7.1 CONFINEMENT BOUNDARY

The primary confinement boundary against the release of radionuclides is the cladding of the individual fuel rods. The spent fuel rods are protected from degradation by maintaining an inert gas atmosphere (helium) inside the MPC and keeping the fuel cladding temperatures below the design basis values specified in Chapter 2.

The HI-STORM 100 confinement boundary consists of any one of the ~~seven~~ fully-welded MPC designs described in Chapter 1. Each MPC is identical from a confinement perspective so the following discussion applies to all MPCs. The confinement boundary of the MPC consists of:

- MPC shell
- bottom baseplate
- MPC lid (including the vent and drain port cover plates)
- MPC closure ring
- associated welds

The above items form a totally seal-welded vessel for the storage of design basis spent fuel assemblies.

The MPC requires no valves, gaskets or mechanical seals for confinement. Figure 7.1.1 shows an elevation cross-section of the MPC confinement boundary. All components of the confinement boundary are Important to Safety, Category A, as specified in Table 2.2.6. The MPC confinement boundary is designed and fabricated in accordance with the ASME Code, Section III, Subsection NB [7.1.1] to the maximum extent practicable. Chapter 2 provides design criteria for the confinement design. Section 2.2.4 provides applicable Code requirements. Exceptions to specific Code requirements with complete justifications are presented in Table 2.2.15.

7.1.1 Confinement Vessel

The HI-STORM 100 confinement vessel is the MPC. The MPC is designed to provide confinement of all radionuclides under normal, off-normal and accident conditions. The MPC is designed, fabricated, and tested in accordance with the applicable requirements of ASME, Section III, Subsection NB [7.1.1] to the maximum extent practicable. The MPC shell and baseplate assembly and basket structure are delivered to the loading facility as one complete component. The MPC lid, vent and drain port cover plates, and closure ring are supplied separately and are installed following fuel loading. The MPC lid and closure ring are welded to the upper part of the MPC shell at the loading site to provide redundant sealing of the confinement boundary. The vent and drain port cover plates are welded to the MPC lid after the lid is welded to the MPC. The welds forming the confinement boundary are described in detail in Section 7.1.3.

The MPC lid is made intentionally thick to minimize radiation exposure to workers during MPC closure operations, and is welded to the MPC shell. The vent and drain port cover plates are welded to the MPC lid following completion of MPC draining, moisture removal, and helium backfill activities to close the MPC vent and drain openings. The MPC lid has a stepped recess around the perimeter for accommodating the closure ring. The MPC closure ring is welded to the MPC lid on the inner diameter of the ring and to the MPC shell on the outer diameter. The combination of the welded MPC lid and closure ring form the redundant closure of the MPC.

Table 7.1.1 provides a summary of the design ratings for normal, off-normal and accident conditions for the MPC confinement vessel. Tables 1.2.2, 2.2.1, and 2.2.3 provide additional design basis information.

The design basis leakage rate for the MPC confinement boundary is provided in Table 7.1.1. The MPC shell and baseplate are helium leakage tested during fabrication in accordance with the requirements defined in Chapter 9. Following fuel loading and MPC lid welding, the MPC lid-to-shell weld is examined by liquid penetrant method (root and final), volumetrically examined (if volumetric examination is not performed, multi-layer liquid penetrant examination must be performed), helium leakage tested, and hydrostatically tested. If the MPC lid weld is acceptable, the vent and drain port cover plates are welded in place, examined by the liquid penetrant method (root and final), and a leakage rate test is performed. Finally, the MPC closure ring is installed, welded and inspected by the liquid penetrant method (root, if multiple pass, and final). Chapters 8, 9, and 12 provide procedural guidance, acceptance criteria, and Technical Specifications, respectively, for performance and acceptance of liquid penetrant examinations, volumetric examination, hydrostatic testing, and leakage rate testing of the field welds on the MPC.

After moisture removal, the MPC cavity is backfilled with helium. The helium backfill provides an inert atmosphere within the MPC cavity that precludes oxidation and hydride attack of the SNF cladding. Use of a helium atmosphere within the MPC contributes to the long-term integrity of the fuel cladding, reducing the potential for release of fission gas or other radioactive products to the MPC cavity. Helium also aids in heat transfer within the MPC and reduces the maximum fuel cladding temperatures. MPC inerting, in conjunction with the thermal design features of the MPC and storage cask, assures that the fuel assemblies are sufficiently protected against degradation, which might otherwise lead to gross cladding ruptures during long-term storage.

7.1.2 Confinement Penetrations

The MPC penetrations are designed to prevent the release of radionuclides under all normal, off-normal and accident conditions of storage. Two penetrations (the MPC vent and drain ports) are provided in the MPC lid for MPC draining, moisture removal and backfilling during MPC loading operations, and for fuel cool-down and MPC flooding during unloading operations. No other confinement penetrations exist in the MPC. 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 connectors 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 MPC vent and drain ports are sealed by cover plates which are seal welded to the MPC lid. No credit is taken for the seal provided by the vent and drain ports. The MPC closure ring covers the vent and drain port cover plate welds and the MPC lid-to-shell weld providing the redundant closure of the MPC vessel. The redundant closures of the MPC satisfy the requirements of 10CFR72.236(e) [7.0.1].

The MPC has no bolted closures or mechanical seals. The confinement boundary contains no external penetrations for pressure monitoring or overpressure protection.

7.1.3 Seals and Welds

The MPC is designed, fabricated, and tested in accordance with the applicable requirements of ASME, Section III, Subsection NB [7.1.1] to the maximum extent practicable. The MPC has no bolted closures or mechanical seals. Section 7.1.1 describes the design of the confinement vessel welds. The welds forming the confinement boundary are summarized in Table 7.1.2.

Confinement boundary welds are performed, inspected, and tested in accordance with the applicable requirements of ASME Section III, Subsection NB [7.1.1] to the maximum extent practicable. The use of multi-pass welds, root pass, for multiple pass welds, and final surface liquid penetrant inspection, and volumetric examination essentially eliminates the chance of a pinhole leak through the weld. If volumetric examination is not performed, multi-layer liquid penetrant examination must be performed. Welds are also helium leak tested, providing added assurance of weld integrity. Additionally, a hydrostatic test is performed on the MPC lid-to-shell weld to confirm the weld's structural integrity. The ductile stainless steel material used for the MPC confinement boundary is not susceptible to delamination or hydrogen-induced weld degradation. The closure weld redundancy assures that failure of any single MPC confinement boundary closure weld does not result in release of radioactive material to the environment. Table 7.1.3 provides a summary of the closure weld examinations and tests.

7.1.4 Closure

The MPC is a totally seal-welded pressure vessel. The MPC has no bolted closure or mechanical seals. The MPC's redundant closures are designed to maintain confinement integrity during normal conditions of storage, and off-normal and postulated accident conditions. There are no unique or special closure devices. Primary closure welds (lid-to-shell and vent/drain port cover plate-to-lid) are examined and leakage tested to ensure their integrity. A description of the MPC weld examinations is provided in Chapter 9.

Since the MPC uses an entirely welded redundant closure system, no direct monitoring of the closure is required. Section 11.2.1.4 describes requirements for verifying the continued confinement capabilities of the MPC in the event of off-normal or accident conditions. As discussed in Section 2.3.3.2, no instrumentation is required or provided for HI-STORM 100 storage operations, other than normal security service instruments and TLDs.

7.1.5 Damaged Fuel Container

The MPC is designed to allow for the storage of specified damaged fuel assemblies and fuel debris in a specially designed damaged fuel container (DFC). Fuel assemblies classified as damaged fuel or fuel debris as specified in the Approved Contents Section of Appendix B to the CoC have been evaluated.

To aid in loading and unloading, damaged fuel assemblies and fuel debris will be loaded into stainless steel DFCs prior to placement in the HI-STORM 100 System. The DFCs that may be loaded into the MPCs are shown in Figures 2.1.1 through Figure 2.1.2c. The DFC is designed to provide SNF loose component retention and handling capabilities. The DFC consists of a smooth-walled, welded stainless steel square container with a removable lid. The container lid provides the means of DFC closure and handling. The DFC is provided with stainless steel wire mesh screens in the top and bottom for draining, moisture removal and helium backfill operations. The screens are specified as a 250-by-250-mesh with an effective opening of 0.0024 inches. There are no other openings in the DFC. The CoC specifies the fuel assembly characteristics for damaged fuel acceptable for loading in the MPC-24E, MPC-24EF, *MPC-32F,* MPC-68, MPC-68F or MPC-68FF and for fuel debris acceptable for loading in the MPC-24EF, *MPC-32F,* MPC-68F or MPC-68FF.

Since the DFC has screens on the top and bottom, the DFC provides no pressure retention function. The confinement function of the DFC is limited to minimizing the release of loose particulates within the sealed MPC. The storage design basis leakage rates are not altered by the presence of the DFCs. The radioactive material available for release from the specified fuel assemblies are bounded by the design basis fuel assemblies analyzed herein.

Table 7.1.1

SUMMARY OF CONFINEMENT BOUNDARY DESIGN SPECIFICATIONS

Design Condition	Design Pressure (psig)	Design Temperature (°F)
Normal	100	MPC Lid: 550
		MPC Shell: 450
		MPC Baseplate: 400
Off-Normal	*110*~~100~~	MPC Lid: 775
		MPC Shell: 775
		MPC Baseplate: 775
Accident	200	MPC Lid: 775
		MPC Shell: 775
		MPC Baseplate: 775

Table 7.1.2

MPC CONFINEMENT BOUNDARY WELDS

Confinement Boundary Welds		
MPC Weld Location	**Weld Type†**	**ASME Code Category (Section III, Subsection NB)**
Shell longitudinal seam	Full Penetration Groove (shop weld)	A
Shell circumferential seam	Full Penetration Groove (shop weld)	B
Baseplate to shell	Full Penetration Groove (shop weld)	C
MPC lid to shell	Partial Penetration Groove (field weld)	C
MPC closure ring to shell	Fillet (field weld)	††
Vent and drain port cover plates to MPC lid	Partial Penetration Groove (field weld)	D
MPC closure ring to closure ring radial	Partial Penetration Groove (field weld)	††
MPC closure ring to MPC lid	Partial Penetration Groove (field weld)	C

† The tests and inspections for the confinement boundary welds are listed in Section 9.1.1.

†† This joint is governed by NB-5271 (liquid penetrant examination).

Table 7.1.3

CLOSURE WELD EXAMINATIONS AND TESTS

Closure Weld Description	Inspections/Tests	ASME Acceptance Criteria
MPC Lid-to-Shell	VT on Tack Welds PT Root Pass PT Final Pass VT Final Pass Volumetric Examination of Weld (UT) or multi-layer PT Hydrostatic Test Post Hydrostatic Test - PT Helium Leakage Test	NF-5360 NB-5350 NB-5350 NF-5360 NB-5332 NB-6000 NB-5350 Sect. V and ANSI N14.5
Vent/Drain Cover Plate to MPC Lid	VT on Tack Welds PT Root Pass PT Final Pass VT Final Pass Helium Leakage Test	NF-5360 NB-5350 NB-5350 NF-5360 Sect. V and ANSI N14.5
Closure Ring Radial Welds	VT on Tack Welds PT Root Pass (if multiple pass) PT Final Pass VT Final Pass	NF-5360 NB-5350 NB-5350 NF-5360
Closure Ring-to-MPC Shell	VT on Tack Welds PT Root Pass (if multiple pass) PT Final Pass VT Final Pass	NF-5360 NB-5350 NB-5350 NF-5360
Closure Ring-to-MPC Lid	VT on Tack Welds PT Root Pass PT Final Pass VT Final Pass	NF-5360 NB-5350 NB-5350 NF-5360

7.2 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 storage conditions. Chapter 4 shows that the peak confinement boundary component temperatures and pressures are within the design basis limits for all normal conditions of storage. Since the MPC confinement vessel remains intact, and the design bases temperatures and pressure are not exceeded, the design basis leakage rate is not exceeded during normal conditions of storage.

7.2.1 Release of Radioactive Material

The MPC is closed by the MPC lid, the vent and drain port cover plates, and the MPC closure ring. Weld examinations, including multiple surface examinations, volumetric examination, hydrostatic testing, and leakage rate testing on the MPC lid weld, and multiple surface examinations and leakage rate testing of the vent and drain port cover plate welds, assure the integrity of the MPC closure. The MPC is a strength-welded pressure vessel designed to meet the stress criteria of the ASME Code, Section III, Subsection NB [7.1.1]. The all-welded construction of the MPC with redundant closure provided by the fully welded MPC closure ring and extensive inspections and testing ensures that no release of fission gas or crud for normal storage and transfer conditions will occur. The above discussion notwithstanding, an analysis is performed in Section 7.2.7 to calculate the annual dose at 100 meters based on an assumed leakage rate of 5×10^{-6} atm-cm^3/sec under reference test conditions.

7.2.2 Pressurization of the Confinement Vessel

The loaded and sealed MPC is drained, removed of moisture, and backfilled with helium gas. This process provides a chemically non-reactive environment for storage of spent fuel assemblies. First, air in the MPC is displaced with water and then the water is displaced by helium or nitrogen gas during MPC blowdown. The MPC is then removed of all moisture, and backfilled with a predetermined mass of helium as specified in the Technical Specifications. Chapter 8 describes the steps of these processes and the Technical Specifications provide the acceptance criteria. This drying and backfilling process ensures that the resulting inventory of oxidizing gases in the MPC remains below 0.25% by volume, and that the MPC pressure is maintained within the design limitations. In addition, the MPC basket fluid contact areas are stainless steel alloy material or aluminum of extremely high corrosion and erosion resistance. The aluminum oxide layer on the aluminum components (e.g., heat conduction elements and Boral neutron absorption plates) ensures that there is no reaction during the short duration of exposure to the fuel pool water. Carbon steels are not employed in the construction of the MPCs. Therefore, no protective coatings which could interact with borated spent fuel pool water are used.

The only means of pressure increase in the MPC is from the temperature rise due to normal heat-up to normal operating temperatures and the release of backfill and fission gas contents from fuel rods into the MPC cavity. Under the most adverse conditions of normal ambient temperature, full insolation, and design basis decay heat, the calculated pressure increase assuming 1% fuel rod failure is well below the system design pressure as shown in Chapter 4. For off-normal conditions of storage, failure of up to 10% of the fuel rods has been analyzed and would result in an MPC internal pressure below the value specified as the *off*-normal design pressure.

7.2.3 Confinement Integrity During Dry Storage

There is no credible mechanism or event that results in a release of radioactive material from the MPC under normal conditions. Since the MPC remains structurally intact and provides redundant welded closures as discussed above, the postulated leakage of radioactive material from the MPC will be limited to a leakage rate equivalent to the acceptance test criteria specified for the MPC helium leak tests. Leakage from the MPC during normal conditions of storage could result in the release of gaseous fission products, fines, volatiles and airborne crud particulates as discussed in Section 7.3.1. The conservative assumption is made that 2.5% of the fuel inventory is available for release under normal conditions of storage and 11.5% of the fuel inventory is available for release under off-normal conditions of storage. The maximum cavity internal operating pressure with *either 1% (normal conditions) or* 10% *(off-normal conditions)* fuel rod failure reported in Table 4.4.14 is bounded by the use of ~~an internal cavity~~ *the design* pressure*s* ~~of 101.4 psia (6.90 ATM)~~, which ~~is~~ *are* assumed as ~~an~~ initial condition*s* for th*ese*~~is~~ evaluation*s*.

The annual dose equivalent for the whole body, thyroid and other critical organs to an individual at the site boundary (100 meters) as a result of an assumed effluent release under normal and off-normal conditions of storage were determined. These doses were determined for each type of MPC. The ISFSI controlled area boundary must be at least 100 meters from the nearest loaded HI-STORM 100 System in accordance with 10CFR72.106(b) [7.0.1]. The doses are compared to the regulatory limits specified in 10CFR72.104(a) [7.0.1].

Confinement boundary welds performed at the fabricator's facility are inspected by volumetric and liquid penetrant examination methods as detailed in Section 9.1. Field welds are performed on the MPC lid, the MPC vent and drain port covers, and MPC closure ring. The weld of the MPC lid-to-shell is liquid penetrant examined on the root and final pass, volumetrically (or multilayer liquid penetrant) examined, hydrostatically tested, and leak rate tested. The vent and drain port cover plates are liquid penetrant examined on the root and final pass and leak rate tested. The MPC closure ring welds are inspected by the liquid penetrant examination method. In Chapter 11, the MPC lid-to-shell weld is postulated to fail to confirm the safety of the HI-STORM 100 confinement boundary. The failure of the MPC lid weld is equivalent to the MPC drain or vent port cover weld failing. The MPC lid weld failure affects the MPC confinement boundary; however, no leakage will occur due to redundant sealing provided by the MPC closure ring.

7.2.4 Control of Radioactive Material During Fuel Loading Operations

The procedures for closure of the MPC, described in Section 8.1, are intended to assure that there is no unintended release of gas, liquid, or solid materials from the MPC during dry storage. During MPC closure operations, the lines used for venting or draining are routed to the plant's spent fuel pool or radioactive waste processing systems. MPC closure operations are performed inside the plant's fuel building in a controlled and monitored environment.

Radioactive effluent handling during fuel loading and MPC draining, moisture removal, helium backfilling, and sealing operations is in accordance with the plant's 10CFR50 license and radioactive waste management system.

7.2.5 External Contamination Control

The external surface of the MPC is protected from contamination by preventing it from coming in contact with the spent fuel pool water. Prior to submergence in the spent fuel pool, an inflatable seal is installed at the top of the annulus formed between the MPC shell and the HI-TRAC transfer cask cavity. This annulus is filled with clean demineralized water and the seal is inflated. The inflated seal, backed by the demineralized water maintained at a slight positive pressure, is sufficient to preclude the entry of contaminated water into the annulus. These steps assure that the MPC surface is free of contamination that could become airborne during storage.

Additionally, following fuel loading operations and removal from the spent fuel pool, the upper end of the MPC shell is surveyed for loose surface contamination in accordance with the Technical Specifications contained in Chapter 12 of this FSAR.

7.2.6 Confinement Vessel Releasable Source Term

As discussed in Section 7.3.1, the source term used to evaluate the annual dose at the minimum controlled area boundary of 100 meters due to leakage from the MPC confinement boundary consists of gaseous fission products, fines, volatiles and airborne crud particulates. *For this evaluation, it is conservatively assumed that 1% of the fuel inventory is available for release under normal conditions of storage and 10% of the fuel inventory is available for release under off-normal conditions of storage. A summary of the isotopes available for release is provided in Table 7.3.1.* ~~For storage of spent fuel assemblies with burnups in excess of 45 GWD/MTU the source term from the assumed rod breakage fractions of ISG-5 [7.2.2] must be augmented by the source term from 50% of the rods having peak cladding thicknesses greater than 70 micrometers. ISG-11 [7.2.1] recommends that for high burnup fuel assemblies to be classified as intact, no more than 3% of the rods may have peak cladding oxide thickness' greater than 70 micrometers and no more than 1% of the rods may have peak cladding oxide thickness' greater than 80 micrometers. Using Equation 7-0 below the fraction of the source term available for release may be determined:~~

~~Equation 7-0~~

$$F_R = F_B * (100\%) + F_{70} * P_S$$

~~where:~~

~~F_R — is the percentage of the source term available for release,~~
~~F_B — is the rod breakage fraction from ISG-5,~~
~~F_{70} — is the percentage of rods that have peak cladding oxide thicknesses greater than 70 microns~~
~~P_S — percentage of the source term for rods having peak cladding oxide thickness' greater than 70 microns that must be included in the total source term available for release.~~

~~Table 7.2.1 contains a summary of the values required for Equation 7-0 and the results for normal and off-normal conditions of storage. Additionally, a summary of the isotopes available for release is provided in Table 7.3.1.~~

7.2.7 Release of Contents Under Normal and Off-Normal Storage Conditions

7.2.7.1 Confinement Boundary Leakage Rate

The methodology presented in Section 7.3.3.1 was used to determine the leakage rate at the upstream conditions. Using the capillary diameter determined in Section 7.3.3.1, and the parameters for normal and off-normal conditions provided in Table 7.3.4, Equation 7-3 was solved for the leakage rate at the upstream conditions. The resultant normal ~~and off-normal~~ condition leakage rate *is calculated to be*~~,~~ -1.~~12~~*24*x10^{-5} cm^3/s ~~(at 581 K, 6.90 ATM) was calculated~~ *and the resultant off-normal condition leakage rate is calculated to be 1.47x*10^{-5} cm^3/s.~~.~~

7.2.7.2 ~~Percentage of Nuclides that Remain Airborne~~*Gravitational Settling*

The fines, volatiles and crud that are released from the fuel cladding to the cask cavity do not remain airborne inside the cask cavity for the entire duration of the normal/off-normal conditions. Therefore, credit is taken for gravitational settling of the fines, volatiles and crud in accordance with the methodology presented in reference [7.2.3].
~~In addition to the small fraction of fines that are released in the event of a cladding breach, only 10% of the fines released to the MPC cavity remain airborne long enough to be available for release from the MPC [7.3.11]. It is conservatively assumed that 100% of the volatiles, crud and gases remain airborne and available for release.~~

7.2.7.2.1 Fines and Crud

Without credit for deposition, all radionuclides released to the MPC cavity must be assumed to be available for release to the environment. Therefore, the total amount available for release without credit for deposition is simply the product of the initial amount available for release and the total time of the release (one year for normal and off-normal conditions and thirty days for accident *conditions):*

Equation 7.2-1: (Total Amount Available for Release Without Credit for Deposition)

$$\int_0^T N(t)dt = \int_0^T N_0 dt = N_0 T$$

As in reference [26] deposition of the aerosol particles inside the confinement is modeled as a first-order rate process as shown in Equation 7.2-2.

Equation 7.2-2:

$$N(t) = N_0 * e^{-\lambda t}$$

where:

N	*is the amount of aerosol airborne at time t,*
N_0	*is the initial amount of aerosol airborne, and*
λ	*is the first-order rate constant for aerosol deposition.*

Equation 7.2-2 provides the amount of aerosol available for release at any time t, however to determine the total amount of aerosol to be released Equation 7.2-2 must be integrated over the duration of the conditions to determine the total amount available for release with credit for deposition.

Equation 7.2-3: (Total Amount Available for Release With Credit for Deposition)

$$\int_0^T N(t)dt = \int_0^T N_0 * e^{-\lambda t}dt = \frac{N_0}{\lambda}(1 - e^{-\lambda t})$$

Here we define the Aerosol Deposition Factor (ADF) as the ratio of the total amount available for release with credit for deposition to the total amount available for release without credit for deposition.

Equation 7.2-4:

$$ADF = \frac{\text{Total Amount Available for Release with credit for deposition}}{\text{Total Amount Available for Release without credit for deposition}}$$

Therefore, substituting Equation 7.2-2 and Equation 7.2-4 into Equation 7.2-5 gives the ADF as a function of the time and first-order rate constant only.

Equation 7.2-5:

$$ADF = \frac{\frac{N_0}{\lambda}(1 - e^{-\lambda T})}{N_0 T} = \frac{(1 - e^{-\lambda T})}{\lambda T}$$

The first-order rate constant, λ, was determined by a calculation of gravitational settling considering the aerosol density, aerosol diameter and aerosol shape factor for a spent fuel cask. The result of this calculation is summarized in Cases 5a, 5b and 5c in reference [7.2.3]. The lowest value of the first-order rate constant for each of these three cases presented in reference [7.2.3] was selected to ensure conservatism. The first order rate constant and the corresponding ADF that is applied to the fines and crud are presented in Table 7.2.2.

7.2.7.2.2 Volatiles

Depending upon the temperature of the cask, a fraction of the isotopes in the "volatiles" category may be in a vapor form and that fraction will not be subject to gravitational settling as a removal mechanism. The methodology to determine the fraction of the volatiles that remain in a vapor form is presented in reference [7.2.3]. This methodology has been repeated for normal and off-normal conditions with the results presented in Table 7.2.2.

7.2.7.2.3 Gases

Gases are not subject to gravitational settling and therefore all gases are assumed to be available for release from the MPC Cavity.

7.2.7.3 <u>Fraction of Volume Released</u>

The minimum free volume of each MPC design is presented in Tables 4.4.12, 4.4.13, 4.4.24, and 4.4.25~~;~~. Using *conservatively reduced values of* these volumes and the upstream normal and off-normal condition leakage rate~~ of 1.12x10^-5^ cm^3^/s~~, the fraction of the volume released per second is calculated. For calculation of the doses from the MPC-24, MPC-24E and MPC-24EF the minimum free volume from the MPC-24E is used as it conservatively bounds the MPC-24 and MPC-24EF.

7.2.7.4 <u>Release Fraction</u>

The release fraction is that portion of the total radionuclide inventory that is released from the inside of the fuel rods to the MPC cavity. The release fractions provided in NUREG/CR-6487 [7.3.2] are used. A summary of the release fractions is provided in Table 7.3.1.

7.2.7.5 <u>Radionuclide Release Rate</u>

The radionuclide release rate is the product of the quantity of isotopes available for release, the number of assemblies, the ~~percentage of nuclides that remain airborne~~*aerosol deposition factor*, the fraction of volume released, and the release fraction.

7.2.7.6 Atmospheric Dispersion Factor

For the evaluation of the dose at the controlled area boundary, the instantaneous χ/Q calculated for accident conditions (8.0×10^{-3} sec/m^3) was reduced to 1.6×10^{-4} sec/m^3 based on the long term nature of the release (1 year); the height of the release being essentially a ground level release ($h_e = 0$); all 16 compass directions (22.5 degree sectors) will be similarly affected due to the long term nature of the continuous release (over one year); the increase in average wind speeds (>1 m/s); and the additional effects of a reduction in atmospheric stability. Therefore, the χ/Q reduction factor of 50 used to correct the short term accident release χ/Q is conservative.

7.2.7.7 Dose Conversion Factors

Dose Conversion Factors (DCF) from EPA Federal Guidance Report No. 11, Table 2.1 [7.3.5] and EPA Federal Guidance Report No. 12, Table III.1 [7.3.6] were used for the analysis. ~~The DCFs are provided on the spread sheets included as Appendix 7.A.~~

7.2.7.8 Occupancy Time

An occupancy time of 8,760 hours is used for the analysis [7.0.2]. This conservatively assumes that the individual is exposed 24 hours per day for 365 days at the minimum controlled area boundary of 100 meters.

7.2.7.9 Breathing Rate

A breathing rate of 3.3×10^{-4} m^3/sec for a worker is used for the analysis [7.0.2]. This assumption is in accordance with the guidance provided in NUREG-1536 [7.0.2] for a worker.

7.2.8 Postulated Doses Under Normal and Off-Normal Conditions of Storage

The annual dose equivalent for the whole body, thyroid and other critical organs to an individual at the site boundary (100 meters) as a result of an assumed effluent release under normal and off-normal conditions of storage were determined. These doses are determined for each type of MPC and for each condition of storage (i.e., normal and off-normal). The postulated doses as a result of exposure to soil with ground surface contamination and soil contaminated to a depth of 15 cm were also determined. The resultant doses were negligible compared to those resulting from submersion in the plume and are therefore not reported.

The doses were determined using spreadsheet software. The resultant doses are summarized for each MPC type in Tables 7.3.2 through Table 7.3.5 of the HI-STORM FSAR. ~~Example spread sheets used for the dose estimates are presented in Appendix 7.A.~~ Table 7.3.~~8~~9 compares the doses to the regulatory limits of 10CFR72.104(a).

7.2.8.1 Whole Body Dose

The annual dose equivalent to the whole body (ADE) is the sum of the inhaled committed effective dose equivalent (CEDE) and the deep dose equivalent to the whole body from submersion in the plume. The postulated doses were determined using spreadsheet software. ~~Example spread sheets are provided in Appendix 7.A.~~

The CEDE is the product of radionuclide release rate, the atmospheric dispersion factor, the occupancy time, the breathing rate, and the effective dose conversion factor.

The Deep Dose Equivalent is the product of the nuclide release rate, the atmospheric dispersion factor, the occupancy time, and the effective dose conversion factor.

7.2.8.2 Critical Organ Dose

The Annual Dose Equivalent (ADE) to the critical organ (or tissue) is the sum of the committed dose equivalent (CDE) to the critical organ or tissue from inhalation and the deep dose equivalent (DDE) to the organ or tissue from submersion in the plume. The postulated doses as a result of exposure to soil with ground surface contamination and soil contaminated to a depth of 15 cm were also determined. The resultant doses were negligible compared to those resulting from submersion in the plume and are therefore not reported.

The committed dose equivalent to the organ or tissue from inhalation is the product of *the* radionuclide release rate, the atmospheric dispersion factor, the occupancy time, the breathing rate, and the organ/tissue dose conversion factor. The deep dose equivalent to the organ or tissue from submersion in the plume is the product of the radionuclide release rate, the atmospheric dispersion factor, the occupancy time, and the organ/tissue dose conversion factor.

7.2.8.3 Site Boundary

The estimated annual dose equivalent for critical organs and the whole body at the minimum site boundary of 100 meters are presented in Tables 7.3.2 through 7.3.5. Since doses from any one MPC does not bound the doses from all other MPCs, bounding doses have been presented in Table 7.3.8 for BWR fuel (MPC-68, MPC-68F and MPC-68FF) and PWR fuel (MPC-24, MPC-24E, MPC-24EF, *MPC-32* and MPC-32*F*) separately. The doses from the MPC-68 bound the doses from all casks containing BWR fuel and the doses from the MPC-32 bounds the doses from all casks containing PWR fuel. Additionally, Table 7.3.8 compares these bounding doses to the regulatory limits of 10CFR72.104(a).

7.2.9 Assumptions

The following presents a summary of assumptions for the normal condition confinement analysis of the HI-STORM 100 System.

- The distance from the cask to the site boundary is 100 meters.

- Under normal conditions of storage, ~~2.5~~*1.0*% of the ~~source term is available for release~~*fuel rods are assumed to have ruptured.* Under off-normal conditions of storage, 1*0*~~1~~.*0*~~5~~% of the ~~source terms are available for release~~*fuel rods are assumed to have ruptured.* This assumption is in accordance with ISG-5 [7.2.2], ~~ISG-11 [7.2.1]~~ and NUREG-1536 [7.0.2] for normal and off-normal storage conditions.

- Unchoked flow correlations were used as the unchoked flow correlations better approximate the true measured flow rate for the leakage rates.

- For conservatism, the upstream pressure at reference test conditions (inside of the MPC) is assumed to be 2 ATM and the down stream pressure (outside of the MPC) is assumed to be 1 ATM.

- The leak hole diameter is determined using reference test conditions rather than actual test conditions from Table 7.3.7. This is conservative, as it yields a larger leak hole diameter.

- The temperature at test conditions is assumed to be equal to a temperature, 212° F based on the maximum temperature achievable by the water in the MPC during performance of the leak test. This is conservative because the leak hole diameter computed from test conditions is larger.

- ~~Off-~~*The MPC pressure for* normal storage conditions ~~(i.e., MPC cavity at a pressure of 101.4 psia (6.90 ATM) at MPC cavity average temperature of 581 K)~~*is conservatively assumed to be equal to the design basis pressure. The MPC pressure for off-normal conditions is conservatively assumed to be larger than the design basis pressure. The off-normal temperature is postulated for this analysis as this temperature bounds the temperature under normal conditions of storage.* ~~are postulated for this analysis as these conditions bound the normal conditions of storage.~~

- The capillary length required for Equation 7-3 was conservatively chosen to be the MPC lid closure weld which is 1.9 cm.

- The majority of the activity associated with crud is due to ^{60}Co. This assumption follows from the discussion provided in NUREG/CR-6487 [7.3.2].

- The normal and off-normal condition leakage rate persists for one year without a decrease in the rate or nuclide concentration.

- The individual at the site boundary is exposed for 8,760 hours [7.0.2]. This conservatively assumes that the individual is exposed 24 hours per day for 365 days.

- A breathing rate of 3.3×10^{-4} m^3/sec for a worker is used for the analysis [7.0.2]. This assumption is in accordance with the guidance provided in NUREG-1536 for a worker.

- All fuel stored in the MPC is of the design basis type with a bounding burnup and cooling time.

- Exposure to dose conversion factors for inhalation reported in EPA Federal Guidance Report No. 11, Table 2.1 [7.3.5] were selected by the most restrictive clearance class for each organ and each radionuclide.

- For conservatism, the maximum possible leakage rate under reference test conditions is assumed to be 7.5×10^{-6} atm-cm^3/s, which is 150% of the reference test leak rate of 5.0×10^{-6} atm-cm^3/s.

- *The MPC internal free volumes presented in Section 4.4 have been conservatively reduced.*

Table 7.2.1

Deleted

~~Parameters for Determining the Percentage of the Source Term Available for Release~~

~~MPC-24, MPC-24E, MPC-24EF, MPC-32, MPC-68 and MPC-68FF~~

~~Parameter~~	~~Normal~~	~~Off-Normal~~
~~F_B~~	~~.01~~	~~.10~~
~~F_{70}~~	~~3.0%~~	~~3.0%~~
~~P_S~~	~~50%~~	~~50%~~
~~F_R~~	~~2.5%~~	~~11.5%~~

~~MPC-68F~~

~~Parameter~~	~~Normal~~	~~Off-Normal~~
~~F_R~~	~~1.0%~~	~~10.0%~~

Table 7.2.2

First-Order Rate Constant for Gravitational Settling and Aerosol Deposition Factors for Normal and Off-Normal Conditions

First Order Rate Constant [1/hour]	
λ = 0.25	
Aerosol Deposition Factors	
Gases	
100%	
Fines and Crud	
Normal/Off-normal	*4.57E-04*
Volatiles	
Normal	*2%*
Off-normal	*2%*

7.3 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 normal, off-normal and 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] to the maximum extent practicable. In summary, there is no mechanistic failure that results in a breach of the MPC confinement boundary.

The above discussion notwithstanding, this section evaluates the consequences of a non-mechanistic postulated ground level breach of the MPC confinement boundary. This breach could result in the release of gaseous fission products, fines, volatiles and airborne crud particulates. The internal design accident pressure of 200 psig, as specified in Table 7.1.1, is conservatively increased in the analysis to 225 psig for this evaluation. The following doses to an individual at the site boundary (100 meters) as a result of an assumed effluent release under accident conditions of storage were determined: the committed dose equivalent (CDE) from inhalation and the deep dose equivalent (DDE) from submersion for critical organs and tissues (gonad, breast, lung, red marrow, bone surface, thyroid); the committed effective dose equivalent (CEDE) from inhalation and the deep dose equivalent (DDE) from submersion for the whole body; the lens dose equivalent (LDE) for the lens of the eye; the shallow dose equivalent (SDE) from submersion for the skin; and the resulting Total Effective Dose Equivalent (TEDE) and Total Organ Dose Equivalent (TODE).

These doses were determined for each type of MPC. The ISFSI controlled area boundary must be at least 100 meters from the nearest loaded HI-STORM 100 System in accordance with 10CFR72.106(b) [7.0.1]. The doses are compared to the regulatory limits specified in 10CFR72.106(b) [7.0.1].

7.3.1 Confinement Vessel Releasable Source Term

In accordance with NUREG/CR-6487 [7.3.2], the following contributions are considered in determining the releasable source term for packages designed to transport irradiated fuel rods: (1) the radionuclides in the fuel rods, (2) the radionuclides on the surface of the fuel rods, and (3) the residual contamination on the inside surfaces of the vessel. NUREG/CR-6487 goes on to state that a radioactive aerosol can be generated inside a vessel when radioactive material from the fuel rods or from the inside surfaces of the container become airborne. The sources for the airborne material are (1) residual activity on the cask interior, (2) fission and activation-product activity associated with corrosion-deposited material (crud) on the fuel assembly surface, and (3) the radionuclides within the individual fuel rods. In accordance with NUREG/CR-6487, contamination due to residual activity on the cask interior surfaces is negligible as compared to crud deposits on the fuel rods themselves and therefore may be neglected. The source term considered for this calculation results from the spallation of crud from the fuel rods and from the fines, gases and volatiles which result from cladding breaches. The methodology of NUREG/CR-6487 is conservatively applied to the storage confinement accident analysis as dry storage conditions are less severe than transport conditions.

The inventory for isotopes other than ^{60}Co is calculated with the SAS2H and ORIGEN-S modules of the SCALE 4.3 system as described in Section 5.2. The inventory for the MPC-24, MPC-24E, MPC-24EF, *MPC-32* and MPC-32*F* was conservatively based on the B&W 15x15 fuel assembly with a burnup of 7*5*~~0~~,000 MWD/MTU, *3*~~5~~ years of cooling time, and an enrichment of *5.0*~~4.8~~%. The inventory for the MPC-68 and MPC-68FF was based on the GE 7x7 fuel assembly with a burnup of 6*5*~~0~~,000 MWD/MTU, ~~5~~*3* years of cooling time, and 4.*84*% enrichment. The CoC limits the fuel assembly burnup below 60,000 MWD/MTU for both BWR and PWR fuel at 5 years of cooling time. This ensures that the inventory used in this calculation exceeds that of the fuel authorized for storage. The inventory for the MPC-68F was based on the GE 6x6 fuel assembly with a burnup of 30,000 MWD/MTU, 18 years of cooling time, and 1.8% enrichment. The CoC limits the burnup and cooling time of fuel (intact, damaged or debris) in an MPC-68F to a maximum of 30,000 MWD/MTU at a minimum of 18 years cooling time. Additionally, the MPC-68F was analyzed containing 67 GE 6x6 assemblies and a DFC containing 18 thorium rods. Finally, an Sb-Be source stored in one fuel rod in one assembly with 67 GE 6x6 assemblies was analyzed. The isotopes which contribute greater than 0.1% to the total curie inventory for the fuel assembly are considered in the evaluation as fines. The analysis also includes actinides as the dose conversion factors for these isotopes are in general, orders of magnitude greater than other isotopes (e.g., isotopes of plutonium, americium, curium, and neptunium were included regardless of their contribution to the inventory). A summary of the isotopes available for release is provided in Table 7.3.1.

7.3.2 Crud Radionuclides

The majority of the activity associated with crud is due to ^{60}Co [7.3.2]. The inventory for ^{60}Co was determined by using the crud surface activity for PWR rods (140×10^{-6} Ci/cm^2) and for BWR rods (1254×10^{-6} Ci/cm^2) provided in NUREG/CR-6487 [7.3.2] multiplied by the surface area per assembly (3×10^5 cm^2 and 1×10^5 cm^2 for PWR and BWR, respectively, also provided in NUREG/CR-6487). The source terms were then decay corrected (*3*~~5~~ years for the MPC-24, MPC-24E, MPC-24EF, MPC-32, *MPC-32F,* MPC-68 and MPC-68FF; 18 years for the MPC-68F) using the basic radioactive decay equation:

Equation 7.*3*-1:

$$A(t) = A_0 e^{-\lambda t}$$

where:

$A(t)$ is activity at time t [Ci]

A_0 is the initial activity [Ci]

λ is the $\ln 2/t_{1/2}$ (where $t_{1/2} = 5.272$ years for ^{60}Co)

t is the time in years (~~3~~5 years for the MPC-24, MPC-24E, MPC-24EF, MPC-32, *MPC-32F*, MPC-68 and MPC-68FF; 18 years for the MPC-68F)

Total ^{60}Co crud is 140 μCi/cm² for PWR and 1254 μCi/cm² for BWR [7.3.2].

PWR
Surface area per Assy = 3.0E+05 cm²
140 μCi/cm² x 3.0E+05 cm² = 42.0 Ci

BWR
Surface area per Assy = 1.0E+05 cm²
1254 μCi/cm² x 1.0E+05 cm² = 125.4 Ci

$^{60}Co(t) = {}^{60}Co_0\, e^{-(\lambda t)}$, where $\lambda = \ln 2/t_{1/2}$, t = ~~5~~3 years (for the MPC-24, MPC-24E, MPC-24EF, MPC-32, *MPC-32F* and MPC-68), t = 18 years (MPC-68F), $t_{1/2}$ = 5.272 years for ^{60}Co [7.3.3]

MPC-24, MPC-24E, MPC-24EF ~~and MPC-32~~
MPC-32 and –32F
$^{60}Co(5) = 42.0\ Ci\ e^{-(\ln 2/5.272)(3~~5~~)}$
$^{60}Co(5)$ = 2*8.31*~~1.77~~ Ci

MPC-68 and MPC-68FF

$^{60}Co(5) = 125.4\ Ci\ e^{-(\ln 2/5\ 272)(3~~5~~)}$
$^{60}Co(5)$ = *84.53*~~64.98~~ Ci

MPC-68F

$^{60}Co(18) = 125.4\ Ci\ e^{-(\ln 2/5\ 272)(18)}$
$^{60}Co(18)$ = 11.76 Ci

A summary of the ^{60}Co inventory available for release is provided in Table 7.3.1.

7.3.3 Release of Contents Under Non-Mechanistic Accident Conditions of Storage

7.3.3.1 Confinement Boundary Leakage Rate

The helium leak rate testing performed on the MPC confinement boundary verifies the helium leak rate under reference test conditions to be less than or equal to $5x10^{-6}$ atm-cm³/s [1] as required by the Technical Specifications. As demonstrated by analysis, the MPC confinement boundary is not compromised as a result of normal, off-normal, and accident conditions. Based on the robust nature of the MPC confinement boundary, the NDE inspection of the welds, and the measurement of the helium leakage rate, there is essentially no leakage. However, it is conservatively assumed that the maximum possible leakage rate under reference test conditions from the confinement vessel is $7.5x10^{-6}$ atm-cm³/s. The actual leakage test is performed at an elevated pressure (~~90 +10/-0~~*85*- psig *min*) to magnify the leakage rate. For purposes of determining the leak hole diameter, reference test condition parameters from Table 7.3.7 are used in Equation ~~7-~~*7.3*-2 and Equation ~~7-~~*7.3*-3 as it results in a larger leak hole diameter.

[1] According to ANSI N14.5 (1997), the mass-like leakage rate specified herein is often used in leakage testing. This is defined as the rate of change of the pressure-volume product of the leaking fluid at test conditions.

Equation B-1 of ANSI N14.5 (1997) [7.3.8] is used to express this mass-like helium flow rate (Q_u) measured in atm-cm^3/s as a function of the upstream volumetric leakage rate (L_u) as follows:

Equation 7.3-2

$$Q_u = L_u * P_u \quad \text{atm-cm}^3/\text{sec (Equation B-1 from ANSI N14.5(1997))}$$

$$L_u = Q_u/P_u \quad \text{cm}^3/\text{sec}$$

where:

L_u is the upstream volumetric leakage rate [cm^3/s],
Q_u is the mass-like helium leak rate [atm cm^3/s], and
P_u is the upstream pressure [ATM]

The corresponding leakage rate at accident conditions is determined using the following methodology. For conservatism, unchoked flow correlations were used as the unchoked flow correlations better approximate the true measured flowrate for the leakage rates. Using the equations for molecular and continuum flow, Equation B-5 provided in ANSI N14.5-1997 [7.3.8], the corresponding capillary diameter, D, was calculated. For conservatism, the upstream pressure at reference test conditions (inside of the MPC) is assumed to be 2 ATM (minimum) and the down stream pressure (outside of the MPC) is assumed to be 1 ATM (at 298 K), therefore, the average pressure is 1.5 ATM. The evaluation was performed using the helium gas temperature at reference test conditions of both 70°F and 212°F. These temperatures are representative of the possible temperature of the helium gas in the confinement vessel during the helium leak test. The 212°F helium temperature is the upper bound because the water inside the MPC is shown not to boil in Chapter 4 as long as the "time-to-boil" time limit is not exceeded. From the two calculations using the two temperatures, it was determined that the higher temperature (212°F) results in a greater capillary diameter. The capillary length required for Equation ~~7~~7.3-3 was conservatively chosen to be the minimum MPC lid closure weld which is 1.9 cm. Table 7.3.6 provides a summary of the parameters used in the calculation.

Equation 7.3-3

$$L_u = \left[\frac{2.49x10^6 D^4}{a\,u} + \frac{3.81x10^3 D^3 \sqrt{\frac{T}{M}}}{a\,P_a}\right][P_u - P_d]\left[\frac{P_a}{P_u}\right]$$

where:

L_u is the allowable leakage rate at the upstream pressure [cm^3/s],
a is the capillary length [cm],
T is the temperature [°K],

M is the gas molecular weight [g/mole] from ANSI N14.5, Table B1 [7.3.8],
u is the fluid viscosity for helium [cP] from Rosenhow and Hartnett [7.3.9]
P_u is the upstream pressure [ATM],
P_d is the downstream pressure [ATM], and
P_a is the average pressure; $P_a = (P_u + P_d)/2$ [ATM].
D is the capillary diameter [cm].

The capillary diameter (D) computed from the above equation is equal to 4.96×10^{-4} cm.

Using the capillary diameter determined above, and the parameters for accident conditions provided in Table 7.3.6, Equation ~~7-~~*7.3*-3 was solved for the leakage rate at the upstream conditions. The resultant hypothetical accident leakage rate~~,~~ *of* 1.95×10^{-5} cm^3/s ~~(at 843 K, 16.31 ATM)~~ was calculated.

7.3.3.2 ~~Percentage of Nuclides that Remain Airborne~~*Gravitational Settling*

~~In addition to the small fraction of fines that are released in the event of a cladding breach, only about 10% of the fines released to the MPC cavity remain airborne long enough to be available for release from the cask MPC [7.3.11]. It is conservatively assumed that 100% of the volatiles, crud and gases remain airborne and available for release.~~*The fines, volatiles and crud that are released from the fuel cladding to the cask cavity do not remain airborne inside the cask cavity for the entire duration of the accident conditions. Therefore, credit is taken for gravitational settling of the fines, volatiles and crud in accordance with the methodology presented in reference [7.2.3]. The aerosol deposition factors for fines, volatiles, crud and gases under accident conditions are presented in Table 7.3.9 in accordance with the methodology presented in Section 7.2.7.2*

7.3.3.3 Fraction of Volume Released

The minimum free volume of each MPC design the confinement vessel is presented in Table 4.4.14, 4.4.13, 4.4.24, and 4.4.25. Using ~~these~~ *conservatively reduced values of these* volumes and the upstream hypothetical accident leakage rate ~~of 1.25x10⁻⁵ cm³/s~~, the fraction of the volume released per second is calculated. For the analysis of the MPC-24 and MPC-24E, the smaller of the two minimum free volumes was conservatively chosen.

7.3.3.4 Release Fraction

The release fraction is that portion of the total radionuclide inventory that is released from the cladding to the MPC cavity. The release fractions provided in NUREG/CR-6487 [7.3.2] are used. A summary of the release fractions is provided in Table 7.3.1.

7.3.3.5 Radionuclide Release Rate

The radionuclide release rate is the product of the quantity of isotopes available for release, the number of assemblies, the ~~percentage of nuclides that remain airborne~~*aerosol deposition factor*, the fraction of volume released, and the release fraction.

7.3.3.6 Atmospheric Dispersion Factor

The short-term accident condition atmospheric dispersion factor at 100 meters was determined using Regulatory Guide 1.145 [7.3.4]. In accordance with NUREG-1536 [7.0.2], the dispersion factor was determined on the basis of F-stability diffusion, a wind speed of 1 m/s, and plume meandering.

Reg Guide 1.145 [7.3.4] specifies that χ/Q be calculated using the following three equations. The values determined using Equations ~~7-~~*7.3*-4 and ~~7-~~*7.3*-5 should be compared and the higher value selected. This value should be compared with the value determined using Equation ~~7-~~*7.3*-6, and the lower value of these two should be selected as the appropriate χ/Q value. This methodology was used to determine the value for χ/Q.

Equation ~~7-~~*7.3*-4

$$\frac{\chi}{Q} = \frac{1}{U(\pi \sigma_y \sigma_z + A/2)}$$

Equation ~~7-~~*7.3*-5

$$\frac{\chi}{Q} = \frac{1}{U(3\pi \sigma_y \sigma_z)}$$

Equation ~~7-~~*7.3*-6

$$\frac{\chi}{Q} = \frac{1}{U\pi \Sigma_y \sigma_z}$$

where:

χ/Q is relative concentration, in sec/m^3,
π is 3.14159,
U is windspeed at 10 meters above plant grade, in m/sec,
σ_y is lateral plume spread, in meters, a function of atmospheric stability and distance (Figure 1, Reg Guide 1.145 [7.3.4]),
σ_z is vertical plume spread, in meters, a function of atmospheric stability and distance (Figure 2,

Reg Guide 1.145 [7.3.4]),

Σ_y is lateral plume spread with meander and building wake effects, in m, = M σ_y, where M is determined from Figure 3, Reg Guide 1.145 [7.3.4], and

A is the smallest vertical-plane cross-sectional area of the structure (cross section of the MPC), m^2.

Equations ~~7-~~7.3-4 through ~~7-~~7.3-6 were solved using the parameters presented in Table 7.3.5. The atmospheric dispersion factor, χ/Q, at 100 meters was selected in accordance with the methodology described above. The χ/Q value used to determine the dose is 8.0×10^{-3} sec/m^3. This short term accident condition χ/Q is deemed conservative for an accident evaluation period of 30 days.

7.3.3.7 Dose Conversion Factors

Dose Conversion Factors (DCF) from EPA Federal Guidance Report No. 11, Table 2.1 [7.3.5] and EPA Federal Guidance Report No. 12, Table III.1 [7.3.6] were used for the analysis. ~~The DCFs are provided on the spread sheets included as Appendix 7.A.~~

7.3.3.8 Occupancy Time

An occupancy time of 720 hours (30 days) is used for the analysis [7.0.2]. This conservatively assumes that the individual is exposed 24 hours per day for 30 days at the minimum controlled area boundary of 100 meters. The accident event duration is considered conservative as any accident condition of storage resulting in the failure of 100% of the stored fuel rods would be detected by the routine security and surveillance inspections and corrective actions would be completed prior to the end of this 30-day period.

7.3.3.9 Breathing Rate

A breathing rate of 3.3×10^{-4} m^3/sec for a worker is used for the analysis [7.0.2]. This assumption is in accordance with the guidance provided in NUREG-1536 [7.0.2] for a worker.

7.3.4 Postulated Accident Doses

The following doses to an individual at the site boundary (100 meters) as a result of an assumed effluent release under accident conditions of storage were determined; the committed dose equivalent (CDE) from inhalation and the deep dose equivalent (DDE) from submersion for critical organs and tissues (gonad, breast, lung, red marrow, bone surface, thyroid); the committed effective dose equivalent (CEDE) from inhalation and the deep dose equivalent (DDE) from submersion for the whole body; the lens dose equivalent (LDE) for the lens of the eye; the shallow dose equivalent (SDE) from submersion for the skin; and the resulting Total Effective Dose Equivalent (TEDE) and Total Organ Dose Equivalent (TODE). These doses are determined for each type of MPC. The postulated doses as a result of exposure to soil with ground surface contamination and soil contaminated to a depth of 15 cm were also determined. The resultant doses were negligible compared to the those resulting from submersion in the plume and are therefore not reported.

The doses were determined using spreadsheet software. The resultant doses are summarized for each MPC type in Tables 7.3.2 through Table 7.3.5 of the HI-STORM FSAR. ~~Example spread sheets used for the dose estimates are presented in Appendix 7.A.~~

7.3.4.1 Whole Body Dose (Total Effective Dose Equivalent)

The Total Effective Dose Equivalent is the sum of the inhaled committed effective dose equivalent (CEDE) from inhalation and the deep dose equivalent (DDE) to the whole body from submersion in the plume. The postulated doses were determined using spreadsheet software. ~~Example spread sheets are provided in Appendix 7.A.~~

The CEDE is the product of radionuclide release rate, the atmospheric dispersion factor, the occupancy time, the breathing rate, and the effective dose conversion factor. The deep dose equivalent to the whole body from submersion is the product of the nuclide release rate, the atmospheric dispersion factor, the occupancy time, and the effective dose conversion factor.

7.3.4.2 Critical Organ Dose

The dose to the critical organ (or tissue) is the sum of the committed dose equivalent to the critical organ or tissue from inhalation and the deep dose equivalent to the organ or tissue from submersion in the plume. The postulated doses as a result of exposure to soil with ground surface contamination and soil contaminated to a depth of 15 cm were also determined. The resultant doses were negligible compared to ~~the~~ those resulting from submersion in the plume and are therefore not reported.

The committed dose equivalent to the organ or tissue from inhalation is the product of radionuclide release rate, the atmospheric dispersion factor, the occupancy time, the breathing rate, and the organ/tissue dose conversion factor. The deep dose equivalent to the organ or tissue from submersion in the plume is the product of the nuclide release rate, the atmospheric dispersion factor, the occupancy time, and the organ/tissue dose conversion factor.

The lens dose equivalent (LDE) as a result of submersion in the plume was estimated using guidance from Dr. James Turner in his book, *Atoms, Radiation, and Radiation Protection* [7.3.10]. Dr. Turner states that alpha particles and low-energy beta particles, such as those from tritium, cannot penetrate to the lens of the eye (at a depth of 3 mm). The discussion continues that many noble gases emit photons and energetic beta particles, which in turn must be considered in the dose estimate. Dr. Turner states that the dose-equivalent rate to tissues near the surface of the body (e.g., lens of the eye) is more than 130 times the dose-equivalent rate in the lung from gases contained in the lung. Using the accident condition of storage for the MPC-68 and the MPC-32 (which have the highest dose to the lung for BWR and PWR fuel respectively), the estimated dose to the lung from gases in the lung is *4.63*~~3.60~~$\times10^{-3}$ mrem and *5.79*~~4.88~~$\times10^{-3}$ mrem, respectively. Conservatively multiplying this value by 150, the estimated LDE is 0.*695*~~540~~ mrem for BWR fuel and 0.*869*~~732~~ mrem for PWR fuel. These estimated LDEs for BWR and PWR fuel are a small fraction of the 15 rem limit imposed by 10CFR72.106(b).

7.3.5 Site Boundary

The estimated accident doses at the controlled area boundary are highest for the accident condition of storage for the MPC-68 for BWR fuel and the MPC-32 for PWR fuel. The estimated TEDEs ~~(39.2mrem for BWR fuel and 29.1 mrem for PWR fuel)~~ *presented in Table 7.3.8* are small fractions of the 5 rem whole body limit imposed by 10 CFR 72.106(b). The maximum estimated Total Organ Dose Equivalents (TODE) to the lung ~~and bone surface~~, which are the highest critical organ doses ~~to~~ *from* BWR and PWR fuel, respectively, ~~(205 mrem and 233 mrem, respectively)~~ are small fractions of the 50 rem critical organ limit imposed by 10 CFR 72.106(b). Additionally, the shallow dose equivalents to the skin ~~(0.303 mrem and 0.202 mrem)~~ are small fractions of the 50 rem shallow dose equivalent to skin or other extremity limit imposed by 10 CFR 72.106(b).

7.3.6 Assumptions

The following presents a summary of assumptions for the accident condition confinement analysis of the HI-STORM 100 System.

- The distance from the cask to the site boundary is 100 meters.
- 100% of the fuel rods have ruptured. This assumption is conservative because it results in the greatest potential release of radioactive material.
- Unchoked flow correlations were used as the unchoked flow correlations better approximate the true measured flowrate for the leakage rates associated with transportation packages.
- For conservatism, the upstream pressure at reference test conditions (inside of the MPC) is assumed to be *2 ATM* and the down stream pressure (outside of the MPC) is assumed to be 1 ATM.
- The leak hole diameter is determined using reference test conditions rather than actual test conditions from Table 7.3.7. This is conservative, as it yields a larger leak hole diameter.
- The temperature at test conditions is assumed to be equal to an ambient reference temperature, 212° F based on the maximum temperature achievable by the water in the MPC during performance of the leak test. This is conservative because the leak hole diameter computed from test conditions is larger.
- Bounding accident conditions (i.e., MPC cavity pressure of 225 psig (which is above the design pressure of 200 psig) at peak cladding temperature limit (570° C)) are postulated for this analysis.

- The capillary length required for Equation 7-*7.3*-3 was conservatively chosen to be the MPC lid closure weld which is 1.9 cm.

- The majority of the activity associated with crud is due to ^{60}Co. This assumption follows from the discussion provided in NUREG/CR-6487 [7.3.2].

- The accident condition leakage rate persists for 30 days without a decrease in the rate or nuclide concentration.

- The individual at the site boundary is exposed for 720 hours (30 days). This conservatively assumes that the individual is exposed 24 hours per day for 30 days.

- A breathing rate of 3.3 x 10^{-4} m^3/sec for a worker is used for the analysis [7.0.2]. This assumption is in accordance with the guidance provided in NUREG-1536 for a worker.

- All fuel stored in the MPC is of the design basis type with a bounding burnup and cooling time.

- Exposure to dose conversion factors for inhalation reported in EPA Federal Guidance Report No. 11, Table 2.1 [7.3.5] were selected by the most restrictive clearance class for each organ and each radionuclide.

- For conservativism, the maximum possible leakage rate at reference test conditions is assumed to be 7.5×10^{-6} atm-cm^3/s, which is 150% of the test leak rate of 5.0×10^{-6} atm-cm^3/s.

- *The MPC internal free volumes presented in Section 4.4 are conservatively reduced.*

Table 7.3.1
Isotope Inventory and Release Fraction

Nuclide	MPC-24 MPC-24E MPC-24EF MPC-32 *MPC-32F* Ci/Assembly	MPC-68 MPC-68FF Ci/Assembly	MPC-68F Ci/Assembly	Release Fraction [7.3.2]
Gases				
^{3}H	*4.37*~~3.68~~E+02	1.*59*~~24~~E+02	1.78E+01	0.30
^{129}I	3.*53*~~31~~E-02	1.*30*~~12~~E-02	3.49E-03	0.30
^{85}Kr	*7.02*~~5.86~~E+03	2.*57*~~04~~E+03	2.37E+02	0.30
Crud				
^{60}Co	2.*83*~~18~~E+01	*8.45*~~6.50~~E+01	1.18E+01	0.15 normal/off-normal 1.0 accident
Volatiles				
^{90}Sr	*7.02*~~6.32~~E+04	2.*65*~~24~~E+04	4.29E+03	2.0E-04
^{106}Ru	*6.41*~~1.59~~E+04	*1.98*~~4.71~~E+0*4*~~3~~	2.30E-01	2.0E-04
^{134}Cs	*8.63*~~4.04~~E+04	*2.79*~~1.18~~E+04	3.16E+01	2.0E-04
^{137}Cs	*1.10*~~9.82~~E+05~~4~~	*4.05*~~3.35~~E+04	7.21E+03	2.0E-04
Fines				
^{241}Pu	*9.65*~~8.53~~E+04	*3.01*~~2.58~~E+04	5.16E+03	3.0 E-05
^{90}Y	*7.02*~~6.32~~E+04	2.*65*~~24~~E+04	4.29E+03	3.0 E-05
^{147}Pm	*4.46*~~2.63~~E+04	*1.61*~~9.63~~E+0*4*~~3~~	1.18E+02	3.0 E-05
^{144}Ce	*4.78*~~8.14~~E+0*4*~~3~~	*1.44*~~2.48~~E+0*4*~~3~~	--	3.0 E-05
^{144}Pr	*4.78*~~8.14~~E+0*4*~~3~~	*1.44*~~2.48~~E+0*4*~~3~~	--	3.0 E-05
^{154}Eu	*7.48*~~5.90~~E+03	*2.41*~~1.74~~E+03	1.44E+02	3.0 E-05
^{244}Cm	1.*30*~~01~~+04	*3.99*~~2.38~~E+03	2.17E+02	3.0 E-05
^{238}Pu	*6.65*~~5.81~~E+03	*2.10*~~1.58~~E+03	2.50E+02	3.0 E-05
^{125}Sb	*3.98*~~2.30~~E+03	*1.43*~~7.91~~E+02	--	3.0 E-05
^{155}Eu	*2.39*~~1.65~~E+03	*8.58*~~5.41~~E+02	--	3.0 E-05

Table 7.3.1
(continued)

Isotope Inventory and Release Fractions

Nuclide	MPC-24 *MPC-24E* *MPC-24EF* *MPC-32* *MPC-32F* Ci/Assembly	MPC-68 *MPC-68FF* Ci/Assembly	MPC-68F Ci/Assembly	Release Fraction [7.3.2]
^{241}Am	*6.34*~~9.00~~E+02	2.*05*~~78~~E+02	2.52E+02	3.0 E-05
^{125m}Te	*9.73*~~5.61~~E+02	*3.51*~~1.93~~E+02	--	3.0 E-05
^{240}Pu	4.*1*~~0~~5E+02	1.*6*~~5~~0E+02	6.81E+01	3.0 E-05
^{151}Sm	3.*57*~~38~~E+02	*1.07*~~9.76~~E+02~~1~~		3.0 E-05
^{239}Pu	2.0*6*4E+02	6.7*3*~~0~~E+01	2.95E+01	3.0 E-05
^{137m}Ba	*1.05*~~9.27~~E+054	3.*82*~~17~~E+04	6.81E+03	3.0 E-05
^{106}Rh	*6.41*~~1.59~~E+04	*1.98*~~4.71~~E+04~~3~~	--	3.0 E-05
^{144m}Pr	*6.70*~~1.14~~E+02	*2.02*~~3.48~~E+02~~1~~	--	3.0 E-05
^{243}Am	*5.46*~~4.87~~E+01	1.*80*~~36~~E+01	3.30E+00	3.0 E-05
^{242}Cm	*6.10*~~3.23~~E+02~~1~~	*2.00*~~9.82~~E+01~~0~~	7.71E-01	3.0 E-05
^{243}Cm	*4.26*~~3.63~~E+01	*1.32*~~9.79~~E+01~~0~~	1.54E+00	3.0 E-05
^{239}Np	*5.46*~~4.87~~E+01	1.*80*~~36~~E+01	3.30E+00	3.0 E-05
^{237}Np	*4.15*~~3.88~~E-01	1.*37*~~18~~E-01	2.72E-02	3.0 E-05
^{242}Pu	*3.09*~~2.85~~E+00	*1.11*~~9.04~~E+-00~~1~~	3.06E-01	3.0 E-05
^{242}Am	*9.24*~~8.72~~E+00	2.*99*~~71~~E+00	9.31E-01	3.0 E-05
^{242m}Am	*9.28*~~8.76~~E+00	*3.00*~~2.72~~E+00	9.35E-01	3.0 E-05
^{119m}Sn	--	*3.35E+02*	--	*3.0 E-05*

Note: The isotopes which contribute greater than 0.1% to the total curie inventory for the fuel assembly are considered in the evaluation as fines.

The analysis also includes actinides as the dose conversion factors for these isotopes are in general, orders of magnitude greater than other isotopes (e.g., isotopes of plutonium, americium, curium, and neptunium were included regardless of their contribution to the inventory).

Table 7.3.2

MPC-24, MPC-24E and MPC-24EF
Postulated Doses
To An Individual at the Controlled Area Boundary (100 meters)
As a Result of an Assumed Effluent Release

Normal Conditions [mrem/yr]

	Gonad	Breast	Lung	Red Marrow	Bone Surface	Thyroid
CDE	6.51E-05	4.95E-05	3.40E-03	4.28E-04	2.00E-03	9.60E-05
DDE	2.59E-06	2.94E-06	2.52E-06	2.42E-06	4.68E-06	2.60E-06
ADE	6.77E-05	5.24E-05	3.40E-03	4.30E-04	2.00E-03	9.86E-05

	Skin/Extremity
SDE	2.42E-04

	Whole Body
CEDE	5.18E-04
DDE	2.62E-06
ADE	5.21E-04

Off-Normal Conditions [mrem/yr]

	Gonad	Breast	Lung	Red Marrow	Bone Surface	Thyroid
CDE	7.43E-04	4.78E-04	3.83E-02	4.97E-03	2.36E-02	1.04E-03
DDE	2.83E-05	3.23E-05	2.76E-05	2.64E-05	5.23E-05	2.85E-05
ADE	7.71E-04	5.10E-04	3.83E-02	5.00E-03	2.37E-02	1.07E-03

	Skin/Extremity
SDE	2.87E-03

	Whole Body
CEDE	5.79E-03
DDE	2.88E-05
ADE	5.82E-03

Accident Conditions [mrem/30 days]

	Gonad	Breast	Lung	Red Marrow	Bone Surface	Thyroid
CDE	1.84E-01	2.66E-02	2.94E+00	1.07E+00	1.12E+01	5.74E-02
DDE	1.56E-03	1.78E-03	1.52E-03	1.46E-03	2.88E-03	1.57E-03
TODE	1.86E-01	2.84E-02	2.94E+00	1.07E+00	1.12E+01	5.90E-02

	Skin/Extremity
SDE	1.57E-01

	Whole Body
CEDE	8.75E-01
DDE	1.58E-03
TEDE	8.77E-01

Table 7.3.3

MPC-32
Postulated Doses
To An Individual at the Controlled Area Boundary (100 meters)
As a Result of an Assumed Effluent Release

Normal Conditions [mrem/yr]

	Gonad	Breast	Lung	Red Marrow	Bone Surface	Thyroid
CDE	8.96E-05	6.82E-05	4.69E-03	5.90E-04	2.75E-03	1.32E-04
DDE	3.54E-06	4.05E-06	3.47E-06	3.33E-06	6.45E-06	3.58E-06
ADE	9.31E-05	7.23E-05	4.69E-03	5.93E-04	2.76E-03	1.36E-04

	Skin/Extremity
SDE	3.33E-04

	Whole Body
CEDE	7.14E-04
DDE	3.60E-06
ADE	7.18E-04

Off-Normal Conditions [mrem/yr]

	Gonad	Breast	Lung	Red Marrow	Bone Surface	Thyroid
CDE	1.02E-03	6.58E-04	5.27E-02	6.85E-03	3.25E-02	1.44E-03
DDE	3.98E-05	4.45E-05	3.81E-05	3.64E-05	7.21E-05	3.93E-05
ADE	1.06E-03	7.03E-04	5.27E-02	6.89E-03	3.26E-02	1.48E-03

	Skin/Extremity
SDE	3.95E-03

	Whole Body
CEDE	7.98E-03
DDE	3.96E-05
ADE	8.02E-03

Accident Conditions [mrem/30 days]

	Gonad	Breast	Lung	Red Marrow	Bone Surface	Thyroid
CDE	2.52E-01	3.66E-02	4.04E+00	1.47E+00	1.54E+01	7.89E-02
DDE	2.14E-03	2.45E-03	2.09E-03	2.00E-03	3.96E-03	2.16E-03
TODE	2.54E-01	3.91E-02	4.04E+00	1.47E+00	1.54E+01	8.11E-02

	Skin/Extremity
SDE	2.15E-01

	Whole Body
CEDE	1.20E+00
DDE	2.18E-03
TEDE	1.20E+00

Table 7.3.4
MPC-68 and MPC-68FF
Postulated Doses
To An Individual at the Controlled Area Boundary (100 meters)
As a Result of an Assumed Effluent Release

Normal Conditions [mrem/yr]

	Gonad	Breast	Lung	Red Marrow	Bone Surface	Thyroid
CDE	8.65E-05	1.33E-04	5.21E-03	5.38E-04	2.07E-03	1.75E-04
DDE	4.45E-06	5.07E-06	4.41E-06	4.29E-06	7.51E-06	4.54E-06
ADE	9.10E-05	1.38E-04	5.21E-03	5.42E-04	2.08E-03	1.80E-04

	Skin/Extremity
SDE	2.70E-04

	Whole Body
CEDE	8.13E-04
DDE	4.55E-06
ADE	8.18E-04

Off-Normal Conditions [mrem/yr]

	Gonad	Breast	Lung	Red Marrow	Bone Surface	Thyroid
CDE	7.71E-04	5.89E-04	4.33E-02	5.46E-03	2.38E-02	1.21E-03
DDE	3.29E-05	3.76E-05	3.22E-05	3.09E-05	6.02E-05	3.32E-05
ADE	8.04E-04	6.27E-04	4.33E-02	5.49E-03	2.39E-02	1.24E-03

	Skin/Extremity
SDE	3.17E-03

	Whole Body
CEDE	6.48E-03
DDE	3.35E-05
ADE	6.51E-03

Accident Conditions [mrem/30 days]

	Gonad	Breast	Lung	Red Marrow	Bone Surface	Thyroid
CDE	1.78E-01	3.59E-02	3.24E+00	1.05E+00	1.07E+01	6.91E-02
DDE	1.87E-03	2.14E-03	1.84E-03	1.77E-03	3.40E-03	1.90E-03
TODE	1.80E-01	3.80E-02	3.24E+00	1.05E+00	1.07E+01	7.10E-02

	Skin/Extremity
SDE	1.73E-01

	Whole Body
CEDE	8.93E-01
DDE	1.91E-03
TEDE	8.95E-01

Table 7.3.5

MPC-68F
Postulated Doses
To An Individual at the Controlled Area Boundary (100 meters)
As a Result of an Assumed Effluent Release

Normal Conditions [mrem/yr]

	Gonad	Breast	Lung	Red Marrow	Bone Surface	Thyroid
CDE	9.75E-06	1.60E-05	6.86E-04	8.11E-05	3.23E-04	1.45E-05
DDE	4.80E-07	5.45E-07	4.77E-07	4.65E-07	7.89E-07	4.90E-07
ADE	1.02E-05	1.65E-05	6.86E-04	8.16E-05	3.24E-04	1.50E-05

	Skin/Extremity
SDE	2.50E-05

	Whole Body
CEDE	1.08E-04
DDE	4.90E-07
ADE	1.08E-04

Off-Normal Conditions [mrem/yr]

	Gonad	Breast	Lung	Red Marrow	Bone Surface	Thyroid
CDE	6.75E-05	4.45E-05	4.69E-03	7.03E-04	3.15E-03	4.32E-05
DDE	2.45E-06	2.80E-06	2.40E-06	2.30E-06	4.49E-06	2.48E-06
ADE	7.00E-05	4.73E-05	4.69E-03	7.05E-04	3.15E-03	4.57E-05

	Skin/Extremity
SDE	2.47E-04

	Whole Body
CEDE	7.05E-04
DDE	2.49E-06
ADE	7.07E-04

Accident Conditions [mrem/30 days]

	Gonad	Breast	Lung	Red Marrow	Bone Surface	Thyroid
CDE	2.63E-02	3.40E-03	4.30E-01	1.63E-01	1.67E+00	3.25E-03
DDE	1.70E-04	1.93E-04	1.66E-04	1.60E-04	3.06E-04	1.71E-04
TODE	2.65E-02	3.59E-03	4.30E-01	1.63E-01	1.67E+00	3.42E-03

	Skin/Extremity
SDE	1.60E-02

	Whole Body
CEDE	1.28E-01
DDE	1.72E-04
TEDE	1.28E-01

Table 7.3.6
χ/Q Parameters

Parameter	Value	Reference
U	1 m/s	NUREG-1536 [7.0.2]
σ_y	4.0 m	Figure 1, Reg Guide 1.145 [7.3.4]
σ_z	2.5 m	Figure 2, Reg Guide 1.145 [7.3.4]
$\Sigma_y = M\,\sigma_y$	16	M is determined from Figure 3, Reg Guide 1.145 [7.3.4]
A	8.41 m^2	Chapter 1, Section 1.5

Table 7.3.7

Parameters for Test, Normal/Off-Normal and Hypothetical Accident Conditions

Parameter	Reference Test	Actual Test	Normal/Off-Normal[1]	Hypothetical Accident
P_u	2 ATM (min)	6.78 ATM (min)	*7.80/9.56*~~.90~~ ATM	16.31 ATM
P_d	1 ATM	1 ATM	1 ATM	1 ATM
T	373 K	373 K	581 K	843 K
M	4 g/mol	4 g/mol	4 g/mol	4 g/mol
u (helium)	0.0231 cP	0.0231 cP	0.0309 cP	0.0397 cP
a	1.9 cm	1.9 cm	1.9 cm	1.9 cm

[1] *The values in this column, with the exception of the pressure are for the off-normal condition*~~—They uniformly bound the normal condition values~~*, as they bound the normal condition values. Pressure values are given for both normal and off-normal conditions and correspondingly used to determine the leakage rates for each condition.*

Table 7.3.8

Postulated Bounding Doses Compared to Regulatory Limits
To An Individual at the Controlled Area Boundary (100 meters)
As a Result of an Assumed Effluent Release

	BWR	PWR	Regulatory Limit
10CFR72.104(a) - Normal			
Whole body ADE	*1.60E-03*~~0.515~~ mrem	*1.73E-03*~~0.159~~ mrem	25 mrem
Thyroid ADE	*3.23E-04*~~0.129~~ mrem	*3.21E-04*~~0.022~~ mrem	75 mrem
Critical Organ ADE (Max)	*1.04E-02*~~2.95~~ mrem	*1.13E-02*~~0.900~~ mrem	25mrem
10CFR72.104(a) - Off-normal			
Whole body ADE	*7.44E-03*~~0.735~~ mrem	*9.22E-03*~~0.486~~ mrem	25 mrem
Thyroid ADE	*1.41E-03*~~0.136~~ mrem	*1.70E-03*~~0.033~~ mrem	75 mrem
Critical Organ ADE (Max)	4.95E-0207 mrem	*6.06E-02*~~4.08~~ mrem	25mrem
10CFR72.106(b) - Accident			
TEDE	*0.895*~~39.2~~ mrem	*1.20*~~29.1~~ mrem	5 rem
TODE=DDE+CDE (Max)	10.7216 mrem	15.4254 mrem	50 rem
LDE	0.*869*~~540~~ mrem	0.*695*~~732~~ mrem	15 rem
SDE	0.*173*~~303~~ mrem	0.2152 mrem	50 rem

ADE: Annual Dose Equivalent
TEDE: Total Effective Dose Equivalent
TODE: Total Organ Dose Equivalent
DDE: Deep Dose Equivalent
CDE: Committed Dose Equivalent
LDE: Lens Dose Equivalent
SDE: Shallow Dose Equivalent

Table 7.3.9

First-Order Rate Constant for Gravitational Settling and Aerosol Deposition Factors for Accident Conditions

First Order Rate Constant [1/hour]	
λ = 0.25	
Aerosol Deposition Factors	
Gases	
100%	
Fines and Crud	
Accident	*5.56E-03*
Volatiles	
Accident	*2%*

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.

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[7.2.2] Interim Staff Guidance-5, Revision 1, "Normal, Off-Normal, and Hypothetical Dose Estimate Calculations", June 18, 1999.

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[7.3.6] U.S. EPA, Federal Guidance Report No. 12, *External Exposure to Radionuclides in Air, Water, and Soil*, EPA 402-R-93-081, 1993.

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[7.3.8] ANSI N14.5-1997. "American National Standard for Radioactive Material Leakage Tests on Packages for Shipment."

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[7.3.10] Turner, James E. *Atoms, Radiation , and Radiation Protection*, McGraw Hill Book Company, New York, 1992.

[7.3.11] ~~Rashid, Y.R., et al, "An Estimate of the Contribution of Spent Fuel Products to the Releaseable Source Term in Spent Fuel Transportation Casks," SAND88-2778C, Sandia National Laboratories, 1988~~
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APPENDIX 7.A

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~~EXAMPLE DOSE CALCULATIONS FOR NORMAL, OFF-NORMAL, AND ACCIDENT CONDITIONS OF STORAGE~~

~~MPC-32, Normal Conditions of Storage, Dose from Inhalation: 7 pages~~
~~MPC-32, Off-Normal Conditions of Storage, Dose from Inhalation: 7 pages~~
~~MPC-32, Accident Conditions of Storage, Dose from Inhalation: 7 pages~~

~~MPC-32, Normal Conditions of Storage, Dose from Submersion: 8 pages~~
~~MPC-32, Off-Normal Conditions of Storage, Dose from Submersion: 8 pages~~
~~MPC-32, Accident Conditions of Storage, Dose from Submersion: 8 pages~~

~~MPC-68, Normal Conditions of Storage, Dose from Inhalation: 7 pages~~
~~MPC-68, Off-Normal Conditions of Storage, Dose from Inhalation: 7 pages~~
~~MPC-68, Accident Conditions of Storage, Dose from Inhalation: 7 pages~~

~~MPC-68, Normal Conditions of Storage, Dose from Submersion: 8 pages~~
~~MPC-68, Off-Normal Conditions of Storage, Dose from Submersion: 8 pages~~
~~MPC-68, Accident Conditions of Storage, Dose from Submersion: 8 pages~~

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. The Technical Specifications in Appendix A to CoC 72-1014 provide Limiting Conditions of Operation (LCO), Surveillance Requirements (SR's), as well as administrative information, such as Use and Application. Appendix B to COC 72-1014 provides the approved contents and design features applicable to the HI-STORM 100 System. FSAR Appendix 12.A includes the Bases for the LCOs. The Technical Specifications impose restrictions and requirements that must be applied throughout the loading and unloading process. 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 and the HI-STORM 100S. 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 artists' 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.

† 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).

Licensees (Users) will utilize the procedures provided in this chapter, the Technical Specifications in Appendix A to CoC 72-1014, the conditions of the Certificate of Compliance, 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 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, ~~and vacuum drying~~*removing moisture*, inerting, and leakage testing 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 the Appendix B to CoC 72-1014 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 vacuum drying operations and during handling of the MPC in the HI-TRAC transfer cask. Chapter 4.5 of the FSAR and the Technical Specification provide 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. Other instrumentation that meets the requirements of the Technical Specifications is also acceptable. 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, including the handling of fuel assemblies in the Damaged Fuel Container (DFC) shall be performed in accordance with written site-specific procedures. DFCs shall be loaded in the spent fuel pool racks prior to placement into the MPC.

Technical and Safety Basis for Loading and Unloading Procedures

The procedures herein (Sections 8.1.2 through 8.1.5) 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

POTENTIAL EVENTS	METHODS USED TO ADDRESS EVENT	COMMENTS/ REFERENCES
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. Technical Specifications limit the cask and overpack lift height outside the fuel building.	See Section 8.1.2. See Technical Specifications in Appendix A to CoC 72-1014 for HI-TRAC and HI-STORM lift height limitations.
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. Technical Specifications require surveys of certain components of the HI-STORM 100 System to monitor for removable contamination.	See Figures 8.1.13 and 8.1.14. See Technical Specifications in Appendix A to CoC 72-1014.
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/thermal shock	Fuel assemblies are never subjected to air or oxygen during loading and unloading operations. Cool-Down System brings fuel assembly bulk temperatures to below water boiling temperature prior to flooding.	See Section 8.1.5, Section 8.3.3 and LCO 3.1.3.
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. It is recommended for defense-in-depth that the space below the MPC lid be evacuated or purged prior to, and during these activities.	See Section 8.1.5 and Section 8.3.3.

Table 8.0.1
OPERATIONAL CONSIDERATIONS
(CONTINUED)

POTENTIAL EVENTS	METHODS USED TO ADDRESS EVENT	COMMENTS/ REFERENCES
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 is used, the temperature of the gas exiting the demoisturizer 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, ~~and~~ Technical Specification LCO 3.1.1, *and Appendix 12.A, Bases B 3.1.1.*
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.

Table 8.0.1
OPERATIONAL CONSIDERATIONS
(CONTINUED)

POTENTIAL EVENTS	METHODS USED TO ADDRESS EVENT	COMMENTS/ REFERENCES
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 8.3.4.
Overstressing MPC lift lugs from side loading	The MPC is upended using the upending frame. The lift lugs are never side loaded.	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*~~vacuum drying~~ 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 Technical Specification 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† and the MPC is filled with either spent fuel pool water or plant demineralized water (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

† 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 water level is raised to the top of the MPC and a hydrostatic test followed by an additional liquid penetrant examination is performed on the MPC Lid-to-Shell weld to verify structural integrity. A small amount of water is displaced with helium gas for leakage testing. A leakage rate test is performed on the MPC lid-to-shell weld to verify weld integrity and to ensure that leakage rates are within acceptance criteria (See Technical Specification LCO 3.1.1).

To calculate the helium backfill requirements for the MPC, 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 heat load of the fuel, moisture is removed from the MPC using either a vacuum drying system or forced helium dehydration system. Section 4.5 of the FSAR has guidance on moisture removal requirements for the various heat loads. For lower heat loads, t~~T~~he vacuum drying system ~~is~~*may be* connected to the MPC and is 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 (See Technical Specification LCO 3.1.1).

~~Alternatively f~~*F*or high*er* ~~burn-up fuel~~ *heat loads, or as an alternative for lower heat loads*, a *forced helium dehydration* ~~moisture removal~~ 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 demoisturizer is maintained below 21 °F for a minimum of 30 minutes to ensure that all liquid water is removed (See Technical Specification LCO 3.1.1)* ~~Gas exiting the MPC is monitored for entrained moisture until no discernable moisture is present in the MPC.~~

Limitations for the at-vacuum duration are evaluated and established on a canister basis to ensure that acceptable cladding temperatures are not exceeded. Refer to FSAR Section 4.5 for requirements on moisture removal based on the heat load in the MPC. Following MPC ~~drying~~*moisture removal*, the MPC is ~~evacuated and~~ backfilled with a predetermined ~~pressure~~ *amount* of helium gas (See Technical Specification LCO 3.1.1). ~~Limitations for the at-vacuum duration are evaluated and established on a canister basis to ensure that acceptable cladding temperatures are not exceeded although a time limit of less than 2 hours at vacuum will bound any MPC.~~ The helium backfill ensures adequate heat transfer during storage, provides an inert atmosphere for long-term fuel integrity, and provides the means of future leakage rate testing of the MPC confinement boundary welds. 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 plates are helium leakage tested to confirm that they meet the established leakage rate criteria.

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 (See Technical Specification LCO 3.2.2) and HI-TRAC dose rates are measured. HI-TRAC top lid[3] is installed and the bolts are torqued (Box 11). 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 not 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[1] 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 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 125D) helps guide HI-TRAC during this operation[2]. 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 the transfer doors are used (i.e. not the HI-TRAC 125D), the MPC is raised slightly, the

1 Vent duct shield inserts are only used on the HI-STORM 100.

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

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

transfer lid door locking pins are removed and the doors are opened. If the HI-TRAC 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 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. 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 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 are installed. 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 in the Technical Specification 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 and the shielding effectiveness test is performed. Finally, the temperature elements and their instrument connections are installed (if used), and the air temperature rise testing (if required by the Technical Specifications) 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. Refer to the Technical Specifications for loaded HI-TRAC and HI-STORM 100 Overpack handling limitations.

1. Vertical Handling of HI-TRAC:

   a. Verify that the lift yoke load test certifications are current.

   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. Refer to Technical Specification 4.9 for additional equipment 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 load test certifications are current.

   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. 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:
A loaded HI-TRAC should only be downended with the transfer lid or other auxiliary shielding installed.

   a. Position the Transfer Frame under the lifting device.

   b. Verify that the lift yoke load test certifications are current.

   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. 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 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:

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 <u>(or equivalent).</u> 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. Ensure that the reducer is fully seated against the bottom of the MPC lid. See Figure 8.1.11.

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.

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, placed in, 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 LCO 3.3.1 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 LCO 3.3.1.

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.

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 Appendix B to CoC 72-1014 have been selected for loading into the MPC.
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. Ensure that the reducer is fully seated against the bottom 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.

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. One course of action involves initiating an MPC water flush for a certain duration and flow rate. Any site-specific analysis shall identify the methods to respond should it become likely that the imposed time limit could be exceeded. Refer to LCO 3.3.1 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.

w.

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

x. 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.

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 shell in accordance with the requirements of Technical Specification LCO 3.2.2.

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 Systembaseplate 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.

Caution:
Oxidation of Boral panels and aluminum components 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 welding operations. It is also recommended for defense-in-depth that the space below the MPC lid be exhausted or purged with inert gas prior to, and during MPC lid welding operations to provide additional assurance that explosive gas mixtures will not develop in this space.

e. Perform combustible gas monitoring and, if desired, exhaust or 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 hydrostatic and MPC leakage rate testing as follows:

ALARA Note:
The leakage rates are determined before the MPC is drained for ALARA reasons. A weld repair is a lower dose activity if water remains inside the MPC.

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 for the hydrostatic 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. 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 LCO 3.3.1 for boron concentration requirements.

c. Perform a hydrostatic test of the MPC as follows:

   1. Close the drain valve and pressurize the MPC to 125 +5/-0 psig.

   2. Close the inlet valve and monitor the pressure for a minimum of 10 minutes. The pressure shall not drop 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. The acceptance criteria is no observable water leakage.

d. Release the MPC internal pressure, disconnect the water fill 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. Attach a regulated helium supply to the vent port and attach the drain line to the drain port as shown on Figure 8.1.21.

f. Verify the correct pressure on the helium supply and open the helium supply valve. Drain approximately twenty gallons.

g. Close the drain port valve and pressurize the MPC.

h. Close the vent port.

Note:
The leakage detector may detect residual helium in the atmosphere. If the leakage tests detects a leak, the area should be flushed with nitrogen or compressed air and the location should be retested. Users may correlate the leakage rate acceptance criteria based on the conditions of the test.

i. Perform a helium sniffer probe leakage rate test of the MPC lid-to shell weld in accordance with the Mass Spectrometer Leak Detector (MSLD) manufacturer's instructions and ANSI N14.5 [8.1.2]. The MPC Helium Leak Rate shall be < 5.0E-6 atm cc/sec (He) based on a 1 atmosphere pressure differential across the weld joint.

j. Repair any weld defects in accordance with the site's approved weld repair procedures. Reperform the Ultrasonic (if necessary), PT, Hydrostatic and Helium Leakage tests if weld repair is performed.

5. Drain the MPC as follows:

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.

6. Dry the MPC as follows:

Caution:
Limitations for the at-vacuum duration are evaluated and established on a canister-specific basis to ensure that acceptable cladding temperatures are not exceeded.

Note:
Vacuum drying or *forced helium dehydration* ~~moisture removal~~ (for higher ~~burn-up~~*heat load* fuel) 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. Steps *6.b*~~8.1.22a~~ through h *in Section 8.1.5* are used for vacuum drying. Steps ~~8.1.22b~~*6*i through k *in Section 8.1.5* are used for moisture removal.

a. *If using the vacuum drying system, go to Section 8.1.5 Step 6.b. If using the forced helium dehydration system, go to Section 8.1.5 Step 6.i.* ~~Attach the drying system (VDS) to the vent and drain port RVOAs. See Figure 8.1.22a for the vacuum drying system and 8.1.22b for the moisture removal system.~~ 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.

b. *Attach the vacuum drying system (VDS) to the vent and drain port RVOAs. See Figure 8.1.22a*~~Deleted~~.

c. Deleted.

d. Deleted.

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.

e. *Open the VDS suction valve and reduce the MPC pressure to below 3 torr*~~Deleted~~.

f. *Shut the VDS valves and verify a stable MPC pressure on the vacuum gage*~~Open the VDS suction valve and reduce the MPC pressure to below 3 torr~~.

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.*

g. *Perform the MPC drying pressure test in accordance with the technical specifications*~~Shut the VDS valves and verify a stable MPC pressure on the vacuum gage~~.

h. ~~Perform the MPC drying pressure test in accordance with the technical specifications.~~*Proceed to Step 6.1 of Section 8.1.5 if not using the forced helium dehydration system.*

i. Attach the ~~moisture removal~~*forced helium dehydration* system to the vent and drain port RVOAs. See Figure 8.1.22b.

j. Circulate the drying gas though the MPC while monitoring the circulating gas for moisture. Collect and remove the moisture from the system as necessary.

k. Continue the monitoring and moisture removal until LCO 3.1.1 is met for MPC dryness. Discontinue MPC drying operations.

l. If necessary, attach the vacuum pump to the MPC.

m. Evacuate the MPC to below 10 torr.

n. Close the vent and drain port valves.

o. Disconnect the VDS from the MPC.

p. Stop the warming pad, if used.

q. Close the drain port RVOA cap and remove the drain port RVOA.

7. Backfill the MPC as follows:

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 Section 4.5 and Technical Specification 3.4.10 for specific time limits for transporting a loaded MPC in the HI-TRAC transfer CASK based on MPC heat loads.*

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

a. Set the helium bottle regulator pressure to the appropriate pressure.

b. Purge the Helium Backfill System to remove oxygen from the lines.

c. Attach the Helium Backfill System to the vent port as shown on Figure 8.1.23 and open the vent port.

d. Slowly open the helium supply valve while monitoring the pressure rise in the MPC.

e. Deleted

f. Deleted

g. Deleted

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.

h. Carefully backfill the MPC in accordance with the technical specifications

i. Disconnect the helium backfill system from the MPC.

j. Close the vent port RVOA and disconnect the vent port RVOA.

8. Weld the vent and drain port cover plates as follows:

Note:
The process provided herein may be modified to perform actions in parallel. Users may perform the final PT on the circumferential and plug welds at the same time.

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. Insert helium into the vent port recess to displace the oxygen.

Deleted. **Note:**
The vent and drain ports are provided with two small threaded holes for the injection of helium. The set screws may be installed or removed during welding.

e. Weld the cover plate and perform NDE with approved procedures (See 9.1 and Table 2.2.15)

f. Deleted.

g. Deleted.

h. Deleted.

i. Deleted.

j. Deleted.

k. 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 detects 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 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 Section 4.5 for more detailed guidance on time limits based on MPC heat loads.

1. Remove the annulus shield (if used) and store it in an approved plant storage location

2. 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 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.

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

5. 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 as described in the Technical Specifications are not exceeded. 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 deenergized 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 125D) and if necessary, install the HI-STORM vent duct shield inserts. See Figure 8.1.30.
4. Deleted.
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 125D and mating device)

10. If using the HI-TRAC 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 125D)and vent duct shield inserts (if used). See Figure 8.1.30.

    b. Inspect the HI-STORM lid studs and nuts 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.. 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 and 8.1.34b.

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.

h. Secure HI-STORM to the transporter device as necessary.

19. Perform a transport route walkdown to ensure that the cask transport conditions are met. See Technical Specification for the on-site cask handling limitations.

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 shielding effectiveness testing per Technical Specification LCO 3.2.3.

23. 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.

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† Applicability					
				1	2	3	4	5	6
Empty HI-STORM 100 overpack (without lid)††	245,040	245,040	245,040					1	
HI-STORM 100 lid (without rigging)	23,963	23,963	23,963					1	
Empty HI-STORM 100S (232) overpack (without lid)††	230,000	230,000	230,000					1	
Empty HI-STORM 100S (243) overpack (without lid)††	239,000	239,000	239,000					1	
HI-STORM 100S lid (without rigging)	25,500	25,500	25,500					1	
Empty MPC (without lid or closure ring including drain line)	29,845	24,503	29,302	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
MPC Closure Ring	145	145	145			1	1	1	1
Fuel (design basis)	40,320	53,760	47,600	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)	3,600	3,600	3,600	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)	119,400	119,400	119,400	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	230	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.

† See Table 8.1.2 for a description of each load handling case.

†† Add an additional 1955 lbs. for the HI-STORM 100A overpack.

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)	231,300	239,300	237,800
2	Loaded HI-TRAC 125 removal from spent fuel pool (neutron tank full)	239,500	247,600	246,100
3	Loaded HI-TRAC 125 During Movement through Hatchway	236,500	244,300	243,700
1A	Loaded HI-TRAC 125D removal from spent fuel pool (neutron tank empty)	232,800	240,900	239,400
2A	Loaded HI-TRAC 125D removal from spent fuel pool (neutron tank full)	241,800	249,900	248,400
3A	Loaded HI-TRAC 125D During Movement through Hatchway	227,300	235,100	234,500
4	MPC during transfer operations	80,467	88,315	87,721
5A	Loaded HI-STORM 100 in storage (See Note 5 to Table 8.1.1)	348,990	357,088	356,244
5B	Loaded HI-STORM 100S (232) in storage (See Note 5 to Table 8.1.1)	335,500	343,600	342,800
5C	Loaded HI-STORM 100S (243) in storage (See Note 5 to Table 8.1.1)	344,500	352,600	351,800
6	Loaded HI-TRAC and transfer frame during on site handling	239,434	247,282	246,688

** 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 COMPONENTS100-TON HI-TRAC**

Component	MPC-24 (Lbs.)	MPC-32 (Lbs.)	MPC-68 (Lbs.)	Case† Applicability					
				1	2	3	4	5	6
Empty HI-STORM 100 overpack (without lid)††	245,040	245,040	245,040					1	
HI-STORM 100 lid (without rigging)	23,963	23,963	23,963					1	
Empty HI-STORM 100S (232) overpack (without lid)††	230,000	230,000	230,000					1	
Empty HI-STORM 100S (243) overpack (without lid)††	239,000	239,000	239,000					1	
HI-STORM 100S lid (without rigging)	25,500	25,500	25,500						
Empty MPC (without lid or closure ring including drain line)	29,845	24,503	29,302	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
MPC Closure Ring	145	145	145			1	1	1	1
Fuel (design basis)	40,320	53,760	47,600	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)	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 (without Top Lid, neutron shield jacket water, or bottom lids)	84,003	84,003	84,003	1	1	1			1
HI-TRAC Top Lid	1,189	1,189	1,189			1			1
HI-TRAC Pool Lid	7,863	7,863	7,863	1	1				
HI-TRAC Transfer Lid	16,686	16,686	16,686			1			1
HI-TRAC Neutron Shield Jacket Water	7,583	7,583	7,583		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.

† See Table 8.1.4 for a description of each load handling case.
†† Add an additional 1955 lbs. for the HI-STORM 100A overpack.

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 removal from spent fuel pool (neutron tank empty)	192,844	200,942	199,425
2	Loaded HI-TRAC removal from spent fuel pool (neutron tank full)	200,427	208,525	207,008
3	Loaded HI-TRAC During Movement through Hatchway	192,647	200,745	199,901
4	MPC during transfer operations	80,467	88,565	87,721
5A	Loaded HI-STORM 100 in storage (See Note 5 to Table 8.1.1)	348,990	357,088	356,244
5B	Loaded HI-STORM 100S (232) in storage (See Note 5 to Table 8.1.1)	335,500	343,600	342,700
5C	Loaded HI-STORM 100S (243) in storage (See Note 5 to Table 8.1.1)	344,500	352,600	351,700
6	Loaded HI-TRAC and transfer frame during on site handling	196,627	204,725	203,881

** 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

Fastener†	Torque (ft-lbs)††	Pattern†††
HI-TRAC Top Lid Bolts†	Hand tight	None
HI-TRAC Pool Lid Bolts (36 Bolt Lid)†	58 ft-lbs	Figure 8.1.37
HI-TRAC Pool Lid Bolts (16 Bolt Lid)†	110 ft-lbs	Figure 8.1.37
100-Ton HI-TRAC Transfer Lid Bolts†	203 ft-lbs	Figure 8.1.37
125-Ton HI-TRAC Transfer Lid Bolts†	270 ft-lbs	Figure 8.1.37
MPC Lift Cleats Stud Nuts†	793 ft-lbs	None
MPC Lift Hole Plugs†	Hand tight	None
Threaded Fuel Spacers	Hand Tight	None
HI-STORM Lid Nuts †	100 ft-lbs	None
HI-STORM 100S Lid Nuts† (Temporary and Permanent Lids)	Hand Tight +1/8 to ¼turn	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

† 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).

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

††† No detorquing pattern is needed.

Table 8.1.6
HI-STORM 100 SYSTEM ANCILLARY EQUIPMENT OPERATIONAL DESCRIPTION

Equipment	Important To Safety Classification	Reference Figure†	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 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 site-specific conditions require transfer cask or overpack handling outside drop analysis basis.	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.
Cool-Down System	Not Important To Safety	8.3.4	A closed-loop forced ventilation cooling system used to gas-cool the MPC fuel assemblies down to a temperature at which water can be introduced without the risk of uncontrolled pressure transients in the MPC due to flashing or thermally shocking the fuel assemblies. The cool-down system is attached between the MPC drain and vent ports. The cool-down system is used only for unloading operations.

† 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†	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 leakage 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 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).

† 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[†]	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 weds. 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.
Hydrostatic 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	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.

[†] 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†	Description
Deleted			
Deleted			
Mating Device	Important-To-Safety – Category B	8 1.31	Used to mate HI-TRAC 125D to HI-ST)RM 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.
MSLD (Helium Leakage Detector)	Not Important To Safety	Not shown	Used for helium leakage testing of the MPC closure welds.
Deleted			
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	Not Important To Safety	8.1.22b	Used for removal of residual moisture from the MPC following water draining.
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.

† 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.
Deleted	
Helium Mass Spectrometer Leak Detector (MSLD)	Ensures leakage rates of welds are within acceptance criteria.
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.

<u>HI-STORM 100 Overpack Lid:</u>

1. Lid studs and nuts 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.

<u>HI-STORM 100 Main Body:</u>

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.

<u>MPC Lid and Closure Ring:</u>

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.

<u>MPC Main Body:</u>

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, end plate damage, corrosion, excessive galling, damage to the locking plate, 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.

Table 8.1.10 (Continued)
HI-TRAC OVERPACK INSPECTION CHECKLIST

HI-TRAC Transfer Lid (Not used with HI-TRAC 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.

8.3 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, cool the stored fuel assemblies in the MPC, 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 methodologies 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 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 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 125D is 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 methodology as with the loading operations.

HI-TRAC and its enclosed MPC are returned to the designated preparation area and the MPC slings, MPC lift cleats and top lid are removed[1] (Box 4). 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 and a water flush is performed on the annulus. Water is fed into the annulus through the drain port and allowed to cool the MPC shell. After a predetermined period (based on the fuel conditions), cover the annulus and HI-TRAC top surfaces 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 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

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

radiation protection personnel. The MPC is cooled using the cool-down system to reduce the MPC internal temperature to allow water flooding (Box 6). The cool-down process gradually reduces the cladding temperature to a point where the MPC may be flooded with water without thermally shocking the fuel assemblies or over-pressurizing the MPC from the formation of steam (See Technical Specification LCO 3.1.3). Following the fuel cool-down, the MPC is filled with water. 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.

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. See Technical Specifications for the on-site lifting requirements.

   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.

   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 and b.

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 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 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)

9. At the user's discretion, install trim plates to cover the gap above and below the door (drawer for 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.

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.

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 Section 4.5 and Technical Specification 3.4.10 for specific time limits for transporting a loaded MPC in the HI-TRAC transfer CASK based on MPC heat loads.

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 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 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.

8.3.3 <u>Preparation for Unloading:</u>

1. Replace the pool lid with the transfer lid as follows (Not required for HI-TRAC 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. Raise and remove the HI-TRAC from the transfer slide.

k. Disconnect the MPC slings and lift cleats.

l. Deleted.

m. Deleted.

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

Warning:
Unless the lift is single-failure proof (or equivalent safety factor) 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.

3. Prepare for MPC cool-down as follows:

a. 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. Users may select the location and means of performing the annulus flush. Users may also elect the source of water and method for collecting the water flowing from the annulus. Water addition should be preformed in a slow and controlled manner until water steam generation has ceased. Water flush should be performed for a minimum of 33 hours at a flow rate of 10 GPM or as specified for the particular heat load of the MPC.

b. Perform annulus flush by injecting water into the HI-TRAC drain port and allowing the water to cool the MPC shell and lid.

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 from 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. Using the vacuum drying system, evacuated 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. Remove the drain port cover plate weld and remove the cover plate.

8. Fill the MPC cavity with water as follows:

a. Configure the cool-down system as shown on Figure 8.3.4.

b. Verify that the helium gas pressure regulator is set to the appropriate pressure.

c. Open the helium gas supply valve to purge the gas lines of air.

d. Deleted.

e. If necessary, slowly open the helium supply valve and increase the Cool-Down System pressure. Close the helium supply valve.

f. Start the gas coolers.

g. Open the vent and drain port caps using the RVOAs.

h. Start the blower and monitor the gas exit temperature. Continue the fuel cool-down operations until the gas exit temperature meets the requirements of the Technical Specification LCO 3.1.3.

Note:
Water filling should commence immediately at the completion of fuel cool-down operations to prevent fuel assembly heat-up. Prepare the water fill line and the vent line in advance of water filling.

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. Turn off the blower and disconnect the gas lines to the vent and drain port RVOAs. Attach the vent line to the MPC vent port and slowly open the vent line valve to depressurize 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. Fill the MPC until bubbling from the vent line has terminated. Close the water supply valve on completion.

Caution:
Oxidation of Boral panels and aluminum components 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. It is also recommended for defense-in-depth that the space below the MPC lid be exhausted prior to, and during MPC lid cutting operations to provide additional assurance that explosive gas mixtures will not develop in this space.

k. Disconnect both lines from the drain and vent ports and, if desired, install an exhaust line to the vent port to evacuate the head space. Perform combustible gas monitoring to ensure there is no combustible mixture present in the exhaust gases.

l. Remove the MPC lid-to-shell weld using the weld removal system. See Figure 8.1.9 for rigging.

m. Vacuum the top surfaces of the MPC and HI-TRAC to remove any metal shavings.

9. Install the inflatable annulus seal as follows:

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.

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.

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 H-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 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 Section 4.5 and Technical Specification 3.4.10 for specific time limits for transporting a loaded MPC in the HI-TRAC transfer CASK based on MPC heat loads..

1. Recover the MPC from storage and position it inside of HI-TRAC in accordance with Section 8.3.2. See the Technical Specifications for lifting requirements.

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 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 Technical Specification.

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 rıng (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.

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 125D) is installed and the MPC lift cleats are attached to the MPC. The tansfer 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 125D is not used, the HI-TRAC is configured with the transfer lid. The top lid[1] 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 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 125D, the pool lid is unbolted. The locking pins are removed and the doors are opened (or mating device drawer opened for HI-TRAC 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.

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

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 10CFR20.205 [8.5.1].

3. Remove the personnel barrier.

4. Perform removable contamination surveys in accordance with 10CFR20.205 [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.

    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 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) 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 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 <u>Perform MPC Transfer into HI-STORM 100</u>

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 Section 4.5 and Technical Specification 3.4.10 for specific time limits for transporting a loaded MPC in the HI-TRAC transfer CASK based on MPC heat loads.

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 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.

8. Place HI-STORM in storage in accordance with the steps provided in Section 8.1.

9. Perform shielding effectiveness testing in accordance with the HI-STORM 100 System Technical Specification LCO 3.2.3.

10. Perform an air temperature rise test per Step 8.1.7.22 if required by the Technical Specifications.

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.

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 technical specifications in Appendix A to CoC 72-1014 and, if necessary, average dose rates computed for comparison against the prescribed limits. The results of the dose rate measurements shall be compared to the limits specified in the technical specifications. The test is considered acceptable if the dose rate readings are less than or equal to limits in the technical specifications. If dose rates are higher than the limits, the required actions provided in the technical specifications shall be completed. Dose rate measurements shall be documented and shall become part of the quality documentation package.~~

9.1.5.3 Neutron Absorber Tests

Each plate of ~~Boral~~ *neutron absorber* shall be visually inspected by the manufacturer for damage (e.g., scratches, cracks, burrs, and peeled cladding, *as applicable*) and foreign material embedded in the surfaces. In addition, the MPC fabricator shall visually inspect the ~~Boral~~ *neutron absorber* plates on a lot sampling basis. The sample size shall be determined in accordance with MIL-STD-105D or equivalent. The selected *neutron absorber* ~~Boral~~ plates shall be inspected for damage such as inclusions, cracks, voids, delamination, and surface finish, *as applicable.*

After manufacturing, a statistical sample of each lot of *neutron absorber* ~~Boral~~ shall be tested using *a proven method, such as* wet chemistry, *spectragraphy,* ~~and/~~or neutron attenuation *testing* ~~techniques~~ to verify a minimum ^{10}B content (areal density) at the ends of the panel. The minimum ^{10}B loading of the *neutron absorber* ~~Boral~~ panels for each MPC model is provided in Table 2.1.15. Any panel in which ^{10}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.

Installation of *neutron absorber*~~Boral~~ 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*~~Boral~~ panel in accordance with the drawings in Chapter 1. These quality control processes, in conjunction with ~~Boral~~ *in-process* manufacturing testing, provide the necessary assurances that the *neutron absorber*~~Boral~~ will perform its intended function. No additional testing or in-service monitoring of the *neutron absorber material* ~~Boral~~ 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 the Design Drawings in Chapter 1.

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 ~~five~~*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 has a transfer step and other auxiliary shielding devices which eliminates streaming paths and simplify operations;
- The pool lid maximizes available fuel assembly water coverage in the spent fuel pool.
- The transfer lid is 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 ~~42,500~~*46,000* MWD/MTU and cooling of ~~5~~*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 ~~57,500~~*75,000* MWD/MTU and cooling of ~~12~~*5* years including BPRAs. The dose rates around the HI-STORM 100 overpack are based on 24 PWR fuel assemblies with a burnup of ~~52~~*47*,500 MWD/MTU and cooling of ~~5~~*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. 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 and 125-ton HI-TRACs were used in conjunction with the very conservative burnup and cooling time for the HI-STORM 100 overpack (as discussed in Section 5.1). 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 both the HI-STORM 100 Overpack and the HI-STORM 100s Overpack. 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 steps 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 125-ton 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 125-ton 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 and the 100-ton HI-TRAC transfer cask, respectively.

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 the maximum occupational exposure required for security surveillance and maintenance of an ISFSI. Although the HI-STORM 100 System requires only minimal maintenance during storage, 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. Security surveillance time is based on a daily security patrol around the perimeter of the ISFSI security fence. The estimated dose rates described below are based on a sample array of HI-STORM 100 overpacks fully loaded with design basis fuel assemblies, placed at their minimum required pitch, in a 2 x 6 HI-STORM array. The maintenance worker is assumed to be at a distance of 5 meters from the center of the long edge of the array. The security worker is assumed to be at a distance of 15 meters from the center of the long edge of the array. 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, a dose rate of 3 mrem/hour is estimated. For maintenance of the casks and the ISFSI, 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† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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	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
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 @ 1/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 @ 1 BOLT/PERSON MINUTES
MEASURE DOSE RATES AT MPC LID	3	5A	1	*37 3*	*1.9*	*1 9*	TELESCOPING DETECTOR USED

† 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† (~~57,500~~*75,000* MWD/MTU, ~~12~~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/PRERSON-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

Table 10.3.1a

HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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
CONNECT MSLD SNIFFER TO AUTOMATED WELDING SYSTEM	4	8A	1	*37.9*	*2.5*	*2.5*	SIMPLE ATTACHMENT NO TOOLS
DISCONNECT MSLD SNIFFER FROM AUTOMATED WELDING SYSTEM	4	8A	1	*37.9*	*2.5*	*2.5*	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
ATTACHM 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)

Table 10.3.1a
HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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 NDE ON VENT AND DRAIN COVER PLATE WELD	100	8A	1	37.9	63.2	63.2	MEASURED DURING WELD MOCKUP TESTING
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
Section 8.1.6							
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
Section 8.1.7							
POSITION HI-TRAC ON TRANSPORT DEVICE	20	11A	2	117.8	39.3	78.5	ALIGN TRUNNIONS, DISCONNECT LIFT YOKE

Table 10.3.1a
HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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
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 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	362.5	60.4	60.4	4 BOLTS,NO TORQUING
INSTALL HOLE PLUGS IN EMPTY MPC BOLT HOLES	2	14A	1	362.5	12.1	12.1	4 PLUGS AT 2/MIN NO TORQUING
REMOVE HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	45.5	1.5	1.5	4 SHACKLES@2/MIN
REMOVE ALIGNMENT DEVICE	4	15A	1	45.5	3.0	3.0	REMOVED BY HAND NO TOOLS (4 PCS@1/MIN)
INSTALL HI-STORM LID AND INSTALL LID STUDS/NUTS	25	16A	2	7.3	3.1	6.1	INSTALL LID AND HYDRO TORQUE 4 BOLTS
INSTALL HI-STORM EXIT VENT GAMMA SHIELD CROSS PLATES	4	16B	1	73.9	4.9	4.9	4 PCS @ 1/MIN INSTALL BY HAND NO TOOLS
INSTALL TEMPERATURE ELEMENTS	20	16B	1	73.9	24.6	24.6	4@5MIN/TEMPERATURE ELEMENT
INSTALL EXIT VENT SCREENS	20	16B	1	73.9	24.6	24.6	4 SCREENS@5MIN/SCREEN
REMOVE HI-STORM LID LIFTING DEVICE	2	16A	1	7.3	0.2	0.2	4 SHACKLES@2/MIN
INSTALL HOLE PLUGS IN EMPTY HOLES	2	16A	1	7.3	0.2	0.2	4 PLUGS AT 2/MIN NO TORQUING
PERFORM SHIELDING EFFECTIVENESS TESTING	16	16D	2	43.8	11.7	23.3	16 POINTS@1 MIN
SECURE HI-STORM TO TRANSPORT DEVICE	10	16A	2	7.3	1.2	2.4	ASSUMES AIR PAD
TRANSFER HI-STORM TO ITS DESIGNATED STORAGE LOCATION	40	16C	1	25.5	17.0	17.0	200 FEET @ 4FT/MIN
INSERT HI-STORM LIFTING JACKS	4	16D	1	43.8	2.9	2.9	4 JACKS@1/MIN
REMOVE AIR PAD	5	16D	2	43.8	3.6	7.3	1 PAD MOVED BY HAND

Table 10.3.1a
HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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 HI-STORM LIFTING JACKS	4	16D	1	*43 8*	*2.9*	*2.9*	4 JACKS@1/MIN
INSTALL INLET VENT SCREENS/CROSS PLATES	20	16D	1	*43.8*	*14.6*	*14 6*	4 SCREENS@5MIN/SCREEN
PERFORM AIR TEMPERATURE RISE TEST	8	16B	1	*73 9*	*9 8*	*9.8*	8 MEASUREMENTS@1/MIN
TOTAL						~~796.0~~ *1804.8* PERSON-MREM	

Table 10.3.1b
HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~42,500~~*46,000* MWD/MTU, ~~5~~*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
				Section 8.1.4			
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
				Section 8.1.5			
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	*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	*76 3*	*7.6*	*15 3*	24 BOLTS @ 1/PERSON-MINUTE
REMOVE HI-TRAC FROM SPENT FUEL POOL	8.5	3C	1	*663.4*	*94 0*	*94.0*	17 FEET @ 2 FT/MIN (CRANE SPEED)
DECONTAMINATE HI-TRAC BOTTOM	10	3D	1	*432.5*	*72 1*	*72.1*	LONG HANDLED TOOLS, PRELIMINARY DECON
TAKE SMEARS OF HI-TRAC EXTERIOR SURFACES	5	5B	1	*919 1*	*76 6*	*76 6*	50 SMEARS @ 10 SMEARS/MINUTE
DISCONNECT ANNULUS OVERPRESSURE SYSTEM	0.5	5C	1	*241.8*	*2 0*	*2.0*	QUICK DISCONNECT COUPLING
SET HI-TRAC IN CASK PREPARATION AREA	10	4A	1	*76 3*	*12 7*	*12 7*	100 FT @ 10 FT/MIN (CRANE SPEED)
REMOVE NEUTRON SHIELD JACKET FILL PLUG	2	4A	1	*76.3*	*2 5*	*2.5*	SINGLE PLUG, NO SPECIAL TOOLS
INSTALL NEUTRON SHIELD JACKET FILL PLUG	2	5B	1	*919.1*	*30 6*	*30.6*	SINGLE PLUG, NO SPECIAL TOOLS

† 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† (~~42,500~~*46,000* MWD/MTU, ~~5~~*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
DISCONNECT LID RETENTION SYSTEM	6	5A	2	*62.5*	*6.3*	*12.5*	24 BOLTS @ 1 BOLT/PERSON MINUTES
MEASURE DOSE RATES AT MPC LID	3	5A	1	*62.5*	*3.1*	*3.1*	TELESCOPING DETECTOR USED
DECONTAMINATE AND SURVEY HI-TRAC	103	5B	1	*919.1*	*1577.8*	*1577.8*	490 SQ-FT@5 SQ-FT/PRERSON-MINUTE+50 SMEARS@10 SMEARS/MINUTE
INSTALL TEMPORARY SHIELD	16	6A	2	*31.3*	*8.3*	*16.7*	8 SEGMENTS @ 1 SEGMENT/PERSON MIN
FILL TEMPORARY SHIELD RING	25	6A	1	*31.3*	*13.0*	*13.0*	230 GAL @10GPM, LONG HANDLED SPRAY WAND
ATTACH DRAIN LINE TO HI-TRAC DRAIN PORT	0.5	5C	1	*241.8*	*2.0*	*2.0*	QUICK DISCONNECT COUPLING
INSTALL RVOAs	2	6A	1	*31.3*	*1.0*	*1.0*	SINGLE THREADED CONNECTION X 2 RVOAs
ATTACH WATER PUMP TO DRAIN PORT	2	6A	1	*31.3*	*1.0*	*1.0*	POSITION PUMP SELF PRIMING
DISCONNECT WATER PUMP	5	6A	1	*31.3*	*2.6*	*2.6*	DRAIN HOSES MOVE PUMP
DECONTAMINATE MPC LID TOP SURFACE AND SHELL AREA ABOVE INFLATABLE ANNULUS SEAL	6	6A	1	*31.3*	*3.1*	*3.1*	30 SQ-FT @5 SQ-FT/MINUTE+10 SMEARS@10 SMEARS/MINUTE
REMOVE INFLATABLE ANNULUS SEAL	3	6A	1	*31.3*	*1.6*	*1.6*	SEAL PULLS OUT DIRECTLY
SURVEY MPC LID TOP SURFACES AND ACCESSIBLE AREAS OF TOP THREE INCHES OF MPC SHELL	1	6A	1	*31.3*	*0.5*	*0.5*	10 SMEARS@10 SMEARS/MINUTE
INSTALL ANNULUS SHIELD	2	6A	1	*31.3*	*1.0*	*1.0*	SHIELD PLACED BY HAND
CENTER LID IN MPC SHELL	20	6A	3	*31.3*	*10.4*	*31.3*	CONSULTATION WITH CALVERT CLIFFS
INSTALL MPC LID SHIMS	12	6A	2	*31.3*	*6.3*	*12.5*	MEASURED DURING WELD MOCKUP TESTING
POSITION AWS BASEPLATE SHIELD ON MPC LID	20	7A	2	*31.3*	*10.4*	*20.9*	ALIGN AND REMOVE 4 SHACKLES

Table 10.3.1b

HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~42,500~~*46,000* MWD/MTU, ~~5~~*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 AUTOMATED WELDING SYSTEM ROBOT	8	7A	2	*31.3*	*4.2*	*8.3*	ALIGN AND REMOVE 4 SHACKLES/4 QUICK CONNECTS@1/MIN
PERFORM NDE ON LID WELD	230	7A	1	*31.3*	*120.0*	*120.0*	MEASURED DURING WELD MOCKUP TESTING
ATTACH DRAIN LINE TO VENT PORT	1	7A	1	*31.3*	*0.5*	*0.5*	1" THREADED FITTING NO TOOLS
VISUALLY EXAMINE MPC LID-TO-SHELL WELD FOR LEAKAGE OF WATER	10	7A	1	*31.3*	*5.2*	*5.2*	10 MIN TEST DURATION
DISCONNECT WATER FILL LINE AND DRAIN LINE	2	7A	1	*31.3*	*1.0*	*1.0*	1" THREADED FITTING NO TOOLS X 2
REPEAT LIQUID PENETRANT EXAMINATION ON MPC LID FINAL PASS	45	7A	1	*31.3*	*23.5*	*23.5*	5 MIN TO APPLY, 7 MIN TO WIPE, 5 APPLY DEV, INSP (24 IN/MIN)
ATTACH GAS SUPPLY TO VENT PORT	1	7A	1	*31.3*	*0.5*	*0.5*	1" THREADED FITTING NO TOOLS
ATTACH DRAIN LINE TO DRAIN PORT	1	7A	1	*31.3*	*0.5*	*0.5*	1" THREADED FITTING NO TOOLS
CONNECT MSLD SNIFFER TO AUTOMATED WELDING SYSTEM	4	8A	1	*60.0*	*4.0*	*4.0*	SIMPLE ATTACHMENT NO TOOLS
DISCONNECT MSLD SNIFFER FROM AUTOMATED WELDING SYSTEM	4	8A	1	*60.0*	*4.0*	*4.0*	SIMPLE ATTACHMENT NO TOOLS
ATTACH DRAIN LINE TO VENT PORT	1	8A	1	*60.0*	*1.0*	*1.0*	1" THREADED FITTING NO TOOLS
ATTACH WATER FILL LINE TO DRAIN PORT	1	8A	1	*60.0*	*1.0*	*1.0*	1" THREADED FITTING NO TOOLS
DISCONNECT WATER FILL DRAIN LINES FROM MPC	2	8A	1	*60.0*	*2.0*	*2.0*	1" THREADED FITTING NO TOOLS X 2
ATTACH HELIUM SUPPLY TO VENT PORT	1	8A	1	*60.0*	*1.0*	*1.0*	1" THREADED FITTING NO TOOLS
ATTACH DRAIN LINE TO DRAIN PORT	1	8A	1	*60.0*	*1.0*	*1.0*	1" THREADED FITTING NO TOOLS
DISCONNECT GAS SUPPLY LINE FROM MPC	1	8A	1	*60.0*	*1.0*	*1.0*	1" THREADED FITTING NO TOOLS

Table 10.3.1b
HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~42,500~~*46,000* MWD/MTU, ~~5~~*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
DISCONNECT DRAIN LINE FROM MPC	1	8A	1	60.0	1.0	1.0	1" THREADED FITTING NO TOOLS
ATTACH MOISTURE REMOVAL SYSTEM () TO VENT AND DRAIN PORT RVOAs	2	8A	1	60.0	2.0	2.0	1" THREADED FITTING NO TOOLS
DISCONNECT MOISTURE REMOVAL SYSTEM FROM MPC	2	8A	1	60.0	2.0	2.0	1" THREADED FITTING NO TOOLS X 2
CLOSE DRAIN PORT RVOA CAP AND REMOVE DRAIN PORT RVOA	1.5	8A	1	60.0	1.5	1.5	SINGLE THREADED CONNECTION (1 RVOA)
ATTACH HELIUM BACKFILL SYSTEM TO VENT PORT	1	8A	1	60.0	1.0	1.0	1" THREADED FITTING NO TOOLS
DISCONNECT HBS FROM MPC	1	8A	1	60.0	1.0	1.0	1" THREADED FITTING NO TOOLS
CLOSE VENT PORT RVOA AND DISCONNECT VENT PORT RVOA	1.5	8A	1	60.0	1.5	1.5	SINGLE THREADED CONNECTION (1 RVOA)
WIPE INSIDE AREA OF VENT AND DRAIN PORT RECESSES	2	8A	1	60.0	2.0	2.0	2 PORTS, 1 MIN/PORT
PLACE COVER PLATE OVER VENT PORT RECESS	1	8A	1	60.0	1.0	1.0	INSTALLED BY HAND NO TOOLS (2/MIN)
PERFORM NDE VENT AND DRAIN COVER PLATE WELD	100	8A	1	60.0	100.0	100.0	MEASURED DURING WELD MOCKUP TESTING
FLUSH CAVITY WITH HELIUM AND INSTALL SET SCREWS	2	8A	1	60.0	2.0	2.0	4 SET SCREWS @2/MINUTE
PLUG WELD OVER ET SCREWS	8	8A	1	60.0	8.0	8.0	FOUR SINGLE SPOT WELDS @ 1 PER 2 MINTES
INSTALL MSLD OVER VENT PORT COVER PLATE	2	8A	1	60.0	2.0	2.0	INSTALLED BY HAND NO TOOLS
INSTALL MSLD OVER DRAIN PORT COVER PLATE	2	8A	1	60.0	2.0	2.0	INSTALLED BY HAND NO TOOLS
INSTALL AND ALIGN CLOSURE RING	5	8A	1	60.0	5.0	5.0	INSTALLED BY HAND NO TOOLS
PERFORM NDE ON CLOSURE RING WELDS	185	8A	1	60.0	185.0	185.0	MEASURED DURING WELD MOCKUP TESTING
RIG AWS TO CRANE	12	8A	1	60.0	12.0	12.0	10 MIN TO DISCONNECT LINES, 4 SHACKLES@2/MIN
Section 8.1.6							
REMOVE ANNULUS SHIELD	1	8A	1	60.0	1.0	1.0	SHIELD PLACED BY HAND

Table 10.3.1b
HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES[†] (~~42,500~~*46,000* MWD/MTU, ~~5~~*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 HI-TRAC	1	9D	1	*1806 3*	*30.1*	*30 1*	1" THREADED FITTING NO TOOLS
POSITION HI-TRAC TOP LID	10	9B	2	*60 0*	*10 0*	*20.0*	VERTICAL FLANGED CONNECTION
TORQUE TOP LID BOLTS	12	9B	1	*60 0*	*12.0*	*12 0*	24 BOLTS AT 2/MIN (INSTALL AND TORQUE,1 PASS)
INSTALL MPC LIFT CLEATS AND MPC SLINGS	25	9A	2	*247.7*	*103.2*	*206 4*	INSTALL CLEATS AND HYDRO TORQUE 4 BOLTS
REMOVE TEMPORARY SHIELD RING DRAIN PLUGS	1	9B	1	*60 0*	*1 0*	*1.0*	8 PLUGS @ 8/MIN
REMOVE TEMPORARY SHIELD RING SEGMENTS	4	9A	1	*247.7*	*16 5*	*16 5*	REMOVED BY HAND NO TOOLS (8 SEGS@2/MIN)
ATTACH MPC SLINGS TO LIFT YOKE	4	9A	2	*247.7*	*16 5*	*33 0*	INSTALLED BY HAND NO TOOLS
POSITION HI-TRAC ABOVE TRANSFER STEP	15	9C	1	*740 6*	*185.2*	*185 2*	100 FT @ 10 FT/MIN (CRANE SPEED)+ 5MIN TO ALIGN
REMOVE BOTTOM LID BOLTS	6	10A	1	*1806 3*	*180 6*	*180 6*	36 BOLTS@6 BOLTS/MIN IMPACT TOOLS USED
INSTALL TRANSFER LID BOLTS	18	11B	1	*1806 3*	*541 9*	*541.9*	36 BOLTS @ 2/MIN IMPACT TOOLS USED 1 PASS
DISCONNECT MPC SLINGS	4	9A	2	*247.7*	*16 5*	*33 0*	INSTALLED BY HAND NO TOOLS
Section 8.1.7							
POSITION HI-TRAC ON TRANSPORT DEVICE	20	11A	2	*740 6*	*246 9*	*493 7*	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	*561 8*	*93.6*	*187 3*	ALIGNMENT GUIDES USED
ATTACH MPC SLINGS TO MPC LIFT CLEATS	10	13A	2	*247 7*	*41.3*	*82.6*	2 SLINGS@5MIN/SLING NO TOOLS
REMOVE TRANSFER LID DOOR LOCKING PINS AND OPEN DOORS	4	13B	2	*561 8*	*37 5*	*74 9*	2 PINS@2MIN/PIN
INSTALL TRIM PLATES	4	13B	2	*561 8*	*37 5*	*74 9*	INSTALLED BY HAND
DISCONNECT SLINGS FROM MPC LIFTING DEVICE	10	13A	2	*247.7*	*41 3*	*82 6*	2 SLINGS@5MIN/SLING
REMOVE MPC LIFT CLEATS AND MPC SLINGS	10	14A	1	*362 5*	*60 4*	*60.4*	4 BOLTS,NO TORQUING

Table 10.3.1b
HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~42,500~~46,000 MWD/MTU, ~~5~~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 HOLE PLUGS IN EMPTY MPC BOLT HOLES	2	14A	1	362.5	12.1	12.1	4 PLUGS AT 2/MIN NO TORQUING
REMOVE HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	45.5	1.5	1.5	4 SHACKLES@2/MIN
REMOVE ALIGNMENT DEVICE	4	15A	1	45.5	3.0	3.0	REMOVED BY HAND NO TOOLS (4 PCS@1/MIN)
INSTALL HI-STORM LID AND INSTALL LID STUDS/NUTS	25	16A	2	7.3	3.1	6.1	INSTALL LID AND HYDRO TORQUE 4 BOLTS
INSTALL HI-STORM EXIT VENT GAMMA SHIELD CROSS PLATES	4	16B	1	73.9	4.9	4.9	4 PCS @ 1/MIN INSTALL BY HAND NO TOOLS
INSTALL TEMPERATURE ELEMENTS	20	16B	1	73.9	24.6	24.6	4@5MIN/TEMPERATURE ELEMENT
INSTALL EXIT VENT SCREENS	20	16B	1	73.9	24.6	24.6	4 SCREENS@5MIN/SCREEN
REMOVE HI-STORM LID LIFTING DEVICE	2	16A	1	7.3	0.2	0.2	4 SHACKLES@2/MIN
INSTALL HOLE PLUGS IN EMPTY HOLES	2	16A	1	7.3	0.2	0.2	4 PLUGS AT 2/MIN NO TORQUING
PERFORM SHIELDING EFFECTIVENESS TESTING	16	16D	2	43.8	11.7	23.3	16 POINTS@1 MIN
SECURE HI-STORM TO TRANSPORT DEVICE	10	16A	2	7.3	1.2	2.4	ASSUMES AIR PAD
TRANSFER HI-STORM TO ITS DESIGNATED STORAGE LOCATION	40	16C	1	25.5	17.0	17.0	200 FEET @ 4FT/MIN
INSERT HI-STORM LIFTING JACKS	4	16D	1	43.8	2.9	2.9	4 JACKS@1/MIN
REMOVE AIR PAD	5	16D	2	43.8	3.6	7.3	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	43.8	2.9	2.9	4 JACKS@1/MIN
INSTALL INLET VENT SCREENS/CROSS PLATES	20	16D	1	43.8	14.6	14.6	4 SCREENS@5MIN/SCREEN
PERFORM AIR TEMPERATURE RISE TEST	8	16B	1	73.9	9.8	9.8	8 MEASUREMENTS@1/MIN
TOTAL						~~2755.0~~5222.8 PERSON-MREM	

Table 10.3.1c
HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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 @ 1/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

† See notes at bottom of Table 10.3.4.

Table 10.3.1c
HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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
DISCONNECT LID RETENTION SYSTEM	6	5A	2	37.3	3 7	7.5	24 BOLTS @ 1 BOLT/PERSON MINUTES
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/PRERSON-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

Table 10.3.1c

HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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 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
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
CONNECT MSLD SNIFFER TO AUTOMATED WELDING SYSTEM	4	8A	1	*37.9*	*2.5*	*2.5*	SIMPLE ATTACHMENT NO TOOLS
DISCONNECT MSLD SNIFFER FROM AUTOMATED WELDING SYSTEM	4	8A	1	*37.9*	*2.5*	*2.5*	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

Table 10.3.1c
HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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 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
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 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

Table 10.3.1c
HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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 8.1.6							
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
Section 8.1.7							
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	*362.5*	*60.4*	*60.4*	4 BOLTS,NO TORQUING

Table 10.3.1c
HI-STORM 100 SYSTEM LOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES[†] (~~57,500~~75,000 MWD/MTU, ~~1~~25-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 HOLE PLUGS IN EMPTY MPC BOLT HOLES	2	14A	1	362.5	12 1	12 1	4 PLUGS AT 2/MIN NO TORQUING
REMOVE HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	45.5	1 5	1 5	4 SHACKLES@2/MIN
REMOVE MATING DEVICE	10	15A	1	45 5	7 6	7 6	3 BOLTS @ 2 MINUTES PER BOLT
INSTALL HI-STORM LID AND INSTALL LID STUDS/NUTS	25	16A	2	7.3	3.1	6 1	INSTALL LID AND HYDRO TORQUE 4 BOLTS
INSTALL HI-STORM EXIT VENT GAMMA SHIELD CROSS PLATES	4	16B	1	73 9	4 9	4.9	4 PCS @ 1/MIN INSTALL BY HAND NO TOOLS
INSTALL TEMPERATURE ELEMENTS	20	16B	1	73 9	24.6	24 6	4@5MIN/TEMPERATURE ELEMENT
INSTALL EXIT VENT SCREENS	20	16B	1	73 9	24.6	24 6	4 SCREENS@5MIN/SCREEN
REMOVE HI-STORM LID LIFTING DEVICE	2	16A	1	7.3	0 2	0 2	4 SHACKLES@2/MIN
INSTALL HOLE PLUGS IN EMPTY HOLES	2	16A	1	7.3	0 2	0.2	4 PLUGS AT 2/MIN NO TORQUING
PERFORM SHIELDING EFFECTIVENESS TESTING	16	16D	2	43 8	11 7	23.3	16 POINTS@1 MIN
SECURE HI-STORM TO TRANSPORT DEVICE	10	16A	2	7.3	1 2	2 4	ASSUMES AIR PAD
TRANSFER HI-STORM TO ITS DESIGNATED STORAGE LOCATION	40	16C	1	25 5	17.0	17 0	200 FEET @ 4FT/MIN
INSERT HI-STORM LIFTING JACKS	4	16D	1	43.8	2.9	2 9	4 JACKS@1/MIN
REMOVE AIR PAD	5	16D	2	43 8	3 6	7.3	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	43 8	2 9	2.9	4 JACKS@1/MIN
INSTALL INLET VENT SCREENS/CROSS PLATES	20	16D	1	43 8	14 6	14 6	4 SCREENS@5MIN/SCREEN
PERFORM AIR TEMPERATURE RISE TEST	8	16B	1	73.9	9 8	9.8	8 MEASUREMENTS@1/MIN
TOTAL							~~779.3~~1759.3 PERSON-MREM

Table 10.3.2a HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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	*43.8*	*14 6*	*14 6*	4 SCREENS@5MIN/SCREEN
INSERT HI-STORM LIFTING JACKS	4	16D	1	*43 8*	*2 9*	*2.9*	4 JACKS@1/MIN
INSERT AIR PAD	5	16D	2	*43.8*	*3 6*	*7 3*	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	*43 8*	*2 9*	*2.9*	4 JACKS@1/MIN
TRANSFER HI-STORM TO MPC TRANSFER LOCATION	40	16C	1	*25 5*	*17.0*	*17 0*	200 FEET @ 4FT/MIN
REMOVE HI-STORM LID STUDS/NUTS	10	16A	1	*7 3*	*1.2*	*1 2*	4 BOLTS NO TORQUE
REMOVE HI-STORM LID LIFTING HOLE PLUGS AND INSTALL LID LIFTING SLING	2	16A	1	*7.3*	*0 2*	*0.2*	4 PLUGS AT 2/MIN NO TORQUING
REMOVE GAMMA SHIELD CROSS PLATES	4	16B	1	*73 9*	*4 9*	*4.9*	4 PLATES@1/MIN
REMOVE TEMPERATURE ELEMENTS	8	16B	1	*73 9*	*9 8*	*9.8*	4 TEMP. ELEMENTS @ 2MIN/TEMP. ELEMENT NO TORQUE
REMOVE HI-STORM LID	2	16A	1	*7 3*	*0.2*	*0 2*	4 SHACKLES@2/MIN
INSTALL HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	*45.5*	*1.5*	*1.5*	4 SHACKLES@2/MIN
INSTALL ALIGNMENT DEVICE	4	15A	1	*45 5*	*3 0*	*3 0*	REMOVED BY HAND NO TOOLS (4 PCS@1/MIN)
REMOVE MPC LIFT CLEAT HOLE PLUGS	2	14A	1	*362.5*	*12 1*	*12.1*	4 PLUGS AT 2/MIN NO TORQUING
INSTALL MPC LIFT CLEATS AND MPC SLINGS	2	14A	1	*362 5*	*12 1*	*12.1*	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

† 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† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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
Section 8.3.3							
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

Table 10.3.2a
HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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 COOL-DOWN SYSTEM TO RVOAs	2	8A	1	*37 9*	*1 3*	*1.3*	1" THREADED FITTING NO TOOLS X 2
DISCONNECT GAS 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)

Table 10.3.2a

HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 125-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~1~~25-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
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
TOTAL						~~380.08~~*809.5* PERSON-MREM	

Table 10.3.2b
HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~42,500~~*46,000* MWD/MTU, ~~5~~*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
Section 8.3.2 (Step Sequence Varies By Site and Mode of Transport)							
REMOVE INLET VENT SCREENS	20	16D	1	*43.8*	*14.6*	*14.6*	4 SCREENS@5MIN/SCREEN
INSERT HI-STORM LIFTING JACKS	4	16D	1	*43.8*	*2.9*	*2.9*	4 JACKS@1/MIN
INSERT AIR PAD	5	16D	2	*43.8*	*3.6*	*7.3*	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	*43.8*	*2.9*	*2.9*	4 JACKS@1/MIN
TRANSFER HI-STORM TO MPC TRANSFER LOCATION	40	16C	1	*25.5*	*17.0*	*17.0*	200 FEET @ 4FT/MIN
REMOVE HI-STORM LID STUDS/NUTS	10	16A	1	*7.3*	*1.2*	*1.2*	4 BOLTS NO TORQUE
REMOVE HI-STORM LID LIFTING HOLE PLUGS AND INSTALL LID LIFTING SLING	2	16A	1	*7.3*	*0.2*	*0.2*	4 PLUGS AT 2/MIN NO TORQUING
REMOVE GAMMA SHIELD CROSS PLATES	4	16B	1	*73.9*	*4.9*	*4.9*	4 PLATES@1/MIN
REMOVE TEMPERATURE ELEMENTS	8	16B	1	*73.9*	*9.8*	*9.8*	4 TEMP. ELEMENTS @ 2MIN/TEMP. ELEMENT NO TORQUE
REMOVE HI-STORM LID	2	16A	1	*7.3*	*0.2*	*0.2*	4 SHACKLES@2/MIN
INSTALL HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	*45.5*	*1.5*	*1.5*	4 SHACKLES@2/MIN
INSTALL ALIGNMENT DEVICE	4	15A	1	*45.5*	*3.0*	*3.0*	REMOVED BY HAND NO TOOLS (4 PCS@1/MIN)
REMOVE MPC LIFT CLEAT HOLE PLUGS	2	14A	1	*362.5*	*12.1*	*12.1*	4 PLUGS AT 2/MIN NO TORQUING
INSTALL MPC LIFT CLEATS AND MPC SLINGS	2	14A	1	*362.5*	*12.1*	*12.1*	4 PLUGS AT 2/MIN NO TORQUING
ALIGN HI-TRAC OVER HI-STORM AND MATE OVERPACKS	10	13B	2	*561.8*	*93.6*	*187.3*	ALIGNMENT GUIDES USED
PULL MPC SLINGS THROUGH TOP LID HOLE	10	13A	2	*247.7*	*41.3*	*82.6*	2 SLINGS@5MIN/SLING
INSTALL TRIM PLATES	4	13B	2	*561.8*	*37.5*	*74.9*	INSTALLED BY HAND NO FASTENERS

† 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† (~~42,500~~*46,000* MWD/MTU, ~~5~~*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	*247.7*	*41.3*	*41.3*	2 SLINGS@5MIN/SLING NO BOLTING
CLOSE HI-TRAC DOORS AND INSTALL DOOR LOCKING PINS	4	13B	2	*561.8*	*37.5*	*74.9*	2 PINS@2MIN/PIN
DISCONNECT SLINGS FROM MPC LIFT CLEATS	10	13A	2	*247.7*	*41.3*	*82.6*	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
Section 8.3.3							
MOVE HI-TRAC TO TRANSFER SLIDE	20	11A	2	*740.6*	*246.9*	*493.7*	ALIGN TRUNNIONS, DISCONNECT LIFT YOKE
ATTACH MPC SLINGS	4	9A	2	*247.7*	*16.5*	*33.0*	INSTALLED BY HAND NO TOOLS
REMOVE TRANSFER LID BOLTS	6	11B	1	*1806.3*	*180.6*	*180.6*	36 BOLTS@6 BOLTS/MIN IMPACT TOOLS USED
INSTALL POOL LID BOLTS	18	10A	1	*1806.3*	*541.9*	*541.9*	36 BOLTS @ 2/MIN IMPACT TOOLS USED 1 PASS
DISCONNECT MPC SLINGS AND LIFT CLEATS	10	9A	1	*247.7*	*41.3*	*41.3*	4 BOLTS,NO TORQUING
PLACE HI-TRAC IN PREPARATION AREA	15	9C	1	*740.6*	*185.2*	*185.2*	100 FT @ 10 FT/MIN (CRANE SPEED)+ 5MIN TO ALIGN
REMOVE TOP LID BOLTS	6	9B	1	*60.0*	*6.0*	*6.0*	24 BOLTS AT 4/MIN (NO TORQUE IMPACT TOOLS)
REMOVE HI-TRAC TOP LID	2	6A	1	*31.3*	*1.0*	*1.0*	4 SHACKLES@2/MIN
ATTACH WATER FILL LINE TO HI-TRAC DRAIN PORT	0.5	9D	1	*1806.3*	*15.1*	*15.1*	QUICK DISCONNECT NO TOOLS
INSTALL BOLT PLUGS OR WATERPROOF TAPE FROM HI-TRAC TOP BOLT HOLES	9	8A	1	*60.0*	*9.0*	*9.0*	18 HOLES@2/MIN
CORE DRILL CLOSURE RING AND VENT AND DRAIN PORT COVER PLATES	40	7A	2	*31.3*	*20.9*	*41.7*	20 MINUTES TO INSTALL/ALIGN +10 MIN/COVER

Table 10.3.2b
HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~42,500~~*46,000* MWD/MTU, ~~5~~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	*60.0*	*1.0*	*1.0*	2 COVERS@2/MIN NO TOOLS
ATTACH RVOAS	2	8A	1	*60.0*	*2.0*	*2.0*	SINGLE THREADED CONNECTION (1 RVOA)
ATTACH A SAMPLE BOTTLE TO VENT PORT RVOA	0.5	8A	1	*60.0*	*0.5*	*0.5*	1" THREADED FITTING NO TOOLS
GATHER A GAS SAMPLE FROM MPC	0.5	8A	1	*60.0*	*0.5*	*0.5*	SMALL BALL VALVE
CLOSE VENT PORT CAP AND DISCONNECT SAMPLE BOTTLE	1	8A	1	*60.0*	*1.0*	*1.0*	1" THREADED FITTING NO TOOLS
ATTACH COOL-DOWN SYSTEM TO RVOAs	2	8A	1	*60.0*	*2.0*	*2.0*	1" THREADED FITTING NO TOOLS X 2
DISCONNECT GAS LINES TO VENT AND DRAIN PORT RVOAs	1	8A	1	*60.0*	*1.0*	*1.0*	1" THREADED FITTING NO TOOLS
VACUUM TOP SURFACES OF MPC AND HI-TRAC	10	6A	1	*31.3*	*5.2*	*5.2*	SHOP VACUUM WITH WAND + HAND WIPE
REMOVE ANNULUS SHIELD	1	8A	1	*60.0*	*1.0*	*1.0*	SHIELD PLACED BY HAND
MANUALLY INSTALL INFLATABLE SEAL	10	6A	2	*31.3*	*5.2*	*10.4*	CONSULTATION WITH CALVERT CLIFFS
OPEN NEUTRON SHIELD JACKET DRAIN VALVE	2	5C	1	*241.8*	*8.1*	*8.1*	SINGLE THREADED CONNECTION
CLOSE NEUTRON SHIELD JACKET DRAIN VALVE	2	5C	1	*241.8*	*8.1*	*8.1*	SINGLE THREADED CONNECTION
REMOVE MPC LID LIFTING HOLE PLUGS	2	5A	1	*62.5*	*2.1*	*2.1*	4 PLUGS AT 2/MIN NO TORQUING
ATTACH LID RETENTION SYSTEM	12	5A	1	*62.5*	*12.5*	*12.5*	24 BOLTS @ 2 MINUTES/BOLT
ATTACH ANNULUS OVERPRESSURE SYSTEM	0.5	5C	1	*241.8*	*2.0*	*2.0*	QUICK DISCONNECT NO TOOLS
POSITION HI-TRAC OVER CASK LOADING AREA	10	5C	1	*241.8*	*40.3*	*40.3*	100 FT @ 10 FT/MIN (CRANE SPEED)
LOWER HI-TRAC INTO SPENT FUEL POOL	8.5	3C	1	*663.4*	*94.0*	*94.0*	17 FEET @ 2 FT/MIN (CRANE SPEED)
REMOVE LID RETENTION BOLTS	12	3B	1	*76.3*	*15.3*	*15.3*	24 BOLTS @ 2/MINUTE
PLACE HI-TRAC ON FLOOR	20	2	2	*3*	*1.0*	*2.0*	40 FEET @ 2 FT/MINUTE (CRANE SPEED)

Table 10.3.2b
HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 100-TON HI-TRAC TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~42,500~~*46,000* MWD/MTU, ~~5~~*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
Section 8.3.4							
REMOVE SPENT FUEL ASSEMBLIES FROM MPC	1020	1	2	*3*	*51.0*	*102.0*	15 MINUTES PER ASSEMBLY/68 ASSY
TOTAL						~~1387.7~~*2569.7* PERSON-MREM	

Table 10.3.2c
HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~12~~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	*43.8*	*14.6*	*14.6*	4 SCREENS@5MIN/SCREEN
INSERT HI-STORM LIFTING JACKS	4	16D	1	*43.8*	*2.9*	*2.9*	4 JACKS@1/MIN
INSERT AIR PAD	5	16D	2	*43.8*	*3.6*	*7.3*	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	*43.8*	*2.9*	*2.9*	4 JACKS@1/MIN
TRANSFER HI-STORM TO MPC TRANSFER LOCATION	40	16C	1	*25.5*	*17.0*	*17.0*	200 FEET @ 4FT/MIN
REMOVE HI-STORM LID STUDS/NUTS	10	16A	1	*7.3*	*1.2*	*1.2*	4 BOLTS NO TORQUE
REMOVE HI-STORM LID LIFTING HOLE PLUGS AND INSTALL LID LIFTING SLING	2	16A	1	*7.3*	*0.2*	*0.2*	4 PLUGS AT 2/MIN NO TORQUING
REMOVE GAMMA SHIELD CROSS PLATES	4	16B	1	*73.9*	*4.9*	*4.9*	4 PLATES@1/MIN
REMOVE TEMPERATURE ELEMENTS	8	16B	1	*73.9*	*9.8*	*9.8*	4 TEMP. ELEMENTS @ 2MIN/TEMP. ELEMENT NO TORQUE
REMOVE HI-STORM LID	2	16A	1	*7.3*	*0.2*	*0.2*	4 SHACKLES@2/MIN
INSTALL HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	*45.5*	*1.5*	*1.5*	4 SHACKLES@2/MIN
INSTALL MATING DEVICE WITH POOL LID	10	15A	1	*45.5*	*7.6*	*7.6*	3 BOLTS AT 2 MINUTES PER BOLT
REMOVE MPC LIFT CLEAT HOLE PLUGS	2	14A	1	*362.5*	*12.1*	*12.1*	4 PLUGS AT 2/MIN NO TORQUING
INSTALL MPC LIFT CLEATS AND MPC SLINGS	2	14A	1	*362.5*	*12.1*	*12.1*	4 PLUGS AT 2/MIN NO TORQUING

† 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† (~~57,500~~*75,000* MWD/MTU, ~~1~~*25*-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
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
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
Section 8.3.3							
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

Table 10.3.2c
HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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 COOL-DOWN SYSTEM TO RVOAs	2	8A	1	37.9	1 3	1.3	1" THREADED FITTING NO TOOLS X 2
DISCONNECT GAS 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)

Table 10.3.2c

HI-STORM 100 SYSTEM UNLOADING OPERATIONS USING THE 125-TON HI-TRAC 125D TRANSFER CASK ESTIMATED OPERATIONAL EXPOSURES† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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
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
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
TOTAL							~~329.1~~*672.6* PERSON-MREM

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† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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	*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

† 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† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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 LIFT CLEAT HOLE PLUGS	2	19A	1	*362.5*	*12.1*	*12.1*	4 PLUGS AT 2/MIN NO TORQUING
INSTALL MPC LIFT CLEATS AND LIFT SLING	25	19A	2	*362.5*	*151.0*	*302.1*	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
Section 8.5.3							
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	*362.5*	*60.4*	*60.4*	4 BOLTS,NO TORQUING
INSTALL HOLE PLUGS IN EMPTY MPC BOLT HOLES	2	14A	1	*362.5*	*12.1*	*12.1*	4 PLUGS AT 2/MIN NO TORQUING
REMOVE HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	*45.5*	*1.5*	*1.5*	4 SHACKLES@2/MIN
REMOVE ALIGNMENT DEVICE	4	15A	1	*45.5*	*3.0*	*3.0*	REMOVED BY HAND NO TOOLS (4 PCS@1/MIN)
INSTALL HI-STORM LID AND INSTALL LID STUDS/NUTS	25	16A	2	*7.3*	*3.1*	*6.1*	INSTALL LID AND HYDRO TORQUE 4 BOLTS
INSTALL HI-STORM EXIT VENT GAMMA SHIELD CROSS PLATES	4	16B	1	*73.9*	*4.9*	*4.9*	4 PCS @ 1/MIN INSTALL BY HAND NO TOOLS
INSTALL TEMPERATURE ELEMENTS	20	16B	1	*73.9*	*24.6*	*24.6*	4@5MIN/TEMPERATURE ELEMENT
INSTALL EXIT VENT SCREENS	20	16B	1	*73.9*	*24.6*	*24.6*	4 SCREENS@5MIN/SCREEN
REMOVE HI-STORM LID LIFTING DEVICE	2	16A	1	*7.3*	*0.2*	*0.2*	4 SHACKLES@2/MIN

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† (~~57,500~~*75,000* MWD/MTU, ~~1~~25-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 HOLE PLUGS IN EMPTY HOLES	2	16A	1	*7.3*	*0.2*	*0.2*	4 PLUGS AT 2/MIN NO TORQUING
PERFORM SHIELDING EFFECTIVENESS TESTING	16	16D	1	*43.8*	*11.7*	*11.7*	16POINTS@1 MIN
SECURE HI-STORM TO TRANSPORT DEVICE	10	16A	1	*7.3*	*1.2*	*1.2*	ASSUMES AIR PAD
TRANSFER HI-STORM TO ITS DESIGNATED STORAGE LOCATION	40	16C	1	*25.5*	*17.0*	*17.0*	200 FEET @ 4FT/MIN
INSERT HI-STORM LIFTING JACKS	4	16D	1	*43.8*	*2.9*	*2.9*	4 JACKS@1/MIN
REMOVE AIR PAD	5	16D	1	*43.8*	*3.6*	*3.6*	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	*43.8*	*2.9*	*2.9*	4 JACKS@1/MIN
INSTALL INLET VENT SCREENS	20	16D	1	*43.8*	*14.6*	*14.6*	4 SCREENS@5MIN/SCREEN
PERFORM AIR TEMPERATURE RISE TEST	8	16B	1	*73.9*	*9.8*	*9.8*	8 MEASMT@1/MIN
TOTAL						~~465.4~~*722.6* PERSON-MREM	

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† (~~42,500~~*46,000* MWD/MTU, ~~5~~*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
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	*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

† 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† (~~42,500~~*46,000* MWD/MTU, ~~5~~*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 LIFT CLEAT HOLE PLUGS	2	19A	1	*362.5*	*12.1*	*12.1*	4 PLUGS AT 2/MIN NO TORQUING
INSTALL MPC LIFT CLEATS AND LIFT SLING	25	19A	2	*362.5*	*151.0*	*302.1*	INSTALL CLEATS AND HYDRO TORQUE 4 BOLTS
MATE OVERPACKS	10	20B	2	*561.8*	*93.6*	*187.3*	ALIGNMENT GUIDES USED
REMOVE DOOR LOCKING PINS AND OPEN DOORS	4	20B	2	*561.8*	*37.5*	*74.9*	2 PINS@2/MIN
INSTALL TRIM PLATES	4	20B	2	*561.8*	*37.5*	*74.9*	INSTALLED BY HAND NO FASTENERS
Section 8.5.3							
REMOVE TRIM PLATES	4	20B	2	*561.8*	*37.5*	*74.9*	INSTALLED BY HAND NO FASTENERS
DISCONNECT SLINGS FROM MPC LIFTING DEVICE	10	20A	2	*247.7*	*41.3*	*82.6*	2 SLINGS@5/MIN
REMOVE TRIM PLATES	4	13B	2	*561.8*	*37.5*	*74.9*	INSTALLED BY HAND NO FASTENERS
REMOVE MPC LIFT CLEATS AND MPC LIFT SLINGS	10	14A	1	*362.5*	*60.4*	*60.4*	4 BOLTS,NO TORQUING
INSTALL HOLE PLUGS IN EMPTY MPC BOLT HOLES	2	14A	1	*362.5*	*12.1*	*12.1*	4 PLUGS AT 2/MIN NO TORQUING
REMOVE HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	*45.5*	*1.5*	*1.5*	4 SHACKLES@2/MIN
REMOVE ALIGNMENT DEVICE	4	15A	1	*45.5*	*3.0*	*3.0*	REMOVED BY HAND NO TOOLS (4 PCS@1/MIN)
INSTALL HI-STORM LID AND INSTALL LID STUDS/NUTS	25	16A	2	*7.3*	*3.1*	*6.1*	INSTALL LID AND HYDRO TORQUE 4 BOLTS
INSTALL HI-STORM EXIT VENT GAMMA SHIELD CROSS PLATES	4	16B	1	*73.9*	*4.9*	*4.9*	4 PCS @ 1/MIN INSTALL BY HAND NO TOOLS
INSTALL TEMPERATURE ELEMENTS	20	16B	1	*73.9*	*24.6*	*24.6*	4@5MIN/TEMPERATURE ELEMENT
INSTALL EXIT VENT SCREENS	20	16B	1	*73.9*	*24.6*	*24.6*	4 SCREENS@5MIN/SCREEN
REMOVE HI-STORM LID LIFTING DEVICE	2	16A	1	*7.3*	*0.2*	*0.2*	4 SHACKLES@2/MIN

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† (~~42,500~~*46,000* MWD/MTU, ~~5~~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 HOLE PLUGS IN EMPTY HOLES	2	16A	1	*7.3*	*0.2*	*0.2*	4 PLUGS AT 2/MIN NO TORQUING
PERFORM SHIELDING EFFECTIVENESS TESTING	16	16D	1	*43.8*	*11.7*	*11.7*	16POINTS@1 MIN
SECURE HI-STORM TO TRANSPORT DEVICE	10	16A	1	*7.3*	*1.2*	*1.2*	ASSUMES AIR PAD
TRANSFER HI-STORM TO ITS DESIGNATED STORAGE LOCATION	40	16C	1	*25.5*	*17.0*	*17.0*	200 FEET @ 4FT/MIN
INSERT HI-STORM LIFTING JACKS	4	16D	1	*43.8*	*2.9*	*2.9*	4 JACKS@1/MIN
REMOVE AIR PAD	5	16D	1	*43.8*	*3.6*	*3.6*	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	*43.8*	*2.9*	*2.9*	4 JACKS@1/MIN
INSTALL INLET VENT SCREENS	20	16D	1	*43.8*	*14.6*	*14.6*	4 SCREENS@5MIN/SCREEN
PERFORM AIR TEMPERATURE RISE TEST	8	16B	1	*73.9*	*9.8*	*9.8*	8 MEASMT@1/MIN
TOTAL						~~718.8~~*1136.5* PERSON-MREM	

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† (~~57,500~~*75,000* MWD/MTU, ~~1~~*25*-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

† See notes at bottom of Table 10.3.4.

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† (~~57,500~~*75,000* MWD/MTU, ~~12~~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 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 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	362.5	12.1	12.1	4 PLUGS AT 2/MIN NO TORQUING
INSTALL MPC LIFT CLEATS AND LIFT SLING	25	19A	2	362.5	151.0	302.1	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
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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	362.5	60.4	60.4	4 BOLTS,NO TORQUING
INSTALL HOLE PLUGS IN EMPTY MPC BOLT HOLES	2	14A	1	362.5	12.1	12.1	4 PLUGS AT 2/MIN NO TORQUING
REMOVE HI-STORM VENT DUCT SHIELD INSERTS	2	15A	1	45.5	1.5	1.5	4 SHACKLES@2/MIN
REMOVE THE MATINGE DEVICE	6	15A	1	45.5	4.5	4.5	3 BOLTS AT 2 MINUTES PER BOLTS

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† (~~57,500~~*75,000* MWD/MTU, ~~12~~*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 LID AND INSTALL LID STUDS/NUTS	25	16A	2	*7.3*	*3.1*	*6.1*	INSTALL LID AND HYDRO TORQUE 4 BOLTS
INSTALL HI-STORM EXIT VENT GAMMA SHIELD CROSS PLATES	4	16B	1	*73.9*	*4.9*	*4.9*	4 PCS @ 1/MIN INSTALL BY HAND NO TOOLS
INSTALL TEMPERATURE ELEMENTS	20	16B	1	*73.9*	*24.6*	*24.6*	4@5MIN/TEMPERATURE ELEMENT
INSTALL EXIT VENT SCREENS	20	16B	1	*73.9*	*24.6*	*24.6*	4 SCREENS@5MIN/SCREEN
REMOVE HI-STORM LID LIFTING DEVICE	2	16A	1	*7.3*	*0.2*	*0.2*	4 SHACKLES@2/MIN
INSTALL HOLE PLUGS IN EMPTY HOLES	2	16A	1	*7.3*	*0.2*	*0.2*	4 PLUGS AT 2/MIN NO TORQUING
PERFORM SHIELDING EFFECTIVENESS TESTING	16	16D	1	*43.8*	*11.7*	*11.7*	16POINTS@1 MIN
SECURE HI-STORM TO TRANSPORT DEVICE	10	16A	1	*7.3*	*1.2*	*1.2*	ASSUMES AIR PAD
TRANSFER HI-STORM TO ITS DESIGNATED STORAGE LOCATION	40	16C	1	*25.5*	*17.0*	*17.0*	200 FEET @ 4FT/MIN
INSERT HI-STORM LIFTING JACKS	4	16D	1	*43.8*	*2.9*	*2.9*	4 JACKS @1/MIN
REMOVE AIR PAD	5	16D	1	*43.8*	*3.6*	*3.6*	1 PAD MOVED BY HAND
REMOVE HI-STORM LIFTING JACKS	4	16D	1	*43.8*	*2.9*	*2.9*	4 JACKS @1/MIN
INSTALL INLET VENT SCREENS	20	16D	1	*43.8*	*14.6*	*14.6*	4 SCREENS@5MIN/SCREEN
PERFORM AIR TEMPERATURE RISE TEST	8	16B	1	*73.9*	*9.8*	*9.8*	8 MEASMT@1/MIN
TOTAL							~~514.08~~*52.9* PERSON–MREM

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.

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 ~~200~~*250* meters and a 2x5 array of HI-STORM 100 systems at ~~350~~*450* meters. These annual doses are based on a full array of design basis fuel with a burnup of ~~52~~*47*,500 MWD/MTU and ~~5~~*3*-year cooling. This burnup and cooling time combination conservatively bounds the allowable burnup and cooling times listed in ~~the Technical Specifications~~*Appendix B to the CoC*. 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 ~~200~~*250* meters for a single cask and at ~~350~~*450* 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.

A minor contributor to the minimum controlled area boundary is the normal storage condition leakage from the welded MPC. Although leakage is not expected, Section 7.2 provides an analysis for the annual dose equivalent based on a continuous leak from the MPC. The annual dose equivalent to an individual at the minimum controlled area boundary based on the assumed leakage rate and continuous occupancy is presented in Table 7.3.8. 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.

However, the annual dose at the controlled area boundary as a result of an assumed effluent release under off-normal conditions is different than that under normal conditions. Under off-normal conditions, 10% of the fuel rods are assumed to have been breached, in lieu of 1% of the fuel rods for normal conditions. The resulting annual dose equivalent to an individual at the minimum controlled area boundary, based on the assumed leakage rate and continuous occupancy, is presented in Table 7.3.8. The analysis to determine the off-normal dose at the controlled area boundary is described in Section 7.2.

10.4.3 Controlled Area Boundary Dose for Accident Conditions

10CFR72.106 [10.0.1] specifies that 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.

Subsection 7.3 *and Table 7.3.8* demonstrates that the resultant doses for a non-mechanistic postulated breach of the MPC confinement boundary at the regulatory minimum site boundary distance of 100 meters is ~~presented in Table 7.3.8~~ within the regulatory limits specified in 10CFR72.106 [10.0.1].

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 ~~1.47~~*4.06* mrem/hour for the loaded HI-TRAC transfer cask during the accident condition. At the calculated dose rate, it would take approximately ~~141~~ *51* 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 100 OVERPACKS
WITH DESIGN BASIS ZIRCALOY CLAD FUEL
~~52~~*47*,500 MWD/MTU AND ~~5~~*3*-YEAR COOLING

Array Configuration	1 Cask	1 Cask	2x5 Array
Annual Dose (mrem/year)†	~~130.0~~*290.3*	~~20.19~~*22.83*	~~18.64~~*15.52*
Distance to Controlled Area Boundary (meters)††, †††	100	~~200~~*250*	~~350~~*450*

† 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 ~~5~~*3*-year cooling as specified in ~~the Technical Specifications~~*Appendix B to the CoC* is lower than the burnup analyzed for the design basis fuel used in this table.

Table 10.4.2
DOSE RATE FOR THE 100-TON HI-TRAC TRANSFER CASK
WITH DESIGN BASIS ZIRCALOY CLAD FUEL

Fuel Burnup & Cooling Time	**100 Meters**	**200 Meters**	**300 Meters**
~~**42,500**~~***46,000*** **MWD/MTU &** ~~**5**~~ ***3*** **Years**	~~0.43~~*0.98* mrem/hr	~~0.07~~*0.15* mrem/hr	~~0.02~~*0.04* mrem/hr
~~**52,500**~~***75,000*** **MWD/MTU &** ~~**10**~~ ***5*** **Years**	~~0.27~~*0.80* mrem/hr	~~0.04~~*0.12* mrem/hr	~~0.01~~*0.03* mrem/hr