SHIELD CROSS PLATES	4	16B	1	205.5	13.7	13.7	4 PLATES@1/MIN
REMOVE TEMPERATURE ELEMENTS	8	16B	1	205.5	27.4	27.4	4 TEMP. ELEMENTS @ 2MIN/TEMP. ELEMENT NO TORQUE
REMOVE HI-STORM LID	2	16A	1	11.7	0.4	0.4	4 SHACKLES@2/MIN
INSTALL HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	43.9	1.5	1.5	4 SHACKLES@2/MIN
INSTALL MATING DEVICE WITH POOL LID	10	15A	1	43.9	7.3	7.3	3 BOLTS AT 2 MINUTES PER BOLT
REMOVE MPC LIFT CLEAT HOLE PLUGS	2	14A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING
INSTALL MPC LIFT CLEATS AND MPC SLINGS	2	14A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING
ALIGN HI-TRAC OVER HI-STORM AND MATE OVERPACKS	10	13B	2	118.5	19.8	39.5	ALIGNMENT GUIDES USED

<sup>†</sup> See notes at bottom of Table 10.3.4.

**Table 10.3.2c**  
**HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
PULL MPC SLINGS THROUGH TOP LID HOLE	10	13A	2	158.5	26.4	52.8	2 SLINGS@5MIN/SLING
INSTALL TRIM PLATES	4	13B	2	118.5	7.9	15.8	INSTALLED BY HAND NO FASTENERS
ATTACH MPC SLING TO LIFTING DEVICE	10	13A	1	158.5	26.4	26.4	2 SLINGS@5MIN/SLING NO BOLTING
CLOSE MATING DEVICE DRAWER AND BOLT-UP POOL LID	36	13B	2	118.5	71.1	142.2	2 PINS@2MIN/PIN, 16 BOLTS @ 2MIN/BOLT
DISCONNECT SLINGS FROM MPC LIFT CLEATS	10	13A	2	158.5	26.4	52.8	2 SLINGS@5MIN/SLING
DOWNEND HI-TRAC ON TRANSPORT FRAME	20	12A	2	26.4	8.8	17.6	ALIGN TRUNNIONS, DISCONNECT LIFT YOKE
TRANSPORT HI-TRAC TO FUEL BUILDING	90	12A	1	26.4	39.6	39.6	DRIVER RECEIVES MOST DOSE
UPEND HI-TRAC	20	12A	2	26.4	8.8	17.6	ALIGN TRUNNIONS, DISCONNECT LIFT YOKE
<b>Section 8.3.3</b>							
PLACE HI-TRAC IN PREPARATION AREA	15	9C	1	117.8	29.5	29.5	100 FT @ 10 FT/MIN (CRANE SPEED)+ 5MIN TO ALIGN
REMOVE TOP LID BOLTS	6	9B	1	37.9	3.8	3.8	24 BOLTS AT 4/MIN (NO TORQUE IMPACT TOOLS)
REMOVE HI-TRAC TOP LID	2	6A	1	18.7	0.6	0.6	4 SHACKLES@2/MIN
ATTACH WATER FILL LINE TO HI-TRAC DRAIN PORT	0.5	9D	1	354.2	3.0	3.0	QUICK DISCONNECT NO TOOLS
INSTALL BOLT PLUGS OR WATERPROOF TAPE FROM HI-TRAC TOP BOLT HOLES	9	8A	1	37.9	5.7	5.7	18 HOLES@2/MIN
CORE DRILL CLOSURE RING AND VENT AND DRAIN PORT COVER PLATES	40	7A	2	18.7	12.5	24.9	20 MINUTES TO INSTALL/ALIGN +10 MIN/COVER
REMOVE CLOSURE RING SECTION AND VENT AND DRAIN PORT COVER PLATES	1	8A	1	37.9	0.6	0.6	2 COVERS@2/MIN NO TOOLS
ATTACH RVOAS	2	8A	1	37.9	1.3	1.3	SINGLE THREADED CONNECTION (1 RVOA)

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**Table 10.3.2c**  
**HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
ATTACH A SAMPLE BOTTLE TO VENT PORT RVOA	0.5	8A	1	37.9	0.3	0.3	1" THREADED FITTING NO TOOLS
GATHER A GAS SAMPLE FROM MPC	0.5	8A	1	37.9	0.3	0.3	SMALL BALL VALVE
CLOSE VENT PORT CAP AND DISCONNECT SAMPLE BOTTLE	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
ATTACH RE-FLOOD SYSTEM TO RVOAs	2	8A	1	37.9	1.3	1.3	1" THREADED FITTING NO TOOLS X 2
DISCONNECT RE-FLOOD LINES TO VENT AND DRAIN PORT RVOAs	1	8A	1	37.9	0.6	0.6	1" THREADED FITTING NO TOOLS
VACUUM TOP SURFACES OF MPC AND HI-TRAC	10	6A	1	18.7	3.1	3.1	SHOP VACUUM WITH WAND + HAND WIPE
REMOVE ANNULUS SHIELD	1	8A	1	37.9	0.6	0.6	SHIELD PLACED BY HAND
MANUALLY INSTALL INFLATABLE SEAL	10	6A	2	18.7	3.1	6.2	CONSULTATION WITH CALVERT CLIFFS
OPEN NEUTRON SHIELD JACKET DRAIN VALVE	2	5C	1	82.7	2.8	2.8	SINGLE THREADED CONNECTION
CLOSE NEUTRON SHIELD JACKET DRAIN VALVE	2	5C	1	82.7	2.8	2.8	SINGLE THREADED CONNECTION
REMOVE MPC LID LIFTING HOLE PLUGS	2	5A	1	37.3	1.2	1.2	4 PLUGS AT 2/MIN NO TORQUING
ATTACH LID RETENTION SYSTEM	12	5A	1	37.3	7.5	7.5	24 BOLTS @ 2 MINUTES/BOLT
ATTACH ANNULUS OVERPRESSURE SYSTEM	0.5	5C	1	82.7	0.7	0.7	QUICK DISCONNECT NO TOOLS
POSITION HI-TRAC OVER CASK LOADING AREA	10	5C	1	82.7	13.8	13.8	100 FT @ 10 FT/MIN (CRANE SPEED)
LOWER HI-TRAC INTO SPENT FUEL POOL	8.5	3C	1	117.8	16.7	16.7	17 FEET @ 2 FT/MIN (CRANE SPEED)
REMOVE LID RETENTION BOLTS	12	3B	1	46.4	9.3	9.3	24 BOLTS @ 2/MINUTE
PLACE HI-TRAC ON FLOOR	20	2	2	2.0	0.7	1.3	40 FEET @ 2 FT/MINUTE (CRANE SPEED)
REMOVE MPC LID	20	2	2	2.0	0.7	1.3	CONSULTATION WITH CALVERT CLIFFS

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**Table 10.3.2c**  
**HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
Section 8.3.4							
REMOVE SPENT FUEL ASSEMBLIES FROM MPC	1020	1	2	1.0	17.0	34.0	15 MINUTES PER ASSEMBLY/68 ASSY
<b>TOTAL</b>						<b>787.5 PERSON-MREM</b>	

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**Table 10.3.3a**  
**MPC TRANSFER INTO THE HI-STORM 100 SYSTEM DIRECTLY FROM TRANSPORT USING**  
**THE 125-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
<b>Section 8.5.2</b>							
MEASURE HI-STAR DOSE RATES	16	17A	2	14.1	3.8	7.5	16 POINTS@1 POINT/MIN
REMOVE PERSONNEL BARRIER	10	17C	2	21.5	3.6	7.2	ATTACH SLING REMOVE 8 LOCKS
PERFORM REMOVABLE CONTAMINATION SURVEYS	1	17C	1	21.5	0.4	0.4	10 SMEARS@10 SMEARS/MINUTE
REMOVE IMPACT LIMITERS	16	17A	2	14.1	3.8	7.5	ATTACH FRAME REMOVE 22 BOLTS IMPACT TOOLS
REMOVE TIE-DOWN	6	17A	2	14.1	1.4	2.8	ATTACH 2-LEGGED SLING REMOVE 4 BOLTS
PERFORM A VISUAL INSPECTION OF OVERPACK	10	17B	1	9.0	1.5	1.5	CHECKSHEET USED
REMOVE REMOVABLE SHEAR RING SEGMENTS	4	17A	1	14.1	0.9	0.9	4 BOLTS EACH @2/MIN X 2 SEGMENTS
UPEND HI-STAR OVERPACK	20	17B	2	9.0	3.0	6.0	DISCONNECT LIFT YOKE
INSTALL TEMPORARY SHIELD RING SEGMENTS	16	18A	1	7.1	1.9	1.9	8 SEGMENTS @ 2 MIN/SEGMENT
FILL TEMPORARY SHIELD RING SEGMENTS	25	18A	1	7.1	3.0	3.0	230 GAL @10GPM, LONG HANDLED SPRAYER
REMOVE OVERPACK VENT PORT COVER PLATE	2	18A	1	7.1	0.2	0.2	4 BOLTS @2/MIN
ATTACH BACKFILL TOOL	2	18A	1	7.1	0.2	0.2	4 BOLTS @2/MIN
OPEN/CLOSE VENT PORT PLUG	0.5	18A	1	7.1	0.1	0.1	SINGLE TURN BY HAND NO TOOLS
REMOVE CLOSURE PLATE BOLTS	39	18A	2	7.1	4.6	9.2	52 BOLTS@4/MIN X 3 PASSES
REMOVE OVERPACK CLOSURE PLATE	2	18A	1	7.1	0.2	0.2	4 SHACKLES@2/MIN
INSTALL HI-STAR SEAL SURFACE PROTECTOR	2	19B	1	7.1	0.2	0.2	PLACED BY HAND NO TOOLS
INSTALL TRANSFER COLLAR ON HI-STAR	10	19B	2	7.1	1.2	2.4	ALIGN AND POSITION REMOVE 4 SHACKLES
REMOVE MPC LIFT CLEAT HOLE PLUGS	2	19A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING

<sup>†</sup> See notes at bottom of Table 10.3.4.

**Table 10.3.3a**  
**MPC TRANSFER INTO THE HI-STORM 100 SYSTEM DIRECTLY FROM TRANSPORT USING**  
**THE 125-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
INSTALL MPC LIFT CLEATS AND LIFT SLING	25	19A	2	487.4	203.1	406.2	INSTALL CLEATS AND HYDRO TORQUE 4 BOLTS
MATE OVERPACKS	10	20B	2	118.5	19.8	39.5	ALIGNMENT GUIDES USED
REMOVE DOOR LOCKING PINS AND OPEN DOORS	4	20B	2	118.5	7.9	15.8	2 PINS@2/MIN
INSTALL TRIM PLATES	4	20B	2	118.5	7.9	15.8	INSTALLED BY HAND NO FASTENERS
<b>Section 8.5.3</b>							
REMOVE TRIM PLATES	4	20B	2	118.5	7.9	15.8	INSTALLED BY HAND NO FASTENERS
DISCONNECT SLINGS FROM MPC LIFTING DEVICE	10	20A	2	158.5	26.4	52.8	2 SLINGS@5/MIN
INSTALL TRIM PLATES	4	13B	2	118.5	7.9	15.8	INSTALLED BY HAND NO FASTENERS
REMOVE MPC LIFT CLEATS AND MPC LIFT SLINGS	10	14A	1	487.4	81.2	81.2	4 BOLTS,NO TORQUING
INSTALL HOLE PLUGS IN EMPTY MPC BOLT HOLES	2	14A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING
REMOVE HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	43.9	1.5	1.5	4 SHACKLES@2/MIN
REMOVE ALIGNMENT DEVICE	4	15A	1	43.9	2.9	2.9	REMOVED BY HAND NO TOOLS (4 PCS@1/MIN)
INSTALL HI-STORM LID AND INSTALL LID STUDS/NUTS	25	16A	2	11.7	4.9	9.8	INSTALL LID AND HYDRO TORQUE 4 BOLTS
INSTALL HI-STORM EXIT VENT GAMMA SHIELD CROSS PLATES	4	16B	1	205.5	13.7	13.7	4 PCS @ 1/MIN INSTALL BY HAND NO TOOLS
INSTALL TEMPERATURE ELEMENTS	20	16B	1	205.5	68.5	68.5	4@5MIN/TEMPERATURE ELEMENT
INSTALL EXIT VENT SCREENS	20	16B	1	205.5	68.5	68.5	4 SCREENS@5MIN/SCREEN
REMOVE HI-STORM LID LIFTING DEVICE	2	16A	1	11.7	0.4	0.4	4 SHACKLES@2/MIN
INSTALL HOLE PLUGS IN EMPTY HOLES	2	16A	1	11.7	0.4	0.4	4 PLUGS AT 2/MIN NO TORQUING
PERFORM SHIELDING EFFECTIVENESS TESTING	16	16D	1	122.7	32.7	32.7	16POINTS@1 MIN

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**Table 10.3.3a**  
**MPC TRANSFER INTO THE HI-STORM 100 SYSTEM DIRECTLY FROM TRANSPORT USING**  
**THE 125-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
SECURE HI-STORM TO TRANSPORT DEVICE	10	16A	1	11.7	2.0	2.0	ASSUMES AIR PAD
TRANSFER HI-STORM TO ITS DESIGNATED STORAGE LOCATION	40	16C	1	69.7	46.5	46.5	200 FEET @ 4FT/MIN
INSERT HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
REMOVE AIR PAD	5	16D	1	122.7	10.2	10.2	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
INSTALL INLET VENT SCREENS	20	16D	1	122.7	40.9	40.9	4 SCREENS@5MIN/SCREEN
PERFORM AIR TEMPERATURE RISE TEST	8	16B	1	205.5	27.4	27.4	8 MEASMT@1/MIN
<b>TOTAL</b>						<b>1068.3 PERSON-MREM</b>	

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**Table 10.3.3b**  
**MPC TRANSFER INTO THE HI-STORM 100 SYSTEM DIRECTLY FROM TRANSPORT USING**  
**THE 100-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (60,000 MWD/MTU, 3-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
<b>Section 8.5.2</b>							
MEASURE HI-STAR DOSE RATES	16	17A	2	14.1	3.8	7.5	16 POINTS@1 POINT/MIN
REMOVE PERSONNEL BARRIER	10	17C	2	21.5	3.6	7.2	ATTACH SLING REMOVE 8 LOCKS
PERFORM REMOVABLE CONTAMINATION SURVEYS	1	17C	1	21.5	0.4	0.4	10 SMEARS@10 SMEARS/MINUTE
REMOVE IMPACT LIMITERS	16	17A	2	14.1	3.8	7.5	ATTACH FRAME REMOVE 22 BOLTS IMPACT TOOLS
REMOVE TIE-DOWN	6	17A	2	14.1	1.4	2.8	ATTACH 2-LEGGED SLING REMOVE 4 BOLTS
PERFORM A VISUAL INSPECTION OF OVERPACK	10	17B	1	9.0	1.5	1.5	CHECKSHEET USED
REMOVE REMOVABLE SHEAR RING SEGMENTS	4	17A	1	14.1	0.9	0.9	4 BOLTS EACH @2/MIN X 2 SEGMENTS
UPEND HI-STAR OVERPACK	20	17B	2	9.0	3.0	6.0	DISCONNECT LIFT YOKE
INSTALL TEMPORARY SHIELD RING SEGMENTS	16	18A	1	6.9	1.8	1.8	8 SEGMENTS @ 2 MIN/SEGMENT
FILL TEMPORARY SHIELD RING SEGMENTS	25	18A	1	6.9	2.9	2.9	230 GAL @10GPM, LONG HANDLED SPRAYER
REMOVE OVERPACK VENT PORT COVER PLATE	2	18A	1	6.9	0.2	0.2	4 BOLTS @2/MIN
ATTACH BACKFILL TOOL	2	18A	1	6.9	0.2	0.2	4 BOLTS @2/MIN
OPEN/CLOSE VENT PORT PLUG	0.5	18A	1	6.9	0.1	0.1	SINGLE TURN BY HAND NO TOOLS
REMOVE CLOSURE PLATE BOLTS	39	18A	2	6.9	4.5	9.0	52 BOLTS@4/MIN X 3 PASSES
REMOVE OVERPACK CLOSURE PLATE	2	18A	1	6.9	0.2	0.2	4 SHACKLES@2/MIN
INSTALL HI-STAR SEAL SURFACE PROTECTOR	2	19B	1	6.9	0.2	0.2	PLACED BY HAND NO TOOLS
INSTALL TRANSFER COLLAR ON HI-STAR	10	19B	2	6.9	1.2	2.3	ALIGN AND POSITION REMOVE 4 SHACKLES
REMOVE MPC LIFT CLEAT HOLE PLUGS	2	19A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING

<sup>†</sup> See notes at bottom of Table 10.3.4.

**Table 10.3.3b**  
**MPC TRANSFER INTO THE HI-STORM 100 SYSTEM DIRECTLY FROM TRANSPORT USING**  
**THE 100-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (60,000 MWD/MTU, 3-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
INSTALL MPC LIFT CLEATS AND LIFT SLING	25	19A	2	487.4	203.1	406.2	INSTALL CLEATS AND HYDRO TORQUE 4 BOLTS
MATE OVERPACKS	10	20B	2	692.0	115.3	230.7	ALIGNMENT GUIDES USED
REMOVE DOOR LOCKING PINS AND OPEN DOORS	4	20B	2	692.0	46.1	92.3	2 PINS@2/MIN
INSTALL TRIM PLATES	4	20B	2	692.0	46.1	92.3	INSTALLED BY HAND NO FASTENERS
<b>Section 8.5.3</b>							
REMOVE TRIM PLATES	4	20B	2	692.0	46.1	92.3	INSTALLED BY HAND NO FASTENERS
DISCONNECT SLINGS FROM MPC LIFTING DEVICE	10	20A	2	363.8	60.6	121.3	2 SLINGS@5/MIN
REMOVE TRIM PLATES	4	13B	2	692.0	46.1	92.3	INSTALLED BY HAND NO FASTENERS
REMOVE MPC LIFT CLEATS AND MPC LIFT SLINGS	10	14A	1	487.4	81.2	81.2	4 BOLTS,NO TORQUING
INSTALL HOLE PLUGS IN EMPTY MPC BOLT HOLES	2	14A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING
REMOVE HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	43.9	1.5	1.5	4 SHACKLES@2/MIN
REMOVE ALIGNMENT DEVICE	4	15A	1	43.9	2.9	2.9	REMOVED BY HAND NO TOOLS (4 PCS@1/MIN)
INSTALL HI-STORM LID AND INSTALL LID STUDS/NUTS	25	16A	2	11.7	4.9	9.8	INSTALL LID AND HYDRO TORQUE 4 BOLTS
INSTALL HI-STORM EXIT VENT GAMMA SHIELD CROSS PLATES	4	16B	1	205.5	13.7	13.7	4 PCS @ 1/MIN INSTALL BY HAND NO TOOLS
INSTALL TEMPERATURE ELEMENTS	20	16B	1	205.5	68.5	68.5	4@5MIN/TEMPERATURE ELEMENT
INSTALL EXIT VENT SCREENS	20	16B	1	205.5	68.5	68.5	4 SCREENS@5MIN/SCREEN
REMOVE HI-STORM LID LIFTING DEVICE	2	16A	1	11.7	0.4	0.4	4 SHACKLES@2/MIN
INSTALL HOLE PLUGS IN EMPTY HOLES	2	16A	1	11.7	0.4	0.4	4 PLUGS AT 2/MIN NO TORQUING
PERFORM SHIELDING EFFECTIVENESS TESTING	16	16D	1	122.7	32.7	32.7	16POINTS@1 MIN

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**Table 10.3.3b**  
**MPC TRANSFER INTO THE HI-STORM 100 SYSTEM DIRECTLY FROM TRANSPORT USING**  
**THE 100-TON HI-TRAC TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (60,000 MWD/MTU, 3-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
SECURE HI-STORM TO TRANSPORT DEVICE	10	16A	1	11.7	2.0	2.0	ASSUMES AIR PAD
TRANSFER HI-STORM TO ITS DESIGNATED STORAGE LOCATION	40	16C	1	69.7	46.5	46.5	200 FEET @ 4FT/MIN
INSERT HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
REMOVE AIR PAD	5	16D	1	122.7	10.2	10.2	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS@1/MIN
INSTALL INLET VENT SCREENS	20	16D	1	122.7	40.9	40.9	4 SCREENS@5MIN/SCREEN
PERFORM AIR TEMPERATURE RISE TEST	8	16B	1	205.5	27.4	27.4	8 MEASMT@1/MIN
<b>TOTAL</b>						<b>1633.3 PERSON-MREM</b>	

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**Table 10.3.3c**  
**MPC TRANSFER INTO THE HI-STORM 100 SYSTEM DIRECTLY FROM TRANSPORT USING**  
**THE 125-TON HI-TRAC 125D TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
Section 8.5.2							
MEASURE HI-STAR DOSE RATES	16	17A	2	14.1	3.8	7.5	16 POINTS@1 POINT/MIN
REMOVE PERSONNEL BARRIER	10	17C	2	21.5	3.6	7.2	ATTACH SLING REMOVE 8 LOCKS
PERFORM REMOVABLE CONTAMINATION SURVEYS	1	17C	1	21.5	0.4	0.4	10 SMEARS@10 SMEARS/MINUTE
REMOVE IMPACT LIMITERS	16	17A	2	14.1	3.8	7.5	ATTACH FRAME REMOVE 22 BOLTS IMPACT TOOLS
REMOVE TIE-DOWN	6	17A	2	14.1	1.4	2.8	ATTACH 2-LEGGED SLING REMOVE 4 BOLTS
PERFORM A VISUAL INSPECTION OF OVERPACK	10	17B	1	9.0	1.5	1.5	CHECKSHEET USED
REMOVE REMOVABLE SHEAR RING SEGMENTS	4	17A	1	14.1	0.9	0.9	4 BOLTS EACH @2/MIN X 2 SEGMENTS
UPEND HI-STAR OVERPACK	20	17B	2	9.0	3.0	6.0	DISCONNECT LIFT YOKE
INSTALL TEMPORARY SHIELD RING SEGMENTS	16	18A	1	7.1	1.9	1.9	8 SEGMENTS @ 2 MIN/SEGMENT
FILL TEMPORARY SHIELD RING SEGMENTS	25	18A	1	7.1	3.0	3.0	230 GAL @10GPM, LONG HANDLED SPRAYER
REMOVE OVERPACK VENT PORT COVER PLATE	2	18A	1	7.1	0.2	0.2	4 BOLTS @2/MIN
ATTACH BACKFILL TOOL	2	18A	1	7.1	0.2	0.2	4 BOLTS @2/MIN
OPEN/CLOSE VENT PORT PLUG	0.5	18A	1	7.1	0.1	0.1	SINGLE TURN BY HAND NO TOOLS
REMOVE CLOSURE PLATE BOLTS	39	18A	2	7.1	4.6	9.2	52 BOLTS@4/MIN X 3 PASSES
REMOVE OVERPACK CLOSURE PLATE	2	18A	1	6.7	0.2	0.2	4 SHACKLES@2/MIN

<sup>†</sup> See notes at bottom of Table 10.3.4.

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**Table 10.3.3c**  
**MPC TRANSFER INTO THE HI-STORM 100 SYSTEM DIRECTLY FROM TRANSPORT USING**  
**THE 125-TON HI-TRAC 125D TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
INSTALL HI-STAR SEAL SURFACE PROTECTOR	2	19B	1	7.1	0.2	0.2	PLACED BY HAND NO TOOLS
INSTALL MATING DEVICE ON HI-STAR	20	19B	2	7.1	2.4	4.7	ALIGN AND BOLT INTO PLACE
REMOVE MPC LIFT CLEAT HOLE PLUGS	2	19A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING
INSTALL MPC LIFT CLEATS AND LIFT SLING	25	19A	2	487.4	203.1	406.2	INSTALL CLEATS AND HYDRO TORQUE 4 BOLTS
MATE OVERPACKS	10	20B	2	118.5	19.8	39.5	ALIGNMENT GUIDES USED
REMOVE LOCKING PINS AND OPEN DRAWER	4	20B	2	118.5	7.9	15.8	2 PINS@2/MIN
INSTALL TRIM PLATES	4	20B	2	118.5	7.9	15.8	INSTALLED BY HAND NO FASTENERS
<b>Section 8.5.3</b>							
REMOVE TRIM PLATES	4	20B	2	118.5	7.9	15.8	INSTALLED BY HAND NO FASTENERS
RAISE THE POOL LID AND BOLT INTO PLACE ON HI-TRAC	32	20B	2	118.5	63.2	126.4	2 MINS/BOLT, 16 BOLTS
DISCONNECT SLINGS FROM MPC LIFTING DEVICE	10	20A	2	158.5	26.4	52.8	2 SLINGS@5/MIN
INSTALL TRIM PLATES	4	13B	2	118.5	7.9	15.8	INSTALLED BY HAND NO FASTENERS
REMOVE MPC LIFT CLEATS AND MPC LIFT SLINGS	10	14A	1	487.4	81.2	81.2	4 BOLTS,NO TORQUING
INSTALL HOLE PLUGS IN EMPTY MPC BOLT HOLES	2	14A	1	487.4	16.2	16.2	4 PLUGS AT 2/MIN NO TORQUING
REMOVE HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	43.9	1.5	1.5	4 SHACKLES@2/MIN
REMOVE THE MATING DEVICE	6	15A	1	43.9	4.4	4.4	3 BOLTS AT 2 MINUTES PER BOLTS
INSTALL HI-STORM LID AND INSTALL LID STUDS/NUTS	25	16A	2	11.7	4.9	9.8	INSTALL LID AND HYDRO TORQUE 4 BOLTS

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**Table 10.3.3c**  
**MPC TRANSFER INTO THE HI-STORM 100 SYSTEM DIRECTLY FROM TRANSPORT USING**  
**THE 125-TON HI-TRAC 125D TRANSFER CASK**  
**ESTIMATED OPERATIONAL EXPOSURES<sup>†</sup> (75,000 MWD/MTU, 5-YEAR COOLED PWR FUEL)**

ACTION	DURATION (MINUTES)	OPERATOR LOCATION (FIGURE 10.3.1)	NUMBER OF OPERATORS	DOSE RATE AT OPERATOR LOCATION (MREM/HR)	DOSE TO INDIVIDUAL (MREM)	TOTAL DOSE (PERSON-MREM)	ASSUMPTIONS
INSTALL HI-STORM EXIT VENT GAMMA SHIELD CROSS PLATES	4	16B	1	205.5	13.7	13.7	4 PCS @ 1/MIN INSTALL BY HAND NO TOOLS
INSTALL TEMPERATURE ELEMENTS	20	16B	1	205.5	68.5	68.5	4@5MIN/TEMPERATURE ELEMENT
INSTALL EXIT VENT SCREENS	20	16B	1	205.5	68.5	68.5	4 SCREENS@5MIN/SCREEN
REMOVE HI-STORM LID LIFTING DEVICE	2	16A	1	11.7	0.4	0.4	4 SHACKLES@2/MIN
INSTALL HOLE PLUGS IN EMPTY HOLES	2	16A	1	11.7	0.4	0.4	4 PLUGS AT 2/MIN NO TORQUING
PERFORM SHIELDING EFFECTIVENESS TESTING	16	16D	1	122.7	32.7	32.7	16POINTS@1 MIN
SECURE HI-STORM TO TRANSPORT DEVICE	10	16A	1	11.7	2.0	2.0	ASSUMES AIR PAD
TRANSFER HI-STORM TO ITS DESIGNATED STORAGE LOCATION	40	16C	1	69.7	46.5	46.5	200 FEET @ 4FT/MIN
INSERT HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS @1/MIN
REMOVE AIR PAD	5	16D	1	122.7	10.2	10.2	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	122.7	8.2	8.2	4 JACKS @1/MIN
INSTALL INLET VENT SCREENS	20	16D	1	122.7	40.9	40.9	4 SCREENS@5MIN/SCREEN
PERFORM AIR TEMPERATURE RISE TEST	8	16B	1	205.5	27.4	27.4	8 MEASMT@1/MIN
<b>TOTAL</b>							<b>1198.6 PERSON-MREM</b>

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Table 10.3.4  
ESTIMATED EXPOSURES FOR HI-STORM 100 SURVEILLANCE AND MAINTENANCE

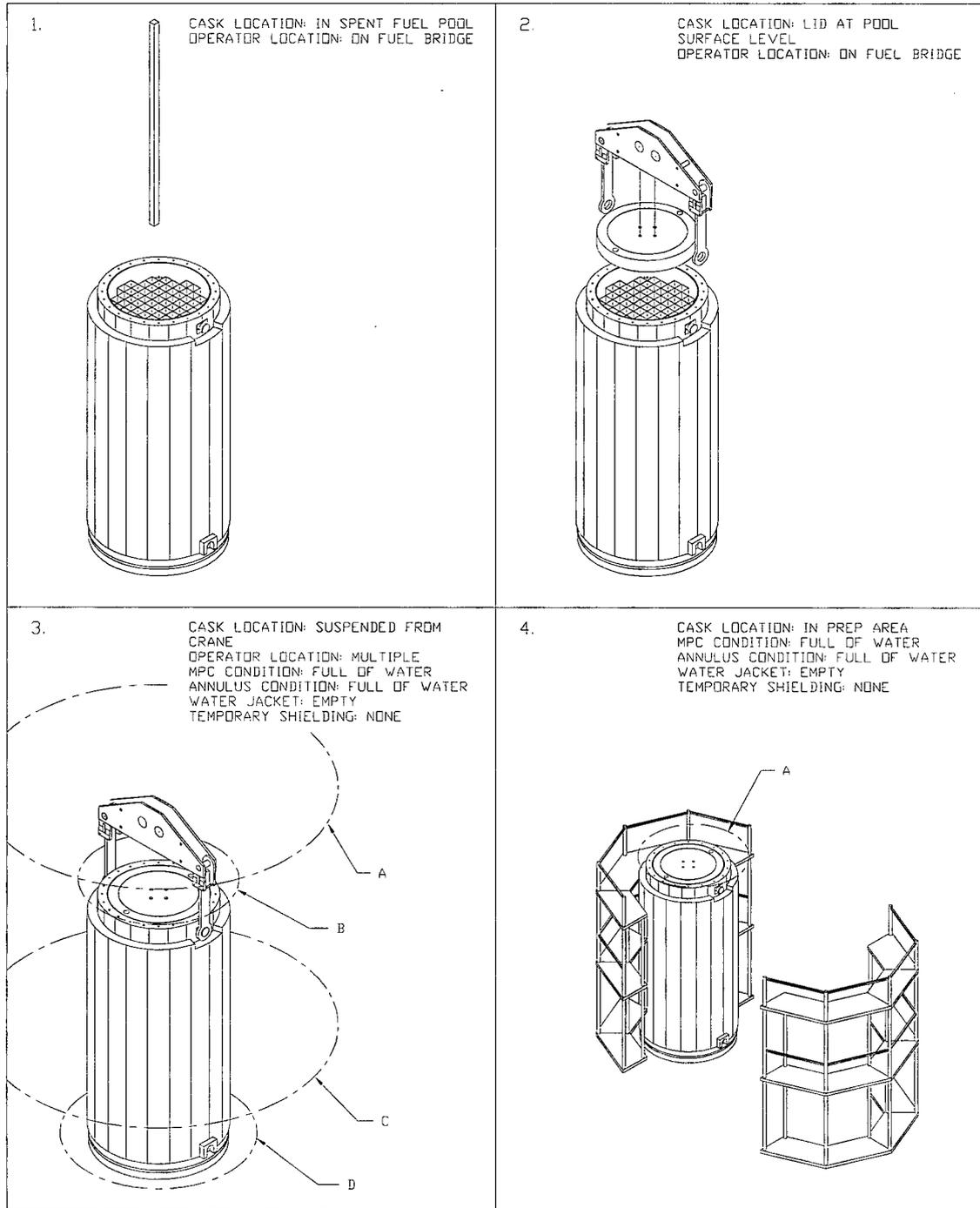
ACTIVITY	ESTIMATED PERSONNEL	ESTIMATED HOURS PER YEAR	ESTIMATED DOSE RATE (MREM/HR)	OCCUPATIONAL DOSE TO INDIVIDUAL (PERSON-MREM)
SECURITY SURVEILLANCE	1	30	3	90
ANNUAL MAINTENANCE	2	15	10	300

Notes for Tables 10.3.1a, 10.3.1b, 10.3.1c, 10.3.2a, 10.3.2b, 10.3.2c, 10.3.3a, 10.3.3b, 10.3.3c and 10.3.4:

1. Refer to Chapter 8 for detailed description of activities.
2. Number of operators may be set to 1 to simplify calculations where the duration is indirectly proportional to the number of operators. The total dose is equivalent in both respects.
3. HI-STAR 100 Operations assume that the cooling time is at least 10 years.

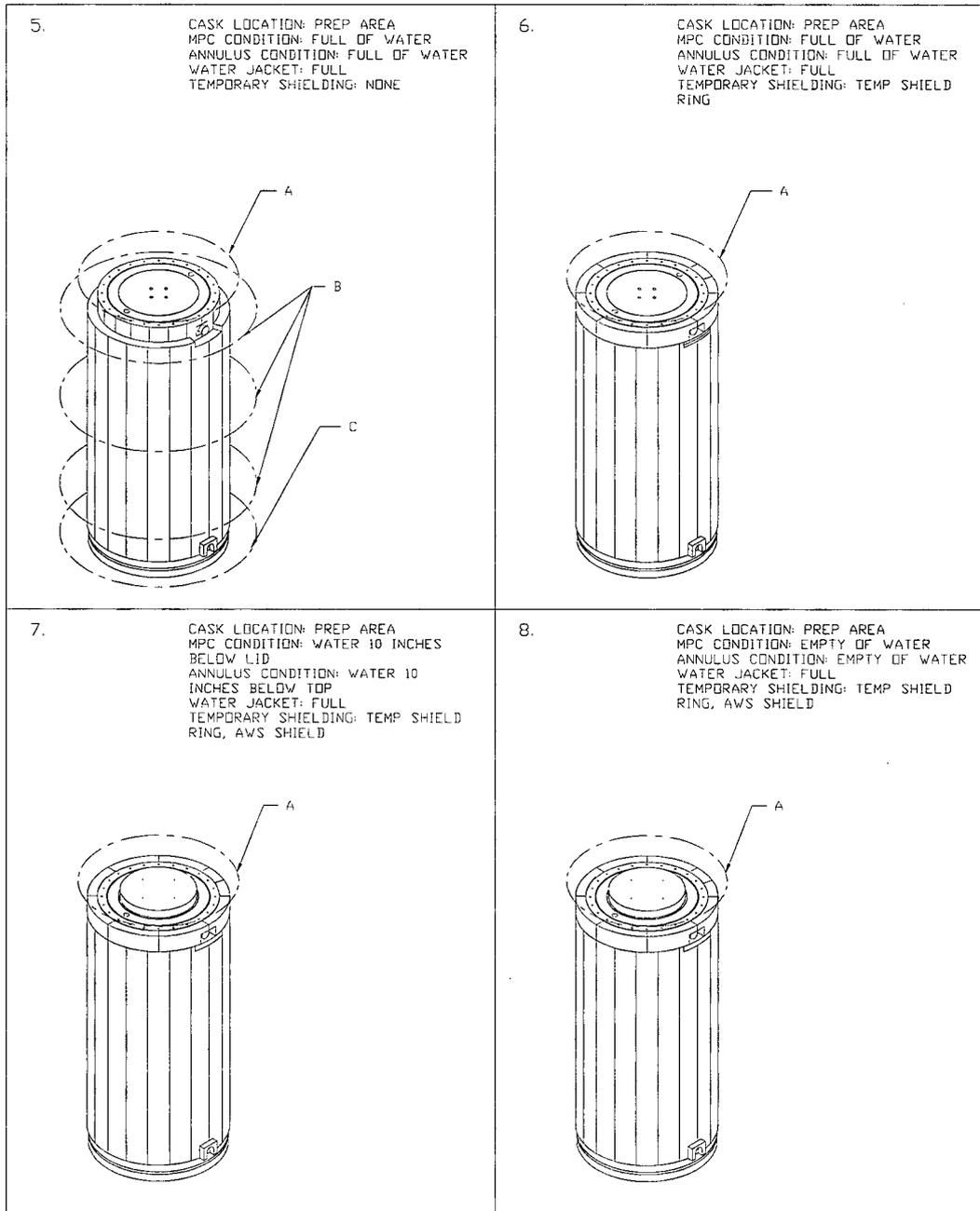
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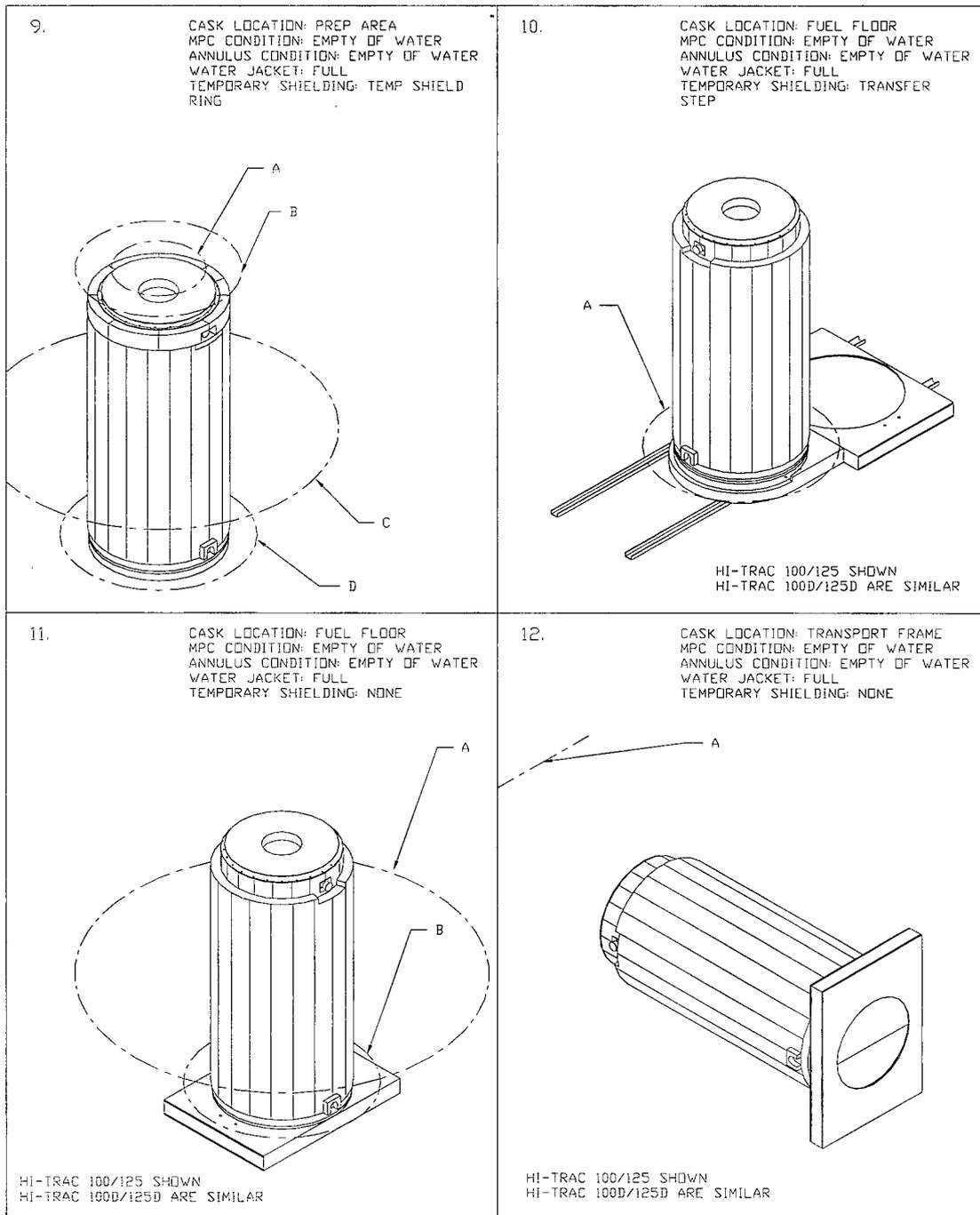


**Figure 10.3.1a; Operator Work Locations Used for Estimating Personnel Exposure**

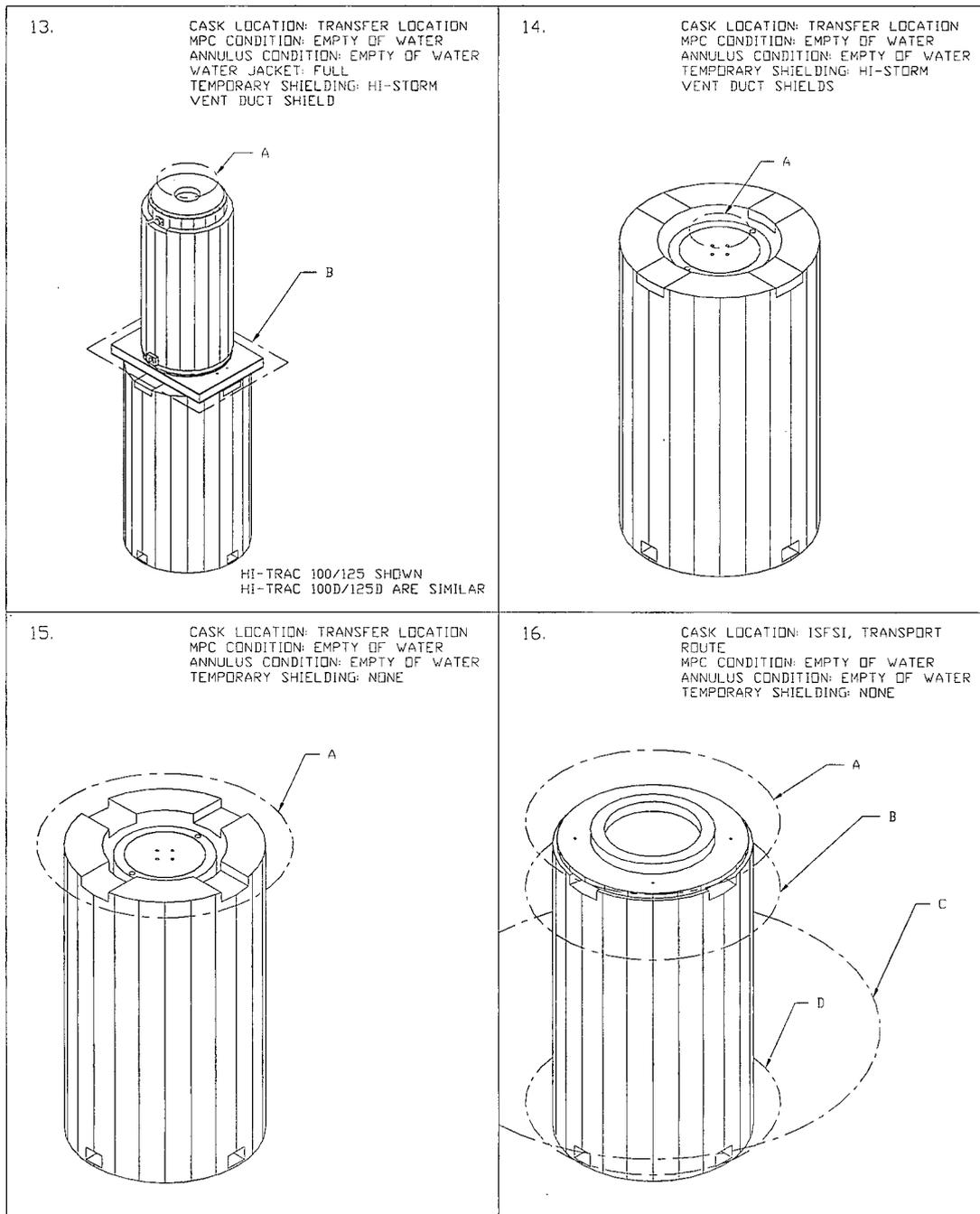
HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL



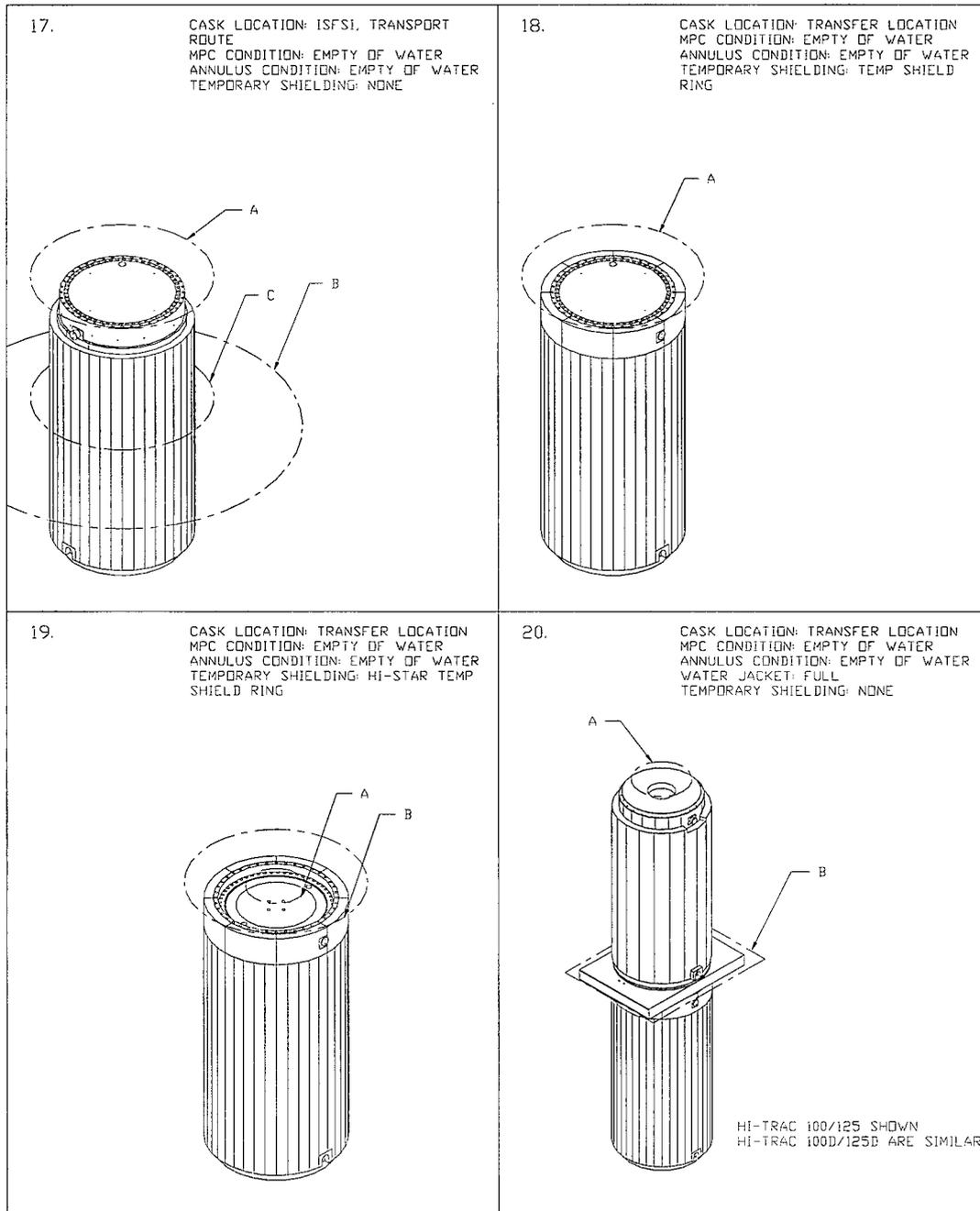
**Figure 10.3.1b; Operator Work Locations Used for Estimating Personnel Exposure**



**Figure 10.3.1c; Operator Work Locations Used for Estimating Personnel Exposure**



**Figure 10.3.1d; Operator Work Locations Used for Estimating Personnel Exposure**



**Figure 10.3.1c; Operator Work Locations Used for Estimating Personnel Exposure**

## 10.4 ESTIMATED COLLECTIVE DOSE ASSESSMENT

### 10.4.1 Controlled Area Boundary Dose for Normal Operations

10CFR72.104 [10.0.1] limits the annual dose equivalent to any real individual at the controlled area boundary to a maximum of 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem for any other critical organ. This includes contributions from all uranium fuel cycle operations in the region.

It is not feasible to predict bounding controlled area boundary dose rates on a generic basis since radiation from plant and other sources; the location and the layout of an ISFSI; and the number and configuration of casks are necessarily site-specific. In order to compare the performance of the HI-STORM 100 System with the regulatory requirements, sample ISFSI arrays were analyzed in Chapter 5. These represent a full array of design basis fuel assemblies. Users are required to perform a site specific dose analysis for their particular situation in accordance with 10CFR72.212 [10.0.1]. The analysis must account for the ISFSI (size, configuration, fuel assembly specifics) and any other radiation from uranium fuel cycle operations within the region.

Table 5.1.9 presents dose rates at various distances from sample ISFSI arrays for the design basis burnup and cooling time which results in the highest off-site dose for the combination of maximum burnup and minimum cooling times analyzed in Chapter 5. 10CFR72.106 [10.0.1] specifies that the minimum distance from the ISFSI to the controlled area boundary is 100 meters. Therefore this was the minimum distance analyzed in Chapter 5. As a summary of Chapter 5, Table 10.4.1 presents the annual dose results for a single overpack at 100 and 350 meters and a 2x5 array of HI-STORM 100 systems at 550 meters. These annual doses are based on a full array of design basis fuel with a burnup of 60,000 MWD/MTU and 3-year cooling. This burnup and cooling time combination conservatively bounds the allowable burnup and cooling times listed in Section 2.1.9. In addition, 100% occupancy (8760 hours) is conservatively assumed. In the calculation of the annual dose, the casks were positioned on an infinite slab of soil to account for earth-shine effects. These results indicate that the calculated annual dose is less than the regulatory limit of 25 mrem/year at a distance of 350 meters for a single cask and at 550 meters for a 2x5 array of HI-STORM 100 Systems containing design basis fuel. These results are presented only as an illustration to demonstrate that the HI-STORM 100 System is in compliance with 10CFR72.104[10.0.1]. Neither the distances nor the array configurations become part of the Technical Specifications. Rather, users are required to perform a site specific analyses to demonstrate compliance with 10CFR72.104[10.0.1] contributors and 10CFR20[10.1.1].

An additional contributor to the controlled area boundary dose is the loaded HI-TRAC transfer cask, if the HI-TRAC is to be used at the ISFSI outside of the fuel building. Table 10.4.2 provides dose rates at 100, 200, and 300 meters for a 100-ton HI-TRAC transfer cask loaded with design basis fuel. The 100-ton HI-TRAC dose rates bound the 125-ton HI-TRAC by large margins. Based on the short duration that the loaded HI-TRAC is used outside at the ISFSI, the HI-STORM 100 System is in compliance with

10CFR72.104[10.0.1] when worst-case design basis fuel is loaded in all fuel cell locations. However, users are required to perform a site specific analysis to demonstrate compliance with 10CFR72.104[10.0.1] and 10CFR20[10.1.1] taking into account the actual site boundary distance and fuel characteristics.

Section 7.1 provides a discussion as to how the Holtec MPC design, welding, testing, and inspection requirements meet the guidance of ISG-18 such that leakage from the confinement boundary may be considered non-credible. Therefore, there is no additional dose contribution due to leakage from the welded MPC. The site licensee is required to perform a site-specific dose evaluation of all dose contributors as part of the ISFSI design. This evaluation will account for the location of the controlled area boundary, the total number of casks on the ISFSI and the effects of the radiation from uranium fuel cycle operations within the region.

#### 10.4.2 Controlled Area Boundary Dose for Off-Normal Conditions

As demonstrated in Section 11.1, the postulated off-normal conditions (off-normal pressure, off-normal environmental temperatures, leakage of one MPC weld, partial blockage of air inlets, and off-normal handling of HI-TRAC) do not result in the degradation of the HI-STORM 100 System shielding effectiveness. Therefore, the dose at the controlled area boundary from direct radiation for off-normal conditions is equal to that of normal conditions.

#### 10.4.3 Controlled Area Boundary Dose for Accident Conditions

10CFR72.106 [10.0.1] specifies the maximum doses allowed to any individual at the controlled area boundary from any design basis accident (See Subsection 10.1.2). In addition, it is specified that the minimum distance from the ISFSI to the controlled area boundary be at least 100 meters.

Chapter 11 presents the results of the evaluations performed to demonstrate that the HI-STORM 100 System can withstand the effects of all accident conditions and natural phenomena without the corresponding radiation doses exceeding the requirements of 10CFR72.106 [10.0.1]. The accident events addressed in Chapter 11 include: handling accidents, tip-over, fire, tornado, flood, earthquake, 100 percent fuel rod rupture, confinement boundary leakage, explosion, lightning, burial under debris, extreme environmental temperature, partial blockage of MPC basket air inlets, and 100% blockage of air inlets.

The worst-case shielding consequence of the accidents evaluated in Section 11.2 for the loaded HI-STORM overpack assumes that as a result of a fire, the outer-most one inch of the concrete experiences temperatures above the concrete's design temperature. Therefore, the shielding effectiveness of this outer-most one inch of concrete is degraded. However, with over 25 inches of concrete providing shielding, the loss of one inch will have a negligible effect on the dose at the controlled area boundary.

The worst case shielding consequence of the accidents evaluated in Section 11.2 for the loaded HI-TRAC transfer cask assumes that as a result of a fire, tornado missile, or handling accident, the all the water in the water jacket is lost. The shielding analysis of the 100-ton HI-TRAC transfer cask with complete loss of the water from the water jacket is discussed in Section 5.1.2. These results bound those for the 125-Ton HI-TRAC transfer cask by a large margin. The results in that section show that the resultant dose rate at the 100-meter controlled area boundary would be approximately 4.22 mrem/hour for the loaded HI-TRAC transfer cask during the accident condition. At the calculated dose rate, it would take approximately 49 days for the dose at the controlled area boundary to reach 5 rem. This length of time is sufficient to implement and complete the corrective actions outlined in Chapter 11. Therefore, the dose requirement of 10CFR72.106 [10.0.1] is satisfied. Once again, this dose is calculated assuming design basis fuel in all fuel cell locations. Users will need to perform site-specific analysis considering the actual site boundary distance and fuel characteristics.

Table 10.4.1

ANNUAL DOSE FOR ARRAYS OF HI-STORM 100S VERSION B OVERPACKS  
WITH DESIGN BASIS ZIRCALOY CLAD FUEL  
60,000 MWD/MTU AND 3-YEAR COOLING

Array Configuration	1 Cask	1 Cask	2x5 Array
Annual Dose (mrem/year) <sup>†</sup>	883.27	19.26	16.34
Distance to Controlled Area Boundary (meters) <sup>††, †††</sup>	100	350	550

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† 100% occupancy is assumed.

†† Dose location is at the center of the long side of the array.

††† Actual controlled area boundary dose rates will be lower because the maximum permissible burnup for 3-year cooling as specified in the Section 2.1.9 is lower than the burnup analyzed for the design basis fuel used in this table.

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Table 10.4.2  
DOSE RATE FOR THE 100-TON HI-TRAC TRANSFER CASK  
WITH DESIGN BASIS ZIRCALOY CLAD FUEL

<b>Fuel Burnup &amp; Cooling Time</b>	<b>100 Meters</b>	<b>200 Meters</b>	<b>300 Meters</b>
<b>60,000 MWD/MTU &amp; 3 Years</b>	0.91 mrem/hr	0.14 mrem/hr	0.04 mrem/hr

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## 10.5 REFERENCES

- [10.0.1] *U.S. Code of Federal Regulations*, Title 10, "Energy" Part 72 "Licensing Requirements for Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste."
- [10.1.1] *U.S. Code of Federal Regulations*, Title 10, "Energy" Part 20 "Standards for Protection Against Radiation."
- [10.1.2] U.S. Nuclear Regulatory Commission "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power at Nuclear Power Stations will be As Low As Reasonably Achievable", Regulatory Guide 8.8, June 1978.
- [10.1.3] U.S. Nuclear Regulatory Commission, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As is Reasonably Achievable", Regulatory Guide 8.10, Revision 1-R, May1997.

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HI-STORM FSAR  
REPORT HI-2002444

10.5-1

Rev. 0

HI-STORM 100 FSAR  
REVISION 10  
APRIL 25, 2012

## SUPPLEMENT 10.I

### RADIATION PROTECTION

The HI-STORM 100U is a modular, underground vertical ventilated module (VVM) designed to accept all MPC models for storage at an ISFSI in lieu of above ground overpacks, like the HI-STORM 100 and HI-STORM 100S. As such, the radiological dose to plant personnel as well as members of the general public is well below those of the HI-STORM 100 and HI-STORM 100S when the MPC is in the overpack. Since the determination of off-site doses is necessarily site-specific, dose assessments similar to those described in Chapter 10 are to be prepared by the licensee as part of implementing the HI-STORM 100U System in accordance with 10CFR72.212 [10.0.1].

#### HI-STORM 100U Loading and Unloading Operations

The operations associated with the use of the HI-STORM 100U, described in Supplements 1.I and 8.I, are quite similar to the operations for all other variations of the HI-STORM 100 system. In both the aboveground and underground overpack, the MPC is transferred between the HI-TRAC and the overpack and in both cases the lid of the overpack is placed atop the overpack once the HI-TRAC is removed from the overpack. The only significant difference between the aboveground and underground overpack is the position of the HI-TRAC relative to ground level. For the aboveground overpack, the bottom of the HI-TRAC is approximately 18 feet above the ground and for the underground overpack, the bottom of the HI-TRAC is essentially at ground level. From an operations perspective, it will be easier to access the mating device and the pool lid bolts when the HI-TRAC is positioned atop the underground overpack rather than the aboveground overpack. In both cases, the same bolting and unbolting operations around the base of the HI-TRAC must be performed. Therefore, the estimated occupational dose for these scenarios is the same. The fact that the body of the HI-TRAC is closer to the ground when the underground overpack is being loaded will not affect the occupational dose rate since it is assumed that the workers not performing a task are positioned far enough away as to receive minimal dose.

Once the MPC transfer is complete and the HI-TRAC has been removed, the lid is placed on the overpack. For the underground overpack, this is a relatively simple operation of lifting the lid and placing it in the correct location. Unlike the aboveground overpack, the lid is not bolted to the body of the overpack. However, the outlet vent cover is installed on the overpack lid after the lid is placed upon the HI-STORM 100U, which installation requires bolting. Installation of the outlet vent cover places workers over the lid and adds some time to the operation. The duration of this operation can be estimated based on information provided in the tables in Section 10.3. Installation of the vent cover would be similar to the installation and alignment of the closure ring on top of the MPC. This activity is listed with an estimated duration of 5 min, for a single operator, in the tables in Section 10.3. Since the outlet vent cover is closer to the center of the lid than the closure ring, it is assumed here that two operators are required. There are four bolts, and bolt installation is typically listed in Section 10.3 to be performed at 2 bolts per minute, resulting in a duration of 2 minutes. Again, due to the location of those bolts, it is assumed that two

operators are necessary to perform this activity. In total, it is then conservatively estimated that it will take 10 minutes for two operators to perform the installation. The dose rate on top of the overpack lid is 31.53 mrem/hr (see Table 5.1.1), which translates to a dose to the individual of 5.26 mrem and a total dose of 10.51 person-mrem. This is a small increase (about 1 %) in the total dose when considering the entire MPC transfer into the HI-STORM system. However, it is recommended that the operators do not spend any unnecessary time on top of the lid to ensure/meet the ALARA principle. It should also be mentioned that actual occupational dose during loading vary widely depending on site specific conditions. Experience has shown that the dose rates are in general significantly lower than those estimated in Chapter 10 of this FSAR.

In conclusion, the operator dose rates will be similar to those described in Chapter 10 for the aboveground overpack. Therefore, occupational exposure estimates for typical canister loading, closure, transfer operations, and ISFSI inspections may be calculated using the information presented in the tables of Chapter 10 for the site-specific application of the HI-STORM 100U system. For the fuel loading/unloading, transportation, and storage operations utilizing the HI-STORM 100U, the dose information provided in Chapter 10 may be considered bounding.

### Excavation Activities

In the event it is desired to expand an ISFSI utilizing the HI-STORM 100U design, excavation of material (i.e., soil) is required. Radiation protection of the excavation activities is achieved by prescribing a minimum proximity of any excavation to an existing HI-STORM 100U array. Site specific radiation protection measures for excavation activities need to include confirmation of the minimum soil properties along with the minimum distances between the excavation area and the loaded VVMs, as well as radiological monitoring of the excavation area.

Site specific evaluations also need to be performed to ensure that the radiation protection space boundary is maintained. Site specific accident scenarios (e.g., seismic conditions) will need to be accounted for in these evaluations. A general accident scenario evaluation, however, has been performed for the HI-STORM 100U design. The impact of a tornado missile penetrating the soil creating a horizontal hole extending from the metal surface of the VVM to the outer surface of the soil was considered. This evaluation, presented in Supplement 5.1, demonstrates that the dose at the site boundary is below the limit specified in 10 CFR 72.

### Normal Operation of Storage

During normal operation of storage, radiation will predominantly emanate from the inlet and outlet vents and the top of the lid. However, there are also some additional radiation streaming paths and scenarios that may have to be considered in the radiation protection program. The following two scenarios have been evaluated for the HI-STORM 100U design.

The first scenario evaluated address radiation streaming from a loaded VVM through an adjacent empty VVM. An empty VVM adjacent to a loaded VVM could potentially constitute a radiation

streaming path since the soil providing shielding is limited between adjacent VVMs. Therefore, radiation passing through the soil to the unloaded VVM will have a path of less shielding and could contribute to occupational dose. This evaluation is presented in detail in Supplement 5.I, and concluded that there are no concerns about the dose rates contributing to occupational dose across the top of the empty VVM due to radiation streaming from the loaded neighboring VVM.

The second scenario concerns the soil access tube, or test station, that is part of the ICCPS design (see Figure 2.I.1) and could represent a potential streaming path. Therefore, radiation passing through the soil access tube could contribute to occupational dose. This evaluation is presented in detail in Supplement 5.I, and assumes a tube located about 5.5 feet from the center of the VVM with a diameter of 4 inches, that reaches down to the support foundation. With these dimensions, it is shown that there are no concerns about the dose rates contributing to occupational dose on the top of the soil access tube due to radiation streaming from a loaded VVM. However, if the tube is larger or located closer to the VVM, then the actual dimensions should be considered in the site specific dose rate calculations, and the result of the calculations should be considered in the site specific radiation protection program.

## CHAPTER 11<sup>†</sup>: ACCIDENT ANALYSIS

This chapter presents the evaluation of the HI-STORM 100 System for the effects of off-normal and postulated accident conditions. The design basis off-normal and postulated accident events, including those resulting from mechanistic and non-mechanistic causes as well as those caused by natural phenomena, are identified in Subsections 2.2.2 and 2.2.3. For each postulated event, the event cause, means of detection, consequences, and corrective action are discussed and evaluated. As applicable, the evaluation of consequences includes structural, thermal, shielding, criticality, confinement, and radiation protection evaluations for the effects of each design event.

The structural, thermal, shielding, criticality, and confinement features and performance of the HI-STORM 100 System are discussed in Chapters 3, 4, 5, 6, and 7. The evaluations provided in this chapter are based on the design features and evaluations described therein.

Chapter 11 is in full compliance with NUREG-1536; no exceptions are taken.

### 11.1 OFF-NORMAL CONDITIONS

Off-normal operations, as defined in accordance with ANSI/ANS-57.9, are those conditions, which, although not occurring regularly, are expected to occur no more than once a year. In this section, design events pertaining to off-normal operation for expected operational occurrences are considered. The off-normal conditions are listed in Subsection 2.2.2.

The following off-normal operation events have been considered in the design of the HI-STORM 100:

- Off-Normal Pressure
- Off-Normal Environmental Temperature
- Leakage of One MPC Seal Weld
- Partial Blockage of Air Inlets
- Off-Normal Handling of HI-TRAC Transfer Cask
- Malfunction of FHD System
- SCS Power Failure
- Off-Normal Loads<sup>‡</sup>

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<sup>†</sup> This chapter has been prepared in the format and section organization set forth in Regulatory Guide 3.61. However, the material content of this chapter also fulfills the requirements of NUREG-1536. Pagination and numbering of sections, figures, and tables are consistent with the convention set down in Chapter 1, Section 1.0, herein. Finally, all terms-of-art used in this chapter are consistent with the terminology of the glossary (Table 1.0.1). This chapter has been substantially revised in support of LAR#3 to enhance clarity of presentation and evaluation of results. Because of extensive editing a clean chapter is issued with this amendment.

<sup>‡</sup> Off-normal load combinations are defined in Chapter 2, Table 2.2.14 and evaluated in Chapter 3, Section 3.4.

For each event, the postulated cause of the event, detection of the event, analysis of the event effects and consequences, corrective actions, and radiological impact from the event are presented.

The results of the evaluations performed herein demonstrate that the HI-STORM 100 System can withstand the effects of off-normal events without affecting function, and are in compliance with the applicable acceptance criteria. The following subsections present the evaluation of the HI-STORM 100 System for the design basis off-normal conditions that demonstrate that the requirements of 10CFR72.122 are satisfied, and that the corresponding radiation doses satisfy the requirements of 10CFR72.104(a) and 10CFR20.

#### 11.1.1 Off-Normal Pressures

The sole pressure boundary in the HI-STORM 100 System is the MPC enclosure vessel. The off-normal pressure condition is specified in Subsection 2.2.2. The off-normal pressure for the MPC internal cavity is a function of the initial helium fill pressure and the temperature reached within the MPC cavity under normal storage. The MPC internal pressure is evaluated with 10% of the fuel rods ruptured and 100% of the rods fill gas and 30% of the fission gases released to the cavity.

##### 11.1.1.1 Postulated Cause of Off-Normal Pressure

After fuel assembly loading, the MPC is drained, dried, and backfilled with an inert gas (helium) to assure long-term fuel cladding integrity during dry storage. Therefore, the probability of failure of intact fuel rods in dry storage is low. Nonetheless, the event is postulated and evaluated.

##### 11.1.1.2 Detection of Off-Normal Pressure

The HI-STORM 100 System is designed to withstand the MPC off-normal internal pressure without any effects on its ability to meet its safety requirements. There is no requirement for detection of off-normal pressure and, therefore, no monitoring is required.

##### 11.1.1.3 Analysis of Effects and Consequences of Off-Normal Pressure

The MPC off normal internal pressure is reported in Subsection 4.6.1 for the following conditions: limiting fuel storage scenario, tech. spec. maximum helium backfill and 10% rod rupture with 100% of rod fill gas and 30% of gaseous fission products released into the MPC cavity. The analysis shows that the MPC pressure remains below the design MPC internal pressure (Table 2.2.1).

It should be noted that this bounding temperature rise does not take any credit for the increase in thermosiphon action that would accompany the pressure increase that results from both the temperature rise and the addition of the gaseous fission products to the MPC cavity. As any such increase in thermosiphon action would decrease the temperature rise, the calculated pressure is higher than would actually occur.

### Structural

The structural evaluation of the MPC enclosure vessel for off-normal internal pressure conditions is discussed in Section 3.4. The stresses resulting from the off-normal pressure are confirmed to be bounded by the applicable pressure boundary stress limits.

### Thermal

The MPC internal pressure for off-normal conditions is reported in Subsection 4.6.1. The design basis internal pressure for off-normal conditions used in the structural evaluation (Table 2.2.1) bounds the off-normal condition pressure. .

### Shielding

There is no effect on the shielding performance of the system as a result of this off-normal event.

### Criticality

There is no effect on the criticality control features of the system as a result of this off-normal event.

### Confinement

There is no effect on the confinement function of the MPC as a result of this off-normal event. As discussed in the structural evaluation above, all stresses remain within allowable values, assuring confinement boundary integrity.

### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this off-normal event.

Based on this evaluation, it is concluded that the off-normal pressure does not affect the safe operation of the HI-STORM 100 System.

#### 11.1.1.4 Corrective Action for Off-Normal Pressure

The HI-STORM 100 System is designed to withstand the off-normal pressure without any effects on its ability to maintain safe storage conditions. There is no corrective action requirement for off-normal pressure.

#### 11.1.1.5 Radiological Impact of Off-Normal Pressure

The event of off-normal pressure has no radiological impact because the confinement barrier and shielding integrity are not affected.

### 11.1.2 Off-Normal Environmental Temperatures

The HI-STORM 100 System is designed for use at any site in the United States. Off-normal environmental temperatures of -40 to 100°F (HI-STORM overpack) and 0 to 100°F (HI-TRAC transfer cask) have been conservatively selected to bound off-normal temperatures at these sites. The off-normal temperature range affects the entire HI-STORM 100 System and must be evaluated against the allowable component design temperatures. The off-normal temperatures are evaluated against the off-normal condition temperature limits listed in Table 2.2.3.

#### 11.1.2.1 Postulated Cause of Off-Normal Environmental Temperatures

The off-normal environmental temperature is postulated as a constant ambient temperature caused by extreme weather conditions. To determine the effects of the off-normal temperatures, it is conservatively assumed that these temperatures persist for a sufficient duration to allow the HI-STORM 100 System to achieve thermal equilibrium. Because of the large mass of the HI-STORM 100 System with its corresponding large thermal inertia and the limited duration for the off-normal temperatures, this assumption is conservative.

#### 11.1.2.2 Detection of Off-Normal Environmental Temperatures

The HI-STORM 100 System is designed to withstand the off-normal environmental temperatures without any effects on its ability to maintain safe storage conditions. There is no requirement for detection of off-normal environmental temperatures for the HI-STORM overpack and MPC. Chapter 2 provides operational limitations to the use of the HI-TRAC transfer cask at temperatures of  $\leq 32^\circ\text{F}$  and prohibits use of the HI-TRAC transfer cask below  $0^\circ\text{F}$ .

#### 11.1.2.3 Analysis of Effects and Consequences of Off-Normal Environmental Temperatures

The off-normal event considers an environmental temperature of  $100^\circ\text{F}$  with insolation for a duration sufficient to reach thermal equilibrium. The evaluation is performed for a limiting fuel storage configuration. The Off-Normal ambient temperature condition is evaluated in Subsection 4.6.1. The results are in compliance with off-normal temperature and pressure limits in Tables 2.2.1 and 2.2.3.

The off-normal event considering an environmental temperature of  $-40^\circ\text{F}$  and no solar insolation for a duration sufficient to reach thermal equilibrium is evaluated with respect to material design temperatures of the HI-STORM overpack. The HI-STORM overpack and MPC are conservatively assumed to reach  $-40^\circ\text{F}$  throughout the structure. The minimum off-normal environmental temperature specified for the HI-TRAC transfer cask is  $0^\circ\text{F}$  and the HI-TRAC is conservatively assumed to reach  $0^\circ\text{F}$  throughout the structure. For ambient temperatures from  $0^\circ$  to  $32^\circ\text{F}$ , antifreeze must be added to the demineralized water in the water jacket to prevent freezing. Chapter 3, Subsection 3.1.2, details the structural analysis and testing performed to assure prevention of brittle fracture failure of the HI-STORM 100 System.

### Structural

The effect on the MPC for the upper off-normal thermal conditions (i.e., 100°F) is an increase in the internal pressure. As shown in Subsection 4.6.1, the resultant pressure is below the off-normal design pressure (Table 2.2.1). The effect of the lower off-normal thermal conditions (i.e., -40°F) requires an evaluation of the potential for brittle fracture. Such an evaluation is presented in Subsection 3.1.2.

### Thermal

The resulting off-normal system and fuel assembly cladding temperatures for the hot conditions are provided in Subsection 4.6.1 for the HI-STORM overpack and MPC. As can be seen from this table, all temperatures for the off-normal environmental temperatures event are within the allowable values for off-normal conditions listed in Table 2.2.3.

### Shielding

There is no effect on the shielding performance of the system as a result of this off-normal event.

### Criticality

There is no effect on the criticality control features of the system as a result of this off-normal event.

### Confinement

There is no effect on the confinement function of the MPC as a result of this off-normal event.

### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this off-normal event.

Based on this evaluation, it is concluded that the specified off-normal environmental temperatures do not affect the safe operation of the HI-STORM 100 System.

#### 11.1.2.4 Corrective Action for Off-Normal Environmental Temperatures

The HI-STORM 100 System is designed to withstand the off-normal environmental temperatures without any effects on its ability to maintain safe storage conditions. There are no corrective actions required for off-normal environmental temperatures.

#### 11.1.2.5 Radiological Impact of Off-Normal Environmental Temperatures

Off-normal environmental temperatures have no radiological impact, as the confinement barrier and shielding integrity are not affected.

#### 11.1.3 Leakage of One Seal

The HI-STORM 100 System has a reliable welded boundary to contain radioactive fission products within the confinement boundary. The radioactivity confinement boundary is defined by the MPC shell, baseplate, MPC lid, vent and drain port cover plates, and associated welds. The closure ring provides a redundant welded closure to the release of radioactive material from the MPC cavity through the field-welded MPC lid closures. Confinement boundary welds are inspected by radiography or ultrasonic examination except for field welds that are examined by the liquid penetrant method on the root (for multi-pass welds) and final pass, at a minimum. Field welds are performed on the MPC lid, the MPC vent and drain port covers, and the MPC closure ring. The welds on the vent and drain port cover plates are leakage tested. Additionally, the MPC lid weld is subjected to a pressure test to verify its integrity.

Section 7.1 provides a discussion as to how the MPC design, welding, testing and inspection requirements meet the guidance of ISG-18 such that leakage from the confinement boundary may be considered non-credible.

##### 11.1.3.1 Postulated Cause of Leakage of One Seal in the Confinement Boundary

There is no credible cause for the leakage of one seal in the confinement boundary. The conditions analyzed in Chapter 3 shows that the confinement boundary components are maintained within their Code-allowable stress limits under all normal and off-normal storage conditions. The MPC lid-to-shell weld meets the requirements of ISG-18, such that leakage from the confinement boundary is not considered credible. Therefore, there is no event that could cause leakage of one seal in the confinement boundary.

##### 11.1.3.2 Detection of Leakage of One Seal in the Confinement Boundary

The HI-STORM 100 System is designed such that leakage of one seal in the confinement boundary is not considered a credible scenario. Therefore, there is no requirement to detect leakage from one seal.

##### 11.1.3.3 Corrective Action for Leakage of One Seal in the Confinement Boundary

There is no corrective action required for the failure of one weld in the closure system of the confinement boundary. Leakage of one weld in the confinement boundary closure system is not a credible event.

#### 11.1.3.4 Radiological Impact of Leakage of One Seal in the Confinement Boundary

The off-normal event of the failure of one weld in the confinement boundary closure system has no radiological impact because leakage from the confinement barrier is not credible.

#### 11.1.4 Partial Blockage of Air Inlets

The HI-STORM 100 System is designed with debris screens on the inlet and outlet air ducts. These screens ensure the air ducts are protected from the incursion of foreign objects. There are four air inlet ducts 90° apart and it is highly unlikely that blowing debris during normal or off-normal operation could block all air inlet ducts. As required by the design criteria presented in Chapter 2, it is conservatively assumed that two of the four air inlet ducts are blocked. The blocked air inlet ducts are assumed to be completely blocked with an ambient temperature of 80°F (Table 2.2.2), full solar insolation, and maximum SNF decay heat values. This condition is analyzed to demonstrate the inherent thermal stability of the HI-STORM 100 System.

##### 11.1.4.1 Postulated Cause of Partial Blockage of Air Inlets

It is conservatively assumed that the blocked air inlet ducts are completely blocked, although screens prevent foreign objects from entering the ducts. The screens are either inspected periodically or the outlet duct air temperature is monitored. It is, however, possible that blowing debris may block two air inlet ducts of the overpack.

##### 11.1.4.2 Detection of Partial Blockage of Air Inlets

The detection of the partial blockage of air inlet ducts will occur during the routine visual inspection of the screens or temperature monitoring of the outlet duct air. The frequency of inspection is based on an assumed complete blockage of all four air inlet ducts. There is no inspection requirement as a result of the postulated two inlet duct blockage, because the complete blockage of all four air inlet ducts is bounding.

##### 11.1.4.3 Analysis of Effects and Consequences of Partial Blockage of Air Inlets

###### Structural

There are no structural consequences as a result of this off-normal event.

###### Thermal

The thermal analysis for the two air inlet ducts blocked off-normal condition is performed in Subsection 4.6.1. The analysis demonstrates that under bounding (steady-state) conditions, no system components exceed the off-normal temperature limits in Table 2.2.3.

### Shielding

There is no effect on the shielding performance of the system as a result of this off-normal event.

### Criticality

There is no effect on the criticality control features of the system as a result of this off-normal event.

### Confinement

There is no effect on the confinement function of the MPC as a result of this off-normal event.

### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this off-normal event.

Based on this evaluation, it is concluded that the specified off-normal partial blockage of air inlet ducts event does not affect the safe operation of the HI-STORM 100 System.

#### 11.1.4.4 Corrective Action for Partial Blockage of Air Inlets

The corrective action for the partial blockage of air inlet ducts is the removal, cleaning, and replacement of the affected mesh screens. After clearing of the blockage, the storage module temperatures will return to the normal temperatures reported in Chapter 4. Partial blockage of air inlet ducts does not affect the HI-STORM 100 System's ability to operate safely.

Periodic inspection of the HI-STORM overpack air duct screens is required. Alternatively, the outlet duct air temperature is monitored. The frequency of inspection is based on an assumed blockage of all four air inlet ducts analyzed in Section 11.2.

#### 11.1.4.5 Radiological Impact of Partial Blockage of Air Inlets

The off-normal event of partial blockage of the air inlet ducts has no radiological impact because the confinement barrier is not breached and shielding is not affected.

#### 11.1.5 Off-Normal Handling of HI-TRAC

During upending and/or downending of the HI-TRAC transfer cask, the total lifted weight is distributed among both the upper lifting trunnions and the lower pocket trunnions. Each of the four trunnions on the HI-TRAC therefore supports approximately one-quarter of the total weight. This even distribution of the load would continue during the entire rotation operation.

If the lifting device is allowed to "go slack", the total weight would be applied to the lower pocket trunnions only. Under this off-normal condition, the pocket trunnions would each be required to

support one-half of the total weight, doubling the load per trunnion. This condition is analyzed to demonstrate that the pocket trunnions possess sufficient strength to support the increased load under this off-normal condition.

This off-normal condition does not apply to the HI-TRAC 125D, which does not have lower pocket trunnions. Upending and downending of the HI-TRAC 125D is performed using an L-frame.

#### 11.1.5.1 Postulated Cause of Off-Normal Handling of HI-TRAC

If the cable of the crane handling the HI-TRAC is inclined from the vertical, it would be possible to unload the upper lifting trunnions such that the lower pocket trunnions are supporting the total cask weight and the lifting trunnions are only preventing cask rotation.

#### 11.1.5.2 Detection of Off-Normal Handling of HI-TRAC

Handling procedures and standard rigging practice call for maintaining the crane cable in a vertical position by keeping the crane trolley centered over the lifting trunnions. In such an orientation it is not possible to completely unload the lifting trunnions without inducing rotation. If the crane cable were inclined from the vertical, however, the possibility of unloading the lifting trunnions would exist. It is therefore possible to detect the potential for this off-normal condition by monitoring the incline of the crane cable with respect to the vertical.

#### 11.1.5.3 Analysis of Effects and Consequences of Off-Normal Handling of HI-TRAC

If the upper lifting trunnions are unloaded, the lower pocket trunnions will support the total weight of the loaded HI-TRAC. The analysis of the pocket trunnions to support the applied load of one-half of the total weight is provided in Subsection 3.4.4. The consequence of off-normal handling of the HI-TRAC is that the pocket trunnions safely support the applied load.

#### Structural

The stress evaluations of the lower pocket trunnions are discussed in Subsection 3.4.4. All stresses are within the allowable values.

#### Thermal

There is no effect on the thermal performance of the system as a result of this off-normal event.

#### Shielding

There is no effect on the shielding performance of the system as a result of this off-normal event.

#### Criticality

There is no effect on the criticality control features of the system as a result of this off-normal event.

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## Confinement

There is no effect on the confinement function of the MPC as a result of this off-normal event.

## Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this off-normal event.

Based on this evaluation, it is concluded that the specified off-normal handling of the HI-TRAC does not affect the safe operation of the system.

### 11.1.5.4 Corrective Action for Off-Normal Handling of HI-TRAC

The HI-TRAC transfer casks are designed to withstand the off-normal handling condition without any adverse effects. There are no corrective actions required for off-normal handling of HI-TRAC other than to attempt to maintain the crane cable vertical during HI-TRAC upending or downending.

### 11.1.5.5 Radiological Consequences of Off-Normal Handling of HI-TRAC

The off-normal event of off-normal handling of HI-TRAC has no radiological impact because the confinement barrier is not breached and shielding is not affected.

### 11.1.6 Malfunction of FHD System

The FHD system is a forced helium circulation device used to effectuate moisture removal from loaded MPCs. For circulating helium, the FHD system is equipped with active components requiring external power for normal operation.

#### 11.1.6.1 Postulated Cause of FHD Malfunction

Likely causes of FHD malfunction are (i) a loss of external power to the FHD System and (ii) an active component trip. In both cases a stoppage of forced helium circulation occurs. Such a circulation stoppage does not result in any helium leakage from the MPC or the FHD itself.

#### 11.1.6.2 Detection of FHD Malfunction

The FHD System is monitored during its operation. An FHD malfunction is detected by operator response to control panel visual displays and alarms.

### 11.1.6.3 Analysis of Effects and Consequences of FHD Malfunction

#### Structural

The FHD System is required to be equipped with safety relief devices§ to prevent the MPC structural boundary pressures from exceeding the design limits. Consequently there is no adverse effect.

#### Thermal

Malfunction of the FHD System is categorized as an off-normal condition, for which the applicable peak cladding temperature limit is 1058°F (Table 2.2.3). The FHD System malfunction event is evaluated assuming the following bounding conditions:

- 1) Steady state maximum temperatures have been reached
- 2) Design basis heat load
- 3) Standing column of air in the annulus
- 4) MPCs backfilled with the minimum helium pressure required by the Technical Specifications

It is noted that operator action may be required to raise the helium regulator set point to ensure that condition 4 above is satisfied. These conditions are the same as for the normal on-site transfer in a vertically oriented HI-TRAC, discussed in Section 4.5. The steady state results are provided in Table 4.5.4. The results demonstrate that the peak fuel cladding temperatures remain below the limit in the event of a prolonged unavailability of the FHD system.

#### Shielding

There is no effect on the shielding performance of the system as a result of this off-normal event.

#### Criticality

There is no effect on the criticality control of the system as a result of this off-normal event.

#### Confinement

There is no effect on the confinement function of the MPC as a result of this off-normal event. As discussed in the structural evaluation above, the structural boundary pressures cannot exceed the design limits.

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§ The relief pressure is below the off-normal design pressure (Table 2.2.1) to prevent MPC overpressure and above 7 atm to enable MPC pressurization for adequate heat transfer.

## Radiation Protection

As there is no adverse effect on the shielding or confinement functions, there is no effect on occupational or public exposures as a result of this off-normal event.

Based on this evaluation, it is concluded that the FHD malfunction does not affect the safe operation of the HI-STORM 100 System.

### 11.1.6.4 Corrective Action for FHD Malfunction

The HI-STORM 100 System is designed to withstand the FHD malfunction without an adverse effect on its safety functions. Consequently no corrective action is required.

### 11.1.6.5 Radiological Impact of FHD Malfunction

The event has no radiological impact because the confinement barrier and shielding integrity are not affected.

### 11.1.7 SCS Power Failure

The SCS system is a fluid circulation device used to provide supplemental HI-TRAC cooling. For fluid circulation, the SCS system is equipped with active components requiring power for normal operation.

#### 11.1.7.1 Postulated Cause of SCS Power Failure

The SCS is normally operated from an external source of power such as from site utilities or a feed from a heavy haul vehicle carrying the HI-TRAC. Occasional interruption in power supply is possible.

#### 11.1.7.2 Detection of SCS Power Failure

The HI-STORM 100 System is designed to withstand a power failure without affecting its ability to meet safety requirements. Consequently SCS monitoring and failure detection is not required.

#### 11.1.7.3 Analysis of Effects and Consequences of SCS Power Failure

The SCS System is required to be equipped with a backup power supply (See SCS specifications in Chapter 2, Appendix 2.C). This ensures uninterrupted operation of the SCS following a power failure. Consequently, a power failure does not effect SCS operation.

## Structural

There is no effect on the structural integrity.

### Thermal

There is no effect on thermal performance.

### Shielding

There is no effect on the shielding performance.

### Criticality

There is no effect on the criticality control.

### Confinement

There is no effect on the confinement function.

### Radiation Protection

As there is no effect on the shielding or confinement functions, there is no effect on occupational or public exposures.

Based on this evaluation, it is concluded that the SCS failure does not affect the safe operation of the HI-STORM 100 System.

#### 11.1.7.4 Corrective Action for SCS Power Failure

The HI-STORM 100 System is designed to withstand a power failure without an adverse effect on its normal operation. Consequently no corrective action is required.

#### 11.1.7.5 Radiological Impact of SCS Power Failure

The event has no radiological impact because the confinement barrier and shielding integrity are not affected.

## 11.2 ACCIDENTS

Accidents, in accordance with ANSI/ANS-57.9, are either infrequent events that could reasonably be expected to occur during the lifetime of the HI-STORM 100 System or events postulated because their consequences may affect the public health and safety. Subsection 2.2.3 defines the design basis accidents considered. By analyzing for these design basis events, safety margins inherently provided in the HI-STORM 100 System design can be quantified.

The results of the evaluations performed herein demonstrate that the HI-STORM 100 System can withstand the effects of all credible and hypothetical accident conditions and natural phenomena without affecting safety function, and are in compliance with the acceptable criteria. The following sections present the evaluation of the design basis postulated accident conditions and natural phenomena which demonstrate that the requirements of 10CFR72.122 are satisfied, and that the corresponding radiation doses satisfy the requirements of 10CFR72.106(b) and 10CFR20.

The load combinations evaluated for postulated accident conditions are defined in Table 2.2.14. The load combinations include normal loads with the accident loads. The accident load combination evaluations are provided in Section 3.4.

### 11.2.1 HI-TRAC Transfer Cask Handling Accident

#### 11.2.1.1 Cause of HI-TRAC Transfer Cask Handling Accident

During the operation of the HI-STORM 100 System, the loaded HI-TRAC transfer cask is transported to the ISFSI in a vertical position. Unless the lifting device is designed in accordance with the criteria specified in Subsection 2.3.3, the height of the loaded overpack above the ground shall be limited to below the handling height limit determined in Chapter 3 to limit the inertia loading on the cask in a horizontal drop to less than 45g's. Although a handling accident is remote, a cask drop from the horizontal handling height limit is credible only if the lifting device is not designed in accordance with the criteria specified in Subsection 2.3.3. A vertical drop of the loaded HI-TRAC transfer cask is not a credible accident as the loaded HI-TRAC shall be transported and handled in the vertical orientation by devices designed in accordance with the criteria specified in Subsection 2.3.3 and a horizontal drop is precluded as HI-TRAC is transported in the vertical orientation. Nevertheless, for defense-in-depth a drop from a horizontal orientation is postulated and structural consequences evaluated. .

#### 11.2.1.2 HI-TRAC Transfer Cask Handling Accident Analysis

The handling accident analysis evaluates the effects of dropping the loaded HI-TRAC in the horizontal position. The analysis of the handling accident is provided in Chapter 3. The analysis shows that the HI-TRAC meets all structural requirements and there is no adverse effect on the confinement, thermal or subcriticality performance of the contained MPC. Limited localized damage to the HI-TRAC water jacket shell and loss of the water in the water jacket may occur as a result of the handling accident. The HI-TRAC top lid and transfer lid housing (pool lid for the HI-TRAC 125D) are demonstrated to remain attached by withstanding the maximum deceleration. The transfer

lid doors (not applicable to HI-TRAC 125D) are also shown to remain closed during the drop. Limiting the inertia loading to 60g's or less ensures the fuel cladding remains intact based on dynamic impact effects on spent fuel assemblies in the literature [11.2.1]. Therefore, demonstrating that the 45g limit for the HI-TRAC transfer cask is met ensures that the fuel cladding remains intact.

### Structural

The structural evaluation of the MPC for 45g's is provided in Section 3.4. As discussed in Section 3.4, the MPC stresses as a result of the HI-TRAC side drop, 45g loading, are all within allowable values.

As discussed above, the water jacket enclosure shell could be punctured which results in a loss of the water within the water jacket. Additionally, the HI-TRAC top lid, transfer lid (pool lid for the HI-TRAC 125D), and transfer lid doors (not applicable to HI-TRAC 125D) are shown to remain in position under the 45g loading. Analysis of the lead in the HI-TRAC is performed in Appendix 3.F and it is shown that there is no appreciable change in the lead shielding.

### Thermal

The loss of the water in the water jacket causes the temperatures to increase due to a reduction in the thermal conductivity through the HI-TRAC water jacket. An analysis of the MPC in the HI-TRAC transfer cask temperatures with no water in the water jacket is presented in Subsection 4.6.2. The analysis results are below the short-term allowable fuel cladding and material temperatures limits for accident conditions.

### Shielding

The assumed loss of the water in the water jacket results in an increase in the radiation dose rates at locations adjacent to the water jacket. The shielding analysis results presented in Chapter 5 demonstrate that the requirements of 10CFR72.106 are not exceeded. As the structural analysis demonstrates that the HI-TRAC top lid, transfer lid (pool lid for the HI-TRAC 125D), and transfer lid doors (not applicable to HI-TRAC 125D) remain in place, there is no change in the dose rates at the top and bottom of the HI-TRAC.

### Criticality

There is no effect on the criticality control features of the system as a result of this accident event.

### Confinement

There is no effect on the confinement function of the MPC as a result of this accident event. As discussed in the structural evaluation above, all stresses remain within allowable values, assuring confinement boundary integrity.

## Radiation Protection

There is no degradation in the confinement capabilities of the MPC, as discussed above. There are increases in the local dose rates adjacent to the water jacket. The dose rates are provided in Chapter 5. Immediately after the drop accident a radiological inspection of the HI-TRAC will be performed and temporary shielding shall be installed to limit exposure. Based on a minimum distance to the controlled area boundary of 100 meters, the 10CFR72.106 dose rate requirements at the controlled area boundary (5 Rem limit) are not exceeded.

### 11.2.1.3 HI-TRAC Transfer Cask Handling Accident Dose Calculations

The handling accident could cause localized damage to the HI-TRAC water jacket shell and loss of the water in the water jacket as the neutron shield impacts the ground.

When the water jacket is impacted, the HI-TRAC transfer cask surface dose rate could increase. The HI-TRAC's post-accident shielding analysis presented in Chapter 5 assumes complete loss of the water in the water jacket and bounds the dose rates anticipated for the handling accident.

If the water jacket of the loaded HI-TRAC is damaged beyond immediate repair and the MPC is not damaged, the loaded HI-TRAC may be unloaded into a HI-STORM overpack, a HI-STAR overpack, or unloaded in the fuel pool. If the MPC is damaged, the loaded HI-TRAC must be returned to the fuel pool for unloading. Depending on the damage to the HI-TRAC and the current location in the loading or unloading sequence, personnel exposure is minimized by continuing to load the MPC into a HI-STORM or HI-STAR overpack. Once the MPC is placed in the HI-STORM or HI-STAR overpack, the dose rates are greatly reduced. The highest personnel exposure will result from returning the loaded HI-TRAC to the fuel pool to unload the MPC.

The analysis of the handling accident presented in Section 3.4 shows that the MPC confinement barrier will not be compromised and, therefore, there will be no release of radioactive material from the confinement vessel. Any possible rupture of the fuel cladding will have no effect on the site boundary dose rates because the magnitude of the radiation source has not changed.

### 11.2.1.4 HI-TRAC Transfer Cask Handling Accident Corrective Action

Following a handling accident, the ISFSI operator shall first perform a radiological and visual inspection to determine the extent of the damage to the HI-TRAC transfer cask and MPC to the maximum practical extent. As appropriate, place temporary shielding around the HI-TRAC to reduce radiation dose rates. Special handling procedures will be developed and approved by the ISFSI operator to lift and upright the HI-TRAC. Upon uprighting, the portion of the overpack not previously accessible shall be radiologically and visually inspected. If damage to the water jacket is limited to a local penetration or crushing, local repairs can be performed to the shell and the water replaced. If damage to the water jacket is extensive, the damage shall be repaired and re-tested in accordance with Chapter 9, following removal of the MPC.

If upon inspection of the damaged HI-TRAC transfer cask and MPC, damage of the MPC is observed, the loaded HI-TRAC transfer cask will be returned to the facility for fuel unloading in accordance with Chapter 8. The handling accident will not affect the ability to unload the MPC using normal means as the structural analysis of the 60g loading (HI-STAR Docket Numbers 71-9261 and 72-1008) shows that there will be no gross deformation of the MPC basket. After unloading, the structural damage of the HI-TRAC and MPC shall be assessed and a determination shall be made if repairs will enable the equipment to return to service. Subsequent to the repairs, the equipment shall be inspected and appropriate tests shall be performed to certify the equipment for service. If the equipment cannot be repaired and returned to service, the equipment shall be disposed of in accordance with the appropriate regulations.

## 11.2.2 HI-STORM Overpack Handling Accident

### 11.2.2.1 Cause of HI-STORM Overpack Handling Accident

During the operation of the HI-STORM 100 System, the loaded HI-STORM overpack is lifted in the vertical orientation. The height of the loaded overpack above the ground shall be limited to below the vertical handling height limit determined in Chapter 3, unless the lifting device is designed in accordance with the criteria specified in Subsection 2.3.3. This vertical handling height limit will maintain the inertial loading on the cask in a vertical drop to 45g's or less. Although a handling accident is remote, a drop from the vertical handling height limit is a credible accident if the lifting device is not designed in accordance with the criteria specified in Subsection 2.3.3.

### 11.2.2.2 HI-STORM Overpack Handling Accident Analysis

The handling accident analysis evaluates the effects of dropping the loaded overpack in the vertical orientation. The analysis of the handling accident is provided in Chapter 3. The analysis shows that the HI-STORM 100 System meets all structural requirements and there are no adverse effects on the structural, confinement, thermal or subcriticality performance of the HI-STORM 100 System. Limiting the inertia loading to 60g's or less ensures the fuel cladding remains intact based on dynamic impact effects on spent fuel assemblies in the literature [11.2.1].

#### Structural

The structural evaluation of the MPC under a 60g vertical load is presented in the HI-STAR FSAR and SAR [11.2.3 and 11.2.4] and it is demonstrated therein that the stresses are within allowable limits. The structural analysis of the HI-STORM overpack is presented in Section 3.4. The structural analysis of the overpack shows that the concrete shield attached to the underside of the overpack lid remains attached and air inlet ducts do not collapse.

#### Thermal

As the structural analysis demonstrates that there is no adverse effect to the MPC or overpack, there is no effect on the thermal performance of the system as a result of this event.

### Shielding

As the structural analysis demonstrates that there is no adverse effect to the MPC or overpack, there is no effect on the shielding performance of the system as a result of this event.

### Criticality

There is no adverse effect on the criticality control features of the system as a result of this event.

### Confinement

There is no adverse effect on the confinement function of the MPC as a result of this event. As discussed in the structural evaluation above, all stresses remain within allowable values, assuring confinement boundary integrity.

### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this event.

Based on this evaluation, it is concluded that the vertical drop of the HI-STORM Overpack with the MPC inside does not affect the safe operation of the HI-STORM 100 System.

#### 11.2.2.3 HI-STORM Overpack Handling Accident Dose Calculations

The vertical drop handling accident of the loaded HI-STORM overpack will not cause any change of the shielding or breach of the MPC confinement boundary. Any possible rupture of the fuel cladding will have no affect on the site boundary dose rates because the magnitude of the radiation source has not changed. Therefore, the dose calculations are equivalent to the normal condition dose rates.

#### 11.2.2.4 HI-STORM Overpack Handling Accident Corrective Action

Following a handling accident, the ISFSI operator shall first perform a radiological and visual inspection to determine the extent of the damage to the overpack. Special handling procedures, as required, will be developed and approved by the ISFSI operator.

If upon inspection of the MPC, structural damage of the MPC is observed, the MPC is to be returned to the facility for fuel unloading in accordance with Chapter 8. After unloading, the structural damage of the MPC shall be assessed and a determination shall be made if repairs will enable the MPC to return to service. Likewise, the HI-STORM overpack shall be thoroughly inspected and a determination shall be made if repairs will enable the HI-STORM overpack to return to service. Subsequent to the repairs, the equipment shall be inspected and appropriate tests shall be performed to certify the HI-STORM 100 System for service. If the equipment cannot be repaired and returned to service, the equipment shall be disposed of in accordance with the appropriate regulations.

### 11.2.3 Tip-Over

#### 11.2.3.1 Cause of Tip-Over

The analysis of the HI-STORM 100 System has shown that the overpack does not tip over as a result of the accidents (i.e., tornado missiles, flood water velocity, and seismic activity) analyzed in this section. It is highly unlikely that the overpack will tip-over during on-site movement because of the required low handling height or the use of a lifting device designed in accordance with the criteria specified in Subsection 2.3.3. The tip-over accident is stipulated as a non-mechanistic accident.

For the anchored HI-STORM designs (HI-STORM 100A and 100SA), a tip-over accident is not possible. As described in Chapter 2 of this FSAR, these system designs are not evaluated for the hypothetical tip-over. As such, the remainder of this accident discussion applies only to the non-anchored designs (i.e., the 100 and 100S designs only).

#### 11.2.3.2 Tip-Over Analysis

The tip-over accident analysis evaluates the effects of the loaded overpack tipping-over onto a reinforced concrete pad. The tip-over analysis is provided in Section 3.4. The structural analysis provided in Appendix 3.A demonstrates that the resultant deceleration loading on the MPC as a result of the tip-over accident is less than the design basis 45g's. The analysis shows that the HI-STORM 100 System meets all structural requirements and there is no adverse effect on the structural, confinement, thermal, or subcriticality performance of the MPC. However, the side impact will cause some localized damage to the concrete and outer shell of the overpack in the radial area of impact.

#### Structural

The structural evaluation of the MPC presented in Section 3.4 demonstrates that under a 45g loading the stresses are well within the allowable values. Analysis presented in Chapter 3 shows that the concrete shields attached to the underside and top of the overpack lid remains attached. As a result of the tip-over accident there will be localized crushing of the concrete in the area of impact.

#### Thermal

The thermal analysis of the overpack and MPC is based on vertical storage. The thermal consequences of this accident while the overpack is in the horizontal orientation are bounded by the burial under debris accident evaluated in Subsection 4.6.2. Damage to the overpack will be limited as discussed above. As the structural analysis demonstrates that there is no significant change in the MPC or overpack, once the overpack and MPC are returned to their vertical orientation there is no effect on the thermal performance of the system.

### Shielding

The effect on the shielding performance of the system as a result of this event is two-fold. First, there may be a localized decrease in the shielding thickness of the concrete in the body of the overpack. Second, the bottom of the overpack, which is normally facing the ground and not accessible, will now be facing the horizon. This orientation will increase the off-site dose rate. However, the dose rate limits of 10CFR72.106 are not exceeded.

### Criticality

There is no effect on the criticality control features of the system as a result of this event.

### Confinement

There is no effect on the confinement function of the MPC as a result of this event. As discussed in the structural evaluation above, all stresses remain within allowable values, assuring confinement boundary integrity.

### Radiation Protection

There is no effect on occupational or public exposures from radionuclide release as a result of this accident event since the confinement boundary integrity of the MPC remains intact.

Immediately after the tip-over accident a radiological inspection of the HI-STORM will be performed and temporary shielding shall be installed to limit exposure from direct radiation. Based on a minimum distance to the controlled area boundary of 100 meters, the 10CFR72.106 dose rate requirements at the controlled area boundary (5 Rem limit) are not exceeded.

Based on this evaluation, it is concluded that the accident does not affect the safe operation of the HI-STORM 100 System.

#### 11.2.3.3 Tip-Over Dose Calculations

The analysis of the tip-over accident has shown that the MPC confinement barrier will not be compromised and, therefore, there will be no release of radioactivity or increase in site-boundary dose rates from release of radioactivity.

The tip-over accident could cause localized damage to the radial concrete shield and outer steel shell where the overpack impacts the surface. The overpack surface dose rate in the affected area could increase due to the damage. However, there should be no noticeable increase in the ISFSI site or boundary dose rate as a result of the localized damage on the side of the overpack.

The tip-over accident will also cause a re-orientation of the bottom of the overpack. As a result, radiation leaving the bottom of the overpack, which would normally be directed into the ISFSI pad, will be directed towards the horizon and the controlled area boundary. The dose rate at 100 meters

from the bottom of the overpack, the minimum distance to the controlled area boundary, was calculated for the HI-STORM 100S Version B with an MPC-24 for an assumed accident duration of 30 days. The burnup and cooling time of the fuel was 60,000 MWD/MTU and 3 years, which is more conservative than consistent with the off-site dose analysis reported in Chapter 10, Table 10.4.1 and the . This combination of overpack, MPC, burnup and cooling time is the same as that used in Chapters 5 and 10 for off-site dose calculations. The results presented below demonstrate that the regulatory requirements of 10CFR72.106 are easily met.

Distance	Dose Rate (mrem/hr)	Accident Duration	Total Dose (mrem)	10CFR72.106 Limit (mrem)
100 meters	2.36	720 hours or 30 days	1699.2	5000

#### 11.2.3.4 Tip-Over Accident Corrective Action

Following a tip-over accident, the ISFSI operator shall first perform a radiological and visual inspection to determine the extent of the damage to the overpack. Special handling procedures, including the use of temporary shielding, will be developed and approved by the ISFSI operator.

If upon inspection of the MPC, structural damage of the MPC is observed, the structural damage shall be assessed and a determination shall be made if repairs will enable the MPC to return to service. If determined necessary, the MPC shall be returned to the facility for fuel unloading or transferred to either a HI-STAR or HI-STORM overpack in accordance with Chapter 8 for a duration that is determined to be appropriate. Likewise, the HI-STORM overpack shall be thoroughly inspected and a determination shall be made if repairs are required and will enable the HI-STORM overpack to return to service. Subsequent to the repairs, the equipment shall be inspected and appropriate tests shall be performed to certify the HI-STORM 100 System for service. If the equipment cannot be repaired and returned to service, the equipment shall be disposed of in accordance with the appropriate regulations.

#### 11.2.4 Fire Accident

##### 11.2.4.1 Cause of Fire

Although the probability of a fire accident affecting a HI-STORM 100 System during storage operations is low, a conservative fire has been assumed and analyzed. The analysis shows that the HI-STORM 100 System continues to perform its structural, confinement, thermal, and subcriticality functions.

#### 11.2.4.2 Fire Analysis

##### 11.2.4.2.1 Fire Analysis for HI-STORM Overpack

The possibility of a fire accident near an ISFSI is considered to be extremely remote due to an absence of combustible materials within the ISFSI and adjacent to the overpacks. The only credible concern is related to a transport vehicle fuel tank fire, causing the outer layers of the storage overpack to be heated by the incident thermal radiation and forced convection heat fluxes. The amount of combustible fuel in the on-site transporter is limited to a volume of 50 gallons.

#### Structural

As discussed in Section 3.4, there are no structural consequences as a result of the fire accident condition.

#### Thermal

Based on a conservative analysis discussed in Subsection 4.6.2, of the HI-STORM 100 System response to a hypothetical fire event, it is concluded that the fire event does not significantly affect the temperature of the MPC or contained fuel. Furthermore, the ability of the HI-STORM 100 System to cool the spent nuclear fuel within temperature limits (Table 2.2.3) during and after fire is not compromised.

#### Shielding

With respect to concrete damage from a fire, NUREG-1536 (4.0,V,5.b) states: “the loss of a small amount of shielding material is not expected to cause a storage system to exceed the regulatory requirements in 10 CFR 72.106 and, therefore, need not be estimated or evaluated in the SAR.” Less than one-inch of the concrete (~4% of the overpack radial concrete thickness ) exceeds the short-term temperature limit.

#### Criticality

There is no effect on the criticality control features of the system as a result of this event.

#### Confinement

There is no effect on the confinement function of the MPC as a result of this event.

#### Radiation Protection

Since there is a much localized reduction in shielding and no effect on the confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this accident event.

Based on this evaluation, it is concluded that the overpack fire accident does not affect the safe operation of the HI-STORM 100 System.

#### 11.2.4.2.2 Fire Analysis for HI-TRAC Transfer Cask

To demonstrate the fuel cladding and MPC pressure boundary integrity under an exposure to a hypothetical short duration fire event during on-site handling operations, a fire accident analysis of the loaded 100-ton HI-TRAC is performed. This analysis, because of the lower mass of the 100-ton HI-TRAC, bounds the effects for the 125-ton HI-TRAC.

##### Structural

As discussed in Section 3.4, there are no adverse structural consequences as a result of the fire accident condition.

##### Thermal

As discussed in Subsection 4.6.2, the MPC internal pressure and fuel temperature increases as a result of the fire accident. The fire accident MPC internal pressure and peak fuel cladding temperature are substantially less than the accident limits for MPC internal pressure and maximum cladding temperature (Tables 2.2.1 and 2.2.3).

The thermal analysis of the MPC in the HI-TRAC transfer cask under a fire accident is performed in Subsection 4.6.2. As can be concluded from the analysis, the temperatures for fuel cladding and components are below the accident temperature limits.

##### Shielding

The assumed loss of all the water in the water jacket results in an increase in the radiation dose rates at locations adjacent to the water jacket. The assumed loss of all the Holtite in the 125-ton HI-TRAC lids results in an increase in the radiation dose rates at locations adjacent to the lids. The shielding evaluation presented in Chapter 5 demonstrates that the requirements of 10CFR72.106 are not exceeded.

##### Criticality

There is no effect on the criticality control features of the system as a result of this event.

##### Confinement

There is no effect on the confinement function of the MPC as a result of this event, since the internal pressure does not exceed the accident condition design pressure and the MPC confinement boundary temperatures do not exceed the short-term allowable temperature limits.

## Radiation Protection

There is no degradation in confinement capabilities of the MPC, as discussed above. Increases in the local dose rates adjacent to the water jacket are evaluated in Chapter 5. . Immediately after the fire accident a radiological inspection of the HI-TRAC shall be performed and temporary shielding shall be installed to limit exposure. .

### 11.2.4.3 Fire Dose Calculations

The complete loss of the HI-TRAC neutron shield along with the water jacket shell is assumed in the shielding analysis for the post-accident analysis of the loaded HI-TRAC in Chapter 5 and bounds the determined fire accident consequences. The loaded HI-TRAC following a fire accident meets the accident dose rate requirement of 10CFR72.106.

The elevated temperatures experienced by the HI-STORM overpack concrete shield are limited to the outermost layer. Therefore, overall reduction in neutron shielding capabilities is quite small. . The slight increase in the neutron dose rate as a result of the concrete in the outer inch reaching elevated temperatures will not significantly increase the site boundary dose rate, due to the limited amount of the concrete shielding with reduced effectiveness and low site boundary dose rates. The loaded HI-STORM overpack following a fire accident meets the accident dose rate requirement of 10CFR72.106.

The analysis of the fire accident shows that the MPC confinement boundary is not compromised and therefore, there is no release of airborne radioactive materials.

### 11.2.4.4 Fire Accident Corrective Actions

Upon detection of a fire adjacent to a loaded HI-TRAC or HI-STORM overpack, the ISFSI operator shall take the appropriate immediate actions necessary to extinguish the fire. Fire fighting personnel should take appropriate radiological precautions, particularly with the HI-TRAC as the water jacket pressure relief valves may open with resulting water loss and increase in radiation doses. Following the termination of the fire, a visual and radiological inspection of the equipment shall be performed.

As appropriate, install temporary shielding around the HI-TRAC. Specific attention shall be taken during the inspection of the water jacket of the HI-TRAC. If damage to the HI-TRAC is limited to the loss of water in the water jacket due to the pressure increase, the water may be replaced . If damage to the HI-TRAC water jacket or HI-TRAC body is widespread and/or radiological conditions require, the HI-TRAC shall be unloaded in accordance with Chapter 8, prior to repair.

If damage to the HI-STORM storage overpack as the result of a fire event is widespread and/or as radiological conditions require, the MPC shall be removed from the HI-STORM overpack in accordance with Chapter 8. However, the thermal analysis described herein demonstrates that only the outermost layer of the radial concrete exceeds its design temperature. The HI-STORM overpack may be returned to service if there is no significant increase in the measured dose rates (i.e., the overpack's shielding effectiveness is confirmed) and if the visual inspection is satisfactory.

### 11.2.5 Partial Blockage of MPC Basket Vent Holes

Each MPC basket fuel cell wall has elongated vent holes at the bottom and top. The partial blockage of the MPC basket vent holes analyzes the effects on the HI-STORM 100 System due to the restriction of the vent openings.

#### 11.2.5.1 Cause of Partial Blockage of MPC Basket Vent Holes

After the MPC is loaded with spent nuclear fuel, the MPC cavity is drained, dried, and backfilled with helium. There are only two possible sources of material that could block the MPC basket vent holes. These are the fuel cladding/fuel pellets and crud. Due to the maintenance of relatively low cladding temperatures during storage, it is not credible that the fuel cladding would rupture and that fuel cladding and fuel pellets would fall to block the basket vent holes. It is conceivable that a percentage of the crud deposited on the fuel rods may fall off of the fuel assembly and deposit at the bottom of the MPC.

Helium in the MPC cavity provides an inert atmosphere for storage of the fuel. The HI-STORM 100 System maintains the peak fuel cladding temperature below the required long-term storage limits. All credible accidents do not cause the fuel assembly to experience an inertia loading greater than 60g's. Therefore, there is no mechanism for the extensive rupture of spent fuel rod cladding.

Crud can be made up of two types of layers, loosely adherent and tightly adherent. The SNF assembly movement from the fuel racks to the MPC may cause a portion of the loosely adherent crud to fall away. The tightly adherent crud is not removed during ordinary fuel handling operations. The MPC basket vent holes that act as the bottom plenum for the MPC internal thermosiphon are of an elongated, semi-circular design to ensure that the flow passages will remain open under a hypothetical shedding of the crud on the fuel rods. For conservatism, only the minimum semi-circular hole area is credited in the thermal models (i.e., the elongated portion of the hole is completely neglected).

The amount of crud on fuel assemblies varies greatly from plant to plant. Typically, BWR plants have more crud than PWR plants. Based on the maximum expected crud volume per fuel assembly provided in reference [11.2.2], and the area at the base of the MPC basket fuel storage cell, the maximum depth of crud at the bottom of the MPC-68 was determined. For the PWR-style MPC designs, 90% of the maximum crud volume was used to determine the crud depth. The maximum crud depths for each of the MPCs are listed in Table 2.2.8. The maximum amount of crud was assumed to be present on all fuel assemblies within the MPC. Both the tightly and loosely adherent crud was conservatively assumed to fall off of the fuel assembly. As can be seen by the values listed in the table, the maximum amount of crud depth does not block the MPC basket vent holes as the crud accumulation depth is less than the elongation of the vent holes. Therefore, the available vent holes area is greater than that used in the thermal models.

#### 11.2.5.2 Partial Blockage of MPC Basket Vent Hole Analysis

The partial blockage of the MPC basket vent holes has no effect on the structural, confinement and thermal analysis of the MPC. There is no effect on the shielding analysis other than a slight increase of the gamma radiation dose rate at the base of the MPC due to the accumulation of crud. As the MPC basket vent holes are not completely blocked, preferential flooding of the MPC fuel basket is not possible, and, therefore, the criticality analyses are not affected.

#### Structural

There are no structural consequences as a result of this event.

#### Thermal

There is no effect on the thermal performance of the system as a result of this event.

#### Shielding

There is no effect on the shielding performance of the system as a result of this accident event.

#### Criticality

There is no effect on the criticality control features of the system as a result of this accident event.

#### Confinement

There is no effect on the confinement function of the MPC as a result of this accident event.

#### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this accident event.

Based on this evaluation, it is concluded that the partial blockage of MPC vent holes does not affect the safe operation of the HI-STORM 100 System.

##### 11.2.5.3 Partial Blockage of MPC Basket Vent Holes Dose Calculations

Partial blockage of basket vent holes will not result in a compromise of the confinement boundary. Therefore, there will be no effect on the site boundary dose rates because the magnitude of the radiation source has not changed. There will be no radioactive material release.

##### 11.2.5.4 Partial Blockage of MPC Basket Vent Holes Corrective Action

There are no consequences that exceed normal storage conditions. No corrective action is required for the partial blockage of the MPC basket vent holes.

## 11.2.6 Tornado

### 11.2.6.1 Cause of Tornado

The HI-STORM 100 System will be stored on an unsheltered ISFSI concrete pad and subject to environmental conditions. Additionally, the transfer of the MPC from the HI-TRAC transfer cask to the overpack may be performed at the unsheltered ISFSI concrete pad. It is possible that the HI-STORM System (storage overpack and HI-TRAC transfer cask) may experience the extreme environmental conditions of a tornado.

### 11.2.6.2 Tornado Analysis

The tornado accident has two effects on the HI-STORM 100 System. The tornado winds and/or tornado missile attempt to tip-over the loaded overpack or HI-TRAC transfer cask. The pressure loading of the high velocity winds and/or the impact of the large tornado missiles act to apply an overturning moment. The second effect is tornado missiles propelled by high velocity winds, which attempt to penetrate the storage overpack or HI-TRAC transfer cask.

During handling operations at the ISFSI pad, the loaded HI-TRAC transfer cask, while in the vertical orientation, shall be attached to a lifting device designed in accordance with the requirements specified in Subsection 2.3.3. Therefore, it is not credible that the tornado missile and/or wind could tip-over the loaded HI-TRAC while being handled in the vertical orientation. During handling of the loaded HI-TRAC in the horizontal orientation, it is possible that the tornado missile and/or wind may cause the rollover of the loaded HI-TRAC on the transport vehicle unless the lifting device is designed in accordance with the requirements specified in Subsection 2.3.3. The horizontal drop handling accident for the loaded HI-TRAC, Subsection 11.2.1, evaluates the consequences of the loaded HI-TRAC falling from the horizontal handling height limit and consequently this bounds the effect of the roll-over of the loaded HI-TRAC on the transport vehicle.

### Structural

Section 3.4 provides the analysis of the pressure loading which attempts to tip-over the storage overpack and the analysis of the effects of the different types of tornado missiles. These analyses show that the loaded storage overpack does not tip-over as a result of the tornado winds and/or tornado missiles.

Analyses provided in Section 3.4 also shows that the tornado missiles do not penetrate the storage overpack or HI-TRAC transfer cask to impact the MPC. The result of the tornado missile impact on the storage overpack or HI-TRAC transfer cask is limited to damage of the shielding.

### Thermal

The thermal consequences are evaluated in Subsection 11.2.1.

## Shielding

The loss of the water in the water jacket results in an increase in the radiation dose rates at locations adjacent to the water jacket. The shielding analysis results presented in Chapter 5 demonstrate that the requirements of 10CFR72.106 are not exceeded.

## Criticality

There is no effect on the criticality control features of the system as a result of this event.

## Confinement

There is no effect on the confinement function of the MPC as a result of this event.

## Radiation Protection

There is no degradation in confinement capabilities of the MPC, since the tornado missiles do not impact the MPC, as discussed above. Increases in the local dose rates as a result of the loss of water in the HI-TRAC water jacket are evaluated in Chapter 5. Immediately after the tornado accident a radiological inspection of the HI-TRAC shall be performed and temporary shielding shall be installed to limit the exposure to the public.

### 11.2.6.3 Tornado Dose Calculations

The tornado winds do not tip-over the loaded storage overpack; damage the shielding materials of the overpack or HI-TRAC; or damage the MPC confinement boundary. There is no effect on the radiation dose as a result of the tornado winds. A tornado missile may cause localized damage in the concrete radial shielding of the storage overpack. However, the damage will have a negligible effect on the site boundary dose. A tornado missile may penetrate the HI-TRAC water jacket shell causing the loss of the neutron shielding (water). The effects of the tornado missile damage on the loaded HI-TRAC transfer cask is bounded by the post-accident dose assessment performed in Chapter 5, which conservatively assumes complete loss of the water in the water jacket and the water jacket shell.

### 11.2.6.4 Tornado Accident Corrective Action

Following exposure of the HI-STORM 100 System to a tornado, the ISFSI operator shall perform a visual and radiological inspection of the overpack and/or HI-TRAC transfer cask. Damage sustained by the overpack outer shell, concrete, or vent screens shall be inspected and repaired. Damage sustained by the HI-TRAC shall be inspected and repaired.

## 11.2.7 Flood

### 11.2.7.1 Cause of Flood

The HI-STORM 100 System will be located on an unsheltered ISFSI concrete pad. Therefore, it is possible for the storage area to be flooded. The potential sources for the flood water could be unusually high water from a river or stream, a dam break, a seismic event, or a hurricane.

#### 11.2.7.2 Flood Analysis

##### Structural

The flood accident affects the HI-STORM 100 overpack structural analysis in two ways. The flood water velocity acts to apply an overturning moment, which attempts to tip-over the loaded overpack. The flood affects the MPC by applying an external pressure.

Section 3.4 provides the analysis of the flood water applying an overturning moment. The results of the analysis show that the loaded overpack does not tip over if the flood velocity does not exceed the value stated in Table 2.2.8.

The structural evaluation of the MPC for the accident condition external pressure (Table 2.2.1) is presented in Section 3.4 and the resulting stresses from this event are shown to be well within the allowable values.

##### Thermal

For a flood of sufficient magnitude to allow the water to come into contact with the MPC, there is no adverse effect on the thermal performance of the system. The thermal consequence of such a flood is an increase in the rejection of the decay heat. Because the storage overpack is ventilated, water from a large flood will enter the annulus between the MPC and the overpack. The water would provide cooling that exceeds that available in the air filled annulus, due to water's higher thermal conductivity.

A smart flood condition that blocks the air flow but is not sufficient to allow water to come into contact with the MPC is bounded by the 100% inlet ducts blocked condition evaluated in Subsection 11.2.13.

##### Shielding

There is no effect on the shielding performance of the system as a result of this event. The flood water provides additional shielding that reduces radiation doses.

##### Criticality

There is no effect on the criticality control features of the system as a result of this event. The criticality analysis is unaffected because under the flooding condition water does not enter the MPC cavity and therefore the reactivity would be less than the loading condition in the fuel pool, which is presented in Section 6.1.

## Confinement

There is no effect on the confinement function of the MPC as a result of this event. As discussed in the structural evaluation above, all stresses remain within allowable values, assuring confinement boundary integrity.

## Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this event.

Based on this evaluation, it is concluded that the flood accident does not affect the safe operation of the HI-STORM 100 System.

### 11.2.7.3 Flood Dose Calculations

Since the flood accident produces no leakage of radioactive material and no reduction in shielding effectiveness, there are no adverse radiological consequences.

### 11.2.7.4 Flood Accident Corrective Action

As shown in the analysis of the flood accident, the HI-STORM 100 System sustains no damage as a result of the flood. At the completion of the flood, exposed surfaces may need debris and adherent foreign matter removal.

## 11.2.8 Earthquake

### 11.2.8.1 Cause of Earthquake

The HI-STORM 100 System may be employed at any reactor or ISFSI facility in the United States. It is possible that during the use of the HI-STORM 100 System, the ISFSI may experience an earthquake.

### 11.2.8.2 Earthquake Analysis

The earthquake accident analysis evaluates the effects of a seismic event on the loaded HI-STORM 100 System. The objective is to determine the stability limits of the HI-STORM 100 System. Based on a static stability criteria, it is shown in Chapter 3 that the HI-STORM 100 System is qualified to seismic activity less than or equal to the values specified in Table 2.2.8. The analyses in Chapter 3 show that the HI-STORM 100 System will not tip over under the conditions evaluated. The seismic activity has no adverse thermal, criticality, confinement, or shielding consequences.

Some ISFSI sites will have earthquakes that exceed the seismic activity specified in Table 2.2.8. For these high-seismic sites, anchored HI-STORM designs (the HI-STORM 100A and 100SA) have been developed. The design of these anchored systems is such that seismic loads cannot result in tip-

over or lateral displacement. Chapter 3 provides a detailed discussion of the anchored systems design.

#### Structural

The sole structural effect of the earthquake is an inertial loading of less than 1g. This loading is bounded by the tip-over analysis presented in Subsection 11.2.3, which analyzes a deceleration of 45g's and demonstrates that the MPC allowable stress criteria are met.

#### Thermal

There is no effect on the thermal performance of the system as a result of this event.

#### Shielding

There is no effect on the shielding performance of the system as a result of this event.

#### Criticality

There is no effect on the criticality control features of the system as a result of this event.

#### Confinement

There is no effect on the confinement function of the MPC as a result of this event.

#### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this event.

Based on this evaluation, it is concluded that the earthquake does not affect the safe operation of the HI-STORM 100 System.

#### 11.2.8.3 Earthquake Dose Calculations

Structural analysis of the earthquake accident shows that the loaded overpack will not tip over as a result of the specified seismic activity. If the overpack were to tip over, the resultant damage would be equal to that experienced by the tip-over accident analyzed in Subsection 11.2.3. Since the loaded overpack does not tip-over, there is no increase in radiation dose rates or release of radioactivity.

#### 11.2.8.4 Earthquake Accident Corrective Action

Following the earthquake accident, the ISFSI operator shall perform a visual and radiological inspection of the overpacks in storage to determine if any of the overpacks have tipped-over. In the unlikely event of a tip-over, the corrective actions shall be in accordance with Subsection 11.2.3.4.

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## 11.2.9 100% Fuel Rod Rupture

This accident event postulates that all the fuel rods rupture and that the appropriate quantities of fission product gases and fill gas are released from the fuel rods into the MPC cavity.

### 11.2.9.1 Cause of 100% Fuel Rod Rupture

Through all credible accident conditions, the HI-STORM 100 System maintains the spent nuclear fuel in an inert environment while maintaining the peak fuel cladding temperature below the required short-term temperature limits, thereby providing assurance of fuel cladding integrity. There is no credible cause for 100% fuel rod rupture. This accident is postulated to evaluate the MPC confinement barrier for the maximum possible internal pressure based on the non-mechanistic failure of 100% of the fuel rods.

### 11.2.9.2 100% Fuel Rod Rupture Analysis

The 100% fuel rod rupture accident has no thermal, structural, criticality or shielding consequences. The event does not change the reactivity of the stored fuel, the magnitude of the radiation source, which is being shielded, the shielding capability, or the criticality control features of the HI-STORM 100 System. The determination of the maximum accident pressure is provided in Chapter 4. The MPC design basis internal pressure bounds the pressure developed assuming 100% fuel rod rupture. The structural analysis provided in Chapter 3 evaluates the MPC confinement boundary under the accident condition design internal pressure.

#### Structural

The structural evaluation of the MPC for the accident condition internal pressure presented in Section 3.4 demonstrates that the MPC stresses are well within the allowable values.

#### Thermal

The MPC internal pressure for the 100% fuel rod rupture condition is presented in Table 4.4.9. As can be seen from the values, the design basis accident condition MPC internal pressure (Table 2.2.1) used in the structural evaluation bounds the calculated value.

#### Shielding

There is no effect on the shielding performance of the system as a result of this event.

#### Criticality

There is no effect on the criticality control features of the system as a result of this event.

## Confinement

There is no effect on the confinement function of the MPC as a result of this event. As discussed in the structural evaluation above, all stresses remain within allowable values, assuring confinement boundary integrity.

## Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this event.

Based on this evaluation, it is concluded that the non-mechanistic 100% fuel rod rupture accident does not affect the safe operation of the HI-STORM 100 System.

### 11.2.9.3 100% Fuel Rod Rupture Dose Calculations

The MPC confinement boundary maintains its integrity. There is no effect on the shielding effectiveness, and the magnitude of the radiation source is unchanged. However, the radiation source could redistribute within the sealed MPC cavity causing a slight change in the radiation dose rates at certain locations. Therefore, there is no release of radioactive material or significant increase in radiation dose rates.

### 11.2.9.4 100% Fuel Rod Rupture Accident Corrective Action

As shown in the analysis of the 100% fuel rod rupture accident, the MPC confinement boundary is not damaged. The HI-STORM 100 System is designed to withstand this accident and continue performing the safe storage of spent nuclear fuel under normal storage conditions. No corrective actions are required.

### 11.2.10 Confinement Boundary Leakage

The MPC uses redundant confinement closures to assure that there is no release of radioactive materials for postulated storage accident conditions. The analyses presented in Chapter 3 and this chapter demonstrate that the MPC remains intact during all postulated accident conditions. The discussion contained in Chapter 7 demonstrates that MPC is designed, welded, tested and inspected to meet the guidance of ISG-18 such that leakage from the confinement boundary is considered non-credible.

#### 11.2.10.1 Cause of Confinement Boundary Leakage

There is no credible cause for confinement boundary leakage. The accidents analyzed in this chapter show that the MPC confinement boundary withstands all credible accidents. There are no man-made or natural phenomena that could cause failure of the confinement boundary restricting radioactive material release. Additionally, because the MPC satisfies the criteria specified in Interim Staff Guidance (ISG) 18, there is no credible leakage that would occur from the confinement boundary.

### 11.2.10.3 Confinement Boundary Leakage Accident Corrective Action

The HI-STORM 100 System is designed to withstand this accident and continue performing the safe storage of spent nuclear fuel. No corrective actions are required.

### 11.2.11 Explosion

#### 11.2.11.1 Cause of Explosion

An explosion within the bounds of an ISFSI is improbable since there are no explosive materials within the site boundary. An explosion as a result of combustion of the fuel contained in cask transport vehicle is possible. As the fuel available for the explosion is limited in quantity the effects of an explosion on a reinforced structure are minimal. Explosions postulated to occur within or beyond the ISFSI boundary would require a site hazards evaluation under the provisions of 72.212 regulations by individual cask users.

#### 11.2.11.2 Explosion Analysis

Any credible explosion accident is bounded by the accident external design pressure (Table 2.2.1) analyzed as a result of the flood accident water depth in Subsection 11.2.7 and the tornado missile accident of Subsection 11.2.6, because explosive materials are not stored within close proximity to the casks. The bounding analysis shows that the MPC and the Overpack can withstand the effects of substantial accident external pressures without collapse or rupture.

#### Structural

The structural evaluations for the MPC accident condition external pressure and overpack pressure differential are presented in Section 3.4 and demonstrate that all stresses are within allowable values.

#### Thermal

There is no effect on the thermal performance of the system as a result of this event.

#### Shielding

There is no effect on the shielding performance of the system as a result of this event.

#### Criticality

There is no effect on the criticality control features of the system as a result of this event.

#### Confinement

There is no effect on the confinement function of the MPC as a result of this event. As discussed in the structural evaluation above, all stresses remain within allowable values, assuring confinement boundary integrity.

### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this event.

Based on this evaluation, it is concluded that the explosion accident does not affect the safe operation of the HI-STORM 100 System.

#### 11.2.11.3 Explosion Dose Calculations

The bounding external pressure load has no effect on the HI-STORM 100 overpack and MPC. Therefore, no effect on the shielding, criticality, thermal or confinement capabilities of the HI-STORM 100 System is experienced as a result of the explosion pressure load. The effects of explosion generated missiles on the HI-STORM 100 System structure is bounded by the analysis of tornado generated missiles.

#### 11.2.11.4 Explosion Accident Corrective Action

The explosive overpressure caused by the explosion is bounded by the external pressure exerted by the flood accident. The external pressure from the flood is shown not to damage the HI-STORM 100 System. Following an explosion, the ISFSI operator shall perform a visual and radiological inspection of the overpack. If the outer shell or concrete is damaged as a result of explosion generated missiles, the concrete material may be replaced and the outer shell repaired.

#### 11.2.12 Lightning

##### 11.2.12.1 Cause of Lightning

The HI-STORM 100 System will be stored on an unsheltered ISFSI concrete pad. There is the potential for lightning to strike the overpack. This analysis evaluates the effects of lightning striking the overpack.

##### 11.2.12.2 Lightning Analysis

The HI-STORM 100 System is a large metal/concrete cask stored in an unsheltered ISFSI. As such, it may be subject to lightning strikes. When the HI-STORM 100 System is hit with lightning, the lightning will discharge through the steel shell of the overpack to the ground. Lightning strikes have high currents, but their duration is short (i.e., less than a second). The overpack outer shell is composed of conductive carbon steel and, as such, will provide a direct path to ground.

The MPC provides the confinement boundary for the spent nuclear fuel. The effects of a lightning strike will be limited to the overpack. The lightning current will discharge into the overpack and directly into the ground. Therefore, the MPC will be unaffected.

#### Structural

There is no structural consequence as a result of this event.

#### Thermal

There is no effect on the thermal performance of the system as a result of this event.

#### Shielding

There is no effect on the shielding performance of the system as a result of this event.

#### Criticality

There is no effect on the criticality control features of the system as a result of this event.

#### Confinement

There is no effect on the confinement function of the MPC as a result of this event.

#### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this event.

Based on this evaluation, it is concluded that the lightning accident does not affect the safe operation of the HI-STORM 100 System.

#### 11.2.12.3 Lightning Dose Calculations

An evaluation of lightning strikes demonstrates that the effect of a lightning strike has no effect on the confinement boundary or shielding materials. Therefore, no further analysis is necessary.

#### 11.2.12.4 Lightning Accident Corrective Action

The HI-STORM 100 System will not sustain any damage from the lightning accident. There is no surveillance or corrective action required.

### 11.2.13 100% Blockage of Air Inlets

#### 11.2.13.1 Cause of 100% Blockage of Air Inlets

This event is defined as a complete blockage of all four bottom inlets. Such blockage of the inlets may be postulated to occur as a result of a flood, blizzard snow accumulation, tornado debris, or volcanic activity.

#### 11.2.13.2 100% Blockage of Air Inlets Analysis

The immediate consequence of a complete blockage of the air inlet ducts is that the normal circulation of air for cooling the MPC is stopped. An amount of heat will continue to be removed by localized air circulation patterns in the overpack annulus and outlet ducts, and the MPC will continue to radiate heat to the relatively cooler storage overpack. As the temperatures of the MPC and its contents rise, the rate of heat rejection will increase correspondingly. Under this condition, the temperatures of the overpack, the MPC and the stored fuel assemblies will rise as a function of time.

As a result of the large mass, and correspondingly large thermal capacity of the storage overpack, it is expected that a significant temperature rise is only possible if the blocked condition is allowed to persist for a number of days. This accident condition is, however, a short duration event that will be identified and corrected by scheduled periodic surveillance at the ISFSI site.

#### Structural

There are no structural consequences as a result of this event.

#### Thermal

A thermal analysis is performed in Subsection 4.6.2 to determine the effect of a complete blockage of all inlets for an extended duration. For this event, both the fuel cladding and component temperatures remain below their short-term temperature limits. The MPC internal pressure for this event is evaluated in Subsection 4.6.2 and is bounded by the design basis internal pressure for accident conditions (Table 2.2.1).

#### Shielding

There is no effect on the shielding performance of the system as a result of this event, since the concrete temperatures do not exceed the short-term condition design temperature provided in Table 2.2.3.

#### Criticality

There is no effect on the criticality control features of the system as a result of this event.

## Confinement

There is no effect on the confinement function of the MPC as a result of this event.

## Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this event.

Based on this evaluation, it is concluded that the 100% blockage of air inlets accident does not affect the safe operation of the HI-STORM 100 System, if the blockage is removed in the specified time period.

### 11.2.13.3 100% Blockage of Air Inlets Dose Calculations

As shown in the analysis of the 100% blockage of air inlets accident, the shielding capabilities of the HI-STORM 100 System are unchanged because the peak concrete temperature does not exceed its short-term condition design temperature. The elevated temperatures will not cause the breach of the confinement system and the short term fuel cladding temperature limit is not exceeded. Therefore, there is no radiological impact.

### 11.2.13.4 100% Blockage of Air Inlets Accident Corrective Action

Analysis of the 100% blockage of air inlet accident shows that the temperatures for cask system components and fuel cladding are within the accident temperature limits if the blockage is cleared within 32 hours. Upon detection of the complete blockage of the air inlet ducts, the ISFSI operator shall assign personnel to clear the blockage with mechanical and manual means as necessary. After clearing the overpack ducts, the overpack shall be visually and radiologically inspected for any damage. If exit air temperature monitoring is performed in lieu of direct visual inspections, the difference between the ambient air temperature and the exit air temperature will be the basis for assurance that the temperature limits are not exceeded.

For an accident event that completely blocks the inlet or outlet air ducts for greater than the analyzed duration, a site-specific evaluation or analysis may be performed to demonstrate adequate heat removal for the duration of the event. Adequate heat removal is defined as the minimum rate of heat dissipation that ensures cladding temperatures limits are met and structural integrity of the MPC and Overpack is not compromised. For those events where an evaluation or analysis is not performed or is not successful in showing that cladding temperatures remain below their short term temperature limits, the site's emergency plan shall include provisions to address removal of the material blocking the air inlet ducts and to provide alternate means of cooling prior to exceeding the time when the fuel cladding temperature reaches its short-term temperature limit. Alternate means of cooling could include, for example, spraying water into the air outlet ducts using pumps or fire-hoses or blowing air into the air outlet ducts using fans, to directly cool the MPC.

### 11.2.14 Burial Under Debris

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#### 11.2.14.1 Cause of Burial Under Debris

Burial of the HI-STORM System under debris is not a credible accident. During storage at the ISFSI, there are no structures over the casks. The minimum regulatory distance(s) from the ISFSI to the nearest site boundary and the controlled area around the ISFSI concrete pad precludes the close proximity of substantial amounts of vegetation.

There is no credible mechanism for the HI-STORM System to become completely buried under debris. However, for conservatism, complete burial under debris is considered. Blockage of the HI-STORM overpack air inlet ducts has already been considered in Subsection 11.2.13.

#### 11.2.14.2 Burial Under Debris Analysis

Burial of the HI-STORM System does not impose a condition that would have more severe consequences for criticality, confinement, shielding, and structural analyses than that performed for the other accidents analyzed. The debris would provide additional shielding to reduce radiation doses. The accident external pressure encountered during the flood bounds any credible pressure loading caused by the burial under debris.

Burial under debris can affect thermal performance because the debris acts as an insulator and heat sink. This will cause the HI-STORM System and fuel cladding temperatures to increase. A thermal analysis has been performed to determine the time for the fuel cladding temperatures to reach the short term accident condition temperature limit during a burial under debris accident.

#### Structural

The structural evaluation of the MPC enclosure vessel for accident internal pressure conditions bounds the pressure calculated herein. Therefore, the resulting stresses from this event are well within the allowable values, as demonstrated in Section 3.4.

#### Thermal

The fuel cladding and MPC integrity is evaluated in Subsection 4.6.2. The evaluation demonstrates that the fuel cladding and confinement function of the MPC are not compromised.

#### Shielding

There is no effect on the shielding performance of the system as a result of this event.

#### Criticality

There is no effect on the criticality control features of the system as a result of this event.

## Confinement

There is no effect on the confinement function of the MPC as a result of this event. As discussed in the structural evaluation above, all stresses remain within allowable values, assuring confinement boundary integrity.

## Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this event.

Based on this evaluation, it is concluded that the burial under debris accident does not affect the safe operation of the HI-STORM 100 System, if the debris is removed within the specified time. The 24-hour minimum duct inspection interval ensures that a burial under debris condition will be detected long before the allowable burial time is reached.

### 11.2.14.3 Burial Under Debris Dose Calculations

As discussed in burial under debris analysis, the shielding is enhanced while the HI-STORM System is covered.

The elevated temperatures will not cause the breach of the confinement system and the short term fuel cladding temperature limit is not exceeded. Therefore, there is no radiological impact.

### 11.2.14.4 Burial Under Debris Accident Corrective Action

Analysis of the burial under debris accident shows that the fuel cladding peak temperatures are not exceeded even for an extended duration of burial. Upon detection of the burial under debris accident, the ISFSI operator shall assign personnel to remove the debris with mechanical and manual means as necessary. After uncovering the storage overpack, the storage overpack shall be visually and radiologically inspected for any damage. The loaded MPC shall be removed from the storage overpack with the HI-TRAC transfer cask to allow complete inspection of the overpack air inlets and outlets, and annulus. Removal of obstructions to the air flow path shall be performed prior to the re-insertion of the MPC. The site's emergency action plan shall include provisions for the performance of this corrective action.

### 11.2.15 Extreme Environmental Temperature

#### 11.2.15.1 Cause of Extreme Environmental Temperature

The extreme environmental temperature is postulated as a constant ambient temperature caused by extreme weather conditions. To determine the effects of the extreme temperature, it is conservatively assumed that the temperature persists for a sufficient duration to allow the HI-STORM 100 System to achieve thermal equilibrium. Because of the large mass of the HI-STORM 100 System, with its

corresponding large thermal inertia and the limited duration for the extreme temperature, this assumption is conservative.

#### 11.2.15.2 Extreme Environmental Temperature Analysis

The accident condition considering an extreme environmental temperature (Table 2.2.2) for a duration sufficient to reach thermal equilibrium is evaluated with respect to accident condition design temperatures listed in Table 2.2.3.

##### Structural

The structural evaluation of the MPC enclosure vessel for accident condition internal pressure bounds the pressure resulting from this event. Therefore, the resulting stresses from this event are bounded by that of the accident condition and are well within the allowable values, as discussed in Section 3.4.

##### Thermal

The resulting temperatures for the system and fuel assembly cladding are provided in evaluation performed in Subsection 4.6.2. As concluded from this evaluation, all temperatures are within the short-term accident condition allowable values specified in Table 2.2.3.

##### Shielding

There is no effect on the shielding performance of the system as a result of this event, since the concrete temperature does not exceed the short-term temperature limit specified in Table 2.2.3.

##### Criticality

There is no effect on the criticality control features of the system as a result of this event.

##### Confinement

There is no effect on the confinement function of the MPC as a result of this event. As discussed in the structural evaluation above, all stresses remain within allowable values, assuring confinement boundary integrity.

##### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this event.

Based on this evaluation, it is concluded that the extreme environment temperature accident does not affect the safe operation of the HI-STORM 100 System.

### 11.2.15.3 Extreme Environmental Temperature Dose Calculations

The extreme environmental temperature will not cause the concrete to exceed its normal design temperature. Therefore, there will be no degradation of the concrete's shielding effectiveness. The elevated temperatures will not cause a breach of the confinement system and the short-term fuel cladding temperature is not exceeded. Therefore, there is no radiological impact on the HI-STORM 100 System for the extreme environmental temperature and the dose calculations are equivalent to the normal condition dose rates.

### 11.2.15.4 Extreme Environmental Temperature Corrective Action

There are no consequences of this accident that require corrective action.

### 11.2.16 Supplemental Cooling System (SCS) Failure

The SCS system is a forced fluid circulation device used to provide supplemental HI-TRAC cooling. For fluid circulation, the SCS system is equipped with active components requiring power for normal operation. Although an SCS System failure is highly unlikely, for defense-in-depth an accident condition that renders it inoperable for an extended duration is postulated herein.

#### 11.2.16.1 Cause of SCS Failure

Possible causes of SCS failure are: (a) Simultaneous loss of external and backup power, or (b) Complete loss of annulus water from an uncontrolled leak or line break.

#### 11.2.16.2 Analysis of Effects and Consequences of SCS Failure

##### Structural

See discussion under thermal evaluation below.

##### Thermal

In the event of a SCS failure due to (a), the following sequence of events occur:

- i) The annulus water temperature rises to reach its boiling temperature (~212°F).
- ii) A progressive reduction of water level and dryout of the annulus.

In the event of an SCS failure due to (b), a rapid water loss occurs and annulus is replaced with air. This condition is evaluated in Section 4.5.5.3.

##### Shielding

There is no adverse effect on the shielding effectiveness of the system.

### Criticality

There is no adverse effect on the criticality control of the system.

### Confinement

There is no adverse effect on the confinement function of the MPC. As discussed in the evaluations above, the structural boundary pressures are within design limits.

### Radiation Protection

As there is no adverse effect on the shielding or confinement functions, there is no effect on occupational or public exposures as a result of this off-normal event.

Based on this evaluation, it is concluded that the SCS failure does not affect the safe operation of the HI-STORM 100 System.

#### 11.2.16.3 SCS Failure Dose Calculations

The event has no radiological impact because the confinement barrier and shielding integrity are not affected.

#### 11.2.16.4 SCS Failure Corrective Action

In the vertical orientation the HI-TRAC is designed to withstand an SCS failure without an adverse effect on its safety functions.

11.3        REFERENCES

- [11.2.1]    Chun et al., “Dynamic Impact Effects on Spent Fuel Assemblies,” Lawrence Livermore National Laboratory, UCID-21246, (October 1987).
- [11.2.2]    ESEERCO Project EP91-29 and EPRI Project 3100-02, “Debris Collection System for Boiling Water Reactor Consolidation Equipment,” B&W Fuel Company, (October 1995).
- [11.2.3]    Docket Number 72-1008, HI-STAR 100 System FSAR, Holtec Report HI-2012610, Revision 2.
- [11.2.4]    Docket Number 71-9261, HI-STAR 100 System SAR, Holtec Report HI-951251, Revision 10.

## SUPPLEMENT 11.I

### ACCIDENT EVALUATION FOR THE HI-STORM 100U SYSTEM

#### 11.1.0 INTRODUCTION

This supplement is focused on the off-normal and accident condition evaluations of the HI-STORM 100U vertical ventilated module (VVM). Only those events that are actually affected by the design of the overpack are discussed in detail herein. The reader is referred to the main body of Chapter 11 for discussions of any off-normal or accident conditions that are not dependent on the design of the storage overpack (i.e., MPC-only or HI-TRAC events).

The evaluations described herein parallel those of the HI-STORM 100 overpack contained in the main body of Chapter 11 of this FSAR. To ensure readability, the sections in this supplement are numbered to be directly analogous to the sections in the main body of the chapter. For example, the fire accident evaluation presented in Supplement Subsection 11.I.2.4 for the HI-STORM 100U is analogous to the evaluation presented in Subsection 11.2.4 of the main body of Chapter 11 for the HI-STORM 100. Tables and figures (if any) in this supplement, however, are labeled sequentially by section. If there is an analogous table or figure in the main body of Chapter 11, an appropriate notation is made in the supplement table or figure.

#### 11.1.1 OFF-NORMAL EVENTS

A general discussion of off-normal events is presented in Section 11.1 of the main body of Chapter 11. The following off-normal events are discussed in this supplement:

- Off-Normal Pressure
- Off-Normal Environmental Temperature
- Leakage of One MPC Seal Weld
- Partial Blockage of Air Inlets
- Off-Normal Handling of HI-TRAC Transfer Cask
- Malfunction of FHD System
- SCS Power Failure
- Off-Normal Wind

The results of the evaluations presented herein demonstrate that the HI-STORM 100U System can withstand the effects of off-normal events without affecting its ability to perform its intended function, and is in compliance with the applicable acceptance criteria.

##### 11.1.1.1 Off-Normal Pressure

A discussion of this off-normal condition is presented in Subsection 11.1.1 of the main body of Chapter 11. A description of the cause of, detection of, corrective actions for and radiological impact of this event is presented therein.

### Structural

The structural evaluation of the MPC enclosure vessel for off-normal internal pressure conditions is discussed in Section 3.4. The applicable pressure boundary stress limits are confirmed to bound the stresses resulting from the off-normal pressure.

### Thermal

In 4.6.1 the MPC internal pressure under the conditions of 10% fuel rods ruptured, insolation and a limiting fuel storage configuration in an aboveground overpack is evaluated. This evaluation is bounding as the MPC temperatures in the 100U overpack are bounded by the aboveground overpack.

### Shielding

There is no effect on the shielding performance of the system as a result of this off-normal event.

### Criticality

There is no effect on the criticality control features of the system as a result of this off-normal event.

### Confinement

There is no effect on the confinement function of the MPC as a result of this off-normal event. As discussed in the structural evaluation mentioned above, all stresses remain within allowable values, assuring confinement boundary integrity.

### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this off-normal event.

Based on this evaluation, it is concluded that the off-normal pressure does not affect the safe operation of the HI-STORM 100U System.

#### 11.1.1.2 Off-Normal Environmental Temperatures

A discussion of this off-normal condition is presented in Subsection 11.1.2 of the main body of Chapter 11. A description of the cause of, detection of, corrective actions for and radiological impact of this event is presented therein.

### Structural

The effect on the MPC for the upper off-normal thermal conditions (i.e., 100°F) is an increase in the internal pressure. However, as shown previously the resultant pressure is below the off-normal design pressure (Table 2.2.1). The effect of the lower off-normal thermal conditions (i.e., -40°F) requires an evaluation of the potential for brittle fracture. Such an evaluation is presented in Subsections 3.1.2 and 3.1.1.

### Thermal

Supplement 4.I calculates bounding temperatures and pressures for the HI-STORM 100U under the elevated temperature condition. The calculated temperatures and pressures are reported in Table 4.I.5 and are below the off-normal limits (Tables 2.2.3, 2.I.8 and 2.2.1).

The off-normal event considering an environmental temperature of -40°F and no solar insolation for a duration sufficient to reach thermal equilibrium is evaluated with respect to material design temperatures of the HI-STORM 100U overpack. The HI-STORM 100U overpack is conservatively assumed to reach -40°F throughout the structure. Chapter 3, Subsection 3.1.2 details the structural analysis and testing performed to assure prevention of brittle fracture failure of the HI-STORM 100U System.

### Shielding

There is no effect on the shielding performance of the system as a result of this off-normal event.

### Criticality

There is no effect on the criticality control features of the system as a result of this off-normal event.

### Confinement

There is no effect on the confinement function of the MPC as a result of this off-normal event.

### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this off-normal event.

Based on this evaluation, it is concluded that the specified off-normal environmental temperatures do not affect the safe operation of the HI-STORM 100U System.

### 11.1.1.3 Leakage of One MPC Seal Weld

A discussion of this off-normal condition is presented in Subsection 11.1.3 of the main body of Chapter 11. The discussion presented therein is applicable in its entirety to an MPC in a HI-STORM 100U VVM as well.

### 11.1.1.4 Partial Blockage of Air Inlets

A discussion of this off-normal condition is presented in Subsection 11.1.4 of the main body of Chapter 11. A description of the cause of, detection of, corrective actions for and radiological impact of this event is presented therein.

#### Structural

There are no structural consequences as a result of this off-normal event.

#### Thermal

Supplement 4.I calculates bounding temperatures for 50% blockage of the air inlets. The calculated bounding temperatures are reported in Table 4.I.6 and are below the MPC and VVM off-normal design temperatures (Tables 2.2.3 and 2.I.8). Additionally, the increased temperatures generate an elevated MPC internal pressure, also reported in Table 4.I.6, which is less than the off-normal design pressure (Table 2.2.1).

#### Shielding

There is no effect on the shielding performance of the system as a result of this off-normal event.

#### Criticality

There is no effect on the criticality control features of the system as a result of this off-normal event.

#### Confinement

There is no effect on the confinement function of the MPC as a result of this off-normal event.

#### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this off-normal event.

Based on this evaluation, it is concluded that the specified off-normal partial blockage of air inlet ducts event does not affect the safe operation of the HI-STORM 100U System.

#### 11.I.1.5 Off-Normal Handling of HI-TRAC

A discussion of this off-normal condition is presented in Subsection 11.1.5 of the main body of Chapter 11. The discussion presented therein remains completely applicable, as the design and method of operation of the HI-TRAC is the same as with the HI-STORM 100U.

#### 11.I.1.6 Failure of FHD System

A discussion of this off-normal condition is presented in Subsection 11.1.6 of the main body of Chapter 11. The discussion presented therein remains completely applicable for all MPCs.

#### 11.I.1.7 SCS Power Failure

A discussion of this off-normal condition is presented in Subsection 11.1.7 of the main body of Chapter 11. The discussion presented therein remains completely applicable to all MPCs.

#### 11.I.1.8 Off-Normal Wind

The HI-STORM 100U is designed for use at any site in the United States. Supplement 4.I evaluates the effects of off-normal wind (>0 and up to 15 MPH). The off-normal wind is postulated as a constant horizontal wind caused by extreme weather conditions (see Table 2.I.1). To determine the effects of the off-normal wind, it is conservatively assumed that these winds persist for a sufficient duration to allow the HI-STORM 100U System to reach thermal equilibrium. Because of the large mass of the HI-STORM 100U System with its corresponding large thermal inertia and the unlikely condition of a unidirectional wind for a long period of time, this assumption is conservative. The analyses presented in Supplement 4.I shows that the peak fuel cladding and material temperatures remains below the off-normal limits (Tables 2.2.3 and 2.I.8). Because the HI-STORM 100U System is designed to withstand the off-normal wind without any effect on its ability to maintain safe storage conditions, there is no requirement for detection of the off-normal wind.

#### Structural

There are no structural consequences as a result of this off-normal event.

#### Thermal

Supplement 4.I calculates peak fuel cladding temperatures for horizontal wind speeds of up to 15 miles per hour. The calculated temperatures (reported in Table 4.I.7) are below the off-normal limits (Table 2.2.3).

#### Shielding

There is no effect on the shielding performance of the system as a result of this off-normal event.

### Criticality

There is no effect on the criticality control features of the system as a result of this off-normal event.

### Confinement

There is no effect on the confinement function of the MPC as a result of this off-normal event.

### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this off-normal event.

Based on this evaluation, it is concluded that the specified off-normal wind event does not affect the safe operation of the HI-STORM 100U System. The HI-STORM 100U System is designed to withstand the off-normal wind without any effect on its ability to maintain safe storage conditions. There are no corrective actions required for the off-normal wind. The off-normal wind has no radiological impact, and the confinement barrier and shielding integrity are not affected.

### 11.1.2 ACCIDENT EVENTS

A general discussion of accident events is presented in Section 11.1 of the main body of Chapter 11. The following accident events are discussed in this supplement section:

- HI-TRAC Transfer Cask Handling Accident
- HI-STORM 100U Overpack Handling Accident
- Tip-Over
- Fire Accident
- Partial Blockage of MPC Basket Vent Holes
- Tornado
- Flood
- Earthquake
- 100% Fuel Rod Rupture
- Confinement Boundary Leakage
- Explosion
- Lightning
- 100% Blockage of Air Inlets
- Burial Under Debris
- Extreme Environmental Temperature
- SCS Failure

The results of the evaluations performed herein demonstrate that the HI-STORM 100U System can withstand the effects of all credible and hypothetical accident conditions and natural phenomena without affecting safety function, and is in compliance with the applicable acceptance criteria.

In addition to the above accidents events, identification of additional hazards during construction proximate to an operating ISFSI is treated in 11.I.2.17.

#### 11.I.2.1 HI-TRAC Transfer Cask Handling Accident

A discussion of this accident condition is presented in Subsection 11.2.1 of the main body of Chapter 11. The discussion presented therein is applicable in its entirety, as the design and method of operation of the HI-TRAC is the same for the HI-STORM 100U.

#### 11.I.2.2 HI-STORM Overpack Handling Accident

This accident event is not applicable to the HI-STORM 100U as this is an underground overpack surrounded by soil.

#### 11.I.2.3 Tip-Over

This accident event is not applicable to the HI-STORM 100U. Due to the subterranean installation of the VVM with a surrounding subgrade for lateral support, tip-over is precluded.

#### 11.I.2.4 Fire Accident

A discussion of this accident condition is presented in Subsection 11.2.4 of the main body of Chapter 11. A description of the cause of and corrective actions for this event is presented therein. In addition, the discussion of the fire analysis for the HI-TRAC transfer cask presented therein remains completely applicable, as the design and method of operation of the HI-TRAC do not need to be changed for use with the HI-STORM 100U.

### Structural

There are no structural consequences as a result of the fire accident condition.

### Thermal

Supplement 4.I discusses the impact of a fire on the HI-STORM 100U System. As justified therein, the evaluation for the fire effects on an aboveground cask presented in Section 11.2 bound the effects on the HI-STORM 100U System. As described in Section 11.2, the effects of the fire do not cause any system component or the contained fuel to exceed any design limit. As such, the results are bounding for the HI-STORM 100U System.

### Shielding

With respect to concrete damage from a fire, NUREG-1536 (4.0,V,5.b) states: “the loss of a small amount of shielding material is not expected to cause a storage system to exceed the regulatory requirements in 10 CFR 72.106 and, therefore, need not be estimated or evaluated in the SAR.”

### Criticality

There is no effect on the criticality control features of the system as a result of this accident event.

### Confinement

There is no effect on the confinement function of the MPC as a result of this accident event.

### Radiation Protection

Since there is a very localized reduction in shielding and no effect on the confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this accident event.

Based on this evaluation, it is concluded that the overpack fire accident does not affect the safe operation of the HI-STORM 100U System.

#### 11.1.2.5 Partial Blockage of MPC Basket Vent Holes

A discussion of this accident condition is presented in Subsection 11.2.5 of the main body of Chapter 11. The discussion presented therein is applicable in its entirety to an MPC in a HI-STORM 100U VVM.

#### 11.1.2.6 Tornado

A discussion of this accident condition is presented in Subsection 11.2.6 of the main body of Chapter 11. A description of the cause of and corrective actions for this event is presented therein.

Because of its underground construction, the HI-STORM 100U is not affected by the tornado wind. The effect of tornado missiles propelled by high velocity winds that attempt to penetrate the exposed portions of the HI-STORM 100U must, however, be considered.

### Structural

Analyses presented in Supplement 3.1 show that the impact of an intermediate tornado missile on the HI-STORM 100U closure lid does not result in the perforation of the lid or result in a

structural collapse. The result of the tornado missile impact on the VVM is limited to localized damage of the shielding.

#### Thermal

There are no thermal consequences as a result of the tornado beyond those discussed for the wind herein.

#### Shielding

A tornado missile may cause localized damage to the HI-STORM 100U closure lid. As the HI-STORM 100U top is heavily shielded (a thick MPC lid backed up by a steel-concrete-steel top) the overall damage consequences (site boundary dose) are insignificant.

#### Criticality

There is no effect on the criticality control features of the system as a result of this accident event.

#### Confinement

There is no effect on the confinement function of the MPC as a result of this accident event.

#### Radiation Protection

There is no degradation in confinement capabilities of the MPC, since the tornado missiles do not impact the MPC, as discussed above. A tornado missile may cause localized damage in the HI-STORM 100U closure lid. However, the damage will have a negligible effect on the site boundary dose.

Based on this evaluation, it is concluded that the tornado accident does not affect the safe operation of the HI-STORM 100U System.

#### 11.1.2.7 Flood

A discussion of this accident condition is presented in Subsection 11.2.7 of the main body of Chapter 11. A description of the cause of this event is presented therein.

#### Structural

The structural evaluation of the MPC for the accident condition external pressure (Table 2.2.1) is presented in Section 3.4 and the resulting stresses from this event are shown to be well within the allowable values.

### Thermal

The thermal consequences of flood are bounded by the 100% air inlets blockage accident (see Subsection 4.I.6.2).

### Shielding

There is no effect on the shielding performance of the system as a result of this accident event. The floodwater provides additional shielding which reduces radiation dose.

### Criticality

There is no effect on the criticality control features of the system as a result of this accident event. The criticality analysis is unaffected because under the flooding condition water does not enter the MPC cavity and therefore the reactivity would be less than the loading condition in the spent fuel pool, which is presented in Section 6.1.

### Confinement

There is no effect on the confinement function of the MPC as a result of this accident event. As discussed in the structural evaluation above, all stresses remain within allowable values, assuring confinement boundary integrity.

### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this accident event.

Based on this evaluation, it is concluded that the flood accident does not affect the safe operation of the HI-STORM 100U System.

### Flood Accident Corrective Action

The configuration of the VVM makes it uniquely suited to withstand a flooding event. Indeed, introducing water in the CEC is an effective method to lower the MPC contents' temperature. However, solid debris packed around the Divider Shell is an undesirable condition. Thus, while the thermal evaluations discussed in Supplement 4.I demonstrate that the HI-STORM 100U System will safely withstand a flood, corrective actions after such an event may be necessary. Periodic VVM air temperature monitoring, required for the HI-STORM 100U System, will identify any blockage of the cooling passages that results in a non-normal thermal condition, including blockages due to a flood borne debris.

If the measured temperature rise exceeds the allowable value, then corrective actions to alleviate the condition will be required. To restore the system to a normal configuration, all flood water and any debris deposited by the receding water must be removed. The specific methods to be

used are appropriately site specific and shall be addressed in the site emergence action plan. Examples of acceptable cleaning approaches include:

1. The MPC is removed from the VVM using the HI-TRAC transfer cask, allowing direct access to the interior of the VVM through both the inlet vents and the top of the module cavity. Water sprays and vacuuming is used to directly clean the VVM passages and surfaces.
2. Appropriate vacuuming equipment is inserted through the inlet ducts and down to the bottom plenum. Water is sprayed in through the outlet vents. Remote cameras are used to inspect the VVM cooling passages to identify debris and remove debris.

The adequacy of the cooling passages clearance operation is verified by visual inspection or, if the optional air temperature monitoring is used, the return of the air outlet temperatures to within allowable limits.

#### 11.I.2.8 Earthquake

A discussion of this accident condition is presented in Subsection 11.2.8 of the main body of Chapter 11. A description of the cause of and corrective actions for this event is presented therein.

#### Structural

Because of its underground construction, the HI-STORM 100U VVM is inherently safe under seismic events. Analyses presented in Supplement 3.I show that the VVM will continue to render its intended function under a seismic event whose ZPAs are bounded by the values set forth in Supplement 2.I.

#### Thermal

There is no effect on the thermal performance of the system as a result of this accident event.

#### Shielding

There is no effect on the shielding performance of the system as a result of this accident event.

#### Criticality

There is no effect on the criticality control features of the system as a result of this accident event.

#### Confinement

There is no effect on the confinement function of the MPC as a result of this accident event.

### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this accident event.

Based on this evaluation, it is concluded that the earthquake does not affect the safe operation of the HI-STORM 100U System.

#### 11.1.2.9 100% Fuel Rod Rupture

A discussion of this accident condition is presented in Subsection 11.2.9 of the main body of Chapter 11. A description of the cause of and corrective actions for this event is presented therein.

### Structural

The structural evaluation of the MPC for the accident condition internal pressure presented in Section 3.4 demonstrates that the MPC stresses are well within the allowable values.

### Thermal

A bounding MPC internal pressure for the 100% fuel rod rupture condition is presented in Table 4.4.9. The design basis accident condition MPC internal pressure (Table 2.2.1) used in the structural evaluation bounds the calculated value.

### Shielding

There is no effect on the shielding performance of the system as a result of this accident event.

### Criticality

There is no effect on the criticality control features of the system as a result of this accident event.

### Confinement

There is no effect on the confinement function of the MPC as a result of this accident event. As discussed in the structural evaluation above, all stresses remain within allowable values, assuring confinement boundary integrity.

### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this accident event.

Based on this evaluation, it is concluded that the non-mechanistic 100% fuel rod rupture accident does not affect the safe operation of the HI-STORM 100U System.

#### 11.I.2.10 Confinement Boundary Leakage

A discussion of this accident condition is presented in Subsection 11.2.10 of the main body of Chapter 11. The discussion presented therein remains completely applicable to an MPC in a HI-STORM 100U VVM as well.

#### 11.I.2.11 Explosion

A discussion of this accident condition is presented in Subsection 11.2.11 of the main body of Chapter 11. A description of the cause of and corrective actions for this event is presented therein.

#### Structural

Because of its underground construction, the HI-STORM 100U and the MPC contained within are essentially shielded by the surrounding earth. Thus, no evaluation of the VVM or the contained MPC is required. The HI-STORM 100U closure lid is, however, aboveground and exposed to the explosion-induced pressure wave. Supplement 3.I includes an evaluation of the effect of the design-basis 10 psi pressure wave applied as a static pressure on the closure lid. This evaluation shows that the overpressure wave does not result in lid separation, and that all lid stresses are a fraction of the allowable limits.

#### Thermal

There is no effect on the thermal performance of the system as a result of this accident event.

#### Shielding

There is no effect on the shielding performance of the system as a result of this accident event.

#### Criticality

There is no effect on the criticality control features of the system as a result of this accident event.

#### Confinement

There is no effect on the confinement function of the MPC as a result of this accident event. As discussed in the structural evaluation above, all stresses remain well within allowable values, assuring confinement boundary integrity.

## Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this accident event.

Based on this evaluation, it is concluded that the explosion accident does not affect the safe operation of the HI-STORM 100U System.

### 11.1.2.12 Lightning

A discussion of this accident condition is presented in Subsection 11.2.12 of the main body of Chapter 11. A description of the cause of and corrective actions for this event is presented therein.

Because of its underground construction, the subterranean portion of the HI-STORM 100U would not be subjected to a direct lightning strike. The HI-STORM 100U closure lid is, however, aboveground and could be subjected to a direct strike. The closure lid is, however, a steel encased concrete structure just like on the aboveground casks. Thus, the discussion presented in Subsection 11.2.12 remains completely applicable to the exposed portions of the HI-STORM 100U System. Therefore, it is concluded that a lightning event will not prevent the VVM from rendering its intended function.

### 11.1.2.13 100% Blockage of Air Inlets

A discussion of this accident condition is presented in Subsection 11.2.13 of the main body of Chapter 11. A description of the cause of and corrective actions for this event is presented therein.

## Structural

There are no structural consequences as a result of this accident event.

## Thermal

Supplement 4.I calculates bounding temperatures for the 100% blockage of the air inlets. The calculated bounding temperatures after 24 hours of 100% blockage are reported in Table 4.I.9. The results are below the MPC and VVM accident temperature limits (Tables 2.2.3 and 2.I.8). Additionally, the increased temperatures generate an elevated MPC internal pressure, also reported in Table 4.I.9, which is less than the design basis accident pressure listed in Table 2.2.1.

## Shielding

There is no effect on the shielding performance of the system as a result of this accident event, since the concrete temperatures do not exceed the accident temperature limit.

### Criticality

There is no effect on the criticality control features of the system as a result of this accident event.

### Confinement

There is no effect on the confinement function of the MPC as a result of this accident event.

### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this accident event.

Based on this evaluation, it is concluded that the 100% blockage of air inlets accident does not affect the safe operation of the HI-STORM 100 System, if the blockage is removed in the specified time period.

#### 11.I.2.14 Burial Under Debris

A discussion of this accident condition is presented in Subsection 11.2.14 of the main body of Chapter 11. A description of the cause of and corrective actions for this event is presented therein.

### Structural

The structural evaluation of the MPC enclosure vessel for accident internal pressure conditions bounds the pressure calculated herein. Therefore, the resulting stresses from this event are well within the allowable values, as demonstrated in Section 3.4.

### Thermal

Supplement 4.I discusses the impact of burial under debris on the HI-STORM 100U System. As explained therein, the evaluation for the effects of such an event on an aboveground cask presented in Section 11.2 bound the HI-STORM 100U.

### Shielding

There is no adverse effect on the shielding performance of the system as a result of this accident event.

### Criticality

There is no effect on the criticality control features of the system as a result of this accident event.

### Confinement

There is no effect on the confinement function of the MPC as a result of this accident event. As discussed in the structural evaluation above, all stresses remain within allowable values, assuring confinement boundary integrity.

### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this accident event.

Based on this evaluation, it is concluded that the burial under debris accident does not affect the safe operation of the HI-STORM 100U System, if the debris is removed within the specified time period.

#### 11.I.2.15 Extreme Environmental Temperature

A discussion of this accident condition is presented in Subsection 11.2.15 of the main body of Chapter 11. A description of the cause of and corrective actions for this event is presented therein.

### Structural

The structural evaluation of the MPC enclosure vessel for accident condition internal pressure bounds the pressure resulting from this event. Therefore, the resulting stresses from this event are bounded by the design-basis internal pressure and are well within the allowable values, as discussed in Section 3.4.

### Thermal

Supplement 4.I calculates bounding temperatures for the HI-STORM 100U under the extreme environmental temperature condition. The calculated bounding temperatures and pressures are reported in Table 4.I.8 and are below the MPC and VVM accident temperature and pressure limits (Tables 2.2.3, 2.I.8 and 2.2.1).

### Shielding

There is no effect on the shielding performance of the system as a result of this accident event, since the concrete temperature does not exceed the short-term temperature limit specified in Table 2.2.3.

### Criticality

There is no effect on the criticality control features of the system as a result of this accident event.

### Confinement

There is no effect on the confinement function of the MPC as a result of this accident event. As discussed in the structural evaluation above, all stresses remain within allowable values, assuring confinement boundary integrity.

### Radiation Protection

Since there is no degradation in shielding or confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this accident event.

Based on this evaluation, it is concluded that the extreme environment temperature accident does not affect the safe operation of the HI-STORM 100U System.

#### 11.I.2.16 Supplemental Cooling System (SCS) Failure

A discussion of this off-normal condition is presented in Subsection 11.2.16 of the main body of Chapter 11. The discussion presented therein remains completely applicable, as the design and method of operation of the SCS and the HI-TRAC is unchanged for use with the HI-STORM 100U System.

#### 11.I.2.17 Additional Hazards during Construction Proximate to the ISFSI

To protect an installed ISFSI from any site construction activity in its proximity, a certain minimum ground buffer distance beyond the edge of the perimeter of the VVM arrays is prescribed in the licensing drawings. This radiation protection space (RPS) defines the no-construction zone around the installed and loaded VVMs (see Section 1.1.4).

As is required for deploying casks certified under 10CFR72, Subpart L, every site modification that may potentially impact the continued operability of the ISFSI must be evaluated for acceptability under 10CFR72.212. A generic evaluation of the shielding consequences of digging a cavity adjacent to the radiation protection zone has been considered in Supplement 5.I of this FSAR. The analyses show that the dose at the edge of the cavity is below 0.2 mrem/hr, which is well below the customary limit that requires radiation posting at nuclear power plants.

Subsection 2.1.4 considers loadings from extreme environmental phenomena assuming that a deep cavity at the edge of the RPS perimeter has been created as a part of site construction work and an accidental mechanical loading event across such cavity is credible. Analyses summarized in Subsection 3.1.4 show that the design basis projectiles (large, medium, or small), specified in

Chapter 2 of this FSAR, applied in the most vulnerable location of the construction cavity, will fail to reach the CEC.

In addition to the generic analyses documented in this FSAR to validate the sufficiency of the RPS boundary, analyses of the consequences of any credible site specific loads or events during site construction work shall be performed with due consideration of the duration and nature of the site construction activity. The user's §72.212 evaluation program, used in considering ISFSI-proximate activities at aboveground ISFSIs, shall apply to the HI-STORM 100U installation as well without limitation.

To summarize, as discussed in Supplement 2.I and documented in the licensing drawing package in Section 1.5, and the technical specifications; a radiation protection space (RPS) has been established per supplement 5.I with sufficient margin (ground buffer) against design basis projectiles analyzed in supplement 3.I. As documented in the technical specifications, the RPS boundary shall not be encroached upon during any site construction activity (this includes excavation). In addition to the generic analyses documented in this FSAR, site specific evaluation pursuant to §72.212 shall be performed for all other credible hazards that can be postulated during site construction. Administrative controls to guard against accidental human error in excavations (such as encroachment of the RPS) shall be addressed through written procedures consistent with the required controls needed for a safety significant activity within a Part 50 controlled area.

Subsection 2.I.6(xii) also requires the ISFSI owner to perform a seismic analysis of the ISFSI for the instance when the maximum amount of excavation of the area adjacent to the RPS will exist. The site's Design Basis Earthquake (DBE) will be used. PRA considerations shall not be used to diminish the strength of the seismic input. The Design Basis Seismic Model, described in 3.I.4, shall be used with appropriate representation of the construction cavity.

Because the actual projectiles for a specific ISFSI site are often different from the tornado borne missiles analyzed in Supplement 3.I herein, a site specific analysis of the effect of all credible missiles shall be performed assuming that the largest construction cavity adjacent to the ISFSI exists. PRA considerations shall not be used to rule out any missile that has been determined to be credible in the plant's FSAR.

Furthermore, the ISFSI owner shall implement ameliorative measures to prevent unacceptable damage to the ISFSI from any other credible adverse scenarios unique to a site that has not been considered in this FSAR. An example of such a measure is the installation of a berm to protect against environmental events such as soil erosion and mud slides. Such site specific design initiatives at any "100U" ISFSI, like its aboveground counterpart, are within the purview of the plant's §72.212 process.

## CHAPTER 12†: OPERATING CONTROLS AND LIMITS

### 12.0 INTRODUCTION

The HI-STORM 100 System provides passive dry storage of spent fuel assemblies in interchangeable MPCs with redundant multi-pass welded closure. The loaded MPC is enclosed in a single-purpose vertical ventilated module or overpack. This chapter defines the operating controls and limits (i.e., Technical Specifications) including their supporting bases for deployment and storage of a HI-STORM 100 System at an ISFSI. The information provided in this Chapter is in full compliance with NUREG-1536 [12.1.1].

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† This chapter has been prepared in the format and section organization set forth in Regulatory Guide 3.61. However, the material content of this chapter also fulfills the requirements of NUREG-1536. Pagination and numbering of sections, figures, and tables are consistent with the convention set down in Chapter 1, Section 1.0, herein. Finally, all terms-of-art used in this chapter are consistent with the terminology of the glossary (Table 1.0.1) and component nomenclature of the Bill-of-Materials (Section 1.5).

## 12.1 PROPOSED OPERATING CONTROLS AND LIMITS

### 12.1.1 NUREG-1536 (Standard Review Plan) Acceptance Criteria

12.1.1.1 This portion of the FSAR establishes the commitments regarding the HI-STORM 100 System and its use. Other 10CFR72 [12.1.2] and 10CFR20 [12.1.3] requirements in addition to the Technical Specifications may apply. The conditions for a general license holder found in 10CFR72.212 [12.1.2] shall be met by the licensee prior to loading spent fuel into the HI-STORM 100 System. The general license conditions governed by 10CFR72 [12.1.2] are not repeated with these Technical Specifications. Licensees are required to comply with all commitments and requirements.

12.1.1.2 The Technical Specifications provided in Appendix A and A-100U to CoC 72-1014 and the authorized contents and design features provided in Appendix B and B-100U to CoC 72-1014 are primarily established to maintain subcriticality, confinement boundary and intact fuel cladding integrity, shielding and radiological protection, heat removal capability, and structural integrity under normal, off-normal and accident conditions. Table 12.1.1 addresses each of these conditions respectively and identifies the appropriate Technical Specification(s) designed to control the condition. Table 12.1.2 provides the list of Technical Specifications for the HI-STORM 100 System.

Table 12.1.1  
HI-STORM 100 SYSTEM CONTROLS

Condition to be Controlled	Applicable Technical Specifications <sup>†</sup>
Criticality Control	3.3.1 Boron Concentration
Confinement Boundary and Intact Fuel Cladding Integrity	3.1.1 Multi-Purpose Canister (MPC) 3.1.4 Supplemental Cooling System
Shielding and Radiological Protection	3.1.1 Multi-Purpose Canister (MPC) 3.1.3 Fuel Cool-Down 3.2.2 TRANSFER CASK Surface Contamination 5.4 Radioactive Effluent Control Program 5.7 Radiation Protection Program
Heat Removal Capability	3.1.1 Multi-Purpose Canister (MPC) 3.1.2 SFSC Heat Removal System 3.1.4 Supplemental Cooling System
Structural Integrity	3.1.5 Impressed Current Cathodic Protection System 5.5 Cask Transport Evaluation Program

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<sup>†</sup> Technical Specifications are located in Appendix A to CoC 72-1014. Authorized contents are specified in FSAR Section 2.1.9

Table 12.1.2  
HI-STORM 100 SYSTEM TECHNICAL SPECIFICATIONS

NUMBER	TECHNICAL SPECIFICATION
1.0	USE AND APPLICATION 1.1    Definitions 1.2    Logical Connectors 1.3    Completion Times 1.4    Frequency
2.0	Not Used
3.0	LIMITING CONDITION FOR OPERATION (LCO) APPLICABILITY SURVEILLANCE REQUIREMENT (SR) APPLICABILITY
3.1.1	Multi-Purpose Canister (MPC)
3.1.2	SFSC Heat Removal System
3.1.3	Fuel Cool-Down
3.1.4	Supplemental Cooling System
3.1.5	Impressed Current Cathodic Protection System
3.2.1	Deleted
3.2.2	TRANSFER CASK Surface Contamination
3.2.3	Deleted
3.3.1	Boron Concentration
Table 3-1	MPC Cavity Drying Limits
Table 3-2	MPC Helium Backfill Limits
4.0	Not Used
5.0	ADMINISTRATIVE CONTROLS
5.1	Deleted
5.2	Deleted
5.3	Deleted
5.4	Radioactive Effluent Control Program
5.5	Cask Transport Evaluation Program
5.6	Deleted
5.7	Radiation Protection Program
Table 5-1	TRANSFER CASK and OVERPACK Lifting Requirements

## 12.2 DEVELOPMENT OF OPERATING CONTROLS AND LIMITS

This section provides a discussion of the operating controls and limits, and training requirements for the HI-STORM 100 System to assure long-term performance consistent with the conditions analyzed in this FSAR.

### 12.2.1 Training Modules

Training modules are to be developed under the licensee's training program to require a comprehensive, site-specific training, assessment, and qualification (including periodic re-qualification) program for the operation and maintenance of the HI-STORM 100 Spent Fuel Storage Cask (SFSC) System and the Independent Spent Fuel Storage Installation (ISFSI). The training modules shall include the following elements, at a minimum:

1. HI-STORM 100 System Design (overview);
2. ISFSI Facility Design (overview);
3. Systems, Structures, and Components Important to Safety (overview);
4. HI-STORM 100 System Final Safety Analysis Report (overview);
5. NRC Safety Evaluation Report (overview);
6. Certificate of Compliance conditions;
7. HI-STORM 100 Technical Specifications, Approved Contents, Design Features and other Conditions for Use;
8. HI-STORM 100 Regulatory Requirements (e.g., 10CFR72.48, 10CFR72, Subpart K, 10CFR20, 10CFR73);
9. Required instrumentation and use;
10. Operating Experience Reviews
11. HI-STORM 100 System and ISFSI Procedures, including
  - Procedural overview
  - Fuel qualification and loading
  - MPC /HI-TRAC/overpack rigging and handling, including safe load pathways
  - MPC welding operations
  - HI-TRAC/overpack/VVM closure
  - Auxiliary equipment operation and maintenance (e.g., draining, moisture removal, helium backfilling, supplemental cooling (if used), and cooldown)

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- MPC/HI-TRAC/overpack/VVM pre-operational and in-service inspections and tests
- Transfer and securing of the loaded HI-TRAC/overpack onto the transport vehicle
- Transfer and offloading of the HI-TRAC/overpack
- Preparation of MPC/HI-TRAC/overpack/VVM for fuel unloading
- Unloading fuel from the MPC/HI-TRAC/overpack/VVM
- Surveillance
- Radiation protection
- Maintenance
- Security
- Off-normal and accident conditions, responses, and corrective actions

### 12.2.2 Dry Run Training

A dry run training exercise of the loading, closure, handling, and transfer of the HI-STORM 100 System shall be conducted by the licensee prior to the first use of the system to load spent fuel assemblies. The dry run shall include, but is not limited to the following:

1. Receipt inspection of HI-STORM 100 System components.
2. Moving the HI-STORM 100 MPC/HI-TRAC into the spent fuel pool.
3. Preparation of the HI-STORM 100 System for fuel loading.
4. Selection and verification of specific fuel assemblies to ensure type conformance.
5. Locating specific assemblies and placing assemblies into the MPC (using a dummy fuel assembly), including appropriate independent verification.
6. Remote installation of the MPC lid and removal of the MPC/HI-TRAC from the spent fuel pool.
7. Replacing the HI-TRAC pool lid with the transfer lid (HI-TRAC 100 and 125 only).
8. MPC welding, NDE inspections, pressure testing, draining, moisture removal, and helium backfilling (for which a mockup may be used).
9. HI-TRAC upending/downending on the horizontal transfer trailer or other transfer device, as applicable to the site's cask handling arrangement.
10. Placement of the HI-STORM 100 System at the ISFSI.
11. HI-STORM 100 System unloading, including cooling fuel assemblies, flooding the MPC cavity, and removing MPC welds (for which a mock-up may be used).

## 12. Installation and operation of the Supplemental Cooling System (if used).

### 12.2.3 Functional and Operating Limits, Monitoring Instruments, and Limiting Control Settings

The controls and limits apply to operating parameters and conditions which are observable, detectable, and/or measurable. The HI-STORM 100 System is completely passive during storage and requires no monitoring instruments. The user may choose to implement a temperature monitoring system to verify operability of the overpack heat removal system in accordance with Technical Specification Limiting Condition for Operation (LCO) 3.1.2.

### 12.2.4 Limiting Conditions for Operation

Limiting Conditions for Operation specify the minimum capability or level of performance that is required to assure that the HI-STORM 100 System can fulfill its safety functions.

### 12.2.5 Equipment

The HI-STORM 100 System and its components have been analyzed for specified normal, off-normal, and accident conditions, including extreme environmental conditions. Analysis has shown in this FSAR that no credible condition or event prevents the HI-STORM 100 System from meeting its safety function. As a result, there is no threat to public health and safety from any postulated accident condition or analyzed event. When all equipment is loaded, tested, and placed into storage in accordance with procedures developed for the ISFSI, no failure of the system to perform its safety function is expected to occur.

### 12.2.6 Surveillance Requirements

The analyses provided in this FSAR show that the HI-STORM 100 System fulfills its safety functions, provided that the Technical Specifications and the Authorized Contents described in Section 2.1.9 are met. Surveillance requirements during loading, unloading, and storage operations are provided in the Technical Specifications.

### 12.2.7 Design Features

This section describes HI-STORM 100 System design features that are Important to Safety. These features require design controls and fabrication controls. The design features, detailed in this FSAR and in Appendix B to CoC 72-1014, are established in specifications and drawings which are controlled through the quality assurance program. Fabrication controls and inspections to assure that the HI-STORM 100 System is fabricated in accordance with the design drawings and the requirements of this FSAR are described in Chapter 9.

### 12.2.8 MPC

- a. Basket material composition, properties, dimensions, and tolerances for criticality control.

- b. Canister material mechanical properties for structural integrity of the confinement boundary.
- c. Canister and basket material thermal properties and dimensions for heat transfer control.
- d. Canister and basket material composition and dimensions for dose rate control.

12.2.9 HI-STORM Overpack/VVM

- a. HI-STORM overpack/VVM material mechanical properties and dimensions for structural integrity to provide protection of the MPC and shielding of the spent nuclear fuel assemblies during loading, unloading and handling operations, as applicable.
- b. HI-STORM overpack/VVM material thermal properties and dimensions for heat transfer control.
- c. HI-STORM overpack/VVM material composition and dimensions for dose rate control.

12.2.10 Verifying Compliance with Fuel Assembly Decay Heat, Burnup, and Cooling Time Limits

The examples below execute the approach and equations described in Section 2.1.9.1 for determining allowable decay heat per storage location, burnup, and cooling time for the approved cask contents.

Example 1

In this example, a demonstration of the use of burnup versus cooling time tables for regionalized fuel loading is provided. In this example it will be assumed that the MPC-32 is being loaded with array/class 16x16A fuel in a regionalized loading pattern and will be stored in an aboveground HI-STORM system.

Step 1: Pick a value of X between 0.5 and 3. For this example X will be 2.8.

Step 2: Calculate  $q_{\text{Region2}}$  as described in Section 2.1.9.1.2:

$$q_{\text{Region2}} = (2 \times 34) / [(1 + (2.8)^{0.2075}) \times ((12 \times 2.8) + 20)] = 0.5668 \text{ kW}^\dagger$$

Step 3: Calculate  $q_{\text{Region1}}$  as described in Section 2.1.9.1.2:

$$q_{\text{Region1}} = X \times q_{\text{Region2}} = 2.8 \times 0.5668 = 1.5871 \text{ kW}$$

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<sup>†</sup> Results are arbitrarily rounded to four decimal places.

Step 4: Develop a burnup versus cooling time table. Since this table is enrichment dependent, it is permitted and advisable to create multiple tables for different enrichments. In this example, two enrichments will be used: 3.1 and 4.185. Tables 12.2.1 and 12.2.2 show the burnup versus cooling time tables calculated for these enrichments for Region 1 and Region 2 as described in Section 2.1.9.1.3.

Table 12.2.3 provides three hypothetical fuel assemblies in the 16x16A array/class that will be evaluated for acceptability for loading in the MPC-32 example above. The decay heat values in Table 12.2.3 are calculated by the user. The other information is taken from the fuel assembly and reactor operating records.

Fuel Assembly Number 1 is not acceptable for storage because its enrichment is lower than that used to determine the allowable burnups in Table 12.2.1 and 12.1.2. The solution is to develop another table using an enrichment of 3.0 wt.%  $^{235}\text{U}$  or less to determine this fuel assembly's suitability for loading in this MPC-32.

Fuel Assembly Number 2 is not acceptable for loading unless a unique maximum allowable burnup for a cooling time of 3.3 years is calculated by linear interpolation between the values in Table 12.2.1 for 3 years and 4 years of cooling. Linear interpolation yields a maximum burnup of 36,497 MWD/MTU (rounded down from 36,497.2), making Fuel Assembly Number 2 acceptable for loading only in Region 1 due to decay heat limitations.

Fuel Assembly Number 3 is acceptable for loading based on the higher allowable burnups in Table 12.2.2, which were calculated using a higher minimum enrichment than those in Table 12.2.1, which is still below the actual initial enrichment of Fuel Assembly Number 3. Due to its relatively low total decay heat of 0.5 kW (fuel: 0.4, non-fuel hardware: 0.1), Fuel Assembly Number 3 may be stored in Region 1 or Region 2.

### Example 2

In this example, each fuel assembly in Table 12.2.3 will be evaluated to determine whether it may be stored in the same hypothetical MPC-32 in a regionalized storage pattern in an aboveground system. Assuming the same value 'X', the same maximum fuel storage location decay heats are calculated. The equation in Section 2.1.9.1.3 is executed for each fuel assembly using its exact initial enrichment to determine its maximum allowable burnup. Linear interpolation is used to further refine the maximum allowable burnup value between cooling times, if necessary.

Fuel Assembly Number 1: The calculated allowable burnup for 3.0 wt.%  $^{235}\text{U}$  and a decay heat value of 1.5871 kW ( $q_{\text{region1}}$ ) is 44,905 MWD/MTU at 4 years minimum cooling. Its decay heat is too high for loading in Region 2. Comparing the fuel assembly burnup and total decay heat of the contents<sup>†</sup> (fuel (1.01 kW) plus non-fuel hardware (0.5 kW)) to the calculated limits indicates that the fuel assembly, including the non-fuel hardware, is acceptable for storage in Region 1.

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<sup>†</sup> The assumption is made that the non-fuel hardware meets burnup and cooling time limits in Table 2.1.25.

Fuel Assembly Number 2: The calculated allowable burnup for 3.2 wt.%  $^{235}\text{U}$  and a decay heat value of 1.5871 kW ( $q_{\text{region1}}$ ) is 32,989 MWD/MTU for 3 years cooling and 45,382 MWD/MTU for 4 years cooling. Linearly interpolating between these values for a cooling time of 3.3 years yields a maximum allowable burnup of 36,706 MWD/MTU and, therefore, the assembly is acceptable for storage in Region 1. This fuel assembly's decay heat is also too high for loading in Region 2.

Fuel Assembly Number 3: The calculated allowable maximum burnup for 4.3 wt.%  $^{235}\text{U}$  and a decay heat value of 0.5668 ( $q_{\text{Region2}}$ ) is 41,693 MWD/MTU for 18 years cooling. Comparing the fuel assembly burnup and total decay heat of the contents (fuel plus non-fuel hardware) against the calculated limits indicates that the fuel assembly and non-fuel hardware are acceptable for storage. Therefore, the assembly is acceptable for storage in Region 2. This fuel assembly would also be acceptable for loading in Region 1 (this conclusion is inferred, but not demonstrated).

### Example 3

In this example, a demonstration of the use of burnup versus cooling time tables for uniform fuel loading is provided. In this example it will be assumed that the MPC-68 is being loaded with array/class 9x9A fuel and will be stored in an aboveground HI-STORM system.

Step 1: CoC TS Appendix B Table 2.4-1 provides the heat load limit on each storage location ( $q_{\text{max}}$ ). For MPC-68 this is 0.5 kW.

Step 2: Develop a burnup versus cooling time table. Since this table is enrichment dependent, it is permitted and advisable to create multiple tables for different enrichments if the fuel being loaded varies significantly in initial enrichment. It is conservative to choose the lowest value of initial enrichment to generate the table.

In this example, two enrichments will be used: 3.0 and 4.5. Tables 12.2.4 and 12.2.5 show the burnup versus cooling time tables calculated for these enrichments for the respective  $q_{\text{max}}$ .

Table 12.2.6 provides three hypothetical fuel assemblies in the 9x9A array/class that will be evaluated for acceptability for loading in the MPC-68 example above. The decay heat values in Table 12.2.6 would be calculated by the user. The other information would be taken from the fuel assembly and reactor operating records.

All of the assemblies meet the per cell heat load limit of 0.5 kW.

Fuel Assembly Number 1 is acceptable for storage because its enrichment is lower than that used to determine the allowable burnups in Table 12.2.4 and the burnup is lower than that allowed for the cooling time of the assembly.

Fuel Assembly Number 2 is not acceptable for loading based on the current tables. The fuel assembly burnup is greater than allowed by Table 12.2.4, even with linear interpolation (30978 MWD/MTU). Fuel Assembly Number 2 may be acceptable for loading if a new table is created specifically for an initial enrichment of 3.5 wt% and the allowable burnup is greater than 35250.

Fuel Assembly Number 3 is acceptable for loading based on the allowable burnups in Table 12.2.5.

#### 12.2.11 Verifying Compliance with Total MPC Heat Load

Some operational steps and/or use of particular equipment are required if  $Q_{CoC}$  is above a certain value, e.g. 28.74 kW in the MPC-32. These include supplemental cooling, forced helium dehydration, helium backfill pressure, and surveillance requirements for LCO 3.1.2. These examples demonstrate the logic behind the decisions for these operational steps. Time to boil limits and vacuum drying are also considered in these examples.

Example 1:

Table 12.2.7 contains a proposed heat load pattern for loading a MPC-68 into an aboveground HI-STORM 100 System. The table provides the decay heat of each storage location. It is assumed that each of these assemblies meets the burnup, cooling time and enrichment criteria for loading as described in the previous examples in Section 12.2.10.

General observations on this loading plan:

1. The heat loads in all cells meet the CoC limits for Uniform Loading, i.e. all cells are  $\leq 0.50$  kW (See Table 2.1.26).
2. The MPC is loaded preferentially for ALARA considerations, i.e. the assemblies with the lower heat loads are in the peripheral cells.
3. The aggregate MPC heat load, as defined in Section 2.1.9.1.2 as the simple summation of the assemblies in the MPC, is 18.917 kW.
4. The maximum heat load in any cell is 0.460 kW.
5.  $Q_{CoC}$ , as defined in Section 2.1.9.1.2 equation c is 31.280 kW.

Recommendations based on the general observations without further site-specific analysis:

1. Vacuum drying without annulus flushing: The MPC *cannot* be dried using vacuum drying without annulus flushing because the maximum heat load in any cell is greater than 0.316 kW (See Tables in FSAR Section 4.5.3.1.2).
2. Vacuum drying with annulus flushing: The MPC *cannot* be dried using vacuum drying with annulus flushing because the maximum heat load in any cell is greater than 0.414 kW (See Tables in FSAR Section 4.5.3.1.3).
3. Forced Helium Dehydration: Even though the aggregate heat load is less than 26kW the MPC should be dried using forced helium dehydration since the heat loads in one or more cells do not meet the values in Tables 4.5.7 or 4.5.8.
4. Helium Backfill Pressure Range: The MPC should be backfilled to the higher pressure range given in the TS because the heat loads in one or more cells do not meet the values in Tables 4.5.7 or 4.5.8.
5. Supplemental Cooling System: A supplemental cooling system would be required for

on-site transport in the HI-TRAC after the MPC is dried, backfilled and sealed because the heat loads in one or more cells do not meet the values in Table 4.5.7 or 4.5.8.

6. Heat Removal Surveillance (LCO 3.1.2): The user has 24 hours to clear blockage on the system containing this MPC since the heat loads in the cells do not meet the values in Table 4.5.7 or 4.5.8.
7. Time to boil determination: The user can calculate the time to boil limit based on the aggregate MPC heat load of 18.917 kW since this is a bulk adiabatic heat up calculation strictly based on the aggregate heat in the MPC.
8. Air mass flow rate test requirements per Condition 9 of the CoC: The user can determine if this test needs to be performed based on the aggregate MPC heat load of 18.917 kW since the air flow on the outside of the MPC is strictly based on the aggregate heat in the MPC.

#### Example 2

Table 12.2.8 contains a proposed heat load pattern for loading a MPC-32. The table provides the decay heat of each storage location. It is assumed that each of these assemblies meets the burnup, cooling time and enrichment criteria for loading as described in the previous examples in Section 12.2.10.

General observations on this loading plan:

1. The heat loads in all cells meet the CoC limits for Uniform Loading, i.e. all cells are  $\leq 1.062$  kW (See Table 2.1.26).
2. The MPC is loaded preferentially for ALARA considerations, i.e. the assemblies with the lower heat loads are in the peripheral cells.
3. The aggregate MPC heat load, as defined in Section 2.1.9.1.2 as the simple summation of the assemblies in the MPC, is 17.471 kW.
4. The maximum heat load in any cell is 0.826 kW.
5.  $Q_{CoC}$ , as defined in Section 2.1.9.1.2 equation c is 26.432 kW.

Recommendations based on the general observations without further site-specific analysis:

1. Vacuum drying without annulus flushing: The MPC *cannot* be dried using vacuum drying without annulus flushing since annulus flushing during vacuum drying of MPC-32 is always required (See Tables in FSAR Section 4.5.3.1.2).
2. Vacuum drying with annulus flushing: The MPC can be dried using vacuum drying if annulus flushing is used since the maximum heat load in any cell does not exceed 0.898 kW (See Tables in FSAR Section 4.5.3.1.3) and the aggregate MPC heat load is less than 26 kW. No time limit is applied to drying this canister since the aggregate heat load (17.471 kW) is less than or equal to 23 kW.
3. Forced Helium Dehydration: The MPC can be dried using forced helium dehydration but it is not required.

4. Helium Backfill Pressure Range: The MPC may be backfilled to either pressure range given in the TS because the maximum heat load in any cell is below the values in Table 4.5.7.
5. Supplemental Cooling System: A supplemental cooling system would NOT be required for on-site transport in the HI-TRAC after the MPC is dried, backfilled and sealed because the maximum heat load in any cell is below the values in Table 4.5.7.
6. Heat Removal Surveillance (LCO 3.1.2): The user has 64 hours to clear blockage on the system containing this MPC since the maximum heat load in any cell is below the values in Table 4.5.7.
7. Time to boil determination: The user can calculate the time to boil limit based on the aggregate MPC heat load of 17.471 kW since this is a bulk adiabatic heat up calculation strictly based on the aggregate heat in the MPC.
8. Air mass flow rate test requirements per Condition 9 of the CoC: The user can determine if this test needs to be performed based on the aggregate MPC heat load of 17.471 kW since the air flow on the outside of the MPC is strictly based on the aggregate heat in the MPC.

### Example 3

Table 1.2.9 contains a proposed heat load pattern for loading a MPC-32. The table provides the decay heat of each storage location. It is assumed that each of these assemblies meets the burnup, cooling time and enrichment criteria for loading as described in the previous examples in Section 12.2.10.

General observations on this loading plan:

1. The heat loads do not meet the CoC limits for Uniform Loading, i.e. some cells are  $\geq 1.0625$  kW (See Table 2.1.26).
2. The X value that most closely meets this pattern (See Table 2.1.30) is 1.5 which means the inner locations cannot have a total decay heat greater than 1.282 kW and the outer locations cannot have a total decay heat greater than 0.855 kW. Note that the pattern also meets the criteria for any X value  $\geq 1.5$ .
3. The aggregate MPC heat load, as defined in Section 2.1.9.1.2 as the simple summation of the assemblies in the MPC, is 20.697 kW.
4. The maximum heat load in any cell is 1.273 kW.
5. Since this MPC is loaded in a regionalized pattern,  $Q_{CoC}$ , as defined in Section 2.1.9.1.2 equation e is 32.484 kW. ( $12 \times 1.282 + 20 \times 0.855$ )

Recommendations based on the general observations without further site-specific analysis:

1. Vacuum drying without annulus flushing: The MPC *cannot* be dried using vacuum drying without annulus flushing since annulus flushing during vacuum drying of MPC-32 is always required (See Tables in FSAR Section 4.5.3.1.2).
2. Vacuum drying with annulus flushing: The MPC cannot be dried using vacuum

drying if annulus flushing is used since the maximum heat load in any cell exceeds 0.898 kW (See Tables in FSAR Section 4.5.3.1.3).

3. Forced Helium Dehydration: The MPC must be dried using forced helium dehydration because the maximum heat load in at least one cell is greater than the value in Table 4.5.7 and the maximum heat load in at least one cell in the inner region is greater than the value in Table 4.5.8.
4. Helium Backfill Pressure Range: The MPC must be backfilled to the higher pressure range given in the TS because the maximum heat load in at least one cell is greater than the value in Table 4.5.7 and the maximum heat load in at least one cell in the inner region is greater than the value in Table 4.5.8.
5. Supplemental Cooling System: A supplemental cooling system is required for on-site transport in the HI-TRAC after the MPC is dried, backfilled and sealed because the maximum heat load in at least one cell is greater than the value in Table 4.5.7 and the maximum heat load in at least one cell in the inner region is greater than the value in Table 4.5.8.
6. Heat Removal Surveillance (LCO 3.1.2): The user has 24 hours to clear blockage on the system containing this MPC since the maximum heat load in at least one cell is greater than the value in Table 4.5.7 and the maximum heat load in at least one cell in the inner region is greater than the value in Table 4.5.8.
7. Time to boil determination: The user can calculate the time to boil limit based on the aggregate MPC heat load of 20.697 kW since this is a bulk adiabatic heat up calculation strictly based on the aggregate heat in the MPC.
8. Air mass flow rate test requirements per Condition 9 of the CoC: The user can determine if this test needs to be performed based on the aggregate MPC heat load of 20.697 kW since the air flow on the outside of the MPC is strictly based on the aggregate heat in the MPC.

Table 12.2.1

EXAMPLE BURNUP VERSUS COOLING TIME LIMITS FOR REGIONALIZED LOADING  
 (MPC-32, Array/Class 16x16A, X = 2.8, and Enrichment = 3.1 wt.% <sup>235</sup>U)  
 ( $q_{\text{Region 1}} = 1.5871 \text{ kW}$ ,  $q_{\text{Region 2}} = 0.5668 \text{ kW}$ )

MINIMUM COOLING TIME (years)	MAXIMUM ALLOWABLE BURNUP IN REGION 1 (MWD/MTU)	MAXIMUM ALLOWABLE BURNUP IN REGION 2 (MWD/MTU)
≥3	32791	10896
≥4	45145	17370
≥5	53769	22697
≥6	59699	26615
≥7	63971	29386
≥8	67343	31437
≥9	68200	33000
≥10	68200	34271
≥11	68200	35384
≥12	68200	36322
≥13	68200	37189
≥14	68200	37980
≥15	68200	38773
≥16	68200	39512
≥17	68200	40234
≥18	68200	40908
≥19	68200	41620
≥20	68200	42324

Table 12.2.2

EXAMPLE BURNUP VERSUS COOLING TIME LIMITS FOR REGIONALIZED LOADING  
 (MPC-32, Array/Class 16x16A, X = 2.8, and Enrichment = 4.185 wt.% <sup>235</sup>U)  
 (q<sub>Region 1</sub> = 1.5871 kW, q<sub>Region 2</sub> = 0.5668 kW)

<b>MINIMUM COOLING TIME (years)</b>	<b>MAXIMUM ALLOWABLE BURNUP IN REGION 1 (MWD/MTU)</b>	<b>MAXIMUM ALLOWABLE BURNUP IN REGION 2 (MWD/MTU)</b>
≥3	34797	11101
≥4	47590	17870
≥5	56438	23272
≥6	62533	27157
≥7	66963	29907
≥8	68200	31935
≥9	68200	33510
≥10	68200	34785
≥11	68200	35927
≥12	68200	36894
≥13	68200	37790
≥14	68200	38593
≥15	68200	39419
≥16	68200	40191
≥17	68200	40937
≥18	68200	41643
≥19	68200	42363
≥20	68200	43094

Table 12.2.3

SAMPLE CONTENTS TO DETERMINE ACCEPTABILITY FOR STORAGE  
(Array/Class 16x16A)

FUEL ASSEMBLY NUMBER	ENRICHMENT (wt. % <sup>235</sup> U)	FUEL ASSEMBLY BURNUP (MWD/MTU)	FUEL ASSEMBLY COOLING TIME (years)	FUEL ASSEMBLY DECAY HEAT (kW)	NON-FUEL HARDWARE STORED WITH ASSEMBLY	NFH DECAY HEAT (kW)
1	3.0	37100	4.7	1.01	BPRA	0.5
2	3.2	35250	3.3	1.45	NA	NA
3	4.3	41276	18.2	0.4	BPRA	0.1

Table 12.2.4

EXAMPLE BURNUP VERSUS COOLING TIME LIMITS FOR REGIONALIZED LOADING  
 (MPC-68, Array/Class 9x9A, and Enrichment = 3.0 wt.% <sup>235</sup>U)  
 ( $q_{\max} = 0.5$  kW)

MINIMUM COOLING TIME (years)	MAXIMUM ALLOWABLE BURNUP (MWD/MTU)
≥3	27739
≥4	38536
≥5	46268
≥6	51583
≥7	55424
≥8	58303
≥9	60733
≥10	62798
≥11	64609
≥12	66331
≥13	68005
≥14	68200
≥15	68200
≥16	68200
≥17	68200
≥18	68200
≥19	68200
≥20	68200

Table 12.2.5

EXAMPLE BURNUP VERSUS COOLING TIME LIMITS FOR REGIONALIZED LOADING  
 (MPC-68, Array/Class 9x9A, and Enrichment =4.5 wt.% <sup>235</sup>U)  
 ( $q_{\max} = 0.5 \text{ kW}$ )

MINIMUM COOLING TIME (years)	MAXIMUM ALLOWABLE BURNUP (MWD/MTU)
≥3	30017
≥4	41399
≥5	49359
≥6	54839
≥7	58856
≥8	61932
≥9	64534
≥10	66802
≥11	68200
≥12	68200
≥13	68200
≥14	68200
≥15	68200
≥16	68200
≥17	68200
≥18	68200
≥19	68200
≥20	68200

Table 12.2.6

SAMPLE CONTENTS TO DETERMINE ACCEPTABILITY FOR STORAGE  
(Array/Class 9x9A)

FUEL ASSEMBLY NUMBER	ENRICHMENT (wt. % <sup>235</sup> U)	FUEL ASSEMBLY BURNUP (MWD/MTU)	FUEL ASSEMBLY COOLING TIME (years)	FUEL ASSEMBLY DECAY HEAT (kW)
1	3.0	37100	4.7	0.3
2	3.5	35250	3.3	0.495
3	4.5	41276	18.2	0.2

Table 12.2.7  
 Loading Map for Storage Cells in an MPC-68  
 Total Decay Heat (kW)

				0.171	0.170				
			0.175	0.171	0.186	0.183	0.180	0.176	
	0.171	0.300	0.313	0.315	0.310	0.309	0.303	0.169	
	0.172	0.312	0.450	0.456	0.449	0.444	0.302	0.176	
0.170	0.181	0.304	0.446	0.457	0.454	0.454	0.307	0.181	0.169
0.159	0.183	0.317	0.441	0.439	0.460	0.441	0.313	0.186	0.170
	0.174	0.315	0.440	0.437	0.445	0.443	0.311	0.181	
	0.161	0.303	0.304	0.316	0.320	0.301	0.302	0.182	
		0.166	0.173	0.181	0.183	0.182	0.178		
				0.169	0.155				

Table 12.2.8  
 Loading Map for Storage Cells in an MPC-32  
 Total Decay Heat (kW)

		0.370	0.394	0.392	0.387	
0.395	0.372	0.81	0.817	0.391	0.372	
0.388	0.810	0.818	0.826	0.825	0.375	
0.382	0.820	0.823	0.821	0.812	0.378	
0.384	0.390	0.813	0.824	0.393	0.395	
	0.373	0.372	0.375	0.374		

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Table 12.2.9  
 Loading Map for Storage Cells in an MPC-32  
 Total Decay Heat (kW)

	0.310	0.349	0.329	0.378	
0.359	0.327	1.110	1.107	0.399	0.372
0.388	1.068	1.207	1.250	1.091	0.373
0.328	1.086	1.273	1.203	1.087	0.374
0.348	0.309	1.100	1.090	0.319	0.375
	0.337	0.327	0.357	0.367	

### 12.3 TECHNICAL SPECIFICATIONS

Technical Specifications for the HI-STORM 100 System are provided in Appendix A to Certificate of Compliance 72-1014. Authorized Contents (i.e., fuel specifications) and Design Features are provided in Appendix B to CoC 72-1014. Bases applicable to the Technical Specifications are provided in FSAR Appendix 12.A. The format and content of the HI-STORM 100 System Technical Specifications and Bases are that of the Improved Standard Technical Specifications for power reactors, to the extent they apply to a dry spent fuel storage cask system. NUMARC Document 93-03, "Writer's Guide for the Restructured Technical Specifications" [12.3.1] was used as a guide in the development of the Technical Specifications and Bases.

## 12.4 REGULATORY EVALUATION

Table 12.1.2 lists the Technical Specifications for the HI-STORM 100 System. The Technical Specifications are detailed in Appendix A and A-100U to Certificate of Compliance 72-1014. The Authorized Contents (i.e., fuel specifications) and Design Features are provided in Appendix B and B-100U to CoC 72-1014.

The conditions for use of the HI-STORM 100 System identify necessary Technical Specifications, limits on authorized contents (i.e., fuel), and cask design features to satisfy 10 CFR Part 72, and the applicable acceptance criteria have been satisfied. Compliance with these Technical specifications and other conditions of the Certificate of Compliance provides reasonable assurance that the HI-STORM 100 System will provide safe storage of spent fuel and is in compliance with 10 CFR Part 72, the regulatory guides, applicable codes and standards, and accepted practices.

12.5        REFERENCES:

- [12.1.1]    U.S. Nuclear Regulatory Commission, NUREG-1536, Standard Review Plan for Dry Cask Storage Systems, Final Report, January 1997.
- [12.1.2]    U.S. Code of Federal Regulations, Title 10, Energy, Part 72, Licensing Requirements for Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste."
- [12.1.3]    U.S. Code of Federal Regulations, Title 10, Energy, Part 20, Standards for Protection Against Radiation."
- [12.3.1]    Nuclear Management and Resources Council, Inc. – Writer's Guide for the Restructured Technical Specifications, NUMARC 93-03, February 1993.

**HI-STORM 100 SYSTEM FSAR**

**APPENDIX 12.A**

**TECHNICAL SPECIFICATION BASES  
FOR THE HOLTEC HI-STORM 100 SPENT FUEL STORAGE CASK SYSTEM**

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HI-STORM FSAR  
REPORT HI-2002444

Rev.3

HI-STORM 100 FSAR  
REVISION 10  
APRIL 25, 2012

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## B 3.0 LIMITING CONDITION FOR OPERATION (LCO) APPLICABILITY

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LCOs LCO 3.0.1, 3.0.2, 3.0.4, and 3.0.5 establish the general requirements applicable to all Specifications and apply at all times, unless otherwise stated.

---

LCO 3.0.1 LCO 3.0.1 establishes the Applicability statement within each individual Specification as the requirement for when the LCO is required to be met (i.e., when the facility is in the specified conditions of the Applicability statement of each Specification).

---

LCO 3.0.2 LCO 3.0.2 establishes that upon discovery of a failure to meet an LCO, the associated ACTIONS shall be met. The Completion Time of each Required Action for an ACTIONS Condition is applicable from the point in time that an ACTIONS Condition is entered. The Required Actions establish those remedial measures that must be taken within specified Completion Times when the requirements of an LCO are not met. This Specification establishes that:

- a. Completion of the Required Actions within the specified Completion Times constitutes compliance with a Specification; and
- b. Completion of the Required Actions is not required when an LCO is met within the specified Completion Time, unless otherwise specified.

There are two basic types of Required Actions. The first type of Required Action specifies a time limit in which the LCO must be met. This time limit is the Completion Time to restore a system or component or to restore variables to within specified limits. Whether stated as a Required Action or not, correction of the entered Condition is an action that may always be considered upon entering ACTIONS. The second type of Required Action specifies the

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LCO 3.0.2  
(continued) remedial measures that permit continued operation that is not further restricted by the Completion Time. In this case, compliance with the Required Actions provides an acceptable level of safety for continued operation.

Completing the Required Actions is not required when an LCO is met or is no longer applicable, unless otherwise stated in the individual Specifications.

The Completion Times of the Required Actions are also applicable when a system or component is removed from service intentionally. The reasons for intentionally relying on the ACTIONS include, but are not limited to, performance of Surveillances, preventive maintenance, corrective maintenance, or investigation of operational problems. Entering ACTIONS for these reasons must be done in a manner that does not compromise safety. Intentional entry into ACTIONS should not be made for operational convenience.

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LCO 3.0.3 This specification is not applicable to a dry storage cask system because it describes conditions under which a power reactor must be shut down when an LCO is not met and an associated ACTION is not met or provided. The placeholder is retained for consistency with the power reactor technical specifications.

---

LCO 3.0.4 LCO 3.0.4 establishes limitations on changes in specified conditions in the Applicability when an LCO is not met. It precludes placing the HI-STORM 100 System in a specified condition stated in that Applicability (e.g., Applicability desired to be entered) when the following exist:

- a. Facility conditions are such that the requirements of the LCO would not be met in the Applicability desired to be entered; and
- b. Continued noncompliance with the LCO requirements, if the Applicability were entered, would result in being required to

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LCO 3.0.4  
(continued)

exit the Applicability desired to be entered to comply with the Required Actions.

Compliance with Required Actions that permit continuing with dry fuel storage activities for an unlimited period of time in a specified condition provides an acceptable level of safety for continued operation. This is without regard to the status of the dry storage system. Therefore, in such cases, entry into a specified condition in the Applicability may be made in accordance with the provisions of the Required Actions. The provisions of this Specification should not be interpreted as endorsing the failure to exercise the good practice of restoring systems or components before entering an associated specified condition in the Applicability.

The provisions of LCO 3.0.4 shall not prevent changes in specified conditions in the Applicability that are required to comply with ACTIONS. In addition, the provisions of LCO 3.0.4 shall not prevent changes in specified conditions in the Applicability that are related to the unloading of an SFSC.

Exceptions to LCO 3.0.4 are stated in the individual Specifications. Exceptions may apply to all the ACTIONS or to a specific Required Action of a Specification.

---

LCO 3.0.5

LCO 3.0.5 establishes the allowance for restoring equipment to service under administrative controls when it has been removed from service or determined to not meet the LCO to comply with the ACTIONS. The sole purpose of this Specification is to provide an exception to LCO 3.0.2 (e.g., to not comply with the applicable Required Action(s)) to allow the performance of testing to demonstrate:

- a. The equipment being returned to service meets the LCO; or
- b. Other equipment meets the applicable LCOs.

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BASES

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LCO 3.0.5  
(continued)

The administrative controls ensure the time the equipment is returned to service in conflict with the requirements of the ACTIONS is limited to the time absolutely necessary to perform the allowed testing. This Specification does not provide time to perform any other preventive or corrective maintenance.

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## B 3.0 SURVEILLANCE REQUIREMENT (SR) APPLICABILITY

### BASES

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SRs SR 3.0.1 through SR 3.0.4 establish the general requirements applicable to all Specifications and apply at all times, unless otherwise stated.

---

SR 3.0.1 SR 3.0.1 establishes the requirement that SRs must be met during the specified conditions in the Applicability for which the requirements of the LCO apply, unless otherwise specified in the individual SRs. This Specification is to ensure that Surveillances are performed to verify that systems and components meet the LCO and variables are within specified limits. Failure to meet a Surveillance within the specified Frequency, in accordance with SR 3.0.2, constitutes a failure to meet an LCO.

Systems and components are assumed to meet the LCO when the associated SRs have been met. Nothing in this Specification, however, is to be construed as implying that systems or components meet the associated LCO when:

- a. The systems or components are known to not meet the LCO, although still meeting the SRs; or
- b. The requirements of the Surveillance(s) are known to be not met between required Surveillance performances.

Surveillances do not have to be performed when the HI-STORM 100 System is in a specified condition for which the requirements of the associated LCO are not applicable, unless otherwise specified.

Surveillances, including Surveillances invoked by Required Actions, do not have to be performed on equipment that has been determined to not meet the LCO because the ACTIONS define the remedial measures that apply. Surveillances have to be met and performed in accordance with SR 3.0.2, prior to returning equipment to service. Upon completion of maintenance, appropriate post-maintenance testing is required. This includes ensuring applicable Surveillances

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BASES

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SR 3.0.1  
(continued)

are not failed and their most recent performance is in accordance with SR 3.0.2. Post maintenance testing may not be possible in the current specified conditions in the Applicability due to the necessary dry storage cask system parameters not having been established. In these situations, the equipment may be considered to meet the LCO provided testing has been satisfactorily completed to the extent possible and the equipment is not otherwise believed to be incapable of performing its function. This will allow dry fuel storage activities to proceed to a specified condition where other necessary post maintenance tests can be completed.

---

SR 3.0.2

SR 3.0.2 establishes the requirements for meeting the specified Frequency for Surveillances and any Required Action with a Completion Time that requires the periodic performance of the Required Action on a "once per..." interval.

SR 3.0.2 permits a 25% extension of the interval specified in the Frequency. This extension facilitates Surveillance scheduling and considers facility conditions that may not be suitable for conducting the Surveillance (e.g., transient conditions or other ongoing Surveillance or maintenance activities).

The 25% extension does not significantly degrade the reliability that results from performing the Surveillance at its specified Frequency. This is based on the recognition that the most probable result of any particular Surveillance being performed is the verification of conformance with the SRs. The exceptions to SR 3.0.2 are those Surveillances for which the 25% extension of the interval specified in the Frequency does not apply. These exceptions are stated in the individual Specifications as a Note in the Frequency stating, "SR 3.0.2 is not applicable."

As stated in SR 3.0.2, the 25% extension also does not apply to the initial portion of a periodic Completion Time that requires performance on a "once per..." basis. The 25% extension applies to each performance after the initial performance. The initial performance of the Required Action, whether it is a particular Surveillance or some other remedial action, is considered a single action with a single Completion Time. One reason for not allowing the 25% extension

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BASES

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SR 3.0.2  
(continued)

to this Completion Time is that such an action usually verifies that no loss of function has occurred by checking the status of redundant or diverse components or accomplishes the function of the affected equipment in an alternative manner.

The provisions of SR 3.0.2 are not intended to be used repeatedly merely as an operational convenience to extend Surveillance intervals or periodic Completion Time intervals beyond those specified.

---

SR 3.0.3

SR 3.0.3 establishes the flexibility to defer declaring affected equipment as not meeting the LCO or an affected variable outside the specified limits when a Surveillance has not been completed within the specified Frequency. A delay period of up to 24 hours or up to the limit of the specified Frequency, whichever is less, applies from the point in time that it is discovered that the Surveillance has not been performed in accordance with SR 3.0.2, and not at the time that the specified Frequency was not met.

This delay period provides adequate time to complete Surveillances that have been missed. This delay period permits the completion of a Surveillance before complying with Required Actions or other remedial measures that might preclude completion of the Surveillance.

The basis for this delay period includes consideration of HI-STORM 100 System conditions, adequate planning, availability of personnel, the time required to perform the Surveillance, the safety significance of the delay in completing the required Surveillance, and the recognition that the most probable result of any particular Surveillance being performed is the verification of conformance with the requirements. When a Surveillance with a Frequency based not on time intervals, but upon specified facility conditions, is discovered not to have been performed when specified, SR 3.0.3 allows the full delay period of 24 hours to perform the Surveillance.

SR 3.0.3 also provides a time limit for completion of Surveillances that become applicable as a consequence of changes in the specified conditions in the Applicability imposed by the Required Actions.

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SR 3.0.3

Failure to comply with specified Frequencies for SRs is expected to

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(continued) be an infrequent occurrence. Use of the delay period established by SR 3.0.3 is a flexibility which is not intended to be used as an operational convenience to extend Surveillance intervals.

If a Surveillance is not completed within the allowed delay period, then the equipment is considered to not meet the LCO or the variable is considered outside the specified limits and the Completion Times of the Required Actions for the applicable LCO Conditions begin immediately upon expiration of the delay period. If a Surveillance is failed within the delay period, then the equipment does not meet the LCO, or the variable is outside the specified limits and the Completion Times of the Required Actions for the applicable LCO Conditions begin immediately upon the failure of the Surveillance.

Completion of the Surveillance within the delay period allowed by this Specification, or within the Completion Time of the ACTIONS, restores compliance with SR 3.0.1.

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SR 3.0.4 SR 3.0.4 establishes the requirement that all applicable SRs must be met before entry into a specified condition in the Applicability.

This Specification ensures that system and component requirements and variable limits are met before entry into specified conditions in the Applicability for which these systems and components ensure safe conduct of dry fuel storage activities.

The provisions of this Specification should not be interpreted as endorsing the failure to exercise the good practice of restoring systems or components before entering an associated specified condition in the Applicability.

However, in certain circumstances, failing to meet an SR will not result in SR 3.0.4 restricting a change in specified condition. When a system, subsystem, division, component, device, or variable is

(continued)

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BASES

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SR 3.0.4  
(continued)

outside its specified limits, the associated SR(s) are not required to be performed per SR 3.0.1, which states that Surveillances do not have to be performed on equipment that has been determined to not meet the LCO. When equipment does not meet the LCO, SR 3.0.4 does not apply to the associated SR(s) since the requirement for the SR(s) to be performed is removed. Therefore, failing to perform the Surveillance(s) within the specified Frequency does not result in an SR 3.0.4 restriction to changing specified conditions of the Applicability. However, since the LCO is not met in this instance, LCO 3.0.4 will govern any restrictions that may (or may not) apply to specified condition changes.

The provisions of SR 3.0.4 shall not prevent changes in specified conditions in the Applicability that are required to comply with ACTIONS. In addition, the provisions of LCO 3.0.4 shall not prevent changes in specified conditions in the Applicability that are related to the unloading of an SFSC.

The precise requirements for performance of SRs are specified such that exceptions to SR 3.0.4 are not necessary. The specific time frames and conditions necessary for meeting the SRs are specified in the Frequency, in the Surveillance, or both. This allows performance of Surveillances when the prerequisite condition(s) specified in a Surveillance procedure require entry into the specified condition in the Applicability of the associated LCO prior to the performance or completion of a Surveillance. A Surveillance that could not be performed until after entering the LCO Applicability would have its Frequency specified such that it is not "due" until the specific conditions needed are met. Alternately, the Surveillance may be stated in the form of a Note as not required (to be met or performed) until a particular event, condition, or time has been reached. Further discussion of the specific formats of SRs' annotation is found in Section 1.4, Frequency.

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B 3.1 SFSC Integrity

B 3.1.1 Multi-Purpose Canister (MPC)

**BASES**

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**BACKGROUND** A TRANSFER CASK with an empty MPC is placed in the spent fuel pool and loaded with fuel assemblies meeting the requirements of the CoC. A lid is then placed on the MPC. The TRANSFER CASK and MPC are raised to the top of the spent fuel pool surface. The TRANSFER CASK and MPC are then moved into the cask preparation area where the MPC lid is welded to the MPC shell and the welds are inspected and tested. The water is drained from the MPC cavity and drying is performed. The MPC cavity is backfilled with helium. Then, the MPC vent and drain port cover plates and closure ring are installed and welded. Inspections are performed on the welds. MPC cavity moisture removal using vacuum drying or forced helium dehydration is performed to remove residual moisture from the MPC cavity space after the MPC has been drained of water. If vacuum drying is used, any water that has not drained from the fuel cavity evaporates from the fuel cavity due to the vacuum. This is aided by the temperature increase due to the decay heat of the fuel and by the heat added to the MPC from the optional warming pad, if used.

If forced helium dehydration is used, the dry gas introduced to the MPC cavity through the vent or drain port absorbs the residual moisture in the MPC. This humidified gas exits the MPC via the other port and the absorbed water is removed through condensation and/or mechanical drying. The dried helium is then forced back to the MPC until the temperature acceptance limit is met.

After the completion of drying, the MPC cavity is backfilled with helium meeting the requirements of the CoC.

(continued)

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BASES

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**BACKGROUND**  
(continued)

Backfilling of the MPC fuel cavity with helium promotes gaseous heat dissipation and the inert atmosphere protects the fuel cladding. Backfilling the MPC with helium in the required quantity eliminates air inleakage over the life of the MPC because the cavity pressure rises due to heat up of the confined gas by the fuel decay heat during storage.

**APPLICABLE  
SAFETY  
ANALYSIS**

The confinement of radioactivity during the storage of spent fuel in the MPC is ensured by the multiple confinement boundaries and systems. The barriers relied on are the fuel pellet matrix, the metallic fuel cladding tubes in which the fuel pellets are contained, and the MPC in which the fuel assemblies are stored. Long-term integrity of the fuel and cladding depend on storage in an inert atmosphere. This is accomplished by removing water from the MPC and backfilling the cavity with an inert gas. The thermal analyses of the MPC assume that the MPC cavity is filled with dry helium of a minimum quantity to ensure the assumptions used for convection heat transfer are preserved. Keeping the backfill pressure below the maximum value preserves the initial condition assumptions made in the MPC overpressurization evaluation.

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(continued)

BASES (continued)

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LCO A dry, helium filled and sealed MPC establishes an inert heat removal environment necessary to ensure the integrity of the multiple confinement boundaries. Moreover, it also ensures that there will be no air in-leakage into the MPC cavity that could damage the fuel cladding over the storage period.

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APPLICABILITY The dry, sealed and inert atmosphere is required to be in place during TRANSPORT OPERATIONS and STORAGE OPERATIONS to ensure both the confinement barriers and heat removal mechanisms are in place during these operating periods. These conditions are not required during LOADING OPERATIONS or UNLOADING OPERATIONS as these conditions are being established or removed, respectively during these periods in support of other activities being performed with the stored fuel.

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ACTIONS A note has been added to the ACTIONS which states that, for this LCO, separate Condition entry is allowed for each MPC. This is acceptable since the Required Actions for each Condition provide appropriate compensatory measures for each MPC not meeting the LCO. Subsequent MPCs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1

If the cavity vacuum drying pressure or demoisurizer exit gas temperature limit has been determined not to be met during TRANSPORT OPERATIONS or STORAGE OPERATIONS, an engineering evaluation is necessary to determine the potential quantity of moisture left within the MPC cavity. Since moisture remaining in the cavity during these modes of operation may represent a long-term degradation concern, immediate action is not necessary. The Completion Time is sufficient to complete the engineering evaluation commensurate with the safety significance of the CONDITION.

(continued)

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BASES

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ACTIONS  
(continued)

A.2

Once the quantity of moisture potentially left in the MPC cavity is determined, a corrective action plan shall be developed and actions initiated to the extent necessary to return the MPC to an analyzed condition. Since the quantity of moisture estimated under Required Action A.1 can range over a broad scale, different recovery strategies may be necessary. Since moisture remaining in the cavity during these modes of operation may represent a long-term degradation concern, immediate action is not necessary. The Completion Time is sufficient to develop and initiate the corrective actions commensurate with the safety significance of the CONDITION.

B.1

Although Holtec steady state analysis for vacuum drying the MPC at the maximum heat load allowed indicates that PCT limits will not be exceeded, a time limit for vacuum drying based on the MPC heat load was mandated by the NRC in the approval of CoC 1014 Amendment 5 [4]. NRC considered that limiting the heat load to 23 kW provided added margin to the PCT limit.

If the MPC cavity vacuum drying acceptance criterion is not met during the allowable time, the Required Action ensures a sufficient quantity of helium within the MPC cavity to provide additional margin to the PCT limits. The Completion Time is sufficient to complete the corrective action commensurate with the safety significance of the CONDITION.

(continued)

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BASES

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ACTIONS  
(continued)

C.1

If the helium backfill quantity limit has been determined not to be met during TRANSPORT OPERATIONS or STORAGE OPERATIONS, an engineering evaluation is necessary to determine the quantity of helium within the MPC cavity. Since too much or too little helium in the MPC during these modes represents a potential overpressure or heat removal degradation concern, an engineering evaluation shall be performed in a timely manner. The Completion Time is sufficient to complete the engineering evaluation commensurate with the safety significance of the CONDITION.

C.2

Once the quantity of helium in the MPC cavity is determined, a corrective action plan shall be developed and initiated to the extent necessary to return the MPC to an analyzed condition either by adding or removing helium or by demonstrating through analysis that all cask system limits will continue to be met. Since the quantity of helium estimated under Required Action C.1 can range over a broad scale, different recovery strategies may be necessary. Since elevated or reduced helium quantities existing in the MPC cavity represent a potential overpressure or heat removal degradation concern, corrective actions should be developed and implemented in a timely manner. The Completion Time is sufficient to develop and initiate the corrective actions commensurate with the safety significance of the CONDITION.

(continued)

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BASES

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ACTIONS  
(continued)

D.1

If the helium leak rate limit has been determined not to be met during TRANSPORT OPERATIONS or STORAGE OPERATIONS, an engineering evaluation is necessary to determine the impact of increased helium leak rate on heat removal and off-site dose. Since the HI-STORM OVERPACK is a ventilated system, any leakage from the MPC is transported directly to the environment. Since an increased helium leak rate represents a potential challenge to MPC heat removal and the off-site doses, reasonably rapid action is warranted. The Completion Time is sufficient to complete the engineering evaluation commensurate with the safety significance of the CONDITION.

D.2

Once the consequences of the elevated leak rate from the MPC are determined, a corrective action plan shall be developed and initiated to the extent necessary to return the MPC to an analyzed condition. Since the recovery mechanisms can range over a broad scale based on the evaluation performed under Required Action C.1, different recovery strategies may be necessary. Since an elevated helium leak rate represents a challenge to heat removal rates and offsite doses, reasonably rapid action is required. The Completion Time is sufficient to develop and initiate the corrective actions commensurate with the safety significance of the CONDITION.

(continued)

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BASES

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ACTIONS  
(continued)

E.1

If the MPC fuel cavity cannot be successfully returned to a safe, analyzed condition, the fuel must be placed in a safe condition in the spent fuel pool. The Completion Time is reasonable based on the time required to replace the transfer lid with the pool lid (if required), perform fuel cooldown operations (if required), re-flood the MPC, cut the MPC lid welds, move the TRANSFER CASK into the spent fuel pool, remove the MPC lid, and remove the spent fuel assemblies in an orderly manner and without challenging personnel.

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BASES

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SURVEILLANCE REQUIREMENTS    SR 3.1.1.1 , SR 3.1.1.2, and SR 3.1.1.3

The long-term integrity of the stored fuel is dependent on storage in a dry, inert environment. For moderate burnup fuel cavity dryness may be demonstrated either by evacuating the cavity to a very low absolute pressure and verifying that the pressure is held over a specified period of time or by recirculating dry helium through the MPC cavity to absorb moisture until the gas temperature or dew point at the specified location reaches and remains below the acceptance limit for the specified time period. A low vacuum pressure or a demister exit temperature meeting the acceptance limit is an indication that the cavity is dry. For high burnup fuel and high decay heat load MPCs, the forced helium dehydration method of moisture removal must be used to provide necessary cooling of the fuel during drying operations. Cooling provided by normal operation of the forced helium dehydration system ensures that the fuel cladding temperature remains below the applicable limits since forced recirculation of helium provides more effective heat transfer than that which occurs during normal storage operations.

Table 3-1 of Appendix A to the CoC provides the appropriate requirements for drying the MPC cavity based on the burnup class of the fuel (moderate or high) and the applicable short-term temperature limit. The temperature limits and associated cladding hoop stress calculation requirements are consistent with the guidance in NRC Interim Staff Guidance (ISG) Document 11.

Having the proper quantity of helium in the MPC ensures adequate heat transfer from the fuel to the fuel basket and surrounding structure of the MPC and precludes any overpressure event from challenging the normal, off-normal, or accident design pressure of the MPC.

Meeting the helium leak rate limit ensures there is adequate helium in the MPC for long term storage and that there is no credible effluent dose from the cask.

(continued)

BASES

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SURVEILLANCE REQUIREMENTS    SR 3.1.1.1, SR 3.1.1.2 , and SR 3.1.1.3 (continued)

All of these surveillances must be successfully performed once, prior to TRANSPORT OPERATIONS to ensure that the conditions are established for SFSC storage which preserve the analysis basis supporting the cask design.

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- REFERENCES
1. FSAR Sections 1.2, 4.4, 4.5, 7.2, 7.3 and 8.1
  2. Interim Staff Guidance Document 11
  3. Interim Staff Guidance Document 18
  4. NRC SER for CoC 72-1014 Amendment #5, ML082030170, Section 4.10.2
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BASES

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APPLICABLE  
SAFETY  
ANALYSIS

The complete blockage of all air inlets stops normal (continued) air cooling of the MPC. The MPC will continue to radiate heat to the relatively cooler OVERPACK. With the loss of normal air cooling, the SFSC component temperatures will increase toward their respective short-term temperature limits. None of the components reach their temperature limits over the duration of the analyzed event.

---

LCO

The SFSC Heat Removal System must be verified to be operable to preserve the assumptions of the thermal analyses. Operability is defined as at least 50% of the inlet air ducts available for air flow (i.e., unblocked). Operability of the heat removal system ensures that the decay heat generated by the stored fuel assemblies is transferred to the environs at a sufficient rate to maintain fuel cladding and other SFSC component temperatures within design limits.

The intent of this LCO is to address those occurrences of air duct blockage that can be reasonably anticipated to occur from time to time at the ISFSI (i.e., Design Event I and II class events per ANSI/ANS-57.9). These events are of the type where corrective actions can usually be accomplished within one 8-hour operating shift to restore the heat removal system to operable status (e.g., removal of loose debris).

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BASES

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LCO  
(continued)

This LCO is not intended to address low frequency, unexpected Design Event III and IV class events such as design basis accidents and extreme environmental phenomena that could potentially block one or more of the air ducts for an extended period of time (i.e., longer than the total Completion Time of the LCO). This class of events is addressed site-specifically as required by Section 3.4.9 of Appendix B to the CoC.

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APPLICABILITY

The LCO is applicable during STORAGE OPERATIONS. Once an OVERPACK containing an MPC loaded with spent fuel has been placed into its storage configuration, the heat removal system must be operable to ensure adequate dissipation of the decay heat from the fuel assemblies.

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ACTIONS

A note has been added to the ACTIONS which states that, for this LCO, separate Condition entry is allowed for each SFSC. This is acceptable since the Required Actions for each Condition provide appropriate compensatory measures for each SFSC not meeting the LCO. Subsequent SFSCs that don't meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1

Although the heat removal system remains operable, the blockage should be cleared expeditiously.

B.1

If the heat removal system has been determined to be inoperable, it must be restored to operable status within eight hours. Eight hours is a reasonable period of time (typically, one operating shift) to take action to remove the obstructions in the air flow path.

(continued)

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BASES

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ACTIONS  
(continued)

C.1

If the heat removal system cannot be restored to operable status within eight hours, the innermost portion of the OVERPACK concrete may experience elevated temperatures. Therefore, dose rates are required to be measured to verify the effectiveness of the radiation shielding provided by the concrete. This Action must be performed immediately and repeated every twelve hours thereafter to provide timely and continued evaluation of the effectiveness of the concrete shielding. As necessary, the cask user shall provide additional radiation protection measures such as temporary shielding. The Completion Time is reasonable considering the expected slow rate of deterioration, if any, of the concrete under elevated temperatures.

C.2.1

In addition to Required Action C.1, efforts must continue to restore cooling to the SFSC. Efforts must continue to restore the heat removal system to operable status by removing the air flow obstruction(s) unless optional Required Action C.2.2 is being implemented.

This Required Action must be complete in 64 hours for an aboveground system with an MPC decay heat load of 28.74 kW or less, in 24 hours for an aboveground system with an MPC decay heat load greater than 28.74 kW, and in 16 hours for an underground system. These Completion Times are consistent with the thermal analyses of this event, which show that all component temperatures remain below their short-term temperature limits up to 72, 32 or 24 hours after event initiation, respectively.

(continued)

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BASES

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ACTIONS

C.2.1 (continued)

The Completion Time reflects the 8 hours to complete Required Action B.1 and the appropriate balance of time consistent with the applicable analysis results. The event is assumed to begin at the time the SFSC heat removal system is declared inoperable. This is reasonable considering the low probability of all inlets becoming simultaneously blocked by trash or debris.

C.2.2

In lieu of implementing Required Action C.2.1, transfer of the MPC into a TRANSFER CASK will place the MPC in an analyzed condition and ensure adequate fuel cooling until actions to correct the heat removal system inoperability can be completed. Transfer of the MPC into a TRANSFER CASK removes the SFSC from the LCO Applicability since STORAGE OPERATIONS does not include times when the MPC resides in the TRANSFER CASK. In this case, the requirements of CoC Appendix A, LCO 3.1.4 apply.

An engineering evaluation must be performed to determine if any concrete deterioration has occurred which prevents it from performing its design function. If the evaluation is successful and the air flow obstructions have been cleared, the OVERPACK heat removal system may be considered operable and the MPC transferred back into the OVERPACK. Compliance with LCO 3.1.2 is then restored. If the evaluation is unsuccessful, the user must transfer the MPC into a different, fully qualified OVERPACK to resume STORAGE OPERATIONS and restore compliance with LCO 3.1.2

(continued)

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BASES

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ACTIONS

C.2.2 (continued)

In lieu of performing the engineering evaluation, the user may opt to proceed directly to transferring the MPC into a different, fully qualified OVERPACK or place the TRANSFER CASK in the spent fuel pool and unload the MPC.

The Completion Times of 64, 24 and 16 hours reflect the Completion Time from Required Action C.2.1 to ensure component temperatures remain below their short-term temperature limits for the respective decay heat loads and OVERPACK styles.

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SURVEILLANCE  
REQUIREMENTS

SR 3.1.2

The long-term integrity of the stored fuel is dependent on the ability of the SFSC to reject heat from the MPC to the environment. There are two options for implementing SR 3.1.2, either of which is acceptable for demonstrating that the heat removal system is OPERABLE.

Visual observation that all air inlets are unobstructed ensures that air flow past the MPC is occurring and heat transfer is taking place. Greater than 50% blockage of the total air inlet area renders the heat removal system inoperable and this LCO is not met. 50% or less blockage of the total air inlet area does not constitute inoperability of the heat removal system. However, corrective actions should be taken promptly to remove the obstruction and restore full flow through the affected inlet(s).

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BASES

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SURVEILLANCE REQUIREMENTS    SR 3.1.2 (continued)

As an alternative, for OVERPACKs with air temperature monitoring instrumentation installed in the air outlets, the temperature rise between ambient and the OVERPACK air outlet may be monitored to verify operability of the heat removal system. Blocked air inlets will reduce air flow and increase the temperature rise experienced by the air as it removes heat from the MPC. Based on the analyses, provided the air temperature rise is less than the limit stated in the SR, adequate air flow and, therefore, adequate heat transfer is occurring to provide assurance of long term fuel cladding integrity. The reference ambient temperature used to perform this Surveillance shall be measured at the ISFSI facility.

The Frequency of 24 hours for aboveground systems and 16 hours for underground systems is reasonable based on the time necessary for SFSC components to heat up to unacceptable temperatures assuming design basis heat loads, and allowing for corrective actions to take place upon discovery of blockage of air inlets.

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- REFERENCES
1.    FSAR Chapter 4
  2.    FSAR Sections 11.2.13 and 11.2.14
  3.    ANSI/ANS 57.9-1992
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B 3.1 SFSC INTEGRITY

B 3.1.3 MPC Cavity Reflooding

BASES

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BACKGROUND

In the event that an MPC must be unloaded, the TRANSFER CASK with its enclosed MPC is returned to the cask preparation area to begin the process of fuel unloading. The MPC closure ring, and vent and drain port cover plates are removed. The MPC gas is sampled to determine the integrity of the spent fuel cladding. The pressure in the MPC cavity is ensured to be less than the 100 psig design pressure. This is accomplished via direct measurement of the MPC gas pressure or via analysis.

After ensuring the MPC cavity pressure meets the LCO limit, the MPC is then re-flooded with water at a controlled rate and/or the pressure monitored to ensure that the pressure remains below 100 psig. Once the cavity is filled with water, the MPC lid weld is removed leaving the MPC lid in place. The transfer cask and MPC are placed in the spent fuel pool and the MPC lid is removed. The fuel assemblies are removed from the MPC and the MPC and transfer cask are removed from the spent fuel pool and decontaminated.

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(continued)

BASES (continued)

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BACKGROUND  
(continued)      Ensuring that the MPC cavity pressure is less than the LCO limit ensures that any steam produced within the cavity is safely vented to an appropriate location and eliminates the risk of high MPC pressure due to sudden generation of large steam quantities during re-flooding.

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APPLICABLE  
SAFETY  
ANALYSIS      The confinement of radioactivity during the storage of spent fuel in the MPC is ensured by the multiple confinement boundaries and systems. The barriers relied on are the fuel pellet matrix, the metallic fuel cladding tubes in which the fuel pellets are contained, and the MPC in which the fuel assemblies are stored. Standard practice in the dry cask industry has historically been to directly reflood the cask with water. This standard practice is known not to induce fuel cladding failures.

The integrity of the MPC depends on maintaining the internal cavity pressures within design limits. This is accomplished by introducing water to the cavity in a controlled manner such that there is no sudden formation of large quantities of steam during MPC re-flooding. (Ref. 1).

---

LCO      Determining the MPC cavity pressure prior to and during re-flooding ensures that there will be sufficient venting of any steam produced to avoid excessive MPC pressurization.

---

APPLICABILITY      The MPC cavity pressure is controlled during UNLOADING OPERATIONS after the transfer cask and integral MPC are back in the FUEL BUILDING and are no longer suspended from, or secured in, the transporter. Therefore, the Cask Reflood LCO does not apply during TRANSPORT OPERATIONS and STORAGE OPERATIONS.

A note has been added to the APPLICABILITY for LCO 3.1.3 which states that the LCO is only applicable during wet UNLOADING OPERATIONS. This is acceptable since the intent of the LCO is to avoid uncontrolled MPC pressurization due to water flashing during re-flooding operations. This is not a concern for dry UNLOADING OPERATIONS.

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(continued)

BASES (continued)

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ACTIONS

A note has been added to the ACTIONS which states that, for this LCO, separate Condition entry is allowed for each MPC. This is acceptable since the Required Actions for each Condition provide appropriate compensatory measures for each MPC not meeting the LCO. Subsequent MPCs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1 and A.2

If the MPC cavity pressure limit is not met, actions must be taken to restore the parameters to within the limits before initiating or continuing re-flooding the MPC.

Immediately is an appropriate Completion Time because it requires action to be initiated promptly and completed without delay, but does not establish any particular fixed time limit for completing the action. This offers the flexibility necessary for users to plan and implement any necessary work activities commensurate with the safety significance of the condition, which is governed by the MPC heat load.

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(continued)

BASES (continued)

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SURVEILLANCE  
REQUIREMENTS

SR 3.1.3.1

The integrity of the MPC is dependent on controlling the internal MPC pressure. By controlling the MPC internal pressure prior to and during re-flooding the MPC there is sufficient steam venting capacity during MPC re-flooding.

The LCO must be met on each SFSC before the initiation of MPC re-flooding operations to ensure the design and analysis basis are preserved. If the re-flood rate is limited to the bounding value given in FSAR Section 4.5 or calculated specifically for the MPC heat load then the MPC pressure must only be verified once prior to the re-flood.

If verifying the MPC pressure using direct measurement only the SR requires checks prior to the re-flood and every hour during re-flood. The direct measurement schedule is sufficient to prevent overpressurization of the MPC cavity as the rate of pressure rise is relatively slow compared to increase in re-flood rate.

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REFERENCES

1. FSAR, Section 4.5, 8.3.2 and 8.3.3.
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B 3.1 SFSC Integrity

B 3.1.4 Supplemental Cooling System

**BASES**

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**BACKGROUND** The Supplemental Cooling System (SCS) is an active cooling system that provides augmented heat removal from the MPC to ensure fuel cladding temperatures remain below the applicable limit during onsite transport operations in the TRANSFER CASK. The system is required for all MPCs meeting the burnup, heat load, and TRANSFER CASK orientation combinations specified in the Applicability of the LCO.

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**APPLICABLE  
SAFETY  
ANALYSIS**

For MPCs containing all moderate burnup fuel ( $\leq 45,000$  MWD/MTU), SCS operation is not required, because the fuel cladding temperature cannot exceed the limit of 1058°F for moderate burnup fuel (Refs. 2 and 3).

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(continued)

BASES

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LCO                      The Supplemental Cooling System must be operable if the MPC/TRANSFER cask assemblage meets one of the following conditions in the Applicability portion of the LCO in order to preserve the assumptions made in the thermal analysis.

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APPLICABILITY        The LCO is applicable within 4 hours after completion of MPC drying operations in accordance with LCO 3.1.1 or within 4 hours of transferring the MPC into the TRANSFER CASK if the MPC is to be unloaded, and the following conditions are met:

MPCs having one or more fuel assemblies with an average burnup greater than 45,000 MWD/MTU.

MPCs having a decay heat load exceeding 28.74 kW[1].

---

ACTIONS

A.1

If the SCS has been determined to be inoperable, the thermal analysis shows that the fuel cladding temperature would not exceed the short term temperature limit applicable to an off-normal condition, even with no water in the TRANSFER CASK-to-MPC annulus. Actions should be taken to restore the SCS to operable status in a timely manner. Because the thermal analysis is a steady-state analysis, there is an indefinite period of time available to make repairs to the SCS. However, it is prudent to require the actions to be completed in a reasonably short period of time. A Completion Time of 7 days is considered appropriate and a reasonable amount of time to plan the work, obtain needed parts, and execute the work in a controlled manner.

(continued)

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BASES

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ACTIONS  
(continued)

B.1

If, after 7 days, the SCS cannot be restored to operable status, actions should be taken to remove the fuel assemblies from the MPC and place them back into the spent fuel pool storage racks. Thirty days is considered a reasonable time frame given that the MPC will be adequately cooled while this action is being planned and implemented, and certain equipment for this infrequent evolution (e.g., weld cutting machine) may take some time to acquire.

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SURVEILLANCE  
REQUIREMENTS

SR 3.1.4.1

The long-term integrity of the stored fuel is dependent on the ability of the SFSC to reject heat from the MPC to the environment, including during short-term evolutions such as on-site transportation in the TRANSFER CASK. The SCS is required to ensure adequate fuel cooling in certain cases. The SCS should be verified to be operable every two hours. This would involve verification that the coolant flow rate and temperatures are within expected ranges. This is a reasonable Frequency given the typical oversight occurring during the on-site transportation evolution, the duration of the evolution, and the simple equipment involved.

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REFERENCES

1. FSAR Section 4.5, 2.1
  2. NRC Interim Staff Guidance 11, Rev. 3
  3. NRC Memorandum, C. Brown to M.W. Hodges, January 29, 2004
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B 3.1 SFSC Integrity

B 3.1.5 Impressed Current Cathodic Protection System (ICCP)

**BASES**

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**BACKGROUND** The Impressed Current Cathodic Protection System (ICCP) is an active corrosion mitigating system, which uses anodes plus a source of electric current that is forced to flow from the anodes to the Cavity Enclosure Container (CEC) to oppose corrosion currents. The user may elect to either extend an existing ICCP to protect the installed ISFSI or establish an autonomous ICCP. The ICCP is designed on a site-specific basis for a particular ISFSI installation in accordance with the design criteria established in FSAR Supplement 3.1, Subsection 3.1.4.1.

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**APPLICABLE SAFETY ANALYSIS** The ICCP provides reasonable assurance that corrosion will not promote degradation of the CEC Container Shell and Bottom Plate to the extent of challenging its structural function or initiate through-wall in-leakage of water into the storage cavity.

The ICCP is required for all HI-STORM 100U VVM's that are installed in environments with aggressive corrosivity. FSAR Supplement 3.1, Subsection 3.1.4.1 provides the design criteria for an ICCP and more details on the evaluation procedure to determine if the environment corrosivity is mild or aggressive.

The ICCP is classified as an interfacing System, Structure or Component (SSC) to the HI-STORM 100U VVM and is designated as not important- to- safety. The ICCP is not required to maintain subcriticality, control radiation doses to workers and public, assure fuel retrievability or maintain the confinement barrier.

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(continued)

BASES

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LCO Although corrosion is expected to be a generally slow process even in the majority of subterranean environments determined to have aggressive corrosivity, the ICCPS will ensure corrosion will be kept to a minimum for the duration of storage operations. In order to be effective at mitigating degradation of the CEC due to corrosion, the ICCPS must be operable as soon as practicable after installation of the first HI-STORM 100U VVM and remain operable as much as practicable during storage operations.

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APPLICABILITY The LCO is applicable during STORAGE OPERATIONS. Once the first VVM to be protected by a particular ICCPS is installed the ICCPS must remain operable at all times to the extent practicable.

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ACTIONS A.1

If the ICCPS has been determined to be inoperable, Actions should be taken to restore the ICCPS to operable status in a timely manner. Because corrosion is an intrinsically slow process, there is sufficient time available to perform repairs and other corrective actions. However, it is prudent to require the actions to be completed in a reasonably short period of time. A Completion Time of 6 months is considered appropriate and a reasonable amount of time to plan the work, obtain needed parts, and execute the work.

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(continued)

BASES

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ACTIONS  
(continued)

A.2

In lieu of Action A.1, the user may opt to perform an engineering evaluation to establish reasonable assurance that CEC Container Shells and Bottom Plate are maintaining adequate integrity and have adequate corrosion reserve for continued storage operation for at least four more years or until the expiration of the license, whichever comes first. This action may include a more detailed review of the subterranean environment corrosivity, experience with corrosion of other buried systems at the site, past performance of the ICCPS and/or thickness measurements (e.g. ultrasonic inspection) of selected CEC Container Shells and Bottom Plates. Because corrosion is generally a slow process, there is sufficient time available to perform the engineering evaluation. In addition, the engineering evaluation if successful provides reasonable assurance that the CEC is experiencing minimal corrosion and will continue to perform its primary function during storage operations. However, it is prudent to require the actions to be completed in a reasonably short period of time. A Completion Time of 1 year is considered appropriate and reasonable.

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(continued)

BASES

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ACTIONS  
(continued)

B.1

If after 8 years the ICCPS has been determined to be operable for less than 70% of the time since initial startup, Actions should be taken to establish reasonable assurance that CEC Container Shells and Bottom Plates are maintaining adequate integrity and have adequate corrosion reserve for continued storage operation of at least three more years or until the expiration of the license, whichever comes first. This action may include a more detailed review of the subterranean environment corrosivity, experience with corrosion of other buried systems at the site, past performance of the ICCPS and/or thickness measurements (e.g. ultrasonic inspection) of selected CEC Container Shells and Bottom Plates. Because corrosion is generally a slow process, there is sufficient time available to perform the engineering evaluation. In addition, the engineering evaluation, if successful, provides reasonable assurance that the CEC is experiencing minimal corrosion and will continue to perform its primary function during storage operations. However, it is prudent to require the actions to be completed in a reasonably short period of time. A Completion Time of 1 year is considered appropriate and a reasonable amount of time to perform the Action. A 70% operable status is determined by engineering judgment to be the minimum duration of cathodic protection that will provide reasonable assurance the CEC will maintain its integrity during storage operations.

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(continued)

BASES

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ACTIONS  
(continued)

B.2

If an engineering evaluation does not establish adequate integrity of the CEC Container Shells and Bottom Plates, Actions should be taken to re-establish their integrity. This may entail performing thickness measurements (e.g. ultrasonic inspections) and repair of CEC components. Welding repairs require the transfer of the MPC into a transfer cask. Other types of repairs shall be evaluated to determine whether removal of the MPC from the VVM is necessary. Repairs with the potential to adversely affect safety functions shall be evaluated to ensure system functionality is maintained. If reasonable assurance is provided that the integrity of the CEC Container Shell and Bottom Plate has been adequately re-established, the initial start-up period shall be reset. Because corrosion is generally a slow process, there is sufficient time available to perform repairs. However, it is prudent to require the actions to be completed in a reasonably short period of time. A Completion Time of 3 years ensures that there is sufficient time to perform the Action.

C.1

If an engineering evaluation cannot conclude adequate integrity of the CEC Container Shells and Bottom Plates or if repairs are not performed to re-establish integrity, Actions should be taken to transfer the MPC's from affected VVM's to unaffected VVM's or other approved and compatible casks. Because corrosion is generally a slow process there is sufficient time available to perform the MPC transfers, including supply of additional storage casks and storage pad(s) if needed. A Completion Time of 3 years is considered appropriate and a reasonable amount of time to perform the Action.

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SURVEILLANCE  
REQUIREMENTS SR 3.1.5.1

The long-term integrity of the CEC Container Shell and Bottom Plate is dependent on the ability of the ICCPS to cathodically protect all surfaces contacting the subgrade. The ICCPS should be verified to be operable one year after installation of the first VVM and every month thereafter. This may involve verification that the current and voltage requirements are in accordance with the site-specific design as well as ensuring that rectifiers are in working order. The surveillance intervals follow the guidance provided in the standards and publications listed in the design criteria provided in FSAR Supplement 3.1, Subsection 3.1.4.1. This is a reasonable Frequency given the generally slow process of corrosion. This surveillance is suspended for 1 year if Action A.2 is met.

SR 3.1.5.2

The long-term integrity of the CEC container shell and Bottom Plate is dependent on the ability of the ICCPS to cathodically protect all surfaces contacting the subgrade. The ICCPS should be verified to be operable for at least 70% of the time on a cumulative basis between 8 and 10 years after initial startup (whether or not initial startup was successful) to allow sufficient operating history. This verification will involve review of records that support the operable status of the ICCPS, which may include review of current and voltage measurements, and other site-specific design data. The surveillance intervals follow the guidance of engineering judgment. This is a reasonable Frequency given the generally slow process of corrosion.

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REFERENCES 1. FSAR Supplement 3.1, Subsection 3.1.4.1

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Deleted  
B 3.2.1

B 3.2 SFSC Radiation Protection

B 3.2.1 Deleted

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B 3.2 SFSC Radiation Protection

B 3.2.2 TRANSFER CASK Surface Contamination

BASES

**BACKGROUND** A TRANSFER CASK is immersed in the spent fuel pool in order to load the spent fuel assemblies. As a result, the surface of the TRANSFER CASK may become contaminated with the radioactive material in the spent fuel pool water. This contamination is removed prior to moving the TRANSFER CASK to the ISFSI, or prior to transferring the MPC into the OVERPACK, whichever occurs first, in order to minimize the radioactive contamination to personnel or the environment. This allows dry fuel storage activities to proceed without additional radiological controls to prevent the spread of contamination and reduces personnel dose due to the spread of loose contamination or airborne contamination. This is consistent with ALARA practices.

**APPLICABLE SAFETY ANALYSIS** The radiation protection measures implemented during MPC transfer and transportation using the TRANSFER CASK are based on the assumption that the exterior surfaces of the TRANSFER CASKs have been decontaminated. Failure to decontaminate the surfaces of the TRANSFER CASKs could lead to higher-than-projected occupational doses.

**LCO** Removable surface contamination on the TRANSFER CASK exterior surfaces and accessible surfaces of the MPC is limited to 1000 dpm/100 cm<sup>2</sup> from beta and gamma sources and 20 dpm/100 cm<sup>2</sup> from alpha sources. These limits are taken from the guidance in IE Circular 81-07 (Ref. 2) and are based on the minimum level of activity that can be routinely detected under a surface contamination control program using direct survey methods. Only loose contamination is controlled, as fixed contamination will not result from the TRANSFER CASK loading process.

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BASES

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LCO  
(continued)

Experience has shown that these limits are low enough to prevent the spread of contamination to clean areas and are significantly less than the levels which would cause significant personnel skin dose. LCO 3.2.2 requires removable contamination to be within the specified limits for the exterior surfaces of the TRANSFER CASK and accessible portions of the MPC. The location and number of surface swipes used to determine compliance with this LCO are determined based on standard industry practice and the user's plant-specific contamination measurement program for objects of this size. Accessible portions of the MPC means the upper portion of the MPC external shell wall accessible after the inflatable annulus seal is removed and before the annulus shield ring is installed. The user shall determine a reasonable number and location of swipes for the accessible portion of the MPC. The objective is to determine a removable contamination value representative of the entire upper circumference of the MPC, while implementing sound ALARA practices.

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APPLICABILITY

The applicability is modified by a note that states that the LCO is not applicable to the TRANSFER CASK if MPC transfer operations occur inside the FUEL BUILDING. This is consistent with the intent of this LCO, which is to ensure loose contamination on the loaded TRANSFER CASK and MPC outside the FUEL BUILDING is within limits. If the MPC transfer is performed inside the FUEL BUILDING the empty TRANSFER CASK remains behind and is treated like any other contaminated hardware under the user's Part 50 contamination control program.

Verification that the surface contamination is less than the LCO limit is performed during LOADING OPERATIONS. This occurs before TRANSPORT OPERATIONS, when the LCO is applicable. Measurement of surface contamination is unnecessary during UNLOADING OPERATIONS as surface contamination would have been measured prior to moving the subject TRANSFER CASK to the ISFSI.

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(continued)

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BASES (continued)

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ACTIONS

A note has been added to the ACTIONS which states that, for this LCO, separate Condition entry is allowed for each TRANSFER CASK. This is acceptable since the Required Actions for each Condition provide appropriate compensatory measures for each TRANSFER CASK not meeting the LCO. Subsequent TRANSFER CASKs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1

If the removable surface contamination of a TRANSFER CASK or MPC, as applicable, that has been loaded with spent fuel is not within the LCO limits, action must be initiated to decontaminate the TRANSFER CASK or MPC and bring the removable surface contamination within limits. The Completion Time of 7 days is appropriate given that sufficient time is needed to prepare for, and complete the decontamination once the LCO is determined not to be met.

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SURVEILLANCE SR 3.2.2.1  
REQUIREMENTS

This SR verifies that the removable surface contamination on the TRANSFER CASK and/or accessible portions of the MPC is less than the limits in the LCO. The Surveillance is performed using smear surveys to detect removable surface contamination. The Frequency requires performing the verification during LOADING OPERATIONS in order to confirm that the TRANSFER CASK or OVERPACK can be moved to the ISFSI without spreading loose contamination.

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- REFERENCES
1. FSAR Sections 8.1.5 and 8.1.6.
  2. NRC IE Circular 81-07.
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B 3.2.3

B 3.2

B 3.2.3 Deleted

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B 3.3 SFSC Criticality Control

B 3.3.1 Boron Concentration

**BASES**

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**BACKGROUND** A TRANSFER CASK with an empty MPC is placed in the spent fuel pool and loaded with fuel assemblies meeting the requirements of the Certificate of Compliance. A lid is then placed on the MPC. The TRANSFER CASK and MPC are raised to the top of the spent fuel pool surface. The TRANSFER CASK and MPC are then moved into the cask preparation area where the MPC lid is welded to the MPC shell and the welds are inspected and tested. The water is drained from the MPC cavity and drying is performed. The MPC cavity is backfilled with helium. Then, the MPC vent and drain cover plates and closure ring are installed and welded. Inspections are performed on the welds. The TRANSFER CASK bottom pool lid is replaced with the transfer lid to allow eventual transfer of the MPC into the OVERPACK.

For those MPCs containing PWR fuel assemblies of relatively high initial enrichment, credit is taken in the criticality analyses for boron in the water within the MPC. To preserve the analysis basis, users must verify that the boron concentration of the water in the MPC meets specified limits when there is fuel and water in the MPC. This may occur during **LOADING OPERATIONS** and **UNLOADING OPERATIONS**.

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**APPLICABLE SAFETY ANALYSIS** The spent nuclear fuel stored in the SFSC is required to remain subcritical ( $k_{eff} < 0.95$ ) under all conditions of storage. The HI-STORM 100 SFSC is analyzed to store a wide variety of spent nuclear fuel assembly types with differing initial enrichments. For all PWR fuel loaded in the MPC-32 and MPC-32F, and for relatively high enrichment PWR fuel loaded in the MPC-24, -24E, and -24EF, credit was taken in the criticality analyses for neutron poison in the form of soluble boron in the water within the MPC. Compliance with this LCO preserves the assumptions made in the criticality analyses regarding credit for soluble boron.

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(continued)

BASES (continued)

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LCO

Compliance with this LCO ensures that the stored fuel will remain subcritical with a  $k_{\text{eff}} \leq 0.95$  while water is in the MPC. LCOs 3.3.1.a and 3.3.1.b provide the minimum concentration of soluble boron required in the MPC water for the MPC-24, and MPC-24E/24EF, respectively, for MPCs containing all INTACT FUEL ASSEMBLIES. The limits are applicable to the respective MPCs if one or more fuel assemblies to be loaded in the MPC had an initial enrichment of U-235 greater than the value in Table 2.1-2 of Appendix B to the CoC for loading with no soluble boron credit.

LCO 3.3.1.e provides the minimum concentration of soluble boron required in the MPC water for the MPC-24E and MPC-24EF containing at least one DAMAGED FUEL ASSEMBLY or one fuel assembly classified as FUEL DEBRIS.

LCO 3.3.1.f provides the minimum concentration of soluble boron required in the MPC water for the MPC-32 and MPC-32F based on the fuel assembly array/class and the classification of the fuel as a DAMAGED FUEL ASSEMBLY or FUEL DEBRIS.

All fuel assemblies loaded into the MPC-24, MPC-24E, MPC-24EF, MPC-32, and MPC-32F are limited by analysis to maximum enrichments of 5.0 wt.% U-235.

The LCO also requires that the minimum soluble boron concentration for the most limiting fuel assembly array/class and classification to be stored in the same MPC be used. This means that the highest minimum soluble boron concentration limit for all fuel assemblies in the MPC applies in cases where fuel assembly array/classes and fuel classifications (intact vs. damaged) are mixed in the same MPC. This ensures the assumptions pertaining to soluble boron used in the criticality analyses are preserved.

(continued)

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BASES

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**APPLICABILITY** The boron concentration LCO is applicable whenever an MPC-24, -24E, -24EF, -32, or -32F has at least one PWR fuel assembly in a storage location and water in the MPC. For the MPC-24 and MPC-24E/24EF, when all fuel assemblies to be loaded have initial enrichments less than the limit for no soluble boron credit as provided in CoC Appendix B, Table 2.1-2, the boron concentration requirement is implicitly understood to be zero.

During **LOADING OPERATIONS**, the LCO is applicable immediately upon the loading of the first fuel assembly in the MPC. It remains applicable until the MPC is drained of water

During **UNLOADING OPERATIONS**, the LCO is applicable when the MPC is re-flooded with water after helium cooldown operations. Note that compliance with SR 3.0.4 assures that the water to be used to flood the MPC is of the correct boron concentration to ensure the LCO is upon entering the Applicability.

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**ACTIONS** A note has been added to the **ACTIONS** which states that, for this LCO, separate Condition entry is allowed for each MPC. This is acceptable since the Required Actions for each Condition provide appropriate compensatory measures for each MPC not meeting the LCO. Subsequent MPCs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1 and A.2

Continuation of **LOADING OPERATIONS**, **UNLOADING OPERATIONS** or positive reactivity additions (including actions to reduce boron concentration) is contingent upon maintaining the SFSC in compliance with the LCO. If the boron concentration of water in the MPC is less than its limit, all activities **LOADING OPERATIONS**, **UNLOADING OPERATIONS** or positive reactivity additions must be suspended immediately.

(continued)

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BASES

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ACTIONS  
(continued)

A.3

In addition to immediately suspending LOADING OPERATIONS, UNLOADING OPERATIONS and positive reactivity additions, action to restore the concentration to within the limit specified in the LCO must be initiated immediately.

One means of complying with this action is to initiate boration of the affected MPC. In determining the required combination of boration flow rate and concentration, there is no unique design basis event that must be satisfied; only that boration be initiated without delay. In order to raise the boron concentration as quickly as possible, the operator should begin boration with the best source available for existing plant conditions.

Once boration is initiated, it must be continued until the boron concentration is restored. The restoration time depends on the amount of boron that must be injected to reach the required concentration.

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SURVEILLANCE  
REQUIREMENTS  
(continued)

SR 3.3.1.1

The boron concentration in the MPC water must be verified to be within the applicable limit within four hours prior to entering the Applicability of the LCO. For LOADING OPERATIONS, this means within four hours of loading the first fuel assembly into the cask.

For UNLOADING OPERATIONS, this means verifying the source of borated water to be used to re-flood the MPC within four hours of commencing re-flooding operations. This ensures that when the LCO is applicable (upon introducing water into the MPC), the LCO will be met.

(continued)

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BASES

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**SURVEILLANCE  
REQUIREMENTS**

(continued)

Surveillance Requirement 3.3.1.1 is modified by a note which states that SR 3.3.1.1 is only required to be performed if the MPC is submerged in water or if water is to be added to, or recirculated through the MPC. This reflects the underlying premise of this SR which is to ensure, once the correct boron concentration is established, it need only be verified thereafter if the MPC is in a state where the concentration could be changed.

There is no need to re-verify the boron concentration of the water in the MPC after it is removed from the spent fuel pool unless water is to be added to, or recirculated through the MPC, because these are the only credible activities that could potentially change the boron concentration during this time. This note also prevents the interference of unnecessary sampling activities while lid closure welding and other MPC storage preparation activities are taking place in an elevated radiation area atop the MPC. Plant procedures should ensure that any water to be added to, or recirculated through the MPC is at a boron concentration greater than or equal to the minimum boron concentration specified in the LCO

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REFERENCES      1.      FSAR Chapter 6.

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**HI-STORM 100 SYSTEM FSAR**

**APPENDIX 12.B**

**THIS APPENDIX HAS BEEN DELETED**

## SUPPLEMENT 12.I

### OPERATING CONTROLS AND LIMITS FOR THE HI-STORM 100U SYSTEM

#### 12.1.0 INTRODUCTION

Operation of the HI-STORM 100 System with the underground HI-STORM 100U overpack is identical to operation of the HI-STORM 100 System with the aboveground overpacks up to the point where MPC transfer from the HI-TRAC transfer cask takes place. The loaded MPC is stored in the vertical orientation in the HI-STORM 100U for long-term storage operations. Operating controls and limits described in FSAR Chapter 12 are implemented for the HI-STORM 100U to the extent they are applicable. This supplement describes the unique operating controls and limits, including training requirements and technical specifications, required for the HI-STORM 100U.

#### 12.1.I OPERATING CONTROLS AND LIMITS

Like the aboveground overpacks, the HI-STORM 100U overpack is completely passive in performing its design functions. It provides for long-term interim storage of the spent fuel without any modifications to the MPC or HI-TRAC transfer cask designs used with the aboveground overpacks. The operating controls and limits established for the MPC and HI-TRAC transfer cask are not altered for use with the HI-STORM 100U.

Operating controls and limits pertaining to movement of the overpack do not apply to the HI-STORM 100U because it is an integral component of the ISFSI and is not able to be moved once installed. It is not required to establish a lift height limit or to evaluate a drop event because the HI-STORM 100U cannot be lifted. It is not required to measure dose rates on the side of the HI-STORM 100U because it is located underground and is, therefore, inaccessible by plant personnel and because side dose rates are limited by shielding from the surrounding soil and provide a negligible contribution to the dose rate at the controlled area boundary.

#### 12.1.2 TRAINING MODULES

The classroom and dry run training programs described in FSAR Subsections 12.2.1 and 12.2.2 must be modified to address the differences between the use of an aboveground, moveable overpack and the belowground, immovable HI-STORM 100U. Specifically, procedures and dry runs must be created or modified to address the operational differences in using the HI-TRAC transfer cask and mating device with the HI-STORM 100U versus the aboveground overpack. These procedures and dry run training shall be based upon the operations of the HI-STORM 100U described in Supplement 8.I.

### 12.1.3 TECHNICAL SPECIFICATIONS

LCO 3.1.2, which requires periodic surveillance to ensure operability of the cask heat removal system, can be implemented with HI-STORM 100U more easily than for the aboveground overpacks because the outlet air ducts are located at approximately ground level. New LCO 3.1.5, for periodic confirmation of operation of the Impressed Current Cathodic Protection System, is added.

## CHAPTER 13<sup>†</sup>: QUALITY ASSURANCE

### 13.0 QUALITY ASSURANCE PROGRAM

#### 13.0.1 Overview

This chapter provides a summary of the quality assurance program implemented for activities related to the design, qualification analyses, material procurement, fabrication, assembly, testing and use of structures, systems, and components of the HI-STORM 100 System and HI-TRAC transfer cask designated as important to safety.

Important-to-safety activities related to construction and deployment of the HI-STORM 100 System are controlled under the NRC-approved Holtec Quality Assurance Program. The Holtec QA program manual (Reference [13.0.2]) is approved by the NRC (Reference [13.0.4]) under Docket 71-0784. The Holtec QA program satisfies the requirements of 10 CFR 72, Subpart G and 10 CFR 71, Subpart H. In accordance with 10 CFR 72.140(d), this approved 10 CFR 71 QA program will be applied to spent fuel storage cask activities under 10 CFR 72. The additional recordkeeping requirements of 10 CFR 72.174 are addressed in the Holtec QA program manual and must also be complied with.

The Holtec QA program is implemented through a hierarchy of procedures and documentation, listed below.

1. Holtec Quality Assurance Program Manual
2. Holtec Quality Assurance Procedures
3. a. Holtec Standard Procedures  
b. Holtec Project Procedures

Quality activities performed by others on behalf of Holtec are governed by the supplier's quality assurance program or Holtec's QA program extended to the supplier. The type and extent of Holtec QA control and oversight is specified in the procurement documents for the specific item or service being procured. The fundamental goal of the supplier oversight portion of Holtec's QA program is to provide assurance that activities performed in support of the supply of safety-significant items and services are performed correctly and in compliance with the procurement documents.

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<sup>†</sup> This chapter has been prepared in the format and section organization set forth in Regulatory Guide 3.61. However, the material content of this chapter also fulfills the intent of NUREG-1536. Pagination and numbering of sections, figures, and tables are consistent with the convention set down in Chapter 1, Section 1.0, herein. Finally, all terms-of-art used in this chapter are consistent with the terminology of the glossary (Table 1.0.1) and component nomenclature of the Bill-of-Materials (Section 1.5).

### 13.0.2 Graded Approach to Quality Assurance

For the HI-STORM 100 System, a graded approach to quality assurance is used by Holtec. This graded approach is controlled by Holtec Quality Assurance (QA) program documents as described in Section 13.0.1.

NUREG/CR-6407 [13.0.1] provides descriptions of quality categories A, B and C. Using the guidance in NUREG/CR-6407, Holtec International assigns a quality category to each individual, important-to-safety component of the HI-STORM 100 System and HI-TRAC transfer cask. The categories assigned to the cask components are identified in Table 2.2.6. Quality categories for ancillary equipment are provided in Table 8.1.6 on a generic basis. Quality categories for other equipment needed to deploy the HI-STORM 100 System at a licensee's ISFSI are defined on a case-specific basis considering the component's design function.

Activities affecting quality are defined by the purchaser's procurement contract for use of the HI-STORM 100 System at an independent spent fuel storage installation (ISFSI) under the general license provisions of 10CFR72, Subpart K. They may include any or all of the following: design, procurement, fabrication, handling, shipping, storing, cleaning, assembly, inspection, testing, operation, maintenance, repair and monitoring of HI-STORM 100 structures, systems, and components that are important to safety.

The quality assurance program described in the QA Program Manual fully complies with the requirements of 10CFR72 Subpart G and the intent of NUREG-1536 [13.0.3]. However, NUREG-1536 does not explicitly address incorporation of a QA program manual by reference. Therefore, invoking the NRC-approved QA program in this FSAR constitutes a literal deviation from NUREG-1536 and has accordingly been added to the list of deviations in Table 1.0.3. This deviation is acceptable since important-to-safety activities are implemented in accordance with the latest revision of the Holtec QA program manual and implementing procedures. Further, incorporating the QA Program Manual by reference in this FSAR avoids duplication of information between the implementing documents and the FSAR and any discrepancies that may arise from simultaneous maintenance to the two program descriptions governing the same activities.

13.1 through 13.5 INTENTIONALLY DELETED

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13.6        REFERENCES

- [13.0.1]    NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety," February 1996.
- [13.0.2]    Holtec International Quality Assurance Program, Latest Approved Revision.
- [13.0.3]    NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems," January 1997.
- [13.0.4]    NRC QA Program Approval for Radioactive Material Packages No. 0784, Docket 71-0784.

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## **SUPPLEMENT 13.I**

### **QUALITY ASSURANCE PROGRAM FOR THE HI-STORM 100U SYSTEM**

The quality assurance program described in Chapter 13 is implemented for activities related to the design, qualification analyses, material procurement, fabrication, assembly, testing and use of structures, systems, and components of the HI-STORM 100U System designated as important-to-safety.