CERTIFICATE OF COMPLIANCE NO. 1032

APPENDIX B

APPROVED CONTENTS AND DESIGN FEATURES

FOR THE HI-STORM FW MPC STORAGE SYSTEM

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Table 2.1-1 (page 2 of 6)
Fuel Assembly Limits

I. MPC MODEL: MPC-37 (continued)

B. Quantity per MPC: 37 FUEL ASSEMBLIES with up to twelve (12) DAMAGED FUEL ASSEMBLIES or FUEL DEBRIS in DAMAGED FUEL CONTAINERS (DFCs). DFCs may be stored in fuel storage locations 3-1, 3-3 through 3-7, 3-10 through 3-14, and 3-16 (see Figure 2.1-1), OR in fuel storage locations 2-1, 2-3, 2-4, 2-5, 2-8, 2-9, 2-10, and 2-12 (see Figure 2.1-1), depending on heat load pattern, see Section 2.3.1. The remaining fuel storage locations may be filled with PWR UNDAMAGED FUEL ASSEMBLIES meeting the applicable specifications. For MPCs utilizing burnup credit, the MPC and DFC loading configuration must also meet the additional requirements of Section 2.4.

C. One (1) Neutron Source Assembly (NSA) is authorized for loading in the MPC-37.

D. Up to thirty (30) ~~BRPAs~~ BPRAs are authorized for loading in the MPC-37.

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. Fuel assemblies containing APSRs, RCCAs, CEAs, CRAs (including, but not limited to those with hafnium), or NSAs may only be loaded in fuel storage Regions 1 and 2 (see Figure 2.1-1).

Note 2: DAMAGED FUEL ASSEMBLIES which can be handled by normal means and whose structural integrity is such that geometric rearrangement of fuel is not expected, may be stored in storage locations designated for DFCs using DFIs or DFCs. Damaged fuel stored in DFIs may contain missing or partial fuel rods and/or fuel rods with known or suspected cladding defects greater than hairline cracks or pinhole leaks.

Table 2.1-1 (page 6 of 6)
Fuel Assembly Limits

III. MPC MODEL: MPC-32ML (continued)

B. Quantity per MPC: 32 FUEL ASSEMBLIES with up to eight (8) DAMAGED FUEL ASSEMBLIES or FUEL DEBRIS in DAMAGED FUEL CONTAINERS (DFCs). DFCs may be stored in fuel storage locations 1-1, 1-4, 1-5, 1-10, 1-23, 1-28, 1-29, and 1-32 (see Figure 2.1-3). The remaining fuel storage locations may be filled with PWR UNDAMAGED FUEL ASSEMBLIES meeting the applicable specifications.

C. One (1) Neutron Source Assembly (NSA) is authorized for loading in the MPC-32ML.

D. Up to thirty-two (32) ~~BRPAs a~~BPRAs are authorized for loading in the MPC-32ML.

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. Fuel assemblies containing APSRs, RCCAs, CEAs, CRAs, or NSAs may only be loaded in fuel cells 1-6 through 1-9, 1-12 through 1-15, 1-18 through 1-21, and 1-24 through 1-27.

Note 2: DAMAGED FUEL ASSEMBLIES which can be handled by normal means and whose structural integrity is such that geometric rearrangement of fuel is not expected, may be stored in storage locations designated for DFCs using DFIs or DFCs. Damaged fuel stored in DFIs may contain missing or partial fuel rods and/or fuel rods with known or suspected cladding defects greater than hairline cracks or pinhole leaks.

2.3 Decay Heat Limits

This section provides the limits on fuel assembly decay heat for storage in the HI-STORM FW System. The method to verify compliance, including examples, is provided in Chapter 13 of the HI-STORM FW FSAR.

2.3.1 Fuel Loading Decay Heat Limits for HI-STORM FW

Tables 2.3-1A, 2.3-1B, and 2.3-1C provide the maximum allowable decay heat per fuel storage location for MPC-37. Tables 2.3-2A and 2.3-2B provide the maximum allowable decay heat per fuel storage location for MPC-89. No drying time limits are required for decay heat values meeting the limits in these tables when using FHD to dry moderate or high burnup fuel and when using VDS to dry moderate burnup fuel. Drying time limits apply when using VDS to dry high burnup fuel with decay heat values meeting the limits in these tables. Tables 2.3-3 and 2.3-4 provide the maximum allowable decay heat per fuel storage location for MPC-37 and MPC-89, respectively, with no drying time limits imposed, when using VDS to dry high burnup fuel. Table 2.3-5 provides the maximum allowable decay heat per fuel storage location for the MPC-32ML for both FHD and VDS drying. The per cell limits in these tables apply to cells containing undamaged fuel or damaged fuel in DFCs/DFIs or fuel debris in DFCs.

Figures 2.3-1 through 2.3-14 provide alternative loading patterns for the MPC-37 and MPC-89, with undamaged fuel and a combination of undamaged fuel and damaged fuel in DFCs/DFIs and fuel debris in DFCs. The per cell limits in these figures are applicable when using vacuum drying or FHD to dry moderate or high burnup fuel in accordance with Table 3-1 of Appendix A of the CoC. The MPC-37 patterns are based on the fuel length to be stored in the MPC, see Table 2.3-6.

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.

2.3.2 Fuel Loading Decay Heat Limits for HI-STORM FW UV

Tables 2.3-7A and 2.3-7B provide the maximum allowable decay heat per fuel storage location for MPC-37 in HI-STORM FW UV. Tables 2.3-8A and 2.3-8B provide the maximum allowable decay heat per fuel storage location for MPC-89 in HI-STORM FW UV. The per cell limits in these tables apply t-o cells containing undamaged fuel or damaged fuel in DFCs/DFIs or fuel debris in DFCs.

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.

2.3.3 Variable Fuel Height for MPC-37 when stored in HI-STORM FW UV

2.3.3.1 For fuel with a longer active fuel length than the reference fuel (144 inches), the maximum total heat load, maximum 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.

2.3.3.2 For fuel with a shorter active fuel length than the reference fuel (144 inches), the maximum total heat load, maximum 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.

2.3.4 Variable Fuel Height for MPC-89 when stored in HI-STORM FW UV

2.3.4.1 For fuel with a longer active fuel length than the reference fuel (150 inches), the maximum total heat load, maximum quadrant heat load limits and specific heat load limits in each cell, may be increased by the ratio SQRT(L/150), where L is the active length of the fuel in inches.

2.3.4.2 For fuel with a shorter active fuel length than the reference fuel (150 inches), the total heat load, quadrant heat load limits and specific heat load limits in each cell, shall be reduced linearly by the ratio L/150, where L is the active fuel length of the fuel in inches.

2.3.5~~2~~ 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.

TABLE 2.3-7A HI-STORM FW UV MPC-37 HEAT LOAD DATA (See Figure 2.1-1)			
Number of Regions: 3			
Number of Storage Cells: 37			
Maximum Total Heat Load (kW): 24			
Maximum ~~Quadrant~~Section Heat Load (kW): 3.0 (Note 1)			
Region No.	Decay Heat Limit per Cell, kW (Note 2)	Number of Cells per Region	Decay Heat Limit per Region, kW
1	0.648	9	5.832
2	0.648	12	7.776
3	0.648	16	10.368
Note 1: Figure 2.1-1 identifies the cell locations, and Table 2.3-9 identifies the cells included in the heat load for each section Note 2: Maximum total heat load, maximum section heat load and specific cell heat load limits may need to be adjusted in accordance with Section 2.3.3. Note 3: This pattern can be modified to develop regionalized patterns in accordance with the requirements in Table 2.3-7B			

TABLE 2.3-7B
HI-STORM FW UV MPC-37 REQUIREMENTS ON DEVELOPING REGIONALIZED HEAT LOAD PATTERNS (See Figure 2.1-1)

1. Pattern-specific total heat load must be equal to 24 kW
2. Section Heat Load must be equal to 3 kW, calculated per Table 2.3-9, and pattern must be 1/8th symmetric
3. Maximum Allowable Decay Heat per Cell in Region 1 is 0.648 kW
4. Maximum Allowable Decay Heat per Cell in Region 2 is 1.296 kW
5. Maximum Allowable Decay Heat per Cell in Region 3 is 1.944 kW
6. Pattern-specific Decay Heat in a storage cell may need to be adjusted to meet items 1 and 2
7. Pattern-specific decay heat for any storage cell in Region 1 may be determined by reducing the allowable in Region 1 of Table 2.3-7A by Δ and pattern-specific decay heat for any storage cell in Regions 2 and 3 may be determined by increasing the allowable in Region 2 and/or Region 3 of Table 2.3-7A by the same Δ.
8. Pattern-specific decay heat for any storage cell in Region 2 may be determined by reducing the allowable in Region 2 of Table 2.3-7A by θ and pattern-specific decay heat for any storage cell in Region 3 may be determined by increasing the allowable in Region 3 of Table 2.3-7A by the same θ. This θ may not be added to other cells in Region 2.
9. Items 1 through 8 need to be scaled in accordance with Section 2.3.4 for non-standard active fuel lengths.

General Note – The limits developed for the patterns are maximums, and any assembly with a heat load less than those limits can be loaded in the applicable cell, provided it meets all other CoC requirements.

TABLE 2.3-8A
HI-STORM FW UV MPC-89 HEAT LOAD DATA (See Figure 2.1-2)

Number of Regions: 3			
Number of Storage Cells: 89			
Maximum Total Heat Load (kW): 24			
Maximum ~~Quadrant~~Section Heat Load (kW): 3.0 (Note 1)			
Region No.	Decay Heat Limit per Cell, kW (Note 2)	Number of Cells per Region	Decay Heat Limit per Region, kW
1	0.269	9	2.421
2	0.269	40	10.76
3	0.269	40	10.76

Note 1: Figure 2.1-2 identifies the cell locations, and Table 2.3-10~~9~~ identifies the cells included in the heat load for ~~in~~ each section.
Note 2: Maximum total heat load, maximum section heat load and specific cell heat load limits may need to be adjusted in accordance with Section 2.3.4.

TABLE 2.3-8B
HI-STORM FW UV MPC-89 REQUIREMENTS ON DEVELOPING REGIONALIZED HEAT LOAD PATTERNS (See Figure 2.1-2)

1. Pattern-specific total heat load must be equal to 24 kW
2. Section Heat Load must be equal to 3 kW, calculated per Table 2.3-10, and pattern must be 1/8th symmetric
3. Maximum Allowable Decay Heat per Cell in Region 1 is 0.269 kW
4. Maximum Allowable Decay Heat per Cell in Region 2 is 0.538 kW
5. Maximum Allowable Decay Heat per Cell in Region 3 is 0.807 kW
6. Pattern-specific Decay Heat in a storage cell may need to be adjusted to meet items 1 and 2
7. Pattern-specific decay heat for any storage cell in Region 1 may be determined by reducing the allowable in Region 1 of Table 2.3-8A by Δ and pattern-specific decay heat for any storage cell in Regions 2 and 3 may be determined by increasing the allowable in Region 2 and/or Region 3 of Table 2.3-8A by the same Δ.
8. Pattern-specific decay heat for any storage cell in Region 2 may be determined by reducing the allowable in Region 2 of Table 2.3-8A by θ and pattern-specific decay heat for any storage cell in Region 3 may be determined by increasing the allowable in Region 3 of Table 2.3-8A by the same θ. This θ may not be added to other cells in Region 2.
9. Items 1 through 8 need to be scaled in accordance with Section 2.3.4 for non-standard active fuel lengths.
10. General Note – The limits developed for the patterns are maximums, and any assembly with a heat load less than those limits can be loaded in the applicable cell, provided it meets all other CoC requirements.

TABLE 2.3.9
SECTION HEAT LOAD CALCULATIONS FOR MPC-37

Section	Equation for Section Heat Load[1]
Section 1	$Q_{3-1} + Q_{2-1} + \frac{1}{2}Q_{3-2} + \frac{1}{2}Q_{3-4} + \frac{1}{2}Q_{2-2} + \frac{1}{2}Q_{1-1} + \frac{1}{2}Q_{1-2} + 1/8Q_{1-5}$
Section 2	$Q_{3-3} + Q_{2-3} + \frac{1}{2}Q_{3-2} + \frac{1}{2}Q_{3-5} + \frac{1}{2}Q_{2-2} + \frac{1}{2}Q_{1-3} + \frac{1}{2}Q_{1-2} + 1/8Q_{1-5}$
Section 3	$Q_{2-5} + Q_{3-7} + \frac{1}{2}Q_{1-6} + \frac{1}{2}Q_{3-5} + \frac{1}{2}Q_{2-7} + \frac{1}{2}Q_{1-3} + \frac{1}{2}Q_{3-9} + 1/8Q_{1-5}$
Section 4	$Q_{2-9} + Q_{3-11} + \frac{1}{2}Q_{1-6} + \frac{1}{2}Q_{1-9} + \frac{1}{2}Q_{2-7} + \frac{1}{2}Q_{3-13} + \frac{1}{2}Q_{3-9} + 1/8Q_{1-5}$
Section 5	$Q_{2-12} + Q_{3-16} + \frac{1}{2}Q_{1-8} + \frac{1}{2}Q_{1-9} + \frac{1}{2}Q_{2-11} + \frac{1}{2}Q_{3-13} + \frac{1}{2}Q_{3-15} + 1/8Q_{1-5}$
Section 6	$Q_{2-10} + Q_{3-14} + \frac{1}{2}Q_{1-8} + \frac{1}{2}Q_{1-7} + \frac{1}{2}Q_{2-11} + \frac{1}{2}Q_{3-12} + \frac{1}{2}Q_{3-15} + 1/8Q_{1-5}$
Section 7	$Q_{2-8} + Q_{3-10} + \frac{1}{2}Q_{1-4} + \frac{1}{2}Q_{1-7} + \frac{1}{2}Q_{2-6} + \frac{1}{2}Q_{3-12} + \frac{1}{2}Q_{3-8} + 1/8Q_{1-5}$
Section 8	$Q_{2-4} + Q_{3-6} + \frac{1}{2}Q_{1-4} + \frac{1}{2}Q_{1-1} + \frac{1}{2}Q_{2-6} + \frac{1}{2}Q_{3-4} + \frac{1}{2}Q_{3-8} + 1/8Q_{1-5}$

Notes

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

TABLE 2.3.10

SECTION HEAT LOAD CALCULATIONS FOR MPC-89

Section	**Equation for Section Heat Load**[1]
Section 1	$Q_{3-1} + Q_{3-4} + Q_{3-5} + Q_{3-6} + Q_{2-2} + Q_{2-3} + Q_{2-9} + \frac{1}{2}Q_{3-2} + \frac{1}{2}Q_{2-1} + \frac{1}{2}Q_{2-4} + \frac{1}{2}Q_{2-10} + \frac{1}{2}Q_{1-}$ $\frac{1}{2}Q_{1-1} + \frac{1}{2}Q_{2-8} + \frac{1}{2}Q_{2-11} + 1/8Q_{1-5}$
Section 2	$Q_{3-3} + Q_{3-7} + Q_{3-8} + Q_{3-9} + Q_{2-5} + Q_{2-6} + Q_{2-11} + \frac{1}{2}Q_{3-2} + \frac{1}{2}Q_{2-1} + \frac{1}{2}Q_{2-4} + \frac{1}{2}Q_{2-10} + \frac{1}{2}Q_{1-2} + \frac{1}{2}Q_{1-3} + \frac{1}{2}Q_{2-12} + \frac{1}{2}Q_{3-12} + 1/8Q_{1-5}$
Section 3	$Q_{3-13} + Q_{2-13} + Q_{3-15} + Q_{2-16} + Q_{2-17} + Q_{3-18} + Q_{3-19} + \frac{1}{2}Q_{1-6} + \frac{1}{2}Q_{2-21} + \frac{1}{2}Q_{2-22} + \frac{1}{2}Q_{2-23} + \frac{1}{2}Q_{3-21} + \frac{1}{2}Q_{1-3} + \frac{1}{2}Q_{2-12} + \frac{1}{2}Q_{3-12} + 1/8Q_{1-5}$
Section 4	$Q_{2-26} + Q_{2-27} + Q_{3-24} + Q_{3-25} + Q_{2-34} + Q_{3-27} + Q_{3-31} + \frac{1}{2}Q_{1-6} + \frac{1}{2}Q_{2-21} + \frac{1}{2}Q_{2-22} + \frac{1}{2}Q_{2-23} + \frac{1}{2}Q_{3-21} + \frac{1}{2}Q_{1-9} + \frac{1}{2}Q_{2-33} + \frac{1}{2}Q_{3-30} + 1/8Q_{1-5}$
Section 5	$Q_{2-32} + Q_{2-38} + Q_{2-39} + Q_{3-35} + Q_{2-36} + Q_{3-37} + Q_{3-40} + \frac{1}{2}Q_{1-8} + \frac{1}{2}Q_{2-31} + \frac{1}{2}Q_{2-37} + \frac{1}{2}Q_{2-40} + \frac{1}{2}Q_{3-39} + \frac{1}{2}Q_{1-9} + \frac{1}{2}Q_{2-33} + \frac{1}{2}Q_{3-30} + 1/8Q_{1-5}$
Section 6	$Q_{2-30} + Q_{2-35} + Q_{2-36} + Q_{3-32} + Q_{2-33} + Q_{3-34} + Q_{3-38} + \frac{1}{2}Q_{1-8} + \frac{1}{2}Q_{2-31} + \frac{1}{2}Q_{2-37} + \frac{1}{2}Q_{2-40} + \frac{1}{2}Q_{3-39} + \frac{1}{2}Q_{1-7} + \frac{1}{2}Q_{2-29} + \frac{1}{2}Q_{3-29} + 1/8Q_{1-5}$
Section 7	$Q_{2-25} + Q_{2-24} + Q_{3-23} + Q_{3-22} + Q_{2-28} + Q_{3-26} + Q_{3-28} + \frac{1}{2}Q_{1-4} + \frac{1}{2}Q_{2-20} + \frac{1}{2}Q_{2-19} + \frac{1}{2}Q_{2-18} + \frac{1}{2}Q_{3-20} + \frac{1}{2}Q_{1-7} + \frac{1}{2}Q_{2-29} + \frac{1}{2}Q_{3-29} + 1/8Q_{1-5}$
Section 8	$Q_{2-15} + Q_{2-14} + Q_{3-17} + Q_{3-16} + Q_{2-7} + Q_{3-14} + Q_{3-10} + \frac{1}{2}Q_{1-4} + \frac{1}{2}Q_{2-20} + \frac{1}{2}Q_{2-19} + \frac{1}{2}Q_{2-18} + \frac{1}{2}Q_{3-20} + \frac{1}{2}Q_{1-1} + \frac{1}{2}Q_{2-8} + \frac{1}{2}Q_{3-11} + 1/8Q_{1-5}$

Notes

1.) Q_{X-Y} is the heat load in kW in cell ID (X-Y), identified in Figure 2.1-2

b. For a free-standing OVERPACK 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.

c. For those ISFSI sites with design basis seismic acceleration values that may overturn or cause excessive sliding of free-standing casks, the anchored ~~HI-STORM FW~~ OVERPACK shall be utilized. Each OVERPACK shall be anchored with studs and compatible nuts of material suitable for the expected ISFSI environment. The embedment design shall comply with Appendix B of ACI-349-97. A later edition of this Code may be used, provided a written reconciliation is performed.

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. a. For storage in a free-standing OVERPACK, the user shall demonstrate that the ISFSI pad parameters used in the non-mechanistic tipover analysis are bounding for the site or a site specific non-mechanistic tipover analysis shall be performed using the dynamic model described in FSAR Section 3.4. The maximum total deflection, d, in the active fuel region of the basket panels shall be limited by the following inequality: $d \leq 0.005\ \ell$, where ℓ is basket cell inside dimension.