RENEWED CERTIFICATE OF COMPLIANCE NO. 1008

APPENDIX B

APPROVED CONTENTS AND DESIGN FEATURES

FOR THE HI-STAR 100 CASK SYSTEM

AMENDMENT 3

TABLE OF CONTENTS

APPENDIX B DESIGN FEATURES

1.0 Definitions

Refer to Appendix A for Definitions

1.1 Fuel Specifications

1.1.1 Fuel To Be Stored In The HI-STAR 100

1. INTACT FUEL ASSEMBLIES, DAMAGED FUEL ASSEMBLIES, FUEL DEBRIS, and certain non-fuel hardware meeting the limits specified in Table 1.1-1 (which refers to Tables 1.1-2 through 1.1-6) may be stored in the HI-STAR 100 System.

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

3. For MPCs partially loaded with DAMAGED FUEL ASSEMBLIES or FUEL DEBRIS, all remaining Zircaloy clad INTACT FUEL ASSEMBLIES in the MPC shall meet the maximum decay heat generation limits for the DAMAGED FUEL ASSEMBLIES.

4. For MPC-68's partially loaded with array/class 6x6A, 6x6B, 6x6C, or 8x8A fuel assemblies, all remaining Zircaloy clad INTACT FUEL ASSEMBLIES in the MPC shall meet the maximum decay heat generation limits for the 6x6A, 6x6B, 6x6C, and 8x8A fuel assemblies.

1.2 Functional and Operating Limits Violations

If any Fuel Specifications defined in Section 1.1 are violated, the following actions shall be completed:

1. The affected fuel assemblies shall be placed in a safe condition without delay and in a controlled manner.

2. Within 24 hours, notify the NRC Operations Center.

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

1.3 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-STAR 100 Cask System, as clarified in Specification 1.3.1 below.

1.3.1 Exceptions to Codes, Standards, and Criteria

Table 1.3-1 lists approved exceptions to the ASME Code for the design of the HI-STAR 100 Cask System.

1.3.2 Construction/Fabrication Exceptions to Codes, Standards, and Criteria

Proposed alternatives to the ASME Code, Sections II and III, 1995 Edition with Addenda through 1997 including exceptions allowed by Specification 1.3.1 may be used 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 exceptions shall be submitted in accordance with 10 CFR 72.4

1.4 Site Specific Parameters and Analyses

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

1. The temperature of 80° F is the maximum allowed average yearly temperature.

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

3. The horizontal and vertical seismic acceleration levels are bounded by the values listed below in Table 1-4.

Table 1-4

<u>Design-Basis Earthquake Input on the Top Surface of an ISFSI Pad</u>

Horizontal g-Level in Each of Two Orthogonal Directions	Horizontal g-Level Vector Sum	Corresponding Vertical g-Level (Upward)
0.222 g	0.314 g	1.00 x 0.222 g = 0.222 g
0.235 g	0.332 g	0.75 x 0.235 g = 0.176 g
0.24 g	0.339 g	0.667 x 0.24 g = 0.160 g
0.25 g	0.354 g	0.500 x 0.25 g = 0.125 g

4. For HI-STAR 100 casks stored horizontally, the following inequality shall be satisfied:

$$\frac{H_{CGH}}{B} \leq \frac{(1-\varepsilon G)}{2G}$$

where H_{CGH} is the center of gravity height of the horizontal cask above the ISFSI pad, B is the width of the supporting structure, G is the zero period acceleration seismic amplifier in horizontal direction, and ε is ratio of the vertical acceleration multiplier.

If the above inequality cannot be satisfied for a particular site, then a 3-D time history analysis may be performed to demonstrate stability of HI-STAR 100 overpack in horizontal storage configuration.

In all cases, H_{CGH} must not exceed 72 inches.

5. The analyzed flood condition of 13 fps water velocity and a height of 656 feet of water (full submergence of the loaded cask) are not exceeded.

6. The potential for fire and explosion shall be addressed, based on site-specific considerations. This includes the condition that the on-site transporter fuel tank will contain no more than 50 gallons of combustible transporter fuel.

7. The cask storage pads shall be verified by analysis to limit cask deceleration during both the design basis drop and the non-mechanistic tipover event to ≤60 g's at the top of the MPC fuel basket. Analyses shall be performed using methodologies consistent with those described in the HI-STAR FSAR.

8. In cases where engineered features (i.e., berms, shield walls) are used to ensure that the requirements of 10CFR72.104(a) are met, such features are to be considered important to safety and must be evaluated to determine the applicable Quality Assurance Category.

1.5 Design Specifications

1.5.1 Specifications Important for Criticality Control

1.5.1.1 MPC-24

1. Minimum flux trap size: 1.09 in.

2. Minimum ^{10}B loading in the neutron absorbers: 0.0267 g/cm^2 (Boral) and 0.0223 g/cm^2 (METAMIC)

1.5.1.2 MPC-68 and MPC-68F

1. Minimum fuel cell pitch: 6.43 in.

2. Minimum ^{10}B loading in the neutron absorbers: 0.0372 g/cm^2 (Boral) and 0.0310 g/cm^2 (METAMIC) in the MPC-68, and 0.01 g/cm^2 (Boral) in the MPC-68F.

1.5.1.3 MPC-32

1. Minimum fuel cell pitch: 9.158 in

2. Minimum ^{10}B loading in the neutron absorbers: 0.0372 g/cm^2 (Boral) and 0.0310 g/cm^2 (Metamic)

1.5.2 Specifications Important for Thermal Performance

1.5.2.1 OVERPACK

The paint used on the HI-STAR 100 OVERPACK must have an emissivity no less than 0.85.

Fuel Assembly Limits

I. MPC MODEL: MPC-24

A. Allowable Contents

1. Uranium oxide, PWR INTACT FUEL ASSEMBLIES, with or without Burnable Poison Rods (BPRAs) or Thimble Plug Devices (TPDs) listed in Table 1.1-2, and meeting the following specifications:

a. Cladding type:	Zircaloy (Zr) or stainless steel (SS) as specified in Table 1.1-2 for the applicable fuel assembly array/class
b. Initial enrichment:	As specified in Table 1.1-2 for the applicable fuel assembly array/class.
c. Decay heat per assembly	
i. Zr Clad:	An assembly decay heat as specified in Table 1.1-4 for the applicable post-irradiation cooling time.
ii. SS Clad	≤575 watts
d. Post-irradiation cooling time and average burnup per assembly	
i. Zr clad:	An assembly post-irradiation cooling time and average burnup as specified in Table 1.1-5. BPRA and TPD post-irradiation cooling time and average burnup as specified in Table 1.1.6.
ii. SS clad:	An assembly post-irradiation cooling time ≥9 years and an average burnup ≤30,000 MWD/MTU. OR An assembly post-irradiation cooling time ≥15 years and an average burnup ≤40,000 MWD/MTU.
e. Nominal fuel assembly length:	≤176.8 inches
f. Nominal fuel assembly width:	≤8.54 inches
g. Fuel assembly weight:	≤1,680 lbs (including non-fuel hardware)

I. MPC MODEL: MPC-24 (continued)

B. Quantity per MPC: Up to 24 PWR fuel assemblies.

C. Fuel assemblies shall not contain control components except as specifically authorized by this certificate of compliance. BPRAs and TPDs are authorized for loading in the HI-STAR 100 System with their associated fuel assemblies provided the burnup and cooling time limits specified in Table 1.1-6 are met.

D. DAMAGED FUEL ASSEMBLIES and FUEL DEBRIS are not authorized for loading into the MPC-24.

II. MPC MODEL: MPC-68

A. Allowable Contents

1. Uranium oxide, BWR INTACT FUEL ASSEMBLIES listed in Table 1.1-3, with or without Zircaloy channels, and meeting the following specifications:

a. Cladding type:	Zircaloy (Zr) or stainless steel (SS) as specified in Table 1.1-3 for the applicable fuel assembly array/class.
b. Maximum PLANAR-AVERAGE INITIAL ENRICHMENT:	As specified in Table 1.1-3 for the applicable fuel assembly array/class.
c. Initial maximum rod enrichment:	As specified in Table 1.1-3 for the applicable fuel assembly array/class.
d. Decay heat per assembly	
i. Zr clad	An assembly decay heat as specified in Table 1.1-4 for the applicable post-irradiation cooling time, except for (1) array/class 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A fuel assemblies, which shall have a decay heat ≤115 watts and (2) array/class 8x8F fuel assemblies, which shall have a decay heat ≤183.5 watts.
ii. SS clad	≤95 watts
e. Post-irradiation cooling time, average burnup per assembly:	
i. Zr clad:	An assembly post-irradiation cooling time and average burnup as specified in Table 1.1-5, except for (1) array/class 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A fuel assemblies, which shall have a cooling time ≥18 years, an average burnup ≤30,000 MWD/MTU, and (2) array/class 8x8F fuel assemblies, which shall have a cooling time ≥10 years, an average burnup ≤27,500 MWD/MTU.
ii. SS clad:	An assembly cooling time after discharge ≥10 years, an average burnup ≤22,500 MWD/MTU.
e. Nominal fuel assembly length:	≤176.2 inches
f. Nominal fuel assembly width:	≤5.85 inches
g. Fuel assembly weight	≤ 700 lbs, including channels

II. MPC MODEL: MPC-68 (continued)

A. Allowable Contents (continued)

2. Uranium oxide, BWR DAMAGED FUEL ASSEMBLIES, with or without Zircaloy channels, placed in DAMAGED FUEL CONTAINERS. BWR DAMAGED FUEL ASSEMBLIES shall meet the criteria specified in Table 1.1-3 for fuel assembly array/class 6x6A, 6x6B, 6x6C, 7x7A, or 8x8A, and meet the following specifications:

a. Cladding type:	Zircaloy (Zr)
b. Maximum PLANAR-AVERAGE INITIAL ENRICHMENT:	As specified in Table 1.1-3 for the applicable fuel assembly array/class.
c. Initial maximum rod enrichment:	As specified in Table 1.1-3 for the applicable fuel assembly array/class.
d. Decay heat per assembly	≤115 watts
e. Post-irradiation cooling time and average burnup per assembly:	An assembly post-irradiation cooling time ≥18 years and an average burnup ≤30,000 MWD/MTU.
f. Nominal fuel assembly length:	≤135.0 inches
g. Nominal fuel assembly width:	≤4.70 inches
h. Fuel assembly weight	≤400 lbs, including channels

II. MPC MODEL: MPC-68 (continued)

A. Allowable Contents (continued)

3. Mixed oxide (MOX), BWR INTACT FUEL ASSEMBLIES, with or without Zircaloy channels. MOX BWR INTACT FUEL ASSEMBLIES shall meet the criteria specified in Table 1.1-3 for fuel assembly array/class 6x6B, and meet the following specifications:

a. Cladding type:	Zircaloy (Zr)
b. Maximum PLANAR-AVERAGE INITIAL ENRICHMENT:	As specified in Table 1.1-3 for fuel assembly array/class 6x6B.
c. Initial maximum rod enrichment:	As specified in Table 1.1-3 for fuel assembly array/class 6x6B.
d. Decay heat per assembly	$\leq$115 watts
e. Post-irradiation cooling time and average burnup per assembly:	An assembly post-irradiation cooling time $\geq$18 years and an average burnup $\leq$30,000 MWD/MTIHM.
f. Nominal fuel assembly length:	$\leq$135.0 inches
g. Nominal fuel assembly width:	$\leq$4.70 inches
h. Fuel assembly weight	$\leq$400 lbs, including channels

II. MPC MODEL: MPC-68 (continued)

A. Allowable Contents (continued)

4. Mixed oxide (MOX), BWR DAMAGED FUEL ASSEMBLIES, with or without Zircaloy channels, placed in DAMAGED FUEL CONTAINERS. MOX BWR DAMAGED FUEL ASSEMBLIES shall meet the criteria specified in Table 1.1-3 for fuel assembly array/class 6x6B, and meet the following specifications:

a. Cladding type:	Zircaloy (Zr)
b. Maximum PLANAR-AVERAGE INITIAL ENRICHMENT:	As specified in Table 1.1-3 for array/class 6x6B.
c. Initial maximum rod enrichment:	As specified in Table 1.1-3 for array/class 6x6B.
d. Decay heat per assembly	≤115 watts
e. Post-irradiation cooling time and average burnup per assembly:	An assembly post-irradiation cooling time ≥18 years and an average burnup ≤30,000 MWD/MTIHM.
f. Nominal fuel assembly length:	≤135.0 inches
g. Nominal fuel assembly width:	≤4.70 inches
h. Fuel assembly weight	≤400 lbs, including channels

II. MPC MODEL: MPC-68 (continued)

A. Allowable Contents (continued)

5. Thoria rods (ThO_2 and UO_2) placed in Dresden Unit 1 Thoria Rod Canisters (as shown in Figure 2.1.2A of the SAR) and meeting the following specifications:

a. Cladding type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}U.
c. Number of rods per Thoria Rod Canister:	$\leq$18
d. Decay heat per Thoria Rod Canister:	$\leq$115 Watts
e. Post-irradiation fuel cooling time and average burnup per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq$18 years and an average burnup $\leq$16,000 MWD/MTIHM.
f. Initial heavy metal weight:	$\leq$27 kg/canister
g. Nominal fuel cladding O.D.:	$\geq$0.412 inches
h. Nominal fuel cladding I.D.:	$\leq$0.362 inches
i. Nominal fuel pellet O.D.:	$\leq$0.358 inches
j. Nominal active fuel length:	$\leq$111 inches
k. Canister weight:	$\leq$550 lbs, including fuel

II. MPC MODEL: MPC-68 (continued)

B. Quantity per MPC: Up to one (1) Dresden Unit 1 Thoria Rod Canister loaded toward the basket periphery (i.e., away from the hot central core of the fuel basket) plus any combination of DAMAGED FUEL ASSEMBLIES in DAMAGED FUEL CONTAINERS and INTACT FUEL ASSEMBLIES, up to a total of 68.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68.

D. Dresden Unit 1 fuel assemblies (fuel assembly array/class 6x6A, 6x6B, 6x6C, or 8x8A) with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium source material shall be in a water rod location.

III. MPC MODEL: MPC-68F

A. Allowable Contents

1. Uranium oxide, BWR INTACT FUEL ASSEMBLIES, with or without Zircaloy channels. BWR INTACT FUEL ASSEMBLIES shall meet the criteria specified in Table 1.1-3 for fuel assembly array/class 6x6A, 6x6C, 7x7A, or 8x8A and meet the following specifications:

a. Cladding type:	Zircaloy (Zr)
b. Maximum PLANAR-AVERAGE INITIAL ENRICHMENT:	As specified in Table 1.1-3 for the applicable fuel assembly array/class.
c. Initial maximum rod enrichment:	As specified in Table 1.1-3 for the applicable fuel assembly array/class.
d. Decay heat per assembly	≤115 watts
e. Post-irradiation cooling time and average burnup per assembly:	An assembly post-irradiation cooling time ≥18 years and an average burnup ≤30,000 MWD/MTU.
f. Nominal fuel assembly length:	≤176.2 inches
g. Nominal fuel assembly width:	≤5.85 inches
h. Fuel assembly weight	≤700 lbs, including channels

III. MPC MODEL: MPC-68F (continued)

A. Allowable Contents (continued)

2. Uranium oxide, BWR DAMAGED FUEL ASSEMBLIES, with or without Zircaloy channels, placed in DAMAGED FUEL CONTAINERS. BWR DAMAGED FUEL ASSEMBLIES shall meet the criteria specified in Table 1.1-3 for fuel assembly array/class 6x6A, 6x6C, 7x7A, or 8x8A, and meet the following specifications:

a. Cladding type:	Zircaloy (Zr)
b. Maximum PLANAR-AVERAGE INITIAL ENRICHMENT:	As specified in Table 1.1-3 for the applicable fuel assembly array/class.
c. Initial maximum rod enrichment:	As specified in Table 1.1-3 for the applicable fuel assembly array/class.
d. Decay heat per assembly	$\leq$115 watts
e. Post-irradiation cooling time and average burnup per assembly:	A post-irradiation cooling time after discharge $\geq$18 years and an average burnup $\leq$30,000 MWD/MTU.
f. Nominal fuel assembly length:	$\leq$135.0 inches
g. Nominal fuel assembly width:	$\leq$4.70 inches
h. Fuel assembly weight	$\leq$400 lbs, including channels

III. MPC MODEL: MPC-68F (continued)

A. Allowable Contents (continued)

3. Uranium oxide, BWR FUEL DEBRIS, with or without Zircaloy channels, placed in DAMAGED FUEL CONTAINERS. The original fuel assemblies for the uranium oxide BWR FUEL DEBRIS shall meet the criteria specified in Table 1.1-3 for fuel assembly array/class 6x6A, 6x6C, 7x7A, or 8x8A, and meet the following specifications:

a. Cladding type:	Zircaloy (Zr)
b. Maximum PLANAR-AVERAGE INITIAL ENRICHMENT:	As specified in Table 1.1-3 for the applicable original fuel assembly array/class.
c. Initial maximum rod enrichment:	As specified in Table 1.1-3 for the applicable original fuel assembly array/class.
d. Decay heat per DFC:	≤115 watts
e. Post-irradiation cooling time and average burnup per assembly:	A post-irradiation cooling time after discharge ≥18 years and an average burnup ≤30,000 MWD/MTU for the original fuel assembly.
f. Nominal original fuel assembly length:	≤135.0 inches
g. Nominal original fuel assembly width:	≤4.70 inches
h. Fuel debris weight	≤400 lbs, including channels

III. MPC MODEL: MPC-68F (continued)

A. Allowable Contents (continued)

4. Mixed oxide(MOX), BWR INTACT FUEL ASSEMBLIES, with or without Zircaloy channels. MOX BWR INTACT FUEL ASSEMBLIES shall meet the criteria specified in Table 1.1-3 for fuel assembly array/class 6x6B, and meet the following specifications:

a. Cladding type:	Zircaloy (Zr)
b. Maximum PLANAR-AVERAGE INITIAL ENRICHMENT:	As specified in Table 1.1-3 for fuel assembly array/class 6x6B.
c. Initial maximum rod enrichment:	As specified in Table 1.1-3 for fuel assembly array/class 6x6B.
d. Decay heat per assembly	≤115 watts
e. Post-irradiation cooling time and average burnup per assembly:	An assembly post-irradiation cooling time after discharge ≥18 years and an average burnup ≤30,000 MWD/MTIHM.
f. Nominal fuel assembly length:	≤135.0 inches
g. Nominal fuel assembly width:	≤4.70 inches
h. Fuel assembly weight	≤400 lbs, including channels

III. MPC MODEL: MPC-68F (continued)

A. Allowable Contents (continued)

5. Mixed oxide (MOX), BWR DAMAGED FUEL ASSEMBLIES, with or without Zircaloy channels, placed in DAMAGED FUEL CONTAINERS. MOX BWR INTACT FUEL ASSEMBLIES shall meet the criteria specified in Table 1.1-3 for fuel assembly array/class 6x6B, and meet the following specifications:

a. Cladding type:	Zircaloy (Zr)
b. Maximum PLANAR-AVERAGE INITIAL ENRICHMENT:	As specified in Table 1.1-3 for array/class 6x6B.
c. Initial maximum rod enrichment:	As specified in Table 1.1-3 for array/class 6x6B.
d. Decay heat per assembly	≤115 watts
e. Post-irradiation cooling time and average burnup per assembly:	A post-irradiation cooling time after discharge ≥18 years and an average burnup ≤30,000 MWD/MTIHM.
f. Nominal fuel assembly length:	≤135.0 inches
g. Nominal fuel assembly width:	≤4.70 inches
h. Fuel assembly weight	≤400 lbs, including channels

III. MPC MODEL: MPC-68F (continued)

A. Allowable Contents (continued)

6. Mixed oxide (MOX), BWR FUEL DEBRIS, with or without Zircaloy channels, placed in DAMAGED FUEL CONTAINERS. The original fuel assemblies for the MOX BWR FUEL DEBRIS shall meet the criteria specified in Table 1.1-3 for fuel assembly array/class 6x6B, and meet the following specifications:

a. Cladding type:	Zircaloy (Zr)
b. Maximum PLANAR-AVERAGE INITIAL ENRICHMENT:	As specified in Table 1.1-3 for original fuel assembly array/class 6x6B.
c. Initial maximum rod enrichment:	As specified in Table 1.1-3 for original fuel assembly array/class 6x6B.
d. Decay heat per DFC	≤115 watts
e. Post-irradiation cooling time and average burnup per assembly:	A post-irradiation cooling time after discharge ≥ 18 years and an average burnup ≤ 30,000 MWD/MTIHM for the original fuel assembly.
f. Nominal original fuel assembly length:	≤135.0 inches
g. Nominal original fuel assembly width:	≤4.70 inches
h. Fuel debris weight	≤400 lbs, including channels

III. MPC MODEL: MPC-68F (continued)

A. Allowable Contents (continued)

7. Thoria rods (ThO_2 and UO_2) placed in Dresden Unit 1 Thoria Rod Canisters (as shown in Figure 2.1.2A of the SAR) and meeting the following specifications:

a. Cladding type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}U.
c. Number of rods per Thoria Rod Canister:	$\leq$18
d. Decay heat per Thoria Rod Canister:	$\leq$115 Watts
e. Post-irradiation fuel cooling time and average burnup per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq$18 years and an average burnup $\leq$ 16,000 MWD/MTIHM.
f. Initial heavy metal weight:	$\leq$27 kg/canister
g. Nominal fuel cladding O.D.:	$\geq$0.412 inches
h. Nominal fuel cladding I.D.:	$\leq$0.362 inches
i. Nominal fuel pellet O.D.:	$\leq$0.358 inches
j. Nominal active fuel length:	$\leq$111 inches
k. Canister weight:	$\leq$550 lbs, including fuel

III. MPC MODEL: MPC-68F (continued)

B. Quantity per MPC:

Up to four (4) DFCs containing uranium oxide or MOX BWR FUEL DEBRIS. The remaining MPC-68F fuel storage locations may be filled with array/class 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A fuel assemblies of the following type, as applicable:

1. Uranium oxide BWR INTACT FUEL ASSEMBLIES;
2. MOX BWR INTACT FUEL ASSEMBLIES;
3. Uranium oxide BWR DAMAGED FUEL ASSEMBLIES placed in DFCs;
4. MOX BWR DAMAGED FUEL ASSEMBLIES placed in DAMAGED FUEL CONTAINERS; or
5. Up to one (1) Dresden Unit 1 Thoria Rod Canister loaded toward the basket periphery (i.e., away from the hot central core of the fuel basket).

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68F.

D. Dresden Unit 1 fuel assemblies (fuel assembly array/class 6x6A, 6x6B, 6x6C or 8x8A) with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68F. The antimony-Beryllium neutron source material shall be in a water rod location.

IV. MPC MODEL MPC-32

A. Allowable Contents

1. Uranium oxide, PWR INTACT FUEL ASSEMBLIES, listed in Table 1.1-2, and meeting the following specifications:

a. Cladding type:	Zircaloy (Zr) as specified in Table 1.1-2 for the applicable fuel assembly array/class. SS clad assemblies are not allowed for storage in the MPC-32
b. Initial enrichment:	As specified in Table 1.1-2 for the applicable fuel assembly array/class.
c. Decay heat per assembly	An assembly decay heat as specified in Table 1.1-4 for the applicable post-irradiation cooling time.
d. Post-irradiation cooling time average burnup per assembly	An assembly post-irradiation cooling time and average burnup as specified in Table 1.1-5.
e. Nominal fuel assembly length:	$\leq$ 176.8 inches
f. Nominal fuel assembly width:	$\leq$ 8.54 inches
g. Fuel assembly weight:	$\leq$ 1,680 lbs (including non-fuel hardware)

Table 1.1-2 (Page 1 of 4)
PWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/Class	**14x14A**	**14x14B**	**14x14C**	**14x14D**	**15x15A**
Clad Material (Note 2)	Zr	Zr	Zr	SS	Zr
Design Initial U (kg/assy.) (Note 3)	≤ 407	≤ 407	≤ 425	≤ 400	≤ 464
Initial Enrichment (MPC-24 without soluble boron credit) (wt % ^{235}U)	≤ 4.6	≤ 4.6	≤ 4.6	≤ 4.0	≤ 4.1
Initial Enrichment (MPC-24 and MPC-32 with soluble boron credit, Note 6) (wt % ^{235}U)	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
No. of Fuel Rods (Note 5)	179	179	176	180	204
Clad O.D. (in.)	≥ 0.400	≥ 0.417	≥ 0.440	≥ 0.422	≥ 0.418
Clad I.D. (in.)	≤ 0.3514	≤ 0.3734	≤ 0.3880	≤ 0.3890	≤ 0.3660
Pellet Dia. (in.) (Note 7)	≤ 0.3444	≤ 0.3659	≤ 0.3805	≤ 0.3835	≤ 0.3580
Fuel Rod Pitch (in.)	≤ 0.556	≤ 0.556	≤ 0.580	≤ 0.556	≤ 0.550
Active Fuel Length (in.)	≤ 150	≤ 150	≤ 150	≤ 144	≤ 150
No. of Guide Tubes	17	17	5 (Note 4)	16	21
Guide Tube Thickness (in.)	≥ 0.017	≥ 0.017	≥ 0.038	≥ 0.0145	≥ 0.0165

Table 1.1-2 (Page 2 of 4)
PWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/Class	**15x15B**	**15x15C**	**15x15D**	**15x15E**	**15x15F**
Clad Material (Note 2)	Zr	Zr	Zr	Zr	Zr
Design Initial U (kg/assy.) (Note 3)	≤ 464	≤ 464	≤ 475	≤ 475	≤ 475
Initial Enrichment (MPC-24 without soluble boron credit) (wt % ^{235}U)	≤ 4.1	≤ 4.1	≤ 4.1	≤ 4.1	≤ 4.1
Initial Enrichment (MPC-24 and MPC-32 with soluble boron credit, Note 6) (wt % ^{235}U)	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
No. of Fuel Rods (Note 5)	204	204	208	208	208
Clad O.D. (in.)	≥ 0.420	≥ 0.417	≥ 0.430	≥ 0.428	≥ 0.428
Clad I.D. (in.)	≤ 0.3736	≤ 0.3640	≤ 0.3800	≤ 0.3790	≤ 0.3820
Pellet Dia. (in.) (Note 7)	≤ 0.3671	≤ 0.3570	≤ 0.3735	≤ 0.3707	≤ 0.3742
Fuel Rod Pitch (in.)	≤ 0.563	≤ 0.563	≤ 0.568	≤ 0.568	≤ 0.568
Active Fuel Length (in.)	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150
No. of Guide Tubes	21	21	17	17	17
Guide Tube Thickness (in.)	≥ 0.015	≥ 0.0165	≥ 0.0150	≥ 0.0140	≥ 0.0140

Table 1.1-2 (Page 3 of 4)
PWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/ Class	**15x15G**	**15x15H**	**16x16A**	**17x17A**	**17x17B**	**17x17C**
Clad Material (Note 2)	SS	Zr	Zr	Zr	Zr	Zr
Design Initial U (kg/assy.) (Note 3)	≤ 420	≤ 475	≤ 443	≤ 467	≤ 467	≤ 474
Initial Enrichment (MPC-24 without soluble boron credit) (wt % ^{235}U)	≤ 4.0	≤ 3.8	≤ 4.6	≤ 4.0	≤ 4.0	≤ 4.0
Initial Enrichment (MPC-24 and MPC-32 with soluble boron credit, Note 6) (wt % ^{235}U)	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
No. of Fuel Rods (Note 5)	204	208	236	264	264	264
Clad O.D. (in.)	≥ 0.422	≥ 0.414	≥ 0.382	≥ 0.360	≥ 0.372	≥ 0.377
Clad I.D. (in.)	≤ 0.3890	≤ 0.3700	≤ 0.3350	≤ 0.3150	≤ 0.3310	≤ 0.3330
Pellet Dia. (in.) (Note 7)	≤ 0.3825	≤ 0.3622	≤ 0.3255	≤ 0.3088	≤ 0.3232	≤ 0.3252
Fuel Rod Pitch (in.)	≤ 0.563	≤ 0.568	≤ 0.506	≤ 0.496	≤ 0.496	≤ 0.502
Active Fuel Length (in.)	≤ 144	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150
No. of Guide Tubes	21	17	5 (Note 4)	25	25	25
Guide Tube Thickness (in.)	≥ 0.0145	≥ 0.0140	≥ 0.0350	≥ 0.016	≥ 0.014	≥ 0.020

Table 1.1-2 (Page 4 of 4)
PWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

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. Zr. Designates cladding material made of Zirconium or Zirconium alloys.

3. Design initial uranium weight is the uranium weight specified for each assembly by the fuel manufacturer or reactor user. For each PWR fuel assembly, the total uranium weight limit specified in this table may be increased up to 2.0 percent for comparison with users' fuel records to account for manufacturer tolerances.

4. Each guide tube replaces four fuel rods.

5. Missing fuel rods must be replaced with dummy fuel rods that displace an equal or greater amount of water as the original fuel rods.

6. Soluble boron concentration per LCO 2.3.1, as applicable

7. Annular fuel pellets are allowed in the top and bottom 12" of the active fuel length.

Table 1.1-3 (Page 1 of 5)
BWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/Class	**6x6A**	**6x6B**	**6x6C**	**7x7A**	**7x7B**	**8x8A**
Clad Material (Note 2)	Zr	Zr	Zr	Zr	Zr	Zr
Design Initial U (kg/assy.) (Note 3)	≤ 110	≤ 110	≤ 110	≤ 100	≤ 195	≤ 120
Maximum PLANAR-AVERAGE INITIAL ENRICHMENT (wt.% ^{235}U)	≤ 2.7	≤ 2.7 for the UO_2 rods. See Note 4 for MOX rods	≤ 2.7	≤ 2.7	≤ 4.2	≤ 2.7
Initial Maximum Rod Enrichment (wt.% ^{235}U)	≤ 4.0	≤ 4.0	≤ 4.0	≤ 5.5	≤ 5.0	≤ 4.0
No. of Fuel Rods (Note 14)	35 or 36	35 or 36 (up to 9 MOX rods)	36	49	49	63 or 64
Clad O.D. (in.)	≥ 0.5550	≥ 0.5625	≥ 0.5630	≥ 0.4860	≥ 0.5630	≥ 0.4120
Clad I.D. (in.)	≤ 0.5105	≤ 0.4945	≤ 0.4990	≤ 0.4204	≤ 0.4990	≤ 0.3620
Pellet Dia. (in.)	≤ 0.4980	≤ 0.4820	≤ 0.4880	≤ 0.4110	≤ 0.4910	≤ 0.3580
Fuel Rod Pitch (in.)	≤ 0.710	≤ 0.710	≤ 0.740	≤ 0.631	≤ 0.738	≤ 0.523
Active Fuel Length (in.)	≤ 120	≤ 120	≤ 77.5	≤ 80	≤ 150	≤ 120
No. of Water Rods (Note 11)	1 or 0	1 or 0	0	0	0	1 or 0
Water Rod Thickness (in.)	≥ 0	≥ 0	N/A	N/A	N/A	≥ 0
Channel Thickness (in.)	≤ 0.060	≤ 0.060	≤ 0.060	≤ 0.060	≤ 0.120	≤ 0.100

Table 1.1-3 (Page 2 of 5)
BWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/Class	**8x8B**	**8x8C**	**8x8D**	**8x8E**	**8x8F**	**9x9A**	**9x9B**
Clad Material (Note 2)	Zr	Zr	Zr	Zr	Zr	Zr	Zr
Design Initial U (kg/assy.) (Note 3)	≤ 185	≤ 185	≤ 185	≤ 185	≤ 185	≤ 177	≤ 177
Maximum PLANAR-AVERAGE INITIAL ENRICHMENT (wt.% ^{235}U)	≤ 4.2	≤ 4.2	≤ 4.2	≤ 4.2	< 3.6	≤ 4.2	≤ 4.2
Initial Maximum Rod Enrichment (wt.% ^{235}U)	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
No. of Fuel Rods (Note 14)	63 or 64	62	60 or 61	59	64	74/66 (Note 5)	72
Clad O.D. (in.)	≥ 0.4840	≥ 0.4830	≥ 0.4830	≥ 0.4930	≥ 0.4576	≥ 0.4400	≥ 0.4330
Clad I.D. (in.)	≤ 0.4295	≤ 0.4250	0.4230	≤ 0.4250	≤ 0.3996	≤ 0.3840	≤ 0.3810
Pellet Dia. (in.)	≤ 0.4195	≤ 0.4160	≤ 0.4140	≤ 0.4160	≤ 0.3913	≤ 0.3760	≤ 0.3740
Fuel Rod Pitch (in.)	≤ 0.642	≤ 0.641	≤ 0.640	≤ 0.640	≤ 0.609	≤ 0.566	≤ 0.572
Design Active Fuel Length (in.)	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150
No. of Water Rods (Note 11)	1 or 0	2	1 - 4 (Note 7)	5	N/A (Note 12)	2	1 (Note 6)
Water Rod Thickness (in.)	≥ 0.034	> 0.00	> 0.00	≥ 0.034	≥ 0.0315	> 0.00	> 0.00
Channel Thickness (in.)	≤ 0.120	≤ 0.120	≤ 0.120	≤ 0.100	≤ 0.055	≤ 0.120	≤ 0.120

Table 1.1-3 (Page 3 of 5)
BWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/Class	**9x9C**	**9x9D**	**9x9E (Note 13)**	**9x9F (Note 13)**	**10x10A**
Clad Material (Note 2)	Zr	Zr	Zr	Zr	Zr
Design Initial U (kg/assy.) (Note 3)	≤ 177	≤ 177	≤ 177	≤ 177	≤ 186
Maximum PLANAR-AVERAGE INITIAL ENRICHMENT (wt.% ^{235}U)	≤ 4.2	≤ 4.2	≤ 4.1	≤ 4.1	≤ 4.2
Initial Maximum Rod Enrichment (wt.% ^{235}U)	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
No. of Fuel Rods (Note 14)	80	79	76	76	92/78 (Note 8)
Clad O.D. (in.)	≥ 0.4230	≥ 0.4240	≥ 0.4170	≥ 0.4430	≥ 0.4040
Clad I.D. (in.)	≤ 0.3640	≤ 0.3640	≤ 0.3640	≤ 0.3860	≤ 0.3520
Pellet Dia. (in.)	≤ 0.3565	≤ 0.3565	≤ 0.3530	≤ 0.3745	≤ 0.3455
Fuel Rod Pitch (in.)	≤ 0.572	≤ 0.572	≤ 0.572	≤ 0.572	≤ 0.510
Design Active Fuel Length (in.)	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150
No. of Water Rods (Note 11)	1	2	5	5	2
Water Rod Thickness (in.)	≥ 0.020	≥ 0.0300	≥ 0.0120	≥ 0.0120	≥ 0.0300
Channel Thickness (in.)	≤ 0.100	≤ 0.100	≤ 0.120	≤ 0.120	≤ 0.120

Table 1.1-3 (Page 4 of 5)
BWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/Class	**10x10B**	**10x10C**	**10x10D**	**10x10E**
Clad Material (Note 2)	Zr	Zr	SS	SS
Design Initial U (kg/assy.) (Note 3)	≤ 186	≤ 186	≤ 125	≤ 125
Maximum PLANAR-AVERAGE INITIAL ENRICHMENT (wt% ^{235}U)	≤ 4.2	≤ 4.2	≤ 4.0	≤ 4.0
Initial Maximum Rod Enrichment (wt.% ^{235}U)	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5
No. of Fuel Rods (Note 14)	91/83 (Note 9)	96	100	96
Clad O.D. (in.)	≥ 0.3957	≥ 0.3780	≥ 0.3960	≥ 0.3940
Clad I.D. (in.)	≤ 0.3480	≤ 0.3294	≤ 0.3560	≤ 0.3500
Pellet Dia. (in.)	≤ 0.3420	≤ 0.3224	≤ 0.3500	≤ 0.3430
Fuel Rod Pitch (in.)	≤ 0.510	≤ 0.488	≤ 0.565	≤ 0.557
Design Active Fuel Length (in.)	≤ 150	≤ 150	≤ 83	≤ 83
No. of Water Rods (Note 11)	1 (Note 6)	5 (Note 10)	0	4
Water Rod Thickness (in.)	> 0.00	≥ 0.031	N/A	≥ 0.022
Channel Thickness (in.)	≤ 0.120	≤ 0.055	≤ 0.080	≤ 0.080

Table 1.1-3 (Page 5 of 5)
BWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

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. Zr designates cladding material made from Zirconium or Zirconium alloys.

3. Design initial uranium weight is the uranium weight specified for each assembly by the fuel manufacturer or reactor user. For each BWR fuel assembly, the total uranium weight limit specified in this table may be increased up to 1.5% for comparison with users' fuel records to account for manufacturer's tolerances.

4. $\leq$ 0.635 wt. % ^{235}U and $\leq$ 1.578 wt. % total fissile plutonium (^{239}Pu and ^{241}Pu), (wt. % of total fuel weight, i.e., UO_2 plus PuO_2).

5. This assembly class contains 74 total fuel rods; 66 full length rods and 8 partial length rods.

6. Square, replacing nine fuel rods.

7. Variable

8. This assembly class contains 92 total fuel rods; 78 full length rods and 14 partial length rods.

9. This assembly class contains 91 total fuel rods, 83 full length rods and 8 partial length rods.

10. One diamond-shaped water rod replacing the four center fuel rods and four rectangular water rods dividing the assembly into four quadrants.

11. These rods may be sealed at both ends and contain Zr material in lieu of water.

12. This assembly is known as "QUAD+" and has four rectangular water cross segments dividing the assembly into four quadrants.

13. For the SPC 9x9-5 fuel assembly, each fuel rod must meet either the 9x9E or 9x9F set of limits for clad O.D., clad I.D., and pellet diameter.

14. Missing fuel rods must be replaced with dummy fuel rods that displace an equal or greater amount of water as the original fuel rods. Storage of 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A fuel assemblies with missing fuel rods are permitted provided the assemblies are stored as DAMAGED FUEL ASSEMBLIES or FUEL DEBRIS.

Table 1.1-4

FUEL ASSEMBLY COOLING AND DECAY HEAT GENERATION

Post-Irradiation Cooling Time (years)	MPC-24 PWR Assembly With or Without BPRAs or TPDs Decay Heat (Watts)	MPC-68 BWR Assembly Decay Heat (Watts)	MPC-32 PWR Assembly Decay Heat (Watts)
≥ 5	≤ 792 (Vertical) ≤ 833 (Horizontal)	≤ 272	≤ 578 (Vertical) ≤ 625 (Horizontal)

Table 1.1-5

FUEL ASSEMBLY COOLING AND AVERAGE BURNUP (Note 1)

Post-Irradiation Cooling Time (years)	MPC-24 PWR Assembly Burnup (Without BPRAs and With or Without TPDs) (MWD/MTU)	MPC-24 PWR Assembly Burnup (With BPRAs) (MWD/MTU)	MPC-68 BWR Assembly Burnup (MWD/MTU)	MPC-32 PWR Assembly Burnup (MWD/MTU)	MPC-32 PWR Assembly Burnup (Non-Zircaloy Grid Spacers) (MWD/MTU)
≥ 5	≤28,700	≤28,300	≤26,000	-	-
≥ 6	≤32,700	≤32,300	≤29,100	-	-
≥ 7	≤33,300	≤32,700	≤29,600	-	-
≥ 8	≤35,500	≤35,000	≤31,400	≤24,500	-
≥ 9	≤37,000	≤36,500	≤32,800	≤29,500	-
≥ 10	≤38,200	≤37,600	≤33,800	≤31,100	-
≥ 11	≤39,300	≤38,700	≤34,800	≤32,800	-
≥ 12	≤40,100	≤39,500	≤35,500	≤34,500	≤24,500
≥ 13	≤40,800	≤40,200	≤36,200	≤37,000	≤27,000
≥ 14	≤41,500	≤40,800	≤36,900	≤39,500	≤29,500
≥ 15	≤42,100	≤41,400	≤37,600	≤40,300	≤32,000
≥ 16				≤41,100	≤34,500
≥ 17				≤42,000	≤36,100
≥ 18				≤42,800	≤39,500
≥ 19				≤43,600	≤39,500
≥ 20				≤44,500	≤42,500

Note: 1. Linear interpolation between points permitted.

Table 1.1-6

NON-FUEL HARDWARE COOLING AND AVERAGE BURNUP (Note 1)

Post-Irradiation Cooling Time (years)	MPC-24 BPRA Burnup (MWD/MTU)	MPC-24 TPD Burnup (MWD/MTU)
≥ 3	≤20,000	NC (Note 2)
≥ 4	NC	≤20,000
≥ 5	≤30,000	NC
≥ 6	≤40,000	≤30,000
≥ 7	NC	≤40,000
≥ 8	≤50,000	NC
≥ 9	≤60,000	≤50,000
≥ 10	NC	≤60,000
≥ 11	NC	NC
≥ 12	NC	≤90,000
≥ 13	NC	≤180,000
≥ 14	NC	≤630,000

Notes:

1. Linear interpolation between points is permitted, except that TPD burnups >180,000 MWD/MTU and ≤630,000 MWD/MTU must be cooled ≥14 years.
2. Not Calculated

LIST OF ASME CODE EXCEPTIONS FOR THE HI-STAR 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Exception, Justification & Compensatory Measures
MPC, MPC basket assembly, and HI-STAR overpack steel structure	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	Because the MPC and overpack are not ASME Code stamped vessels, none of the specifications, reports, certificates, or other general requirements specified by NCA are required. The HI-STAR FSAR includes the design criteria, service conditions, and load combinations for the design and operation of the HI-STAR 100 System 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 various articles of Subsections NB, NG, and NF of 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	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.

LIST OF ASME CODE EXCEPTIONS FOR THE HI-STAR 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Exception, Justification & Compensatory Measures
MPC	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 basket supports and lift lugs	NB-1130	NB-1132.2(d) requires that the first connecting weld of a nonpressure-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 MPC basket supports (nonpressure-retaining structural attachments) and lift lugs (nonstructural attachments 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 basket supports and associated attachment welds are designed to satisfy the stress limits of Subsection NG and the lift lugs and associated attachment welds are designed to satisfy the stress limits of Subsection NF, as a minimum. These attachments and their welds are shown by analysis to meet the respective stress limits for their service conditions. Likewise, non-structural items, such as shield plugs, spacers, etc., if used, can be attached to pressure-retaining parts in the same manner.

Table 1.3-1 (Page 3 of 11)
LIST OF ASME CODE EXCEPTIONS FOR THE HI-STAR 100 CASK SYSTEM

Component	**Reference ASME Code Section/Article**	**Code Requirement**	**Exception, Justification & Compensatory Measures**
MPC, MPC basket assembly, and HI-STAR overpack steel structure	NB-3100 NG-3100 NF-3100	Provides requirements for determining design loading conditions, such as pressure, temperature, and mechanical loads.	These requirements are not applicable. The HI-STAR FSAR serving as the Design Specification, establishes the service conditions and load combinations for the storage system.
MPC	NB-3350	NB-3352.3 requires, for Category C joints, that the minimum dimensions of the welds and throat thickness shall be as shown in Figure NB-4243-1.	The MPC shell-to-baseplate weld joint design (designated Category C) may not include a reinforcing fillet weld or a bevel in the MPC baseplate, which makes it different than any of the representative configurations depicted in Figure NB-4243-1. The transverse thickness of this weld is equal to the thickness of the adjoining shell. The weld is designed as a full penetration weld that receives VT and RT or UT, as well as final surface PT examinations. Because the MPC shell design thickness is considerably larger than the minimum thickness required by the Code, a reinforcing fillet weld that would intrude into the MPC cavity space is not included. Not including this fillet weld provides for a higher quality radiographic examination of the full penetration weld. From the standpoint of stress analysis, the fillet weld serves to reduce the local bending stress (secondary stress) produced by the gross structural discontinuity defined by the flat plate / shell junction. In the MPC design, the shell and baseplate thicknesses are well beyond that required to meet their respective membrane stress intensity limits.

Table 1.3-1 (Page 4 of 11)
LIST OF ASME CODE EXCEPTIONS FOR THE HI-STAR 100 CASK SYSTEM

Component	**Reference ASME Code Section/Article**	**Code Requirement**	**Exception, Justification & Compensatory Measures**
MPC. MPC basket assembly, and HI-STAR overpack steel structure	NB-4120 NG-4120 NF-4120	NB-4121.2, NG-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, coating, and pouring of Holtite are not, unless explicitly stated by the Code, defined as heat treatment operations For the steel parts in the HI-STAR 100 System components, the duration for which a part exceeds the off-normal temperature limit shall be limited to 24 hours in a particular manufacturing process (such as the Holtite pouring process).
MPC and HI-STAR overpack steel structure	NB-4220 NF-4220	Requires certain forming tolerance 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-overpack) 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 chose 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 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. Additionally, a weld efficiency factor of 0.45 has been applied to the analyses of these welds.

Table 1.3-1 (Page 5 of 11)
LIST OF ASME CODE EXCEPTIONS FOR THE HI-STAR 100 CASK SYSTEM

Component	**Reference ASME Code Section/Article**	**Code Requirement**	**Exception, Justification & Compensatory Measures**
MPC Lid to Shell Weld	NB-5230	Radiographic (RT) or ultrasonic (UT) examination required	Only UT or multi-layer liquid penetrant (PT) examination is permitted. If PT alone is used, at a minimum, it will include the root and final weld layers and each approximately 3/8 inch of weld depth.
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 MPC vent and drain cover plate welds are leak tested. The closure ring provides independent redundant closure for vent and drain cover plates.

Component	Reference ASME Code Section/Article	Code Requirement	Exception, Justification & Compensatory Measures
MPC Enclosure Vessel and Lid	NB-6111	All completed pressure retaining systems shall be pressure tested.	The MPC enclosure vessel is seal welded in the field following fuel assembly loading. The MPC enclosure vessel shall then be hydrostatically tested as defined in Chapter 9. Accessibility for leakage inspections preclude a Code compliant hydrostatic test. All MPC enclosure vessel welds (except the closure ring and vent/drain cover plate) are inspected by volumetric examination, except the MPC lid-to-shell weld shall be verified by volumetric or multi-layer PT examination. If PT alone is used, at a minimum, it must include the root and final layers and each approximately 3/8 inch of weld depth. For either UT or PT, the maximum undetectable flaw size must be demonstrated to be less than the critical flaw size. The critical flaw size must be determined in accordance with ASME Section XI methods. The critical flaw size shall not cause the primary stress limits of NB-3000 to be exceeded. The vent/drain cover plate weld is confirmed by liquid penetrant examination and the closure ring weld is confirmed by liquid penetrant examination. The inspection process, including findings, (indications) shall be made a permanent part of the certificate holder's records by video, photographic, or other means which provide an equivalent retrievable record of weld integrity. The video or photographic records should be taken during the final interpretation period described in ASME Section V, Article 6, T-676. The inspection of the weld must be performed by qualified personnel and shall meet the acceptance requirements of ASME Code Section III, NB-5350 for PT or NB-5332 for UT.

Table 1.3-1 (Page 7 of 11)
LIST OF ASME CODE EXCEPTIONS FOR THE HI-STAR 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Exception, Justification & Compensatory Measures
MPC Enclosure Vessel	NB-7000	Vessels are required to have overpressure protection	No overpressure protection is provided. The function of the MPC enclosure vessel is to contain the radioactive contents under normal, off-normal, and accident conditions. The 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-STAR 100 Cask 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.
Overpack Helium Retention Boundary	NB-1100	Statement of requirements for Code stamping of components	Overpack helium retention boundary 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.
Overpack Helium Retention Boundary	NB-2000	Requires materials to be supplied by ASME approved Material Supplier	Material will be supplied by Holtec approved suppliers with CMTRs per NB-2000.
Overpack Helium Retention Boundary	NB-7000	Vessels are required to have overpressure protection	No overpressure protection is provided. Function of overpack vessel is to contain helium contents under normal, off-normal, and accident conditions. Overpack vessel is designed to withstand maximum internal pressure and maximum accident temperatures.

Table 1.3-1 (Page 8 of 11)
LIST OF ASME CODE EXCEPTIONS FOR THE HI-STAR 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Exception, Justification & Compensatory Measures
Overpack Helium Retention Boundary	NB-8000	Statement of requirements for nameplates, stamping and reports per NCA-8000	The HI-STAR 100 Cask 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.
MPC Basket Assembly	NG-2000	Requires materials to be supplied by ASME-approved material supplier.	Materials will be supplied by Holtec-approved supplier with CMTRs per NG-2000 requirements.

Table 1.3-1 (Page 9 of 11)
LIST OF ASME CODE EXCEPTIONS FOR THE HI-STAR 100 CASK SYSTEM

Component	**Reference ASME Code Section/Article**	**Code Requirement**	**Exception, Justification & Compensatory Measures**
MPC Basket Assembly	NG-4420	NG-4427(a) allows a fillet weld in any single continuous weld to be less than the specified fillet weld dimension by not more than 1/16 inch, provided that the total undersize portion of the weld does not exceed 10 percent of the length of the weld. Individual undersize weld portions shall not exceed 2 inches in length	Modify the Code requirement (intended for core support structures) with the following text prepared to accord with the geometry and stress analysis imperatives for the fuel basket: For the longitudinal MPC basket fillet welds, the following criteria apply: 1) The specified fillet weld throat dimension must be maintained over at least 92 percent of the total weld length. All regions of undersized weld must be less than 3 inches long and separated from each other by at least 9 inches. 2) Areas of undercuts and porosity beyond that allowed by the applicable ASME Code shall not exceed ½ inch in weld length. The total length of undercut and porosity over any 1-foot length shall not exceed 2 inches. 3) The total weld length in which items (1) and (2) apply shall not exceed a total of 10 percent of the overall weld length. The limited access of the MPC basket panel longitudinal fillet welds makes it difficult to perform effective repairs of these welds and creates the potential for causing additional damage to the basket assembly (e.g., to the neutron absorber and its sheathing) if repairs are attempted. The acceptance criteria provided in the foregoing have been established to comport with the objectives of the basket design and preserve the margins demonstrated in the supporting stress analysis. From the structural standpoint, the weld acceptance criteria are established to ensure that any departure from the ideal, continuous fillet weld seam would not alter the primary bending stresses on which the design of the fuel baskets is predicated. Stated differently, the permitted weld discontinuities are limited in size to ensure that they remain classifiable as local stress elevators ("peak stress," F, in the ASME Code for which specific stress intensity limits do not apply).

LIST OF ASME CODE EXCEPTIONS FOR THE HI-STAR 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Exception, Justification & Compensatory Measures
MPC Basket Assembly	NG-8000	States requirements for nameplates, stamping and reports per NCA-8000.	The HI-STAR 100 Cask System will be marked and identified in accordance with 10CFR71 and 10CFR72 requirements. No code stamping is required. The MPC basket data package will be in conformance with Holtec’s QA program.
Overpack Intermediate Shells	NF-4622	All welds, including repair welds, shall be post-weld heat treated (PWHT).	Intermediate shell-to-top flange welds and intermediate shell-to-bottom plate welds do not require PWHT. These welds attach non-pressure retaining parts to pressure retaining parts. The pressure retaining parts are >7 inches thick. Localized PWHT will cause material away from the weld to experience elevated temperatures which will have an adverse effect on the material properties.

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LIST OF ASME CODE EXCEPTIONS FOR THE HI-STAR 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Exception, Justification & Compensatory Measures
Overpack Helium Retention Boundary	NG-2000	Perform radiographic examination after post-weld heat treatment (PWHT)	Radiography of helium retention boundary welds after PWHT is not required. All welds (including repairs) will have passed radiographic examination prior to PWHT of the entire containment boundary. Confirmatory radiographic examination after PWHT is not necessary because PWHT is not known to introduce new weld defects in nickel steels.
Overpack Intermediate Shells	NF-2000	Requires materials to be supplied by ASME approved Material Supplier	Materials will be supplied by Holtec-approved supplier with CMTRs in accordance with NF-2000 requirements.
Overpack Helium Retention Boundary	NB-2330	Defines the methods for determining the T_{NDT} for impact testing of materials	T_{NDT} shall be defined in accordance with Regulatory Guides 7.11 and 7.12 for the helium retention boundary components.