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BY FAX AND OVERNIGHT MAIL

February 1, 2000

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: USNRC Docket No. 72-1014; TAC No. L22221
HI-STORM 100 Storage Application
Resolution of Public Comments

Reference: Holtec Project 5014

Dear Sir:

In response to your request, we are pleased to enclose herewith draft copies of change pages comprising proposed Revision 10 to the HI-STORM 100 Topical Safety Analysis Report (TSAR). The proposed changes are identified with revision bars in the margin. These changes include those discussed with the NRC in a conference call held on January 28, 2000 to address public comments received during rulemaking as well as other minor editorial changes and clarifications. Please note that changes to drawings are not included with this submittal as discussed with the NRC project manager previously.

In the interest of absolute technical accuracy, we have also revised the results of the cask tip-over events in TSAR Table 3.A.4 even though the deceleration values change only in the second decimal place. Recent discovery of a data input discrepancy in the LS-DYNA3D input file led us to re-run the tip-over cases which, as proposed revised Table 3.A.4 shows, produced infinitesimal changes in the results. Associated TSAR Figures 3.A.19 through 22 are also proposed to be replaced.

If you have any questions or require additional information, please contact us.

Sincerely,

Brian Gutherman, P.E.
Licensing Manager

Approval:

K.P. Singh, Ph.D, P.E.
President and CEO

cc: Ms. Marissa Bailey (w/encl..)

NMSS01 Public

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Attachment: Draft Revision 10 of the HI-STORM 100 System Topical Safety Analysis Report (replacement pages).

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DRAFT PROPOSED REVISION 10

HI-STORM TSAR CHANGES

(49 PAGES INCLUDING THIS PAGE)

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Table 1.0.3 (continued)

HI-STORM 100 SYSTEM TSAR CLARIFICATIONS AND EXCEPTIONS TO NUREG-1536

NUREG-1536 Requirement	Alternate Method to Meet NUREG-1536 Intent	Justification
4.V.5.c, Page 4-10, Para. 3 "free volume calculations should account for thermal expansion of the cask internal components and the fuel when subjected to accident temperatures.	Exception: All free volume calculations use nominal confinement boundary dimensions, but the volume occupied by the MPC internals (i.e., fuel assemblies, fuel basket, etc.) are calculated using maximum weights and minimum densities.	Calculating the volume occupied by the MPC internals (i.e., fuel assemblies, fuel basket, etc.) using maximum weights and minimum densities conservatively overpredicts the volume occupied by the internal components and correspondingly underpredicts the remaining free volume.
7.V.4.c, Page 7-7, Para. 2 and 3 "Because the leak is assumed to be instantaneous, the plume meandering factor of Regulatory Guide 1.145 is not typically applied." and "Note that for an instantaneous release (and instantaneous exposure), the time that an individual remains at the controlled area boundary is not a factor in the dose calculation."	Exception: As described in Section 7.3, in lieu of an instantaneous release, the assumed leakage rate is set equal to the leakage rate acceptance criteria ($5x10^{-6}$ atm cm^3/s) plus 50% for conservatism, which yields $7.5x10^{-6}$ cm^3/s. Because the release is assumed to be a leakage rate, the individual is assumed to be at the controlled area boundary for 720 hours. Additionally, the atmospheric dispersion factors of Regulatory Guide 1.145 are applied.	The MPC uses redundant closures to assure that there is no release of radioactive materials under all credible conditions. Analyses presented in Chapters 3 and 11 demonstrate that the confinement boundary does not degrade under all normal, off-normal, and accident conditions. Multiple inspection methods are used to verify the integrity of the confinement boundary (e.g., helium leakage, hydrostatic, and volumetric weld inspection). The NRC letter to Holtec International dated 9/15/97, Subject: Supplemental Request for Additional Information - HI-STAR 100 Dual Purpose Cask System (TAC No. L22019), RAI 7.3 states "use the verified confinement boundary leakage rate in lieu of the assumption that the confinement boundary fails."

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1.2.1.1 Multi-Purpose Canisters

The MPCs are welded cylindrical structures as shown in cross sectional views of Figures 1.2.2 and 1.2.4. The outer diameter and cylindrical height of each MPC are fixed. Each spent fuel MPC is an assembly consisting of a honeycombed fuel basket, a baseplate, canister shell, a lid, and a closure ring, as depicted in the MPC cross section elevation view, Figure 1.2.5. The number of spent nuclear fuel storage locations in each of the MPCs depends on the fuel assembly characteristics. There are three MPC models, distinguished by the type and number of fuel assemblies authorized for loading. The MPC-24 is designed to store up to 24 intact PWR fuel assemblies. The MPC-68 is designed to stored up to 68 intact or damaged BWR fuel assemblies. The MPC-68F is designed to store up to 68 intact or damaged BWR fuel assemblies and up to four BWR fuel assemblies classified as fuel debris. Design Drawings for all of the MPCs are provided in Section 1.5.

The MPC provides the confinement boundary for the stored fuel. Figure 1.2.6 provides an elevation view of the MPC confinement boundary. The confinement boundary is defined by the MPC baseplate, shell, lid, port covers, and closure ring. The confinement boundary is a seal-welded enclosure of all stainless steel construction.

The construction features of the PWR MPC-24 and the BWR MPC-68 are similar. However, the PWR MPC-24 canister in Figure 1.2.4, which is designed for high-enriched PWR fuel, differs in construction from the MPC-68 in one important aspect: the fuel storage cells are physically separated from one another by a "flux trap", for criticality control. All MPC baskets are formed from an array of plates welded to each other, such that a honeycomb structure is created which resembles a multiflanged, closed-section beam in its structural characteristics.

The MPC fuel basket is positioned and supported within the MPC shell by a set of basket supports welded to the inside of the MPC shell. Between the periphery of the basket, the MPC shell, and the basket supports, heat conduction elements are installed. These heat conduction elements are fabricated from thin aluminum alloy 1100 in shapes which enable a snug fit in the confined spaces and ease of installation. The heat conduction elements are installed along the full length of the MPC basket to create a nonstructural thermal connection which facilitates heat transfer from the basket to shell. In their installed condition, the heat conduction elements contact the MPC shell and basket walls.

Lifting lugs attached to the inside surface of the MPC canister shell serve to permit placement of the empty MPC into the HI-TRAC transfer cask. The lifting lugs also serve to axially locate the MPC lid prior to welding. These internal lifting lugs are not used to handle a loaded MPC. Since the MPC lid is installed prior to any handling of a loaded MPC, there is no access to the lifting lugs once the MPC is loaded.

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Table 1.2.1

KEY SYSTEM DATA FOR HI-STORM 100 SYSTEM

ITEM	QUANTITY	NOTES
Types of MPCs included in this revision of the submittal	3	1 for PWR 2 for BWR
MPC storage capacity:	MPC-24	Up to 24 intact zircaloy or stainless steel clad PWR fuel assemblies. Control components and non-fuel hardware are not authorized for loading.
	MPC-68 MPC-68F	Any combination of damaged fuel assemblies in damaged fuel containers and intact fuel assemblies, up to a total of 68 in the MPC-68 OR Up to 4 damaged fuel containers with zircaloy clad BWR fuel debris and the complement damaged zircaloy clad BWR fuel assemblies in damaged fuel containers or intact fuel assemblies within an MPC-68F.

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2.2.1 Normal Condition Design Criteria

2.2.1.1 Dead Weight

The HI-STORM 100 System must withstand the static loads due to the weights of each of its components, including the weight of the HI-TRAC with the loaded MPC atop the storage overpack.

2.2.1.2 Handling

The HI-STORM 100 System must withstand loads experienced during routine handling. Normal handling includes:

i. vertical lifting and transfer to the ISFSI of the HI-STORM 100 Overpack with loaded MPC
ii. lifting, upending/downending, and transfer to the ISFSI of the HI-TRAC with loaded MPC in the vertical or horizontal position
iii. lifting of the loaded MPC into and out of the HI-TRAC, HI-STORM, or HI-STAR Overpack

The loads shall be increased by 15% to include any dynamic effects from the lifting operations as directed by CMAA #70 [2.2.16].

Handling operations of the loaded HI-TRAC transfer cask or HI-STORM 100 Overpack is limited to ambient temperatures above 0EF. This limitation is specified to ensure that a sufficient safety margin exists before brittle fracture might occur during handling operations. Subsection 3.1.2.3 provides the demonstration of the adequacy of the HI-TRAC transfer cask and the HI-STORM 100 Overpack for use during handling operations at a minimum service temperature of 0EF.

Lifting attachments and devices shall meet the requirements of ANSI N14.6† [2.2.3].

† Yield and ultimate strength values used in the stress compliance demonstration per ANSI N14.6 shall utilize confirmed material test data through either independent coupon testing or material suppliers' CMTR or COC, as appropriate. To ensure consistency between the design and fabrication of a lifting component, compliance with ANSI N14.6 in this TSAR implies that the guidelines of ASME Section III, Subsection NF for Class 3 structures are followed for material procurement and testing, fabrication, and for NDE during manufacturing.

Analysis for each site for such transient hydrological loadings must be made for that site. It is expected that the plant licensee will perform this evaluation under the provisions of 10CFR72.212.

2.2.3.7 Seismic Design Loadings

The HI-STORM 100 must withstand loads arising due to a seismic event and must be shown not to tip over during a seismic event. Subsection 3.4.7 contains calculations based on conservative static "incipient tipping" calculations which demonstrate static stability. The calculations in Section 3.4.7 result in the values reported in Table 2.2.8, which provide the maximum horizontal zero period acceleration (ZPA) versus vertical acceleration multiplier above which static incipient tipping would occur. This conservatively assumes the peak acceleration values of each of the two horizontal earthquake components occur simultaneously. The maximum horizontal ZPA provided in Table 2.2.8 is the vector sum of two horizontal earthquakes.

2.2.3.8 100% Fuel Rod Rupture

The HI-STORM 100 System must withstand loads due to 100% fuel rod rupture. For conservatism, 100 percent of the fuel rods are assumed to rupture with 100 percent of the fill gas and 30% of the significant radioactive gases (e.g., H^3, Kr, and Xe) released in accordance with NUREG-1536.

2.2.3.9 Confinement Boundary Leakage

No credible scenario has been identified that would cause failure of the confinement system. To demonstrate the overall safety of the HI-STORM 100 System, the largest test leakage rate for the confinement boundary plus 50% for conservatism is assumed as the maximum credible confinement boundary leakage rate and 100 percent of the fuel rods are assumed to have failed. Under this accident condition, doses to an individual located at the boundary of the controlled area are calculated.

2.2.3.10 Explosion

The HI-STORM 100 System must withstand loads due to an explosion. The accident condition MPC external pressure and overpack pressure differential specified in Table 2.2.1 bounds all credible external explosion events. There are no credible internal explosive events since all materials are compatible with the various operating environments, as discussed in Section 3.4.1. The MPC is composed of stainless steel, Boral, and aluminum alloy 1100, all of which have a long proven history of use in fuel pools at nuclear power plants. For these materials there is no credible cause for an internal explosive event.

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Table 2.2.9

CHARACTERISTICS OF REFERENCE ISFSI PAD[†]

Concrete thickness	≤ 36 inches
Concrete Compressive Strength	≤ 4,200 psi at 28 days
Reinforcement Top and Bottom (both directions)	Reinforcing bar shall be ASTM Grade 60
Subgrade Soil Effective Modulus of Elasticity[††]	≤ 28,000 psi (measured prior to ISFSI pad installation)
Top Concrete Surface	A static coefficient of friction of ≥ 0.53 between the ISFSI pad and the bottom of the overpack shall be verified by test. The test procedure shall follow the guidelines included in the Sliding Analysis in TSAR Subsection 3.4.7.1

† The characteristics of this pad are identical to the pad considered by Lawrence Livermore Laboratory (see Appendix 3.A).

†† An acceptable method of defining the soil effective modulus of elasticity applicable to the drop and tipover analysis is provided in Table 13 of NUREG/CR-6608 with soil classification in accordance with ASTM-D2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System USCS) and density determination in accordance with ASTM-D1586 Standard Test Method for Penetration Test and Split/Barrel Sampling of Soils.

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9. Pre-service examination requirements

10. In-use inspection and maintenance requirements

11. Number and magnitude of repetitive loading significant to fatigue

12. Insulation and enclosure requirements (on electrical motors and machinery)

13. Applicable Reg. Guides and NUREGs.

14. Welding requirements

15. Painting, marking, and identification requirements

16. Design Report documentation requirements

17. Operational and Maintenance (O&M) Manual information requirements

All design documentation shall be subject to a review, evaluation, and safety assessment process in accordance with the provisions of the QA program described in Chapter 13.

Users may effectuate the inter-cask transfer of the MPC between the HI-TRAC transfer cask and either the HI-STORM 100 or the HI-STAR 100 overpack in a location of their choice, depending upon site-specific needs and capabilities. For those users choosing to perform the MPC inter-cask transfer outside of a facility governed by the regulations of 10 CFR Part 50 (e.g., fuel handling or reactor building), a Cask Transfer Facility (CTF) is required. The CTF is a stand-alone facility located on-site, near the ISFSI that incorporates or is compatible with lifting devices designed to lift a loaded or unloaded HI-TRAC transfer cask, place it atop the overpack, and transfer the loaded MPC to or from the overpack. ~~For the specific case of auxiliary equipment and structures required to perform inter-cask transfers of a loaded MPC outside Part 50 structures (i.e., fuel handling or reactor building, as applicable),~~ The detailed design criteria which must be followed for the design and operation of the CTF are set down in Paragraphs A through R below. ~~in this subsection and must be followed in the design and operation of a Cask Transfer Facility (CTF).~~

The inter-cask transfer operations consist of the following potential scenarios of MPC transfer:

- Transfer between a HI-TRAC transfer cask and a HI-STORM 100 overpack
- Transfer between a HI-TRAC transfer cask and a HI-STAR 100 overpack

In both scenarios, HI-TRAC is mounted on top of the overpack (HI-STAR 100 or HI-STORM 100) and the MPC transfer is carried out by opening the transfer lid doors located at the bottom of the HI-

Table 3.A.1: Essential Variables for Reference ISFSI Pad Data (from [3.A.2] and [3.A.4])

Thickness of concrete	36 inches
Nominal compressive strength of concrete	4,200 psi *at 28 days*
Concrete mass density	2.097E-04 lb-sec^2/in^4
Concrete Poisson's ratio	0.22
Mass density of the soil	1.872E-04 lb.-sec^2/in^4
Effective ~~M~~*m*odulus of elasticity of the *subgrade* soil	28,000 psi
Poisson's ratio of the soil	0.4

Note 1: The concrete Young's Modulus is derived from the American Concrete Institute recommended formula $57000(f)^{1/2}$ where f is the nominal compressive strength of the concrete (psi).

Note 2: The effective modulus of elasticity of the subgrade soil is to be measured by an appropriate "plate test" before pouring of the concrete ISFSI pad.

Note 3: The pad thickness of 36", concrete compressive strength of 4200 psi (nom.) at 28 days of curing, and the subgrade soil effective modulus of 28000 psi are the upper bound values to ensure that the deceleration limits under the postulated impact events set forth in Table 3.1.2 are satisfied.

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Table 3.A.2: Essential Steel Material Properties for HI-STORM 100 Overpack

Steel Type	Parameter	Value
SA-516-70 at T = 350 deg. F	E	2.800E + 07
	S_y	3.315E+04 psi
	S_u	7.000E+04 psi
	ϵ_u	~~0.38~~ *0.21*
	ν	0.30

Note that the properties of the steel components, except for the radial channels used to position the MPC, do not affect the results reported herein since the HI-STORM 100 is eventually assumed to behave as a rigid body (by internal constraint equations automatically computed by DYNA3D upon issue of a "make rigid" command). In Section 3.4, however, stress and strain results for an additional tip-over analysis, performed using the actual material behavior ascribed to the storage overpack, are presented for the sole purpose of demonstrating ready retrievability of the MPC after the tip-over.

Table 3.A.4: Results (*)

Drop Event	Max. Displ (in)	Impact Velocity (in/sec)	Max. Acc. (g's)	Acc. Pulse Duration (msec.)
End-11"	0.696	92.20	44.13	2.96
Tipover Cask Top[1]	~~4.958~~ *4.903*	341.3	~~48.48~~ *48.41*	~~9.40~~ *9.76*
Tipover (Basket Top)	~~4.417~~ *4.368*	304.03	~~43.19~~ *43.12*	--
Tipover (with Increased Initial Clearance) Cask Top[1]	4.998	341.3	48.52	10.0
Tipover (with Increased Initial Clearance) (Basket Top)	4.452	304.03	43.22	--

1 The distance of the top of the fuel basket is 206" from the pivot point. The distance of the top of the cask is 231.25" from the pivot point. Therefore, all displacements, velocities, and accelerations at the top of the fuel basket are 89.08% of those at the cask top (206"/231.25").

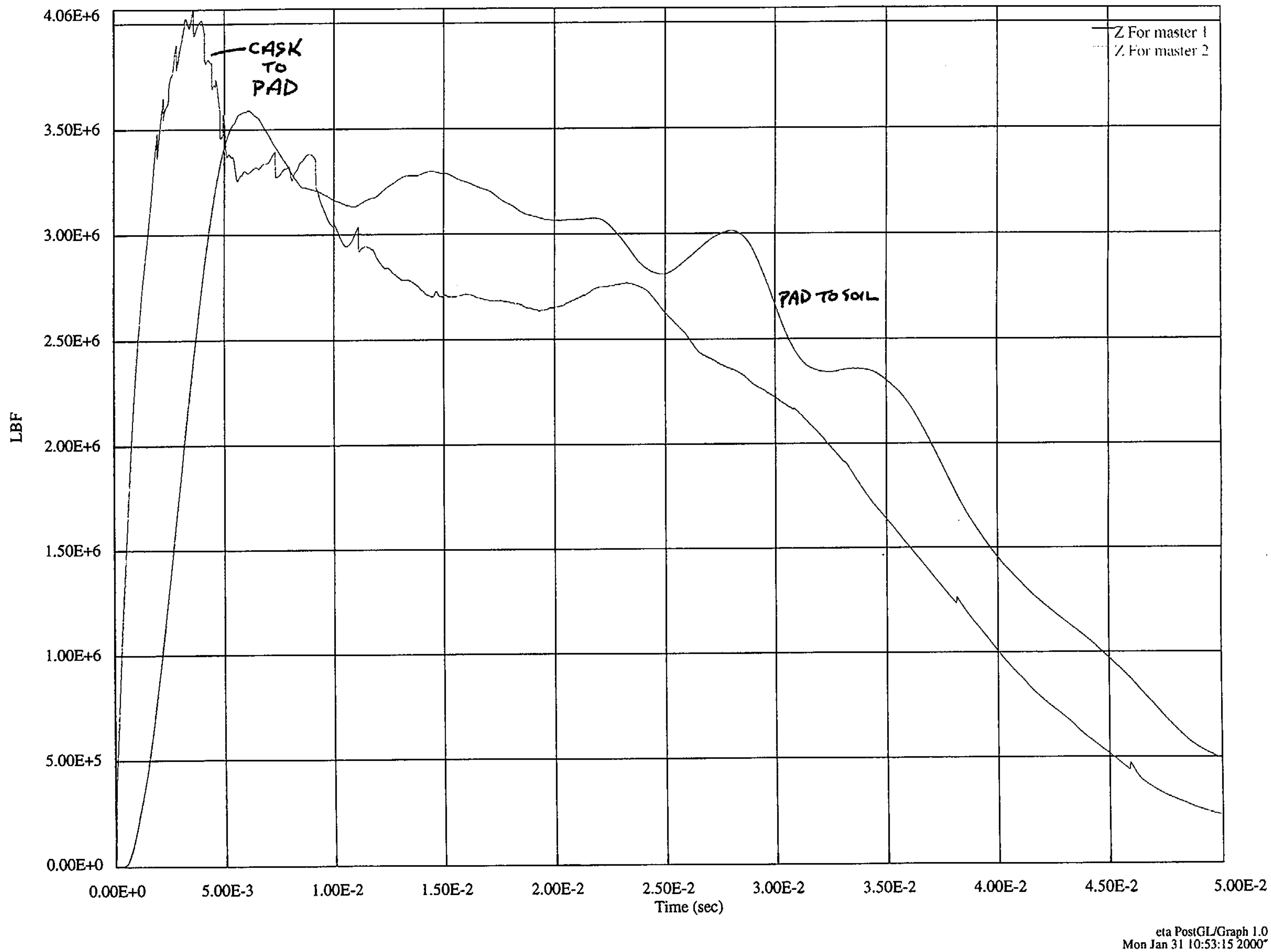

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FIG. 3.A.19 Tipover Scenario: Impact Force Time Histories

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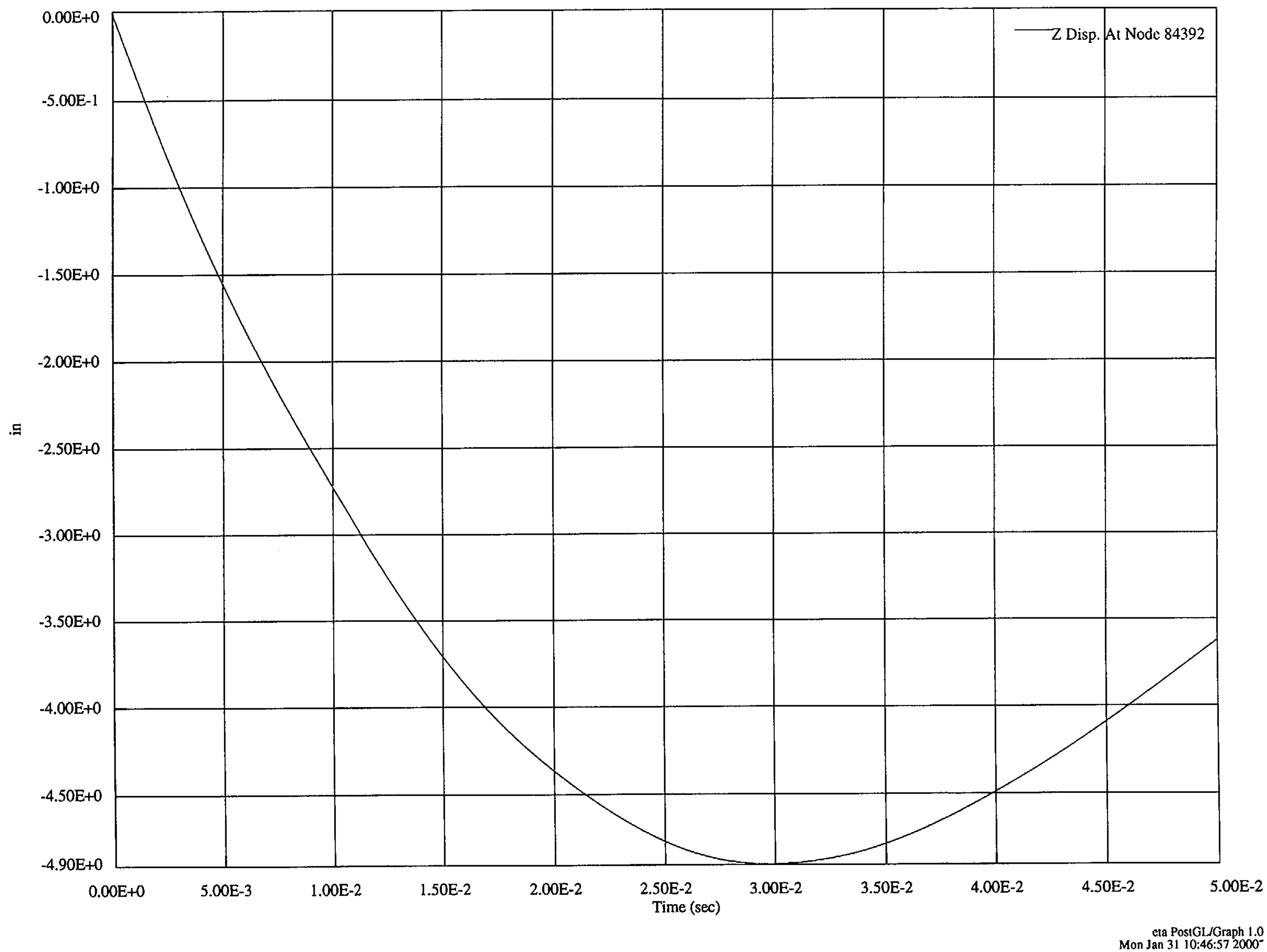

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FIG. 3.A.20 Tipover Scenario: Channel A2 Displacement Time History

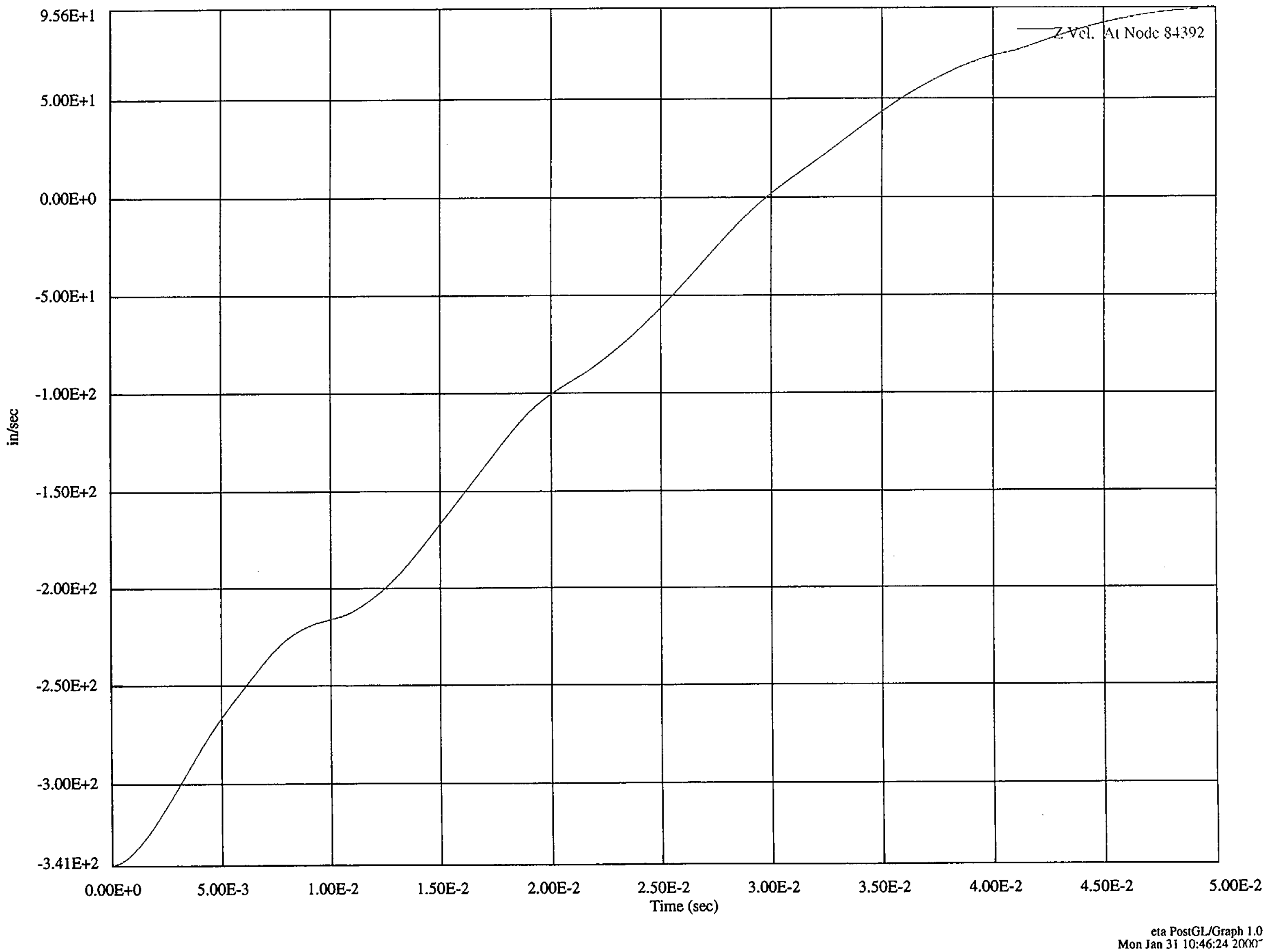

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FIG 3.A.21 Tipover Scenario: Channel A2 Velocity Time History

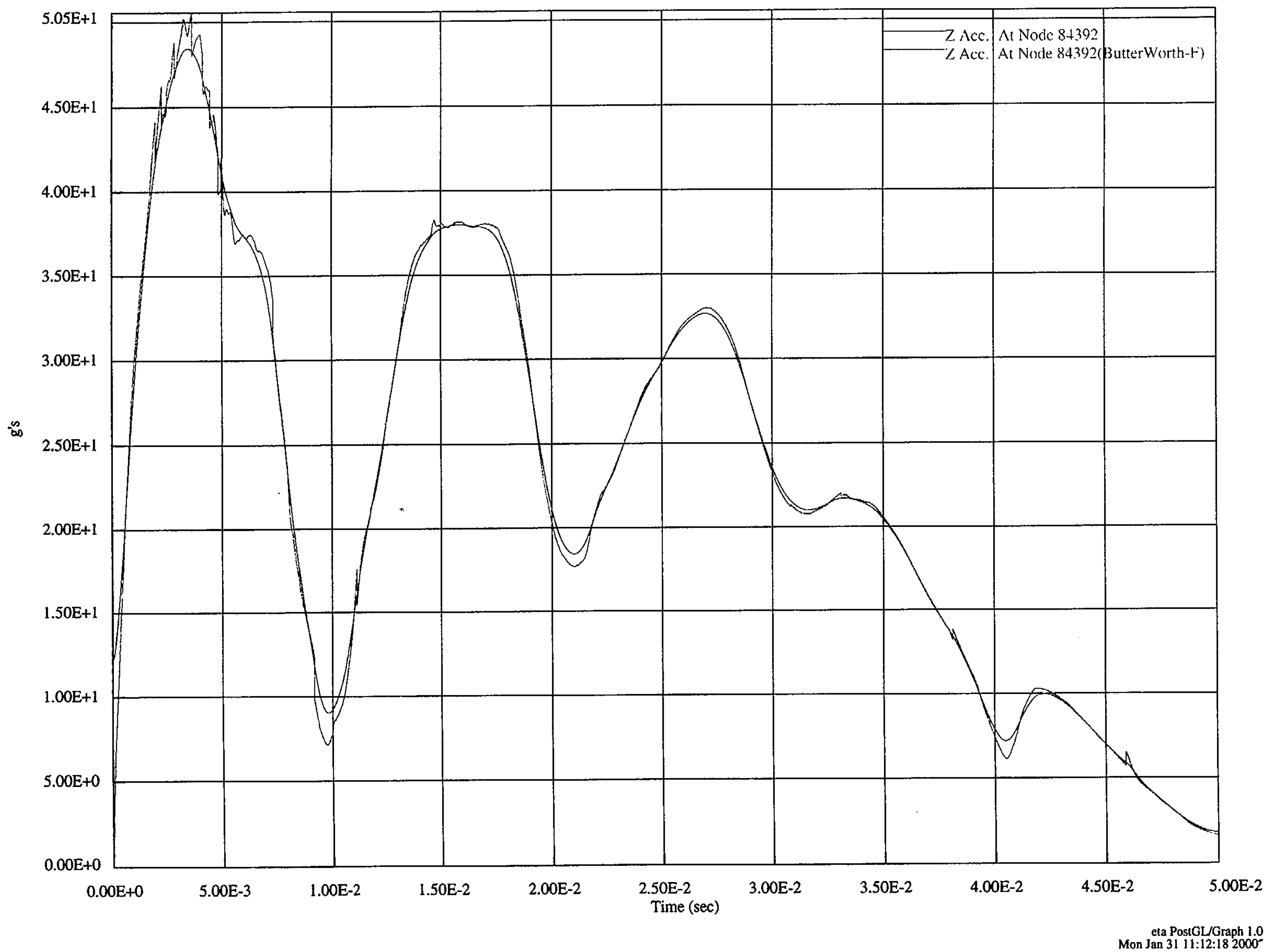

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FIG 3A.22 Tipover Scenario: Channel A2 Deceleration Time Histories

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Table 4.4.20

MPC-24 DESIGN-BASIS MAXIMUM HEAT LOAD[1]
VERSUS FUEL AGE AT LOADING

Fuel Age At Loading (years)	Permissible Heat Load (kW)
5	20.88
6	20.17
7	18.18
10	17.72
15	17.17

1 The cask heat load limits (Q_τ) presented in this table pertain to loading the MPC with uniformly aged fuel assemblies emitting heat at the design basis maximum rate (q_τ), where "τ" is the age of the fuel at the start of dry storage. For a cask loaded with a mix of fuel ages, the cask heat load limit shall be the sum of the individual assembly decay heat limits (as a function of τ) as specified in the Appendix B to COC 1014.

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Table 4.4.21

MPC-68 DESIGN-BASIS MAXIMUM HEAT LOAD[1]
VERSUS FUEL AGE AT LOADING

Fuel Age At Loading (years)	Permissible Heat Load (kW)
5	21.52
6	20.31
7	18.41
10	17.95
15	17.45

1 The cask heat load limits (Q_τ) presented in this table pertain to loading the MPC with uniformly aged fuel assemblies emitting heat at the design basis maximum rate (q_τ), where "τ" is the age of fuel at the start of dry storage. For a cask loaded with a mix of fuel ages, the cask heat load limit shall be the sum of the individual assembly decay heat limits (as a function of fuel age) as specified in the Appendix B to COC 1014.

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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 ~~plus the minimum test sensitivity of 2.5×10^{-6} atm-cm^3/sec~~ under normal and off-normal conditions of storage. |

7.2.2 Pressurization of the Confinement Vessel

The loaded and sealed MPC is drained, vacuum dried, 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 vacuum dried, 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

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7.2.8.2 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 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 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 doses for tissues and organs other than lens of the eye were determined using spreadsheet software. The dose to the lens of the eye 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. The estimated dose to the lens of the eye ~~o~~is greatest using the accident condition of storage for the MPC-68. Section 7.3.4.2 presents the detailed discussion of the dose to the lens of the eye.

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, 1% of the fuel rods have ruptured. This assumption is in accordance with NUREG-1536 for normal storage conditions.
- Under off-normal conditions of storage, 10% of the fuel rods have ruptured. This assumption is in accordance with ISG-5 and NUREG-1536 for 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.

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- For conservatism, the upstream pressure at 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 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.

- Normal storage conditions (i.e., MPC cavity at a pressure of 80 psia (5.44 ATM) at MPC cavity average temperature of 510 K) are postulated for this analysis as these condition bound the off-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 lung clearance class which reports the most conservative values.

- *For conservativism, the maximum possible leakage rate is assumed to be $7.5x10^{-6}$ atm-cm^3/s, which is 150% of the test leak rate of $5.0x10^{-6}$ atm-cm^3/s*

PWR
Surface area per Assy = 3.0E+05 cm^2
140 μCi/cm^2 x 3.0E+05 cm^2 = 42.0 Ci

BWR
Surface area per Assy = 1.0E+05 cm^2
1254 μCi/cm^2 x 1.0E+05 cm^2 = 125.4 Ci

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

MPC-24

$^{60}Co(5) = 42.0 \text{ Ci } e^{-(\ln 2/5.272)(5)}$
$^{60}Co(5) = 21.77$ Ci

MPC-68

$^{60}Co(5) = 125.4 \text{ Ci } e^{-(\ln 2/5.272)(5)}$
$^{60}Co(5) = 64.98$ Ci

MPC-68F

$^{60}Co(18) = 125.4 \text{ Ci } e^{-(\ln 2/5.272)(18)}$
$^{60}Co(18) = 11.76$ 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 Seal Leakage Rate

The helium leak rate testing performed on the MPC confinement boundary verifies the helium leak rate to be less than or equal to 5x10^{-6} atm-cm^3/s [1] as required by the Technical Specifications ~~with a minimum sensitivity of 2.5x10^{-6} atm-cm^3/s.~~ 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 from the confinement vessel is ~~the maximum leakage rate acceptance criteria plus the sensitivity. This yields an assumed helium leakage rate of~~ 7.5x10^{-6} atm-cm^3/s.

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:

[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.

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- 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 lung clearance class which reports the most conservative values.

- *For conservativism, the maximum possible leakage rate 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.*

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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 or delete steps as necessary provided that the intent of this guidance is 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 12.A~~ *Appendix A to CoC 72-1014* provide ~~functional and Operating Limits,~~ 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. TSAR* Appendix 12.A ~~also~~ includes *the* Bases for the ~~Functional and Operating Limits, and 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 TSAR 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. 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 rendition. Users may select alternate configurations, equipment and methodology to accommodate their specific needs. 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.

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

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Licensees (Users) will utilize the procedures provided in this chapter, the Technical Specifications in ~~Chapter 12~~ *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, 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 and QA category, 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 ~~Technical Specifications~~ *Appendix B to CoC 72-1014* are loaded into the HI-STORM 100 System.

In addition to the requirements set forth in the ~~Technical Specifications~~ *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 TSAR provides some sample time limits for the time to initiation of draining for various spent fuel pool water temperatures using design basis heat loads.

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 shall 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.

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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 ~~12.A~~ *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 Step 1. 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 ~~the MPC shell and HI-TRAC internals~~*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 ~~12.A~~ *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 temperatures to below water boiling temperature prior to flooding.	See Section 8.1.5 Step 24b, Section 8.3.3 Step 8 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.

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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 via the quick disconnect. See Figure 8.1.14.

b. 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.

c. Wet the surfaces of HI-TRAC and lift yoke with plant demineralized water while slowly lowering HI-TRAC into the spent fuel pool.

d. 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.

e. 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.

f. 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.

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 ~~the Technical Specifications~~ *Appendix B to CoC 72-1014* have been selected for loading into the MPC.

Load the pre-selected fuel assemblies into the MPC in accordance with the approved fuel loading pattern.

Perform a post-loading visual verification of the assembly identification to confirm that the serial numbers match the approved fuel loading pattern.

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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 (pressure set to 10+10/-0 psig) to the vent port and attach the drain line to the drain port as shown on Figure 8.1.21.

f. Reset the totalizer on the drain line.

g. Verify the correct pressure (pressure set to 10+10/-0 psig) on the helium supply and open the helium supply valve. Drain approximately twenty gallons as measured by the totalizer.

h. Close the drain port valve and pressurize the MPC to 10+10/-0 psig helium.

i. 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.

j. 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 ~~std~~*atm* cc/sec (He)~~ with a minimum test sensitivity less than 2.5E-6 std cc/sec (He)~~. See Technical Specification LCO 3.1.1.

k. 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.

27. Drain the MPC as follows:

Note:
It is necessary to completely fill the MPC with water to get an accurate measurement of the MPC internal free space.

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.

g. Perform a liquid penetrant examination on the closure ring root welds.

h. Complete the closure ring 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 are contained in the ASME Boiler and Pressure Vessel Code, Section III, Subsection NB, Article NB-5350. 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.

i. Perform a liquid penetrant examination on the closure ring final weld.

j. Remove the Automated Welding System.

k. If necessary, remove the AWS baseplate shield. 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.

Remove the annulus shield and store it in an approved plant storage location

a. 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.

b. Install HI-TRAC Top Lid as follows:

Warning:
When traversing the MPC with 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.

1. Install HI-TRAC Top Lid. Inspect the bolts for general condition. Replace worn or damaged bolts with new bolts.

2. Install and torque the Top Lid bolts. See Table 8.1.5 for torque requirements.

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 support stays and store them in an approved plant storage location.

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

3. 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, 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 truck bay 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.

8.1.7 <u>Placement of HI-STORM into Storage</u>

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, or on a flatbed trailer. If necessary, remove the exit vent screens and gamma shield cross plates 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.

Table 8.1.1

HI-STORM 100 SYSTEM COMPONENT AND HANDLING WEIGHTS
125-TON HI-TRAC

Component	MPC-24	MPC-68	Case† Applicability					
			1	2	3	4	5	6
Empty HI-STORM 100 overpack (without lid)	245,040	245,040					1	
HI-STORM 100 lid (without rigging)	23,963	23,963					1	
Empty MPC (without lid or closure ring including drain line)	29,845	29,302	1	1	1	1	1	1
MPC lid (without fuel spacers or drain line)	9677	10,194	1	1	1	1	1	1
MPC Closure Ring	145	145			1	1	1	1
Fuel (design basis)	40,320	47,600	1	1	1	1	1	1
Damaged Fuel Container (Dresden 1)	0	150						
Damaged Fuel Container (Humboldt Bay)	0	120						
MPC water (with fuel in MPC)	17,630	16,957	1	1				
Annulus Water	~~280~~*256*	~~280~~*256*	1	1				
HI-TRAC Lift Yoke (with slings)	3600	3600	1	1	1			
Annulus Seal	50	50	1	1				
Lid Retention System	2300	2300						
Transfer frame	6700	6700						1
Empty HI-TRAC (without Top Lid, neutron shield jacket water, or bottom lids)	118,470	118,470	1	1	1			1
HI-TRAC Top Lid	2730	2730			1			1
HI-TRAC Pool Lid (with bolts)	12,031	12,031	1	1				
HI-TRAC Transfer Lid (with bolts)	21,679	21,679			1			1
HI-TRAC Neutron Shield Jacket Water	9757	9757		1	1			1
MPC Stays (total of 2)	200	200						
MPC Lift Cleat	480	480			1	1		1

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† See Table 8.1.2.

TABLE 8.1.2
MAXIMUM 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-68**
1	Loaded HI-TRAC removal from spent fuel pool (neutron tank empty)	~~231,903~~ *231,879*	~~238,484~~ *238,460*
2	Loaded HI-TRAC removal from spent fuel pool (neutron tank full)	~~241,660~~ *241,636*	~~248,241~~ *248,217*
3	Loaded HI-TRAC During Movement through Hatchway	236,703	243,957
4	MPC during transfer operations	80,467	87,721
5	Loaded HI-STORM in storage	348,990	356,244
6	Loaded HI-TRAC and transfer frame during on site handling	239,803	247,057

Table 8.1.3
HI-STORM 100 SYSTEM COMPONENT AND HANDLING WEIGHTS
100-TON HI-TRAC

Component	Weight (lbs)		Case† Applicability					
	MPC-24	MPC-68	1	2	3	4	5	6
Empty HI-STORM 100 overpack (without lid)	245,040	245,040					1	
HI-STORM 100 lid (without rigging)	23,963	23,963					1	
Empty MPC (without lid or closure ring including drain line)	29,845	29,302	1	1	1	1	1	1
MPC lid (without fuel spacers or drain line)	9677	10,194	1	1	1	1	1	1
MPC Closure Ring	145	145			1	1	1	1
Fuel (design basis)	40,320	47,600	1	1	1	1	1	1
Damaged Fuel Container (Dresden 1)	0	150						
Damaged Fuel Container (Humboldt Bay)	0	120						
MPC water (with fuel in MPC)	17,630	16,957	1	1				
Annulus Water	~~280~~*256*	~~280~~*256*	1	1				
HI-TRAC Lift Yoke (with slings)	3200	3200	1	1	1			
Annulus Seal	50	50	1	1				
Lid Retention System	2300	2300						
Transfer frame	6700	6700						1
Empty HI-TRAC (without Top Lid, neutron shield jacket water, or bottom lids)	~~91,843~~ *84,031*	~~91,843~~ *84,031*	1	1	1			1
HI-TRAC Top Lid	1202	1202			1			1
HI-TRAC Pool Lid (with bolts)	7,915	7,915	1	1				
HI-TRAC Transfer Lid (with bolts)	16,425	16,425			1			1
HI-TRAC Neutron Shield Jacket Water	~~7465~~*7556*	~~7465~~*7556*		1	1			1
MPC Stays (total of 2)	200	200						
MPC Lift Cleat	480	480			1	1		1

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† See Table 8.1.4.

Table 8.1.4
MAXIMUM 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-68**
1	Loaded HI-TRAC removal from spent fuel pool (neutron tank empty)	~~200,760~~ *193,180*	~~207,341~~ *199,505*
2	Loaded HI-TRAC removal from spent fuel pool (neutron tank full)	~~208,225~~ *200,736*	~~214,806~~ *207,061*
3	Loaded HI-TRAC During Movement through Hatchway	~~200,602~~ *193,137*	~~207,856~~ *200,135*
4	MPC during transfer operations	80,467	87,721
5	Loaded HI-STORM in storage	348,990	356,244
6	Loaded HI-TRAC and transfer frame during on site handling	~~204,102~~ *196,637*	~~211,356~~ *203,635*

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9.1 ACCEPTANCE CRITERIA

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

These inspections and tests are also intended to demonstrate that the operation of the HI-STORM 100 System complies with the applicable regulatory requirements and the Technical Specifications contained in Appendix A to CoC 72-1014. Noncompliances encountered during the required inspections and tests shall be corrected or dispositioned to bring the item into compliance with this TSAR. Identification and resolution of noncompliances shall be performed in accordance with the Holtec International Quality Assurance Program as described in Chapter 13 of this TSAR, or the licensee's NRC-approved Quality Assurance Program.

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

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

9.1.1 Fabrication and Nondestructive Examination (NDE)

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

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

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

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ring, port cover plates and shell) shall also be inspected per the requirements of ASME Section III, Article NB-2500.

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

   NOTE: Exceptions to these Code requirements are provided in TSAR Chapter 2 and in Table 3-1 of Appendix B to CoC 72-1014.

3. ASME Code welding shall be performed using welders and weld procedures that have been qualified in accordance with ASME Code Section IX and the applicable ASME Section III Subsections (e.g., NB, NG, or NF, as applicable to the SSC). AWS code welding may be performed using welders and weld procedures that have been qualified in accordance with applicable AWS requirements or in accordance with ASME Code Section IX

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

5. Machined surfaces of the metal components of the HI-STORM 100 System shall be visually examined in accordance with ASME Section V, Article 9, to verify they are free of cracks and pin holes.

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

Concrete testing shall be performed for each lot of concrete. Concrete testing shall comply with ACI 349, as described in Table 1.D.2. Test specimens shall be in accordance with ASTM C39.

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

9.1.3 Leakage Testing

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

At completion of welding the MPC shell to the baseplate, an MPC confinement boundary weld helium leakage test shall be performed using a helium mass spectrometer leak detector (MSLD). ~~having a minimum calibrated sensitivity of $2.5x10^{-6}$ std cm^3/s (helium)~~. A temporary test closure lid is used in order to provide a sealed MPC. The confinement boundary welds shall have indicated helium leakage rates less than or equal to $5x10^{-6}$ atm cm^3/s (helium). If a leakage rate exceeding the acceptance criterion is detected, then the area of leakage shall be determined and the area repaired per ASME Code Section III, Subsection NB, Article NB-4450 requirements. Re-testing shall be performed until the leakage rate acceptance criteria is met.

If failure of the leakage rate retest occurs after initial repairs are completed, a nonconformance report shall be issued, and a root cause evaluation and appropriate corrective actions taken before further repairs and retest are performed.

Leakage testing of the field welded MPC lid-to-shell weld shall be performed following the successful completion of the MPC hydrostatic test performed per Section 9.1.2.2.2. Leakage testing of the vent and drain port cover plate welds shall be performed after welding of the cover plates and subsequent NDE. The description and procedures for these field leakage tests are provided in TSAR Section 8.1, and the acceptance criteria are defined in the Technical Specifications in Appendix A to CoC 72-1014.

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

9.1.4 Component Tests

9.1.4.1 Valves, Rupture Discs, and Fluid Transport Devices

There are no fluid transport devices or rupture discs associated with the HI-STORM 100 System. The only valve-like components in the HI-STORM 100 System are the specially designed caps installed in the MPC lid for the drain and vent ports. These caps are recessed inside the MPC lid and covered by the fully-welded vent and drain port cover plates. No credit is taken for the caps' ability of the cask in the lead pour region. The gamma scanning shall be performed prior to installation of the water jacket. The purpose of the gamma scanning test is to demonstrate that the gamma shielding of the transfer cask body, pool lid, and transfer lid doors is at least as effective as that of a lead and steel test block. For the test block, the steel thickness shall be equivalent to the minimum design thickness of steel in the transfer cask component and the lead thickness shall be 5 percent lower than the minimum design thickness of lead in the transfer cask component (see the Design Drawings for the design values). Data shall be recorded on a 6-inch by 6-inch (nominal) grid pattern over the surfaces to be scanned. Should the measured gamma dose rates exceed those established with the test block, the shielding of that transfer cask component shall be deemed unacceptable. Corrective actions shall be taken as appropriate and the testing re-performed until successful results are achieved. 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.

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, vacuum dried, 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

After manufacturing, a statistical sample of each lot of Boral shall be tested using wet chemistry and/or neutron attenuation techniques to verify a minimum ^{10}B content (areal density) at the ends of the panel. 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 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 Boral panel in accordance with Design Drawings in Chapter 1. These quality control processes, in conjunction with Boral manufacturing testing, provide the necessary assurances that the Boral will perform its intended function. No additional testing or in-service monitoring of the Boral will be required.

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12.1 PROPOSED OPERATING CONTROLS AND LIMITS

12.1.1 NUREG-1536 (Standard Review Plan) Acceptance Criteria

12.1.1.1 This portion of the TSAR establishes the commitments regarding the HI-STORM 100 System and its use. Other 10CFR72 [12.1.2] and 10CFR20 [12.1.3] requirements in addition to the Technical Specifications may apply. The conditions for a general license holder found in 10CFR72.212 [12.1.2] shall be met by the licensee prior to loading spent fuel into the HI-STORM 100 System. The general license conditions governed by 10CFR72 [12.1.2] are not repeated with these Technical Specifications. Licensees are required to comply with all commitments and requirements.

12.1.1.2 The Technical Specifications provided in Appendix A to CoC 72-1014 and the authorized contents and design features provided in Appendix B to Co 72-1014 are primarily established to maintain subcriticality, confinement boundary integrity, shielding and radiological protection, heat removal capability, and structural integrity under normal, off-normal and accident conditions. Table 12.1.1 addresses each of these conditions respectively and identifies the appropriate Technical Specification(s) designed to control the condition. Table 12.1.2 provides the list of Technical Specifications for the HI-STORM 100 System.

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Table 12.1.1

HI-STORM 100 SYSTEM CONTROLS

Condition to be Controlled	**Applicable Technical Specifications**[1]
Criticality Control	Refer to Appendix B to Certificate of Compliance 72-1014 for fuel specifications and design features
Confinement Boundary Integrity	3.1.1 Multi-Purpose Canister (MPC)
Shielding and Radiological Protection	Refer to Appendix B to Certificate of Compliance 72-1014 for fuel specifications and design features 3.1.1 Multi-Purpose Canister (MPC) 3.1.3 Fuel Cool-Down 3.2.1 TRANSFER CASK Average Surface Dose Rates 3.2.2 TRANSFER CASK Surface Contamination 3.2.3 OVERPACK Average Surface Dose Rates
Heat Removal Capability	Refer to Appendix B to Certificate of Compliance 72-1014 for fuel specifications and design features 3.1.1 Multi-Purpose Canister (MPC) 3.1.2 SFSC Heat Removal System
Structural Integrity	3.5 Cask Transfer Facility (CTF) (CoC 72-1014, Appendix B – Design Features) 5.5 Cask Transport Evaluation Program

[1] Technical Specifications are located in Appendix A to CoC 72-1014

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Table 12.1.2

HI-STORM 100 SYSTEM TECHNICAL SPECIFICATIONS

NUMBER	TECHNICAL SPECIFICATION
1.0	USE AND APPLICATION 1.1 Definitions 1.2 Logical Connectors 1.3 Completion Times 1.4 Frequency
2.0	Not Used. Refer to Appendix B to CoC 72-1014 for fuel specifications.
3.0	LIMITING CONDITION FOR OPERATION (LCO) APPLICABILITY SURVEILLANCE REQUIREMENT (SR) APPLICABILITY
3.1.1	Multi-Purpose Canister (MPC)
3.1.2	SFSC Heat Removal System
3.1.3	Fuel Cool-Down
3.2.1	TRANSFER CASK Average Surface Dose Rates
3.2.2	TRANSFER CASK Surface Contamination
3.2.3	OVERPACK Average Surface Dose Rates
Table 3-1	MPC Model-Dependent Limits
4.0	Not Used. Refer to Appendix B to CoC 72-1014 for design features.
5.0	ADMINSTRATIVE CONTROLS AND PROGRAMS
5.1	Training Program
5.2	Pre-Operational testing and Training Exercise
5.3	Special Requirements For First System In Place
5.4	Radioactive Effluent Control Program
5.5	Cask Transport Evaluation Program
Table 5-1	TRANSFER CASK and OVERPACK Lifting Requirements

12.2 DEVELOPMENT OF OPERATING CONTROLS AND LIMITS

This section provides a discussion of the operating controls and limits for the HI-STORM 100 System to assure long-term performance consistent with the conditions analyzed in this TSAR. In addition to the controls and limits provided in the Technical Specifications contained in Appendix A to Certificate of Compliance 72-1014 and the Approved Contents and Design Features in Appendix B to Certificate of Compliance 72-1014, the licensee shall ensure that the following training and dry run activities are performed.

12.2.1 Training Modules

Training modules are to be developed under the licensee's training program to require a comprehensive, site-specific training, assessment, and qualification (including periodic re-qualification) program for the operation and maintenance of the HI-STORM 100 Spent Fuel Storage Cask (SFSC) System and the Independent Spent Fuel Storage Installation (IFSI). The training modules shall include the following elements, at a minimum:

1. HI-STORM 100 System Design (overview);
2. ISFSI Facility Design (overview);
3. Systems, Structures, and Components Important to Safety (overview)
4. HI-STORM 100 System Topical Safety Analysis Report (overview);
5. NRC Safety Evaluation Report (overview);
6. Certificate of Compliance conditions;
7. HI-STORM 100 Technical Specifications, Approved Contents, Design Features and other Conditions for Use;
8. HI-STORM 100 Regulatory Requirements (e.g., 10CFR72.48, 10CFR72, Subpart K, 10CFR20, 10CFR73);
9. Required instrumentation and use;
10. Operating Experience Reviews

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accordance with procedures developed for the ISFSI, no failure of the system to perform its safety function is expected to occur.

12.2.6 Surveillance Requirements

The analyses provided in this TSAR show that the HI-STORM 100 System fulfills its safety functions, provided that the Technical Specifications in Appendix A to CoC 72-1014 and the Authorized Contents and Design Features in Appendix B to CoC 72-1014 are met. Surveillance requirements during loading, unloading, and storage operations are provided in the Technical Specifications.

12.2.7 Design Features

This section describes HI-STORM 100 System design features that are Important to Safety. These features require design controls and fabrication controls. The design features, detailed in this TSAR and in Appendix B to CoC 72-1014, are established in specifications and drawings which are controlled through the quality assurance program presented in Chapter 13. Fabrication controls and inspections to assure that the HI-STORM 100 System is fabricated in accordance with the design drawings and the requirements of this TSAR are described in Chapter 9.

12.2.8 MPC

a. Basket material composition, properties, dimensions, and tolerances for criticality control.

b. Canister material mechanical properties for structural integrity of the confinement boundary.

c. Canister and basket material thermal properties and dimensions for heat transfer control.

d. Canister and basket material composition and dimensions for dose rate control.

12.2.9 HI-STORM 100 Overpack

a HI-STORM 100 overpack material mechanical properties and dimensions for structural integrity to provide protection of the MPC and shielding of the spent nuclear fuel assemblies during loading, unloading and handling operations.

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12.3 TECHNICAL SPECIFICATIONS

Technical Specifications for the HI-STORM 100 System are provided in Appendix A to Certificate of Compliance 72-1014. Authorized Contents (i.e., fuel specifications) and Design Features are provided in Appendix B to CoC 72-1014. Bases applicable to the Technical Specifications are provided in TSAR Appendix 12.A. The format and content of the HI-STORM 100 System Technical Specifications and Bases are that of the Improved Standard Technical Specifications for power reactors, to the extent they apply to a dry spent fuel storage cask system. NUMARC Document 93-03, "Writer's Guide for the Restructured Technical Specifications" [12.3.1] was used as a guide in the development of the Technical Specifications and Bases.

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12.4 REGULATORY EVALUATION

Table 12.1.2 lists the Technical Specifications for the HI-STORM 100 System. The Technical Specifications are detailed in Appendix A to Certificate of Compliance 72-1014. The Authorized Contents (i.e., fuel specifications) and Design Features are provided in Appendix B to CoC 72-1014.

The conditions for use of the HI-STORM 100 System identify necessary Technical Specifications, limits on authorized contents (i.e., fuel), and cask design features to satisfy 10 CFR Part 72, and the applicable acceptance criteria have been satisfied. Compliance with these Technical specifications and other conditions of the Certificate of Compliance provides reasonable assurance that the HI-STORM 100 System will provide safe storage of spent fuel and is in compliance with 10 CFR Part 72, the regulatory guides, applicable codes and standards, and accepted practices.

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HI-STORM 100 SYSTEM TSAR

APPENDIX 12.A

TECHNICAL SPECIFICATION BASES

FOR THE HOLTEC HI-STORM 100 SPENT FUEL STORAGE CASK SYSTEM

(36 PAGES, INCLUDING THIS PAGE)

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BASES TABLE OF CONTENTS

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BASES

SURVEILLANCE REQUIREMENTS

SR 3.1.1.1, SR 3.1.1.2, and SR 3.1.1.3 (continued)

The leakage rate acceptance limit is specified in units of atm-cc/sec. This is a mass-like leakage rate as specified in ANSI N14.5 (1997). This is defined as the rate of change of the pressure-volume product of the leaking fluid at test conditions. This allows the leakage rate as measured by a mass spectrometer leak detector (MSLD) to be compared directly to the acceptance limit without the need for unit conversion from test conditions to standard, or reference conditions.

All three of these surveillances must be successfully performed once, prior to TRANSPORT OPERATIONS to ensure that the conditions are established for SFSC storage which preserve the analysis basis supporting the cask design.

REFERENCES

1. TSAR Sections 4.4, 7.2, 7.3 and 8.1

BASES

ACTIONS

B.1 (continued)

assemblies must be placed in a safe condition in the spent fuel pool. The Completion Time is reasonable based on the time required to replace the transfer lid with the pool lid, perform fuel cooldown operations, re-flood the MPC, cut the MPC lid welds, move the TRANSFER CASK into the spent fuel pool, remove the MPC lid, and remove the spent fuel assemblies in an orderly manner and without challenging personnel.

SURVEILLANCE REQUIREMENTS

SR 3.2.1.1

This SR ensures that the TRANSFER CASK average surface dose rates are within the LCO limits prior to TRANSPORT OPERATIONS. The surface dose rates are measured approximately at the locations indicated on Figure 3.2.1-1 following standard industry practices for determining average dose rates for large containers. The SR requires specific locations for taking dose rate measurements to ensure the dose rates measured are indicative of the average value around the cask.

REFERENCES

1. 10 CFR Parts 20 and 72.
2. TSAR Sections 5.1 and 8.1.6.

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B 3.2 SFSC Radiation Protection

B 3.2.2 TRANSFER CASK Surface Contamination

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BASES

BACKGROUND

A TRANSFER CASK is immersed in the spent fuel pool in order to load the spent fuel assemblies. As a result, the surface of the TRANSFER CASK may become contaminated with the radioactive material in the spent fuel pool water. This contamination is removed prior to moving the TRANSFER CASK to the ISFSI, or prior to transferring the MPC into the OVERPACK, whichever occurs first, in order to minimize the radioactive contamination to personnel or the environment. This allows dry fuel storage activities to proceed without additional radiological controls to prevent the spread of contamination and reduces personnel dose due to the spread of loose contamination or airborne contamination. This is consistent with ALARA practices.

APPLICABLE SAFETY ANALYSIS

The radiation protection measures implemented during MPC transfer and transportation using the TRANSFER CASK are based on the assumption that the exterior surfaces of the TRANSFER CASKs have been decontaminated. Failure to decontaminate the surfaces of the TRANSFER CASKs could lead to higher-than-projected occupational doses.

LCO

Removable surface contamination on the TRANSFER CASK exterior surfaces and accessible surfaces of the MPC is limited to 1000 dpm/100 cm^2 from beta and gamma sources and 20 dpm/100 cm^2 from alpha sources. These limits are taken from the guidance in IE Circular 81-07 (Ref. 2) and are based on the minimum level of activity that can be routinely detected under a surface contamination control program using direct survey methods. Only loose contamination is controlled, as fixed contamination will not result from the TRANSFER CASK loading process. Experience has shown that these limits are low enough to prevent the spread of contamination to clean areas and are significantly less than the levels which would cause significant personnel skin dose.

(continued)