RENEWED CERTIFICATE OF COMPLIANCE NO. 1014

APPENDIX D

APPROVED CONTENTS AND DESIGN FEATURES

FOR THE HI-STORM 100S VERSION E CASK AND HI-TRAC MS

AMENDMENT NO. 16

TABLE OF CONTENTS

1.0 Definitions

Refer to Appendix C for Definitions.

2.0 APPROVED CONTENTS

2.1 Fuel Specifications and Loading Conditions

a. UNDAMAGED FUEL ASSEMBLIES, DAMAGED FUEL ASSEMBLIES, FUEL DEBRIS, and NON-FUEL HARDWARE meeting the limits specified in Table 2.1-1 and other referenced tables may be stored in MPC- 32M.

b. For MPCs partially loaded with stainless steel clad fuel assemblies, all remaining fuel assemblies in the MPC shall meet the decay heat generation limit for the stainless steel clad fuel assemblies.

c. INTACT FUEL ASSEMBLIES, UNDAMAGED FUEL ASSEMBLIES, DAMAGED FUEL ASEMBLIES, FUEL DEBRIS and NON-FUEL HARDWARE meeting the limits specified in Appendix B Table 2.1-1 and other referenced Appendix B tables for MPC-24/24E/24EF/32/32F/68/68F/68FF/68M may be stored in the applicable MPC in the HI-STORM 100S Version E.

d. INTACT FUEL ASSEMBLIES, UNDAMAGED FUEL ASSEMBLIES, FUEL DEBRIS, DAMAGED FUEL ASSEMBLIES and NON-FUEL HARDWARE meeting the limits specified in Appendix B Table 2.1-1 and other referenced Appendix B tables for the MPC-68 may be stored in the MPC-68 version 1 in the HI-STORM 100S Version E.

e. INTACT FUEL ASSEMBLIES, UNDAMAGED FUEL ASSEMBLIES, FUEL DEBRIS, DAMAGED FUEL ASSEMBLIES and NON-FUEL HARDWARE meeting the limits specified in Appendix B Table 2.1-1 and other referenced Appendix B tables for the MPC-32 may be stored in the MPC-32 version 1 in the HI-STORM 100 Version E.

2.1.2 Fuel Loading

Fuel assembly decay heat limits and other restrictions related to DAMAGED FUEL, FUEL DEBRIS, and NON-FUEL HARDWARE are specified in Section 2.4. Cell identification for MPC-32M is in Figure 2.1-1.

2.2 Violations

If any Fuel Specifications or Loading Conditions of 2.1 are violated, the following actions shall be completed:

2.2.1 The affected fuel assemblies shall be placed in a safe condition.

2.2.2 Within 24 hours, notify the NRC Operations Center.

2.2.3 Within 30 days, submit a special report which describes the cause of the violation, and actions taken to restore compliance and prevent recurrence.

2.3 Not Used

Table 2.1-1 (page 1 of 4)
Fuel Assembly Limits

V. MPC MODEL: MPC-32M

A. Allowable Contents

1. Uranium oxide, PWR UNDAMAGED FUEL ASSEMBLIES listed in Table 2.1-2, with or without NON-FUEL HARDWARE and meeting the following specifications (Note 1):

a. Cladding Type:	ZR for all fuel assembly array/class except, Stainless Steel (SS) for 14x14D and 15x15G fuel assembly array/class
b. Maximum Initial Enrichment:	5.0 wt. % U-235
c. Post-irradiation Cooling Time and Average Burnup Per Assembly:	
i. All Array/Classes	Zr clad:Cooling time ≥ 1 year and average burnup ≤ 68,200 MWD/MTU. SS clad: Cooling time ≥ 9 years and ≤ 30,000 MWD/MTU or ≥ 20 years and ≤ 40,000MWD/MTU
ii. NON-FUEL HARDWARE	As specified in Table 2.1-3.

Table 2.1-1 (page 2 of 4)
Fuel Assembly Limits

V. MPC MODEL: MPC-32M stored in HI-STORM 100S Version E SFSC (cont'd)

A. Allowable Contents (cont'd)

d. Decay Heat Per Fuel Storage Location:	
i. Array/Classes 14x14D and 15x15G	≤ 500 Watts.
ii. All Other Array/Classes	As specified in Section 2.4.
e. Fuel Assembly Length	≤ 176.8 inches (nominal design)
f. Fuel Assembly Width	≤ 8.54 inches (nominal design)
g. Fuel Assembly Weight	≤ 2,050 lbs (including NON-FUEL HARDWARE)

Table 2.1-1 (page 3 of 4)
Fuel Assembly Limits

V. MPC MODEL: MPC-32M (cont'd)

A. Allowable Contents (cont'd)

2. Uranium oxide, PWR DAMAGED FUEL ASSEMBLIES and FUEL DEBRIS, with or without NON-FUEL HARDWARE, placed in DAMAGED FUEL CONTAINERS. Uranium oxide PWR DAMAGED FUEL ASSEMBLIES whose damage is limited such that the fuel assembly is able to be handled by normal means and whose structural integrity remains intact to the extent that geometric rearrangement of fuel is not expected, may be placed in basket cell locations containing top and bottom DAMAGED FUEL ISOLATORS. Uranium oxide PWR DAMAGED FUEL ASSEMBLIES and FUEL DEBRIS shall meet the criteria specified in Table 2.1-2 and meet the following specifications (Note 1):

a. Cladding Type:	ZR for all fuel assembly array/class except, Stainless Steel (SS) for 14x14D and 15x15G fuel assembly array/class
b. Maximum Initial Enrichment:	5.0 wt. % U-235
c. Post-irradiation Cooling Time and Average Burnup Per Assembly:	
i. All Array/Classes	Zr clad: Cooling time ≥ 1 year and average burnup ≤ 68,200 MWD/MTU. SS clad: Cooling time ≥ 9 years and ≤ 30,000 MWD/MTU or ≥ 20 years and ≤ 40,000MWD/MTU
ii. NON-FUEL HARDWARE	As specified in Table 2.1-3.

Table 2.1-1 (page 4 of 4)
Fuel Assembly Limits

V. MPC MODEL: MPC-32M stored in HI-STORM 100S Version E SFSC (cont'd)

A. Allowable Contents (cont'd)

d. Decay Heat Per Fuel Storage Location:	
i. Array/Classes 14x14D and 15x15G	≤ 500 Watts.
ii. All Other Array/Classes	As specified in Section 2.4.
e. Fuel Assembly Length	≤ 176.8 inches (nominal design)
f. Fuel Assembly Width	≤ 8.54 inches (nominal design)
g. Fuel Assembly Weight	≤ 2,050 lbs (including NON-FUEL HARDWARE and DFC)

B. Quantity per MPC: Up to sixteen (16) DAMAGED FUEL ASSEMBLIES stored using DAMAGED FUEL ISOLATORS or DAMAGED FUEL CONTAINERS and/or FUEL DEBRIS in DAMAGED FUEL CONTAINERS, stored in fuel storage locations in Table 2.4-1. The remaining fuel storage locations may be filled with PWR UNDAMAGED FUEL ASSEMBLIES meeting the applicable specifications.

C. One NSA is permitted for loading.

Note 1: Fuel assemblies containing BPRAs, TPDs, WABAs, water displacement guide tube plugs, orifice rod assemblies, or vibration suppressor inserts, with or without ITTRs, may be stored in any fuel storage location.

Table 2.1-2 (page 1 of 4)

PWR FUEL ASSEMBLY CHARACTERISTICS FOR MPC-32M (Note 1)

Fuel Assembly Array/Class	**14x14A**	**14x14B**	**14x14C**	**14x14D**
No. of Fuel Rod Locations	179	179	176	180
Fuel Rod Clad O.D. (in.)	≥ 0.400	≥ 0.417	≥ 0.440	≥ 0.422
Fuel Rod Clad I.D. (in.)	≤ 0.3514	≤ 0.3734	≤ 0.3880	≤ 0.3890
Fuel Pellet Dia. (in.) (Note 3)	≤ 0.3444	≤ 0.3659	≤ 0.3805	≤ 0.3835
Fuel Rod Pitch (in.)	≤ 0.556	≤ 0.556	≤ 0.580	≤ 0.556
Active Fuel Length (in.)	≤ 150	≤ 150	≤ 150	≤ 144
No. of Guide and/or Instrument Tubes	17	17	5 (Note 2)	16
Guide/Instrument Tube Thickness (in.)	≥ 0.017	≥ 0.017	≥ 0.038	≥ 0.0145

Table 2.1-2 (page 2 of 4)

PWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/Class	**15x15A**	**15x15B**	**15x15C**	**15x15D**	**15x15E**	**15x15F**
No. of Fuel Rod Locations	204	204	204	208	208	208
Fuel Rod Clad O.D. (in.)	≥ 0.418	≥ 0.420	≥ 0.417	≥ 0.430	≥ 0.428	≥ 0.428
Fuel Rod Clad I.D. (in.)	≤ 0.3660	≤ 0.3736	≤ 0.3640	≤ 0.3800	≤ 0.3790	≤ 0.3820
Fuel Pellet Dia. (in.) (Note 3)	≤ 0.3580	≤ 0.3671	≤ 0.3570	≤ 0.3735	≤ 0.3707	≤ 0.3742
Fuel Rod Pitch (in.)	≤ 0.550	≤ 0.563	≤ 0.563	≤ 0.568	≤ 0.568	≤ 0.568
Active Fuel Length (in.)	≤ 150	≤ 150	≤ 150	≤150	≤ 150	≤ 150
No. of Guide and/or Instrument Tubes	21	21	21	17	17	17
Guide/Instrument Tube Thickness (in.)	≥ 0.0165	≥ 0.015	≥ 0.0165	≥ 0.0150	≥ 0.0140	≥ 0.0140

Table 2.1-2 (page 3 of 4)

PWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/ Class	**15x15G**	**15x15H**	**15x15I**	**16x16A**	**16x16B**	**16x16C**
No. of Fuel Rod Locations	204	208	216	236	236	235
Fuel Rod Clad O.D. (in.)	≥ 0.422	≥ 0.414	≥ 0.413	≥ 0.382	≥ 0.374	≥ 0.374
Fuel Rod Clad I.D. (in.)	≤ 0.3890	≤ 0.3700	≤ 0.367	≤ 0.3350	≤ 0.3290	≤ 0.3290
Fuel Pellet Dia. (in.) (Note 3)	≤ 0.3825	≤ 0.3622	≤ 0.360	≤ 0.3255	≤ 0.3225	≤ 0.3225
Fuel Rod Pitch (in.)	≤ 0.563	≤ 0.568	≤ 0.550	≤ 0.506	≤ 0.506	≤ 0.485
Active Fuel Length (in.)	≤ 144	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150
No. of Guide and/or Instrument Tubes	21	17	9 (Note 4)	5 (Note 2)	5 (Note 2)	21
Guide/Instrument Tube Thickness (in.)	≥ 0.0145	≥ 0.0140	≥ 0.0140	≥ 0.0350	≥ 0.0400	≥ 0.0157

Table 2.1-2 (page 4 of 4)

PWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/ Class	**17x17A**	**17x17B**	**17x17C**
No. of Fuel Rod Locations	264	264	264
Fuel Rod Clad O.D. (in.)	≥ 0.360	≥ 0.372	≥ 0.377
Fuel Rod Clad I.D. (in.)	≤ 0.3150	≤ 0.3310	≤ 0.3330
Fuel Pellet Dia. (in.) (Note 3)	≤ 0.3088	≤ 0.3232	≤ 0.3252
Fuel Rod Pitch (in.)	≤ 0.496	≤ 0.496	≤ 0.502
Active Fuel Length (in.)	≤ 150	≤ 150	≤ 150
No. of Guide and/or Instrument Tubes	25	25	25
Guide/Instrument Tube Thickness (in.)	≥ 0.016	≥ 0.014	≥ 0.020

Notes:

1. All dimensions are design nominal values. Maximum and minimum dimensions are specified to bound variations in design nominal values among fuel assemblies within a given array/class.
2. Each guide tube replaces four fuel rods.
3. Annular fuel pellets are allowed in the top and bottom 12" of the active fuel length.
4. One Instrument Tube and eight Guide Bars (Solid ZR)

Table 2.1-3
MPC-32M NON-FUEL HARDWARE COOLING AND AVERAGE BURNUP
(Notes 1 and 2)

Post-irradiation Cooling Time (years)	**Inserts** (Note 3) **Burnup (MWD/MTU)**	**TPD Burnup** (Note 4) **(MWD/MTU)**	**Control Component** (Note 5)**, NSA Burnup (MWD/MTU)**
≥ 1	≤ 60,000	≤ 225,000	NA (Note 6)
≥ 2	-	-	≤ 630,000

Notes:
1. Burnups for NON-FUEL HARDWARE are to be determined based on the burnup and uranium mass of the fuel assemblies in which the component was inserted during reactor operation.
2. Non-fuel hardware burnup and cooling times are not applicable to ITTRs since they are installed post irradiation.
3. Includes Burnable Poison Rod Assemblies (BPRAs), Wet Annular Burnable Absorbers (WABAs), and vibration suppressor inserts.
4. Includes Thimble Plug Devices (TPDs), water displacement guide tube plugs and orifice rod assemblies.
5. Includes Axial Power Shaping Rods (APSRs), Control Rod Assemblies (CRAs), Control Element Assemblies (CEAs) and Rod Cluster Control Assemblies (RCCAs).
6. NA means not authorized for loading at this cooling time.

Table 2.1-4
BURNUP AND COOLING TIME FUEL QUALIFICATION FOR MPC-32M

Region No. (see Figure 2.1-1)	Polynomial Coefficients, see Paragraph 2.II.1.5.2			
	A	B	C	D
1 (Inner)	6.57083E-14	-4.02593E-09	1.47107E-04	8.01647E-01
2 (Outer)	5.58795e-15	-5.13598e-10	5.81723e-05	4.09393e-01

The burnup and cooling time for every fuel loaded into the MPC-32M must satisfy the following equation:

$$Ct = A \cdot Bu^3 + B \cdot Bu^2 + C \cdot Bu + D$$

where,

Ct = Minimum cooling time (years),

Bu = Assembly-average burnup (MWd/mtU),

A, B, C, D = Polynomial coefficients listed in Table 2.1-4

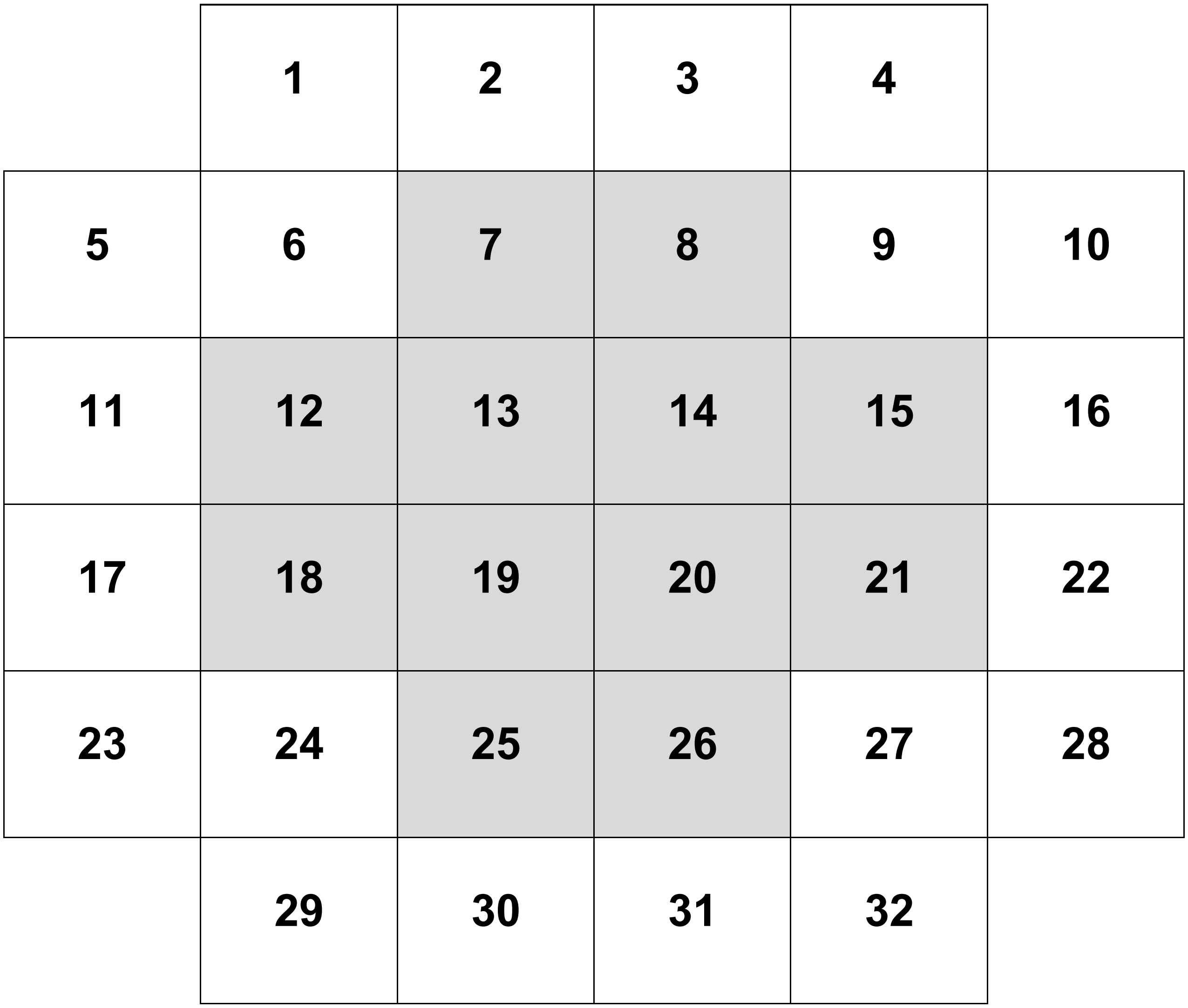

Figure 2.1-1
Cell Identification for MPC-32M

Note: Cells shaded in grey are designated as region 1 (inner)

2.4 Decay Heat, Burnup & Cooling Time Limits for ZR Clad Fuel

For MPC-24/24E/24EF/32/32F/68/68F/68FF/68M decay heat, burnup, and cooling time limits from Appendix B Section 2.4 apply for ZR clad fuel. Decay heat limits from Appendix B Table 2.1-1 apply for SS clad fuel.

For MPC-32 Version 1 decay heat, burnup and cooling time limits for MPC-32 from Appendix B Section 2.4 apply for ZR clad fuel. Decay heat limits for MPC-32 from Appendix B Table 2.1-1 apply for SS clad fuel.

For MPC-68 Version 1 decay heat, burnup and cooling time limits for MPC-68 from Appendix B Section 2.4 apply for ZR clad fuel. Decay heat limits for MPC-68 from Appendix B Table 2.1-1 apply for SS clad fuel.

Decay heat limits for ZR clad for storage in MPC-32M in HI-STORM 100S Version E are provided in the following subsections. Burnup and cooling time limits for the MPC-32M are provided in Table 2.1-4.

2.4.1 Regionalized Fuel Loading Decay Heat Limits for ZR-Clad Fuel for MPC-32M for a VENTILATED OVERPACK

The maximum allowable decay heat per fuel storage location for intact fuel assemblies in regionalized loading is determined using the following equations:

$Q(X) = 2 \times Q0 / (1 + X^{y})$

$y = 0.23 / X^{0.1}$

$q_2 = Q(X) / (n_1 \times X + n_2)$

$q_1 = q_2 \times X$

Where:

Q_0 = Maximum uniform storage MPC decay heat (38 kW)

X = Inner region to outer region assembly decay heat ratio ($0.5 \leq X \leq 3$)

n_1 = Number of storage locations in inner region from Table 2.4-3.

n_2 = Number of storage locations in outer region from Table 2.4-3.

Allowable heat loads for Damaged Fuel and Fuel Debris are shown in Table 2.4-1. Allowable storage locations for Damaged Fuel in DFIs and Damaged Fuel or Fuel Debris in DFCs are shown in Table 2.4-1. Cell heat load limits and total heat load limits may need to be adjusted in accordance with Section 2.4.4.

2.4.2 Discrete Loading Pattern Decay Heat Limits for ZR-Clad Fuel in MPC-32M for a VENTILATED OVERPACK

Discrete decay heat loading patterns (Patterns A and B) for MPC-32M are shown in Figures 2.4-1 and 2.4-2. Figures 2.4-1 and 2.4-2 provide the maximum allowable decay heat loads per fuel storage location. Table 2.4-2 provides the maximum total allowable decay heat load and maximum allowable quadrant decay heat load for Figures 2.4-1 and 2.4-2. Cell heat load limits, quadrant heat load limits and total heat load limit may need to be adjusted in accordance with Section 2.4.4.

2.4.3 When complying with the maximum fuel storage location decay heat limits, users must account for the decay heat from both the fuel assembly and any NON-FUEL HARDWARE, as applicable for the particular fuel storage location, to ensure the decay heat emitted by all contents in a storage location does not exceed the limit.

2.4.4 Variable Fuel Height for MPC-32M

2.4.4.1 For fuel with a longer active fuel length than the reference fuel (144 in), the total heat load, quadrant heat load limits and specific heat load limits in each cell, may be increased by the ratio SQRT(L/144), where L is the active length of the fuel in inches.

2.4.4.2 For fuel with a shorter active fuel length than the reference fuel (144 in), the total heat load, quadrant heat load limits and specific heat load limits in each cell, shall be reduced linearly by the ratio L/144, where L is the active fuel length of the fuel in inches.

2.4.5 Decay Heat Limits for MPC-32M for the UNVENTILATED OVERPACK

Tables 2.4-5a and 2.4-5b provide the maximum allowable decay heat per fuel storage location for MPC-32M for UNVENTILATED OVERPACK.

A minor deviation from the prescribed loading pattern in an MPC’s permissible contents to allow one slightly thermally-discrepant fuel assembly per quadrant to be loaded as long as the peak cladding temperature for the MPC remains below the ISG-11 Rev 3 requirements is permitted for essential dry storage campaigns to support decommissioning.

Table 2.4-1

Allowable Heat Loads and Soluble Boron Requirements for MPC-32M

Row No.	DFC/DFI (Note 1)	Number of DFC/DFI Locations	Locations/Storage Cell Numbers (Note 2)	Penalty on per storage cell heat load limit (Note 3)	Min. Soluble Boron Content
1	DFC	4	2, 11, 22, 31 (NOTE 4)	0%	Appendix C Table 3-6
2		8	1, 4, 5, 10, 23, 28, 29, 32	5%	Appendix C Table 3-5
3		12	1, 2, 4, 5, 10, 16, 17, 23, 28, 29, 31, 32	5%	Appendix C Table 3-5
4		16	1, 2, 3, 4, 5, 10, 11, 16, 17, 22, 23, 28, 29, 30, 31, 32 (NOTE 4)	0%	Appendix C Table 3-6
5		16	1, 2, 3, 4, 5, 10, 11, 16, 17, 22, 23, 28, 29, 30, 31, 32	5%	Appendix C Table 3-6
6	DFI	4	2, 11, 22, 31	10%	Appendix C Table 3-4
7		12	1, 2, 4, 5, 10, 16, 17, 23, 28, 29, 31, 32	40%	Appendix C Table 3-4
8		16	1, 2, 3, 4, 5, 10, 11, 16, 17, 22, 23, 28, 29, 30, 31, 32	40%	Appendix C Table 3-4
9	DFI or DFC	16	1, 2, 3, 4, 5, 10, 11, 16, 17, 22, 23, 28, 29, 30, 31, 32	DFCs – 5% DFIs – 40%	Appendix C Table 3-6

Note 1: Damaged fuel assemblies or fuel debris can be loaded in DFCs while only damaged fuel assemblies that can be handled by normal means can be loaded in DFIs.

Note 2: DFCs/DFIs are allowed for storage in certain basket peripheral locations as defined herein. Basket storage cell numbers are identified in Figure 2.1-1.

Note 3: Heat load penalties are applicable to ONLY those cells where DFCs/DFIs are located and are applied to the allowable undamaged fuel assembly decay heat limit in that storage cell location. The penalties remain the same for all regionalized patterns and discrete loading patterns.

Note 4: Storage cell locations 6, 9, 24, 27 all must remain empty.

Table 2.4-2

Maximum Allowable Decay Heat Loads for MPC-32M Note 2

Heat Load Pattern	Maximum Total Decay Heat Load (kW)	Maximum Quadrant Note1 Decay heat Load (kW)
Figure 2.4-1 (Discrete Loading Pattern A)	40.0	10.0
Figure 2.4-2 (Discrete Loading Pattern B)	39.0	9.75
Regionalized Loading per Section 2.4.1	41.2	N/A

Notes:

1. Figure 2.1-1 identifies cell locations. Table 2.4-4 lists cell locations in each quadrant.
2. Quadrant heat load limits and total heat load limits may need to be adjusted in accordance with Section 2.4.4.

Table 2.4-3
MPC-32M Fuel Storage Regions

MPC	Number of Storage Cells		Storage Cell IDs Note 1	
	Inner Region (n_1)	Outer Region (n_2)	Inner Region	Outer Region
MPC-32M	12	20	7, 8, 12 through 15, 18 through 21, 25 and 26	All other locations
1. See Figure 2.1-1 for storage cell numbering for MPC-32M.				

Table 2.4-4
MPC-32M Fuel Storage Quadrants

Quadrant	Storage Cell IDs Note 1
1	3, 4, 8, 9, 10, 14, 15, 16
2	20, 21, 22, 26, 27, 28, 31, 32
3	17, 18, 19, 23, 24, 25, 29, 30
4	1, 2, 5, 6, 7, 11, 12, 13
1. See Figure 2.1-1 for storage cell numbering for MPC-32M.	

TABLE 2.4-5a
MPC-32M HEAT LOAD DATA for UNVENTILATED OVERPACK

Number of Regions: 2			
Number of Storage Cells: 32			
Maximum Total Heat Load (kW): 25			
Maximum Section Heat Load (kW): 3.125			
Region No. (Note 1)	Decay Heat Limit per Cell, kW (Note 2)	Number of Cells per Region	Decay Heat Limit per Region, kW
1 (Inner)	0.781	12	9.375
2 (Outer)	0.781	20	15.625
Note 1: Figure 2.1-1 identifies the cell locations. The inner region consists of cells 7, 8,12 through 15,18 through 21, 25 and 26. The outer region is maintained by all other cell locations. Note 2: Heat load limits provided in this table are for reference length fuel assemblies (144 in.active length). Maximum total heat load, maximum quadrant heat load and specific cell heat load limits may need to be adjusted in accordance with Section 2.4.4.			

TABLE 2.4-5b
MPC-32M REQUIREMENTS ON DEVELOPING REGIONALIZED HEAT LOAD PATTERNS for UNVENTILATED OVERPACK (See Figure 2.1-1)

1. Total MPC aggregate Heat Load must be equal to 25 kW.
2. Maximum Section Heat Load must be equal to 3.125 kW, calculated as defined in Table 2.4-6, and pattern must be 1/8th symmetric.
3. Maximum Heat Load per Cell in Region 1 is 0.781 kW.
4. Maximum Heat Load per Cell in Region 2 is 1.562 kW.
5. Pattern-specific Heat Loads in a storage cell may need to be adjusted to meet items 1 and 2.
6. Pattern-specific Heat Load for storage cells may be determined by reducing the allowable heat load in any Region 1 cell in Table 2.4-5a by a certain amount (Δ) and adding the same Δ to a single cell or distributed amongst multiple cells in Region 2, i.e., any reduction of total allowable heat load in Region 1 must be compensated by an equivalent addition in Region 2.

General Notes –
1. Any assembly with a Heat Load less than the limits defined above can be loaded in the applicable cell, provided it meets all other CoC requirements.
2. 2. DFCs/DFIs are permitted in locations denoted in Table 2.4-7 with the applicable Heat Load penalties identified therein.

TABLE 2.4-6
SECTION HEAT LOAD CALCULATIONS FOR MPC-32M for
UNVENTILATED OVERPACK

Section	Equation for Section Heat Load[1]
Section 1	$Q_3 + Q_4 + Q_8 + \frac{1}{2}Q_9 + \frac{1}{2}Q_{14}$
Section 2	$Q_{10} + Q_{15} + Q_{16} + \frac{1}{2}Q_9 + \frac{1}{2}Q_{14}$
Section 3	$Q_{21} + Q_{22} + Q_{28} + \frac{1}{2}Q_{20} + \frac{1}{2}Q_{27}$
Section 4	$Q_{31} + Q_{32} + Q_{26} + \frac{1}{2}Q_{20} + \frac{1}{2}Q_{27}$
Section 5	$Q_{29} + Q_{30} + Q_{25} + \frac{1}{2}Q_{19} + \frac{1}{2}Q_{24}$
Section 6	$Q_{17} + Q_{18} + Q_{23} + \frac{1}{2}Q_{19} + \frac{1}{2}Q_{24}$
Section 7	$Q_{11} + Q_{12} + Q_5 + \frac{1}{2}Q_6 + \frac{1}{2}Q_{13}$
Section 8	$Q_1 + Q_2 + Q_7 + \frac{1}{2}Q_6 + \frac{1}{2}Q_{13}$

Notes:

1. Q_{X-Y} is the heat load in kW in cell ID (X-Y), identified in Figure 2.1-1

TABLE 2.4-7
DFC and DFI STORAGE LOCATIONS WITH HEAT LOAD PENALTIES for
MPC-32M for UNVENTILATED OVERPACK

MPC Type	DFC/DFI (Note 1)	Locations/Storage Cell Numbers (Note 2)	Heat Load Penalty (Note 3)	Min. Soluble Boron Content
MPC-32M	DFI	1, 2, 3, 4, 5, 10, 11, 16, 17, 22, 23, 28, 29, 30, 31, 32	40%	Appendix C Table 3-4
	DFC		5%	Appendix C Table 3-6
	DFC or DFI		DFCs – 5% DFIs – 40%	

Note 1: Damaged fuel assemblies or fuel debris can be loaded in DFCs while only damaged fuel assemblies that can be handled by normal means can be loaded in DFIs.
Note 2: DFCs/DFIs are allowed for storage in certain basket peripheral locations as defined herein. Basket storage cell numbers are identified in Figure 2.1-1 for the MPC-32M.
Note 3: Heat load penalties are applicable to ONLY those cells where DFCs/DFIs are located and are applied to the allowable undamaged fuel assembly decay heat limit in that storage cell location. The penalties remain the same for all regionalized patterns and discrete loading patterns.

Quadrant No. 4 | Quadrant No. 1

	1 3.000	2 0.775	3 0.775	4 3.000	
5 3.000	6 0.825	7 1.025	8 1.025	9 0.825	10 3.000
11 0.775	12 1.025	13 1.400	14 1.400	15 1.025	16 0.775
17 0.775	18 1.025	19 1.400	20 1.400	21 1.025	22 0.775
23 3.000	24 0.825	25 1.025	26 1.025	27 0.825	28 3.000
	29 3.000	30 0.775	31 0.775	32 3.000	

Quadrant No. 3 | Quadrant No. 2

Cell No. Heat Load (kW)

*Notes:

1. This figure provides per cell allowable heat loads for MPC-32M with all UNDAMAGED FUEL assemblies.
2. Location of DFCs/ DFIs, applicable cell heat load penalties, and the soluble boron requirements are provided in Table 2.4-1.

Figure 2.4-1
Discrete Pattern A Per Cell Allowable Heat Loads (kW) - MPC-32M

Quadrant No. 4	**1** **3.255**	**2** **0.745**	**3** **0.745**	**4** **3.255**	Quadrant No. 1
5 **3.255**	**6** **0.375**	**7** **0.990**	**8** **0.990**	**9** **0.375**	**10** **3.255**
11 **0.745**	**12** **0.990**	**13** **1.275**	**14** **1.275**	**15** **0.990**	**16** **0.745**
17 **0.745**	**18** **0.990**	**19** **1.275**	**20** **1.275**	**21** **0.990**	**22** **0.745**
23 **3.255**	**24** **0.375**	**25** **0.990**	**26** **0.990**	**27** **0.375**	**28** **3.255**
Quadrant No. 3	**29** **3.255**	**30** **0.745**	**31** **0.745**	**32** **3.255**	Quadrant No. 2

Cell No. **Heat Load (kW)**

*Notes:
1. This figure provides per cell allowable heat loads for MPC-32M with all UNDAMAGED FUEL assemblies.
2. Location of DFCs/ DFIs, applicable cell heat load penalties, and the soluble boron requirements are provided in Table 2.4-1.

Figure 2.4-2
Discrete Pattern B, Per Cell Allowable Heat Loads (kW) - MPC-32M

3.0 DESIGN FEATURES

3.1 Site

3.1.1 Site Location

The HI-STORM 100S Version E Cask System is authorized for general use by 10 CFR Part 50 license holders at various site locations under the provisions of 10 CFR 72, Subpart K.

3.2 Design Features Important for Criticality Control

3.2.1 MPC-24, 24E, 24EF, 32, 32F, 68, 68F, 68FF and 68M, in HI-STORM 100S Version E shall meet the specifications of Appendix B Section 3.2.

3.2.2 MPC-32 version 1

1. Fuel cell pitch: ≥ 9.158 in.
2. ^{10}B loading in the neutron absorbers: ≥ 0.0310 g/cm^2 (METAMIC)

3.2.3 MPC-68 version 1

1. Fuel cell pitch: ≥ 6.43 in.
2. ^{10}B loading in the neutron absorbers: ≥ 0.0310 g/cm^2 (METAMIC)

3.2.4 MPC-32M

1. Basket Cell wall thickness 0.5 in. (nom.)
2. B_4C content in METAMIC-HT shall be ≥ 10 wt. %

3.2.6 Neutron Absorber Tests

MPC-24, 24E, 24EF, 32, 32F, 68, 68F, 68FF and 68M

MPCs listed in 3.2.1 shall meet the minimum requirements for ^{10}B areal density or B_4C content, as applicable in Appendix B, Section 3.2.9.

MPC-32 Version 1 and MPC-68 Version 1 – Metamic Classic

Section 9.1.5.3 of the HI-STORM 100 FSAR is hereby incorporated by reference into the HI-STORM 100 CoC. For each MPC model specified in Sections 3.2.2 and 3.2.3 (MPC-32 version 1 and MPC-68 version 1) above, the neutron absorber shall meet the minimum requirements for ^{10}B areal density or B_4C content, as applicable.

MPC-32M - Metamic-HT

1. The weight percentage of the boron carbide must be confirmed to be greater than or equal to 10% in each lot of Al/B_4C powder.

2. The areal density of the B-10 isotope corresponding to the 10% min. weight density in the manufactured Metamic-HT panels shall be independently confirmed by the neutron attenuation test method by testing at least one coupon from a randomly selected panel in each lot.

3. If the B-10 areal density criterion in the tested panels fails to meet the specific minimum, then the manufacturer has the option to reject the

entire lot or to test a statistically significant number of panels and perform statistical analysis for acceptance.

4. All test procedures used in demonstrating compliance with the above requirements shall conform to the cask designer's QA program which has been approved by the USNRC under docket number 71-0784.

3.3 Codes and Standards

The American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), 1995 Edition with Addenda through 1997, is the governing Code for the HI- STORM 100 System MPCs, OVERPACKs, and TRANSFER CASKs, as clarified in Specification 3.3.1 below, except for Code Sections V and IX. The latest effective editions of ASME Code Sections V and IX, including addenda, may be used for activities governed by those sections, provided a written reconciliation of the later edition against the 1995 Edition, including addenda, is performed by the certificate holder. American Concrete Institute (ACI) 349-85 is the governing Code for plain concrete as clarified in Appendix 1.D of the Final Safety Analysis Report for the HI-STORM 100 Cask System.

3.3.1 Alternatives to Codes, Standards, and Criteria

Table 3-1 lists approved alternatives to the ASME Code for the design of the MPCs, OVERPACKs, and TRANSFER CASKs of the HI-STORM 100 Cask System.

3.3.2 Construction/Fabrication Alternatives to Codes, Standards, and Criteria

Proposed alternatives to the ASME Code Sections II and III, 1995 Edition with Addenda through 1997 including modifications to the alternatives allowed by Specification 3.3.1 may be used on a case-specific basis when authorized by the Director of the Office of Nuclear Material Safety and Safeguards or designee. The request for such alternative should demonstrate that:

1. The proposed alternatives would provide an acceptable level of quality and safety, or

2. Compliance with the specified requirements of the ASME Code, Section III, 1995 Edition with Addenda through 1997, would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Requests for alternatives shall be submitted in accordance with 10 CFR 72.4.

Table 3-1
List of ASME Code Alternatives for HI-STORM Multi-Purpose Canisters (MPCs)

MPC Enclosure Vessel	Subsection NCA	General Requirements. Requires preparation of a Design Specification, Design Report, Overpressure Protection Report, Certification of Construction Report, Data Report, and other administrative controls for an ASME Code stamped vessel.b	Because the MPC is not an ASME Code stamped vessel, none of the specifications, reports, certificates, or other general requirements specified by NCA are required. In lieu of a Design Specification and Design Report, the HI- STORM FSAR includes the design criteria, service conditions, and load combinations for the design and operation of the MPCs as well as the results of the stress analyses to demonstrate that applicable Code stress limits are met. Additionally, the fabricator is not required to have an ASME-certified QA program. All important-to-safety activities are governed by the NRC-approved Holtec QA program. Because the cask components are not certified to the Code, the terms “Certificate Holder” and “Inspector” are not germane to the manufacturing of NRC-certified cask components. To eliminate ambiguity, the responsibilities assigned to the Certificate Holder in the Code, as applicable, shall be interpreted to apply to the NRC Certificate of Compliance (CoC) holder (and by extension, to the component fabricator) if the requirement must be fulfilled. The Code term “Inspector” means the QA/QC personnel of the CoC holder and its vendors assigned to oversee and inspect the manufacturing process.
MPC Enclosure Vessel	NB-1100	Statement of requirements for Code stamping of components.	MPC Enclosure Vessel is designed and will be fabricated in accordance with ASME Code, Section III, Subsection NB to the maximum practical extent, but Code stamping is not required.

Table 3-1
List of ASME Code Alternatives for HI-STORM Multi-Purpose Canisters (MPCs)

MPC lift lugs	NB-1130	NB-1132.2(d) requires that the first connecting weld of a non-pressure retaining structural attachment to a component shall be considered part of the component unless the weld is more than 2t from the pressure retaining portion of the component, where t is the nominal thickness of the pressure retaining material. NB-1132.2(e) requires that the first connecting weld of a welded nonstructural attachment to a component shall conform to NB-4430 if the connecting weld is within 2t from the pressure retaining portion of the component.	The lugs that are used exclusively for lifting an empty MPC are welded to the inside of the pressure-retaining MPC shell, but are not designed in accordance with Subsection NB. The lug-to-Enclosure Vessel Weld is required to meet the stress limits of Reg. Guide 3.61 in lieu of Subsection NB of the Code.
MPC Enclosure Vessel	NB-2000	Requires materials to be supplied by ASME-approved material supplier.	Materials will be supplied by Holtec approved suppliers with Certified Material Test Reports (CMTRs) in accordance with NB-2000 requirements.
MPC Enclosure Vessel	NB-2121	Provides permitted material specification for pressure-retaining material, which must conform to Section II, Part D, Tables 2A and 2B.	Certain duplex stainless steels are not included in Section II, Part D, Tables 2A and 2B. UNS S31803 duplex stainless-steel alloy is evaluated in the HI-STORM FW FSAR and meet the required design criteria for use in the HI- STORM 100 system per ASME Code Case N- 635-1. Appendix 1.A provides the required property data for the necessary safety analysis.
MPC Enclosure Vessel	NB-3100 NF-3100	Provides requirements for determining design loading conditions, such as pressure, temperature, and mechanical loads.	These requirements are not applicable. The HI-STORM FSAR, serving as the Design Specification, establishes the service conditions and load combinations for the storage system.

MPC Enclosure Vessel	NB-4120	NB-4121.2 and NF-4121.2 provide requirements for repetition of tensile or impact tests for material subjected to heat treatment during fabrication or installation.	In-shop operations of short duration that apply heat to a component, such as plasma cutting of plate stock, welding, machining, and coating are not, unless explicitly stated by the Code, defined as heat treatment operations.

Table 3-1
List of ASME Code Alternatives for HI-STORM Multi-Purpose Canisters (MPCs)

MPC Enclosure Vessel	NB-4220	Requires certain forming tolerances to be met for cylindrical, conical, or spherical shells of a vessel.	The cylindricity measurements on the rolled shells are not specifically recorded in the shop travelers, as would be the case for a Code-stamped pressure vessel. Rather, the requirements on inter-component clearances (such as the MPC-to-transfer cask) are guaranteed through fixture-controlled manufacturing. The fabrication specification and shop procedures ensure that all dimensional design objectives, including inter-component annular clearances are satisfied. The dimensions required to be met in fabrication are chosen to meet the functional requirements of the dry storage components. Thus, although the post-forming Code cylindricity requirements are not evaluated for compliance directly, they are indirectly satisfied actually exceeded) in the final manufactured components.
MPC Enclosure Vessel	NB-4122	Implies that with the exception of studs, bolts, nuts and heat exchanger tubes, CMTRs must be traceable to a specific piece of material in a component.	MPCs are built in lots. Material traceability on raw materials to a heat number and corresponding CMTR is maintained by Holtec through markings on the raw material. Where material is cut or processed, markings are transferred accordingly to assure traceability. As materials are assembled into the lot of MPCs being manufactured, documentation is maintained to identify the heat numbers of materials being used for that item in the multiple MPCs being manufactured under that lot. A specific item within a specific MPC will have a number of heat numbers identified as possibly being used for the item in that particular MPC of which one or more of those heat numbers (and corresponding CMTRS) will have actually been used. All of the heat numbers identified will comply with the requirements for the particular item.
MPC Lid and Closure Ring Welds	NB-4243	Full penetration welds required for Category C Joints (flat head to main shell per NB-3352.3)	MPC lid and closure ring are not full penetration welds. They are welded independently to provide a redundant seal.

Table 3-1
List of ASME Code Alternatives for HI-STORM Multi-Purpose Canisters (MPCs)

MPC Closure Ring, Vent and Drain Cover Plate Welds	NB-5230	Radiographic (RT) or ultrasonic (UT) examination required.	Root (if more than one weld pass is required) and final liquid penetrant examination to be performed in accordance with NB-5245. The closure ring provides independent redundant closure for vent and drain cover plates. Vent and drain port cover plate welds are helium leakage tested.
MPC Lid to Shell Weld	NB-5230	Radiographic (RT) or ultrasonic (UT) examination required.	• Only progressive liquid penetrant (PT) examination is permitted. PT examination will include the root and final weld layers and each approx. 3/8" of weld depth.

Table 3-1
List of ASME Code Alternatives for HI-STORM Multi-Purpose Canisters (MPCs)

MPC Enclosure Vessel and Lid	NB-6111	All completed pressure retaining systems shall be pressure tested.	• The MPC vessel is strength welded in the field following fuel assembly loading. Pressure tests (Hydrostatic or pneumatic) will not be performed because lack of accessibility for leakage inspections precludes a meaningful pressure retention capability test. The different models of MPCs available in the industry are not subject to pressure tests because of the dose to the crew, the proven ineffectiveness of the pressure tests to reveal any leaks and the far more effective tests performed on the MPC confinement boundary, such as: All MPC enclosure vessel welds (except closure ring and vent/drain cover plate) are inspected by volumetric examination. All MPC shell and baseplate materials are UT tested. Finally, the MPC lid-to-shell weld shall be verified by progressive PT examination. PT must include the root and final layers and each approximately 3/8 inch of weld depth. • The inspection results, including relevant findings (indications) shall be made a permanent part of the user's records by video, photographic, of other means which provide an equivalent record of weld integrity. The video or photographic records should be taken during the final interpretation period described in ASME Section V, Article 6, T-676. The vent/drain cover plate and the closure ring welds are confirmed by liquid penetrant examination. The inspection of the weld must be performed by qualified personnel and shall meet the acceptance requirements of ASME Code Section III, NB-5350.

Table 3-1
List of ASME Code Alternatives for HI-STORM Multi-Purpose Canisters (MPCs)

MPC Enclosure Vessel	NB-7000	Vessels are required to have overpressure protection.	• No overpressure protection is provided. Function of MPC enclosure vessel is to contain radioactive contents under normal, off-normal, and accident conditions of storage. MPC vessel is designed to withstand maximum internal pressure considering 100% fuel rod failure and maximum accident temperatures.
MPC Enclosure Vessel	NB-8000	States requirements for nameplates, stamping and reports per NCA-8000.	• The HI-STORM 100 System is to be marked and identified in accordance with 10CFR71 and 10CFR72 requirements. Code stamping is not required. QA data package to be in accordance with Holtec approved QA program.

DESIGN FEATURES (continued)

3.4 Site-Specific Parameters and Analyses for HI-STORM 100S Version E with all MPCs

Site-specific parameters and analyses that will require verification by the system user are, as a minimum, as follows:

1. The temperature of 70° F is the maximum average yearly temperature. A site's yearly average ambient temperature may be used for site-speciic analysis.

2. The allowed temperature extremes, averaged over a 3-day period, shall be greater than -40° F and less than 125° F.

3. a. The resultant horizontal acceleration (vectorial sum of two horizontal Zero Period Accelerations (ZPAs) at a three-dimensional seismic site), a_H, and vertical ZPA, a_V, on the top surface of the ISFSI pad, expressed as fractions of gravity, shall satisfy the following inequalities:

$$a_H \le f\,(1 - a_V);\ \text{and}\ a_H \le r\,(1 - a_V) / h$$

where f is the Coulomb friction coefficient for the cask/ISFSI pad interface, r is the radius of the cask, and h is the height of the cask center-of-gravity above the ISFSI pad surface. Unless demonstrated by appropriate testing that a higher coefficient of friction value is appropriate for a specific ISFSI, the value used shall be 0.53. If acceleration time-histories on the ISFSI pad surface are available, a_H and a_V may be the coincident values of the instantaneous net horizontal and vertical accelerations. If instantaneous accelerations are used, the inequalities shall be evaluated at each time step in the acceleration time history over the total duration of the seismic event.

If this static equilibrium based inequality cannot be met, a dynamic analysis of the cask/ISFSI pad assemblage with appropriate recognition of soil/structure interaction effects shall be performed to ensure that the casks will not tip over or undergo excessive sliding under the site's Design Basis Earthquake.

(continued)

DESIGN FEATURES (continued)

3.4 Site-Specific Parameters and Analyses (continued)

b. Under environmental conditions that may degrade the pad/cask interface friction (such as due to icing) the response of the casks under the site's Design Basis Earthquake shall be established using the best estimate of the friction coefficient in an appropriate analysis model. The analysis should demonstrate that the earthquake will not result in cask tipover or cause excessive sliding such that impact between casks could occur. Any impact between casks should be considered an accident for which the maximum total deflection, d, in the active fuel region of the basket panels shall be limited by the following inequality: $d \leq 0.005\ l$, where l is the basket cell inside dimension.

4. The maximum permitted depth of submergence under water shall not exceed 125 feet.

5. The maximum permissible velocity of floodwater, V, for a flood of height, h, shall be the lesser of V_1 or V_2, where:

$$V_1 = (1.876\ W^*)^{1/2} / h$$

$$V_2 = (1.876\ f\ W^*/\ D\ h)^{1/2}$$

and W* is the apparent (buoyant weight) of the loaded overpack (in pounds force), D is the diameter of the overpack (in feet), and f is the interface coefficient of friction between the ISFSI pad and the overpack, as used in step 3.a above. Use the height of the overpack, H, if h>H.

6. The potential for fire and explosion while handling a loaded OVERPACK or TRANSFER CASK shall be addressed, based on site-specific considerations. The user shall demonstrate that the site-specific potential for fire is bounded by the fire conditions analyzed by the Certificate Holder, or an analysis of the site-specific fire considerations shall be performed.

7. The ISFSI pad shall be verified by analysis to meet the structural acceptance criteria set forth in section 2.II.2.2 of the HI-STORM FSAR. A restriction on the lift and/or drop height is not required to be established if the cask is lifted with a device designed in accordance with applicable stress limits from ANSI N14.6, and/or NUREG-0612, and has redundant drop protection features.

(continued)

3.4 Site-Specific Parameters and Analyses (continued)

8. In cases where engineered features (i.e., berms and shield walls) are used to ensure that the requirements of 10 CFR 72.104(a) are met, such features are to be considered important to safety and must be evaluated to determine the applicable quality assurance category.

9. LOADING OPERATIONS, OVERPACK TRANSPORT OPERATIONS, and UNLOADING OPERATIONS shall only be conducted with working area ambient temperatures ≥ 0° F for all MPC heat loads, and

   a. ≤ 90°F (averaged over a 3-day period) for operations subjected to direct solar heating

   b. ≤ 110°F (averaged over a 3-day period) for operations not subjected to direct solar heating for all MPC heat loads.

   If the reference ambient temperature exceeds the corresponding Threshold Temperature then a site specific analysis shall be performed using the actual heat load and reference ambient temperature equal to the three day average to demonstrate that the steady state peak fuel cladding temperature will remain below the 400°C limit.

10. For those users whose site-specific design basis includes an event or events (e.g., flood) that result in the blockage of any OVERPACK inlet or outlet air ducts for an extended period of time (i.e, longer than the total Completion Time of LCO 3.1.2), an analysis or evaluation may be performed to demonstrate adequate heat removal is available for the duration of the event. Adequate heat removal is defined as fuel cladding temperatures remaining below the accident temperature limit. If the analysis or evaluation is not performed, or if fuel cladding temperature limits are unable to be demonstrated by analysis or evaluation to remain below the accident temperature limit for the duration of the event, provisions shall be established to provide alternate means of cooling to accomplish this objective.

11. Users shall establish procedural and/or mechanical barriers to ensure that during LOADING OPERATIONS and UNLOADING OPERATIONS, either the fuel cladding is covered by water, or the MPC is filled with an inert gas.

12. The entire haul route shall be evaluated to ensure that the route can support the weight of the loaded system and its conveyance.

13. The loaded system and its conveyance shall be evaluated to ensure under the site-specific Design Basis Earthquake the system does not tipover or slide off the haul route.

14. The HI-STORM 100S Version E /HI-TRAC stack which occurs during MPC TRANSFER shall be evaluated to ensure under the site specific Design Basis Earthquake the system does not tipover. A probabilistic

risk assessment cannot be used to rule out the occurrence of the earthquake during MPC TRANSFER.

(continued)

DESIGN FEATURES (continued)

3.5 Cask Transfer Facility (CTF)

3.5.1 TRANSFER CASK and MPC Lifters

Lifting of a loaded TRANSFER CASK and MPC using devices that are not integral to structures governed by 10 CFR Part 50 shall be performed with a CTF that is designed, operated, fabricated, tested, inspected, and maintained in accordance with the guidelines of NUREG-0612, “Control of Heavy Loads at Nuclear Power Plants”, as applicable, and the below clarifications. The CTF Structure requirements below do not apply to heavy loads bounded by the regulations of 10 CFR Part 50 or to the loading of an OVERPACK in a belowground restraint system which permits MPC TRANSFER near grade level and does not require an aboveground CTF.

3.5.2 CTF Structure Requirements

3.5.2.1 Cask Transfer Station and Stationary Lifting Devices

1. The metal weldment structure of the CTF structure shall be designed to comply with the stress limits of ASME Section III, Subsection NF, Class 3 for linear structures. The applicable loads, load combinations, and associated service condition definitions are provided in Table 3-2. All compression loaded members shall satisfy the buckling criteria of ASME Section III, Subsection NF.
2. If a portion of the CTF structure is constructed of reinforced concrete, then the factored load combinations set forth in ACI-318 (89) for the loads defined in Table 3-2 shall apply.
3. The TRANSFER CASK and MPC lifting device used with the CTF shall be designed, fabricated, operated, tested, inspected and maintained in accordance with NUREG-0612, Section 5.1.
4. The CTF shall be designed, constructed, and evaluated to ensure that if the MPC is dropped during inter-cask transfer operations, its confinement boundary would not be breached. This requirement applies to CTFs with either stationary or mobile lifting devices.

(continued)

DESIGN FEATURES (continued)

3.5 Cask Transfer Facility (CTF) (continued)

3.5.2.2 Mobile Lift Devices

If a mobile lifting device is used as the lifting device, in lieu of a stationary lifting device, it shall meet the guidelines of NUREG-0612, Section 5.1, with the following clarifications:

1. Mobile lifting devices shall have a minimum safety factor of two over the allowable load table for the lifting device in accordance with the guidance of NUREG-0612, Section 5.1.6(1)(a) and shall be capable of stopping and holding the load during a Design Basis Earthquake (DBE) event.
2. Mobile lifting devices shall conform to meet the requirements of ANSI B30.5, “Mobile and Locomotive Cranes,” in lieu of the requirements of ANSI B30.2, “Overhead and Gantry Cranes.”
3. Mobile cranes are not required to meet the requirements of NUREG-0612, Section 5.1.6(2) for new cranes.
4. Horizontal movements of the TRANSFER CASK and MPC using a mobile crane are prohibited.

(continued)

DESIGN FEATURES (continued)

3.5 Cask Transfer Facility (CTF)(continued)

Table 3-2

Load Combinations and Service Condition Definitions for the CTF Structure (Note 1)

Load Combination	ASME III Service Condition for Definition of Allowable Stress	Comment
D* D + S	Level A	All primary load bearing members must satisfy Level A stress limits
D + M + W' (Note 2) D + F D + E D + Y	Level D	Factor of safety against overturning shall be ≥ 1.1

D = Dead load
D* = Apparent dead load
S = Snow and ice load for the CTF site
M = Tornado missile load for the CTF site
W' = Tornado wind load for the CTF site
F = Flood load for the CTF site
E = Seismic load for the CTF site
Y = Tsunami load for the CTF site

Notes:
1. The reinforced concrete portion of the CTF structure shall also meet the factored combinations of loads set forth in ACI-318(89).
2. Tornado missile load may be reduced or eliminated based on a PRA for the CTF site.

DESIGN FEATURES (continued)

3.6 Forced Helium Dehydration System

3.6.1 System Description

Use of a forced helium dehydration (FHD) system, (a closed-loop system) is an alternative to vacuum drying the MPC for moderate burnup fuel (≤ 45,000 MWD/MTU) with lower MPC heat load and for drying MPCs containing one or more high burnup fuel assemblies or higher MPC heat loads as indicated in Appendix C Table 3-1. The FHD system shall be designed for normal operation (i.e., excluding startup and shutdown ramps) in accordance with the criteria in Section 3.6.2.

3.6.2 Design Criteria

3.6.2.1 The temperature of the helium gas in the MPC shall be at least 15^{o}F higher than the saturation temperature at coincident pressure.

3.6.2.2 The pressure in the MPC cavity space shall be ≤ 60.3 psig (75 psia) during drying. Backfill pressures shall be as described in Appendix C.

3.6.2.3 The hourly recirculation rate of helium shall be ≥ 10 times the nominal helium mass backfilled into the MPC for fuel storage operations.

3.6.2.4 The partial pressure of the water vapor in the MPC cavity will not exceed 3 torr. The limit is met if the gas temperature at the demoisturizer outlet is verified by measurement to remain ≤ 21°F for a period of 30 minutes or if the dew point of the gas exiting the MPC is verified by measurement to remain ≤ 22.9°F for ≥ 30 minutes.

3.6.2.5 The condensing module shall be designed to de-vaporize the recirculating helium gas to a dew point ≤ 120°F.

3.6.2.6 The demoisturizing module shall be configured to be introduced into its helium conditioning function after the condensing module has been operated for the required length of time to assure that the bulk moisture vaporization in the MPC (defined as Phase 1 in FSAR Appendix 2.B) has been completed.

3.6.2.7 The helium circulator shall be sized to effect the minimum flow rate of circulation required by these design criteria.

3.6.2.8 The pre-heater module shall be engineered to ensure that the temperature of the helium gas in the MPC meets these design criteria.

DESIGN FEATURES (continued)

3.6 Forced Helium Dehydration System (continued)

3.6.3 Fuel Cladding Temperature

A steady-state thermal analysis of the MPC under the forced helium flow scenario shall be performed using the methodology described in HI- STORM 100 FSAR Section 4.4, with due recognition of the forced convection process during FHD system operation. This analysis shall demonstrate that the peak temperature of the fuel cladding, under the most adverse condition of FHD system operation, is below the peak cladding temperature limit for normal conditions of storage for the applicable fuel type (PWR or BWR) and cooling time at the start of dry storage.

3.6.4 Pressure Monitoring During FHD Malfunction

During an FHD malfunction event, described in HI-STORM 100 FSAR Chapter 11 as a loss of helium circulation, the system pressure must be monitored to ensure that the conditions listed therein are met.

DESIGN FEATURES (continued)

3.7 Supplemental Cooling System

3.7.1 System Description

A supplemental cooling system (SCS) is an external system for cooling the MPC inside the HI-TRAC transfer cask during on-site transport. The SCS is NOT required for transport of fuel in all approved MPCs using HI-TRAC MS. The SCS may be used with HI-TRAC MS to provide additional thermal margin.

The SCS is required for transport of high burnup fuel under certain heat load conditions defined in Appendix B Table 3-3 when using HI-TRAC versions other than HI-TRAC MS. The SCS shall be designed for normal operation (i.e., excluding startup and shutdown ramps) in accordance with the criteria in Section 3.7.2.

3.7.2 Design Criteria

3.7.2.1 If water is used as the coolant, the system shall be sized to limit the coolant temperature to below 180°F under steady-state conditions for the design basis heat load at an ambient air temperature of 110°F. Any electric motors shall have a backup power supply for uninterrupted operation.

3.7.2.2 The system shall utilize a contamination-free fluid medium in contact with the external surfaces of the MPC and inside surfaces of the HI -TRAC transfer cask to minimize corrosion.

3.7.2.3 All passive components such as tubular heat exchangers, manually operated valves and fittings shall be designed to applicable standards (TEMA, ANSI).

3.7.2.4 The heat dissipation capacity of the SCS shall be equal to or greater than the minimum necessary to ensure that the peak cladding temperature is below 400°C (752°F). All heat transfer surfaces in heat exchangers shall be assumed to be fouled to the maximum limits specified in a widely used heat exchange equipment standard such as the Standards of Tubular Exchanger Manufacturers Association.

3.7.2.5 The coolant utilized to extract heat from the MPC shall be high purity water or air. Antifreeze may be used to prevent water from freezing if warranted by operating conditions.

3.7.2.6 All pressure boundaries (as defined in the ASME Boiler and Pressure Vessel Code, Section VIII Division 1) shall have pressure ratings that are greater than the maximum system operating pressure by at least 15 psi.

3.7.2.7 All ASME Code components shall comply with Section VIII Division 1 of the ASME Boiler and Pressure Vessel Code.

3.7.2.8 All gasketed and packed joints shall have a minimum design pressure rating of the pump shut-off pressure plus 15 psi.

DESIGN FEATURES (continued)

3.8 Combustible Gas Monitoring Lid Welding and Cutting

During MPC lid-to-shell welding and cutting operations, combustible gas monitoring of the space under the MPC lid is required, to ensure that there is no combustible mixture present.

3.9 Environmental Temperature Requirements

TRANSPORT OPERATIONS involving any version of the HI-TRAC transfer cask can be carried out if the reference ambient temperature (three day average around the cask) is ABOVE ≥ 0° F and below the Threshold Temperature of 110 deg. F ambient temperature, applicable during HI-TRAC MS transfer operations inside the 10 CFR Part 50 or 10 CFR Part 52 structural boundary and 90 deg. F outside of it. The determination of the Threshold Temperature compliance shall be made based on the best available thermal data for the site.

If the reference ambient temperature exceeds the corresponding Threshold Temperature then a site specific analysis shall be performed using the actual heat load and reference ambient temperature equal to the three day average to ensure that the steady state peak fuel cladding temperature will remain below the ISG-11 Rev 3 limits. If the peak fuel cladding temperature exceeds ISG-11 Rev 3 limits, then the operation of a Supplemental Cooling System (SCS) in accordance with LCO 3.1.4 is mandatory.