PROPOSED CERTIFICATE OF COMPLIANCE NO. 1014

APPENDIX A

INSPECTIONS, TESTS, AND EVALUATIONS

FOR THE HI-STORM 100 CASK SYSTEM

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1 INSPECTIONS, TESTS, AND EVALUATIONS

1.1 Definitions

Refer to Appendix B for Definitions.

1.2 Neutron Absorber Tests

1.2.1 Boral and 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 1.2.3.1 through 1.2.3.5 below, the neutron absorber shall meet the minimum requirements for 10B areal density or B4C content, as applicable.

1.2.2 Metamic-HT

(Section 1.2.3.6 below)

1.2.2.1 The weight percentage of the boron carbide must be confirmed to be greater than or equal to 10% in each lot of Al/B4C powder.

1.2.2.2 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.

1.2.2.3 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.

1.2.3 Design Important to Neutron Absorber Tests

1.2.3.1 MPC-24

a. Flux trap size: ≥ 1.09 in.
b. 10B loading in the neutron absorbers: ≥ 0.0267 g/cm2 (Boral) and ≥ 0.0223 g/cm2 (METAMIC)

1.2.3.2 MPC-68 and MPC-68FF

a. Fuel cell pitch: ≥ 6.43 in.
b. 10B loading in the neutron absorbers: ≥ 0.0372 g/cm2 (Boral) and ≥ 0.0310 g/cm2 (METAMIC)

1.2.3.3 MPC-68F

a. Fuel cell pitch: ≥ 6.43 in.
b. 10B loading in the Boral neutron absorbers: ≥ 0.01 g/cm2

1.2.3.4 MPC-24E and MPC-24EF

a. Flux trap size:
   i. Cells 3, 6, 19, and 22: ≥ 0.776 inch
   ii. All Other Cells: ≥ 1.076 inches
b. 10B loading in the neutron absorbers: ≥ 0.0372 g/cm2 (Boral) and ≥ 0.0310 g/cm2 (METAMIC)

1.2.3.5 MPC-32 and MPC-32F

a. Fuel cell pitch: ≥ 9.158 inches
b. ^{10}B loading in the neutron absorbers: ≥ 0.0372 g/cm^2 (Boral) and ≥ 0.0310 g/cm^2 (METAMIC)

1.2.3.6 MPC-68M

a. Basket Cell wall thickness 0.4 in. (nom.)
b. B4C content in METAMIC-HT shall be ≥ 10 wt. %

1.2.3.7 Fuel spacers shall be sized to ensure that the active fuel region of intact or undamaged fuel assemblies remains within the neutron poison region of the MPC basket with water in the MPC.

1.2.3.8 The B4C content in METAMIC shall be ≤ 33.0 wt.%

1.3 Fabrication Helium Leak Test

At completion of welding the MPC shell to baseplate, an MPC confinement weld helium leak test shall be performed using a helium mass spectrometer. This test shall include the base metals of the MPC shell and baseplate. A helium leak test shall also be performed on the base metal of the fabricated MPC lid. The confinement boundary leakage rate tests shall be performed in accordance with ANSI N14.5 to “leaktight” criteria. If a leakage rate exceeding the acceptance criteria is detected, then the area of leakage shall be determined and the area repaired per ASME Code Section III, Subsection NB requirements. Re-testing shall be performed until the leakage rate acceptance criterion is met.

Casks initially loaded to Amendments No. 2 through 7 must meet the following:

- Casks fabricated on or after July 1, 2009 a fabrication helium leak test at completion of the welding of the MPC shell to baseplate must be performed in accordance with the above requirements.
- Casks loaded before July 1, 2009 must meet the fabrication helium leak test requirements of the lid base metal of the amendment to which they were originally loaded.
- Casks loaded before July 1, 2009 do not meet the above fabrication helium leak test requirements after MPC shell to baseplate welding. These casks may be upgraded to Amendment 15.

2 SITE

2.1 Site Specific Parameters and Analyses

2.1.1.1 The temperature of 80º F is the maximum average yearly temperature, for the VENTILATED OVERPACK. The temperature of 70°F is the maximum average yearly temperature for the UNVENTILATED OVERPACK.

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

2.1.1.3

a. For storage in freestanding OVERPACKs, the resultant horizontal acceleration (vectorial sum of two horizontal Zero Period Accelerations (ZPAs) at a three-dimensional seismic site), GH, and vertical ZPA, GV, on the top surface of the ISFSI pad, expressed as fractions of ‘g’, shall satisfy the following inequality:

   $GH + \mu GV \leq \mu$

   where μ is either the Coulomb friction coefficient for the cask/ISFSI pad interface or the ratio r/h, where ‘r’ is the radius of the cask and ‘h’ is the height of the cask center-of-gravity above the ISFSI pad surface. The above inequality must be met for both definitions of μ, but only applies to ISFSIs where the casks are deployed in a freestanding configuration. 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, GH and GV may be the coincident values of the instantaneous net horizontal and vertical accelerations. If instantaneous accelerations are used, the inequality 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.

b. For free-standing casks, 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 a cask to fall off the pad. In addition, impact between casks should be precluded, or should be considered an accident for which the maximum g-load experienced by the stored fuel shall be limited to 45 g’s.

c. For those ISFSI sites with design basis seismic acceleration values that may overturn or cause excessive sliding of free-standing casks, the OVERPACKs shall be anchored to the ISFSI pad. The site seismic characteristics and the anchorage system shall meet the following requirements:

   i. The site acceleration response spectra at the top of the ISFSI pad shall have ZPAs that meet the following inequalities:

$G_H \leq 2.12$

AND

$G_V \leq 1.5$

Where:

G_H is the vectorial sum of the two horizontal ZPAs at a three-dimensional seismic site (or the horizontal ZPA at a two-dimensional site) and G_V is the vertical ZPA.

ii. Each HI-STORM 100 dry storage cask shall be anchored with twenty-eight (28), 2-inch diameter studs and compatible nuts of material suitable for the expected ISFSI environment. The studs shall meet the following requirements:

Yield Strength at Ambient Temperature: ≥ 80 ksi

Ultimate Strength at Ambient Temperature: ≥ 125 ksi

Initial Tensile Pre-Stress: ≥ 55 ksi AND ≤ 65 ksi

NOTE: The above anchorage specifications are required for the seismic spectra defined in item 2.1.1.3.c.i. Users may use fewer studs or those of different diameter to account for site-specific seismic spectra less severe than those specified above. 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.

iii. Embedment Concrete Compressive Strength: ≥ 4,000 psi at 28 days

2.1.1.4 The analyzed flood condition of 15 fps water velocity and a height of 125 feet of water (full submergence of the loaded cask) are not exceeded.

2.1.1.5 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.

2.1.1.6

a. For freestanding casks, the ISFSI pad shall be verified by analysis to limit cask deceleration during design basis drop and non-mechanistic tip-over events to ≤ 45 g's at the top of the MPC fuel basket. Analyses shall be performed using methodologies consistent with those described in the HI-STORM 100 FSAR. A restriction on the lift and/or drop height is not required 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.

b. For anchored casks, the ISFSI pad shall be designed to meet the embedment requirements of the anchorage design. A cask tip-over event for an anchored cask is not credible. The ISFSI pad shall be verified by analysis to limit cask deceleration during a design basis drop event to ≤ 45 g's at the top of the MPC fuel basket, except as provided for in this paragraph below. Analyses shall be performed using methodologies consistent with those described in the HI-STORM 100 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.

2.1.1.7 In cases where engineered features (i.e., berms and 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.

2.1.1.8 LOADING OPERATIONS, OVERPACK TRANSPORT OPERATIONS, and UNLOADING OPERATIONS shall only be conducted with working area ambient temperatures ≥ 0ºF for all MPC heat loads, and

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

b. ≤ 110ºF (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.

2.1.1.9 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 short term 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 short term temperature limit for the duration of the event, provisions shall be established to provide alternate means of cooling to accomplish this objective.

2.1.1.10 Site ambient temperature under HI-TRAC TRANSPORT OPERATIONS shall be evaluated in accordance with Section 2.2 requirements.

2.2 Environmental Temperature Requirements

TRANSPORT OPERATIONS involving 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°F ambient temperature, applicable during HI-TRAC transfer operations inside the 10 CFR Part 50 or 10 CFR Part 52 structural boundary and 90°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 400°C limit. If the peak fuel cladding temperature exceeds 400°C limit then the operation of a Supplemental Cooling System (SCS) in accordance with LCO 3.1.4 is mandatory.

SCS operation is mandatory if site data is not available or if a user elects to deploy Supplemental Cooling in lieu of site ambient temperature evaluation.

2.3 Cask Transfer Facility (CTF)

2.3.1 <u>Transfer Cask and MPC Lifters</u>

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.

2.3.2 <u>CTF Structure Requirements</u>

2.3.2.1 Cask Transfer Station and Stationary Lifting Devices

a. 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 2-1. All compression loaded members shall satisfy the buckling criteria of ASME Section III, Subsection NF.

b. 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 2-1 shall apply.

c. 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.

d. 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.

2.3.2.2 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:

a. 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.

b. 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.”

c. Mobile cranes are not required to meet the requirements of NUREG-0612, Section 5.1.6(2) for new cranes.

d. Horizontal movements of the TRANSFER CASK and MPC using a mobile crane are prohibited.

Table 2-1: 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.

2.4 Forced Helium Dehydration System

2.4.1 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 B Tables 3.3-1 and 3.3-2. The FHD system shall be designed for normal operation (i.e., excluding startup and shutdown ramps) in accordance with the criteria in Section 2.4.2.

2.4.2 Design Criteria

2.4.2.1 The temperature of the helium gas in the MPC shall be at least 15ºF higher than the saturation temperature at coincident pressure.

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

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

2.4.2.4 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 ≤ 21ºF for a period of 30 minutes or if the dew point of the gas exiting the MPC is verified by measurement to remain ≤ 22.9ºF for ≥ 30 minutes.

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

2.4.2.6 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.

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

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

2.4.3 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.

2.4.4 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.

2.5 72.212 Evaluations for Renewed CoC Use

Any general licensee that initiates spent fuel dry storage operations with the HI-STORM 100 system after the effective date of the renewal of the CoC and any general licensee operating a HI-STORM 100 system as of the effective date of the renewal of the CoC, including those that put additional storage systems into service after that date, shall:

2.5.1 Evaluations

2.5.1.1 As part of the evaluations required by 10CFR72.212(b)(5), include the evaluations related to the terms, conditions, and specifications of this CoC amendment as modified (i.e., changed or added) as a result of the renewal of the CoC.

2.5.1.2 As part of the document review required by 10CFR72.212(b)(6), include a review of the FSAR changes resulting from the renewal of the CoC; and

2.5.1.3 Ensure that the evaluations required by 10CFR72.212(b)(7) and (8) capture the evaluations and review described in (a) and (b) of this CoC condition.

3 LIST OF ASME CODE ALTERNATIVES FOR HI-STORM 100 CASK SYSTEM

Table 3-1: LIST OF ASME CODE ALTERNATIVES FOR HI-STORM 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
MPC, MPC basket assembly, HI-STORM OVERPACK steel structure, and HI-TRAC TRANSFER CASK 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, OVERPACK, and TRANSFER CASK are not ASME Code stamped vessels, 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 HI-STORM 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.

Table 3-1: LIST OF ASME CODE ALTERNATIVES FOR HI-STORM 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
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.
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 (relative to the function of lifting a loaded MPC) 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 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 3-1: LIST OF ASME CODE ALTERNATIVES FOR HI-STORM 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, 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	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 100 FSAR and meets the required design criteria for use in the HI-STORM 100 system per ASME Code Case N-635-1.
MPC, MPC basket assembly, HI-STORM OVERPACK and HI-TRAC TRANSFER CASK	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-STORM FSAR, serving as the Design Specification, establishes the service conditions and load combinations for the storage system.

Table 3-1: LIST OF ASME CODE ALTERNATIVES FOR HI-STORM 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
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.	Due to MPC basket-to-shell interface requirements, the MPC shell-to-baseplate weld joint design (designated Category C) does 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 (1/2 inch). 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 3-1: LIST OF ASME CODE ALTERNATIVES FOR HI-STORM 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
MPC, MPC Basket Assembly, HI-STORM OVERPACK steel structure, and HI-TRAC TRANSFER CASK 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 lead are not, unless explicitly stated by the Code, defined as heat treatment operations. For the steel parts in the HI-STORM 100 System components, the duration for which a part exceeds the off-normal temperature limit defined in Chapter 2 of the FSAR shall be limited to 24 hours in a particular manufacturing process (such as the HI-TRAC lead pouring process).
MPC, MPC basket assembly, HI-STORM OVERPACK steel structure, and HI-TRAC TRANSFER CASK steel structure	NB-4220 NF-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 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 3-1: LIST OF ASME CODE ALTERNATIVES FOR HI-STORM 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, 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 closure ring provides independent redundant closure for vent and drain cover plates. Vent and drain port cover plate welds are helium leakage tested. As an alternative, the helium leakage test does not have to be performed if the REDUNDANT PORT COVER DESIGN is used.

Table 3-1: LIST OF ASME CODE ALTERNATIVES FOR HI-STORM 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, 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 pressure tested as defined in Chapter 9. Accessibility for leakage inspections precludes a Code compliant pressure test. Since the shell welds of the MPC cannot be checked for leakage during this pressure test, the shop leakage test to 10^{-7} ref-cc/sec provides reasonable assurance as to its leak tightness. All MPC enclosure vessel welds (except 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 inspection results, including relevant findings (indications), shall be made a permanent part of the user'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 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 for PT or NB-5332 for UT.

Table 3-1: LIST OF ASME CODE ALTERNATIVES FOR HI-STORM 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, 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-STORM100 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 in accordance with NG-2000 requirements.

Table 3-1: LIST OF ASME CODE ALTERNATIVES FOR HI-STORM 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, 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 1/2 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).

Table 3-1: LIST OF ASME CODE ALTERNATIVES FOR HI-STORM 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
MPC Basket Assembly	NG-8000	States requirements for nameplates, stamping and reports per NCA-8000.	The HI-STORM100 System is to be marked and identified in accordance with 10CFR71 and 10CFR72 requirements. Code stamping is not required. The MPC basket data package to be in accordance with Holtec approved QA program.
OVERPACK Steel Structure	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.
TRANSFER CASK Steel Structure	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 Baseplate and Lid Top Plate	NF-4441	Requires special examinations or requirements for welds where a primary member of thickness 1 inch or greater is loaded to transmit loads in the through thickness direction.	The margins of safety in these welds under loads experienced during lifting operations or accident conditions are quite large. The OVERPACK baseplate welds to the inner shell, pedestal shell, and radial plates are only loaded during lifting conditions and have large safety factors during lifting. Likewise, the top lid plate to lid shell weld has a large structural margin under the inertia loads imposed during a non-mechanistic tipover event.

Table 3-1: LIST OF ASME CODE ALTERNATIVES FOR HI-STORM 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
OVERPACK Steel Structure	NF-3256 NF-3266	Provides requirements for welded joints.	Welds for which no structural credit is taken are identified as "Non-NF" welds in the design drawings. These non-structural welds are specified in accordance with the pre-qualified welds of AWS D1.1. These welds shall be made by welders and weld procedures qualified in accordance with AWS D1.1 or ASME Section IX. Welds for which structural credit is taken in the safety analyses shall meet the stress limits for NF-3256.2, but are not required to meet the joint configuration requirements specified in these Code articles. The geometry of the joint designs in the cask structures are based on the fabricability and accessibility of the joint, not generally contemplated by this Code section governing supports.

Table 3-1: LIST OF ASME CODE ALTERNATIVES FOR HI-STORM 100 CASK SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
HI-STORM OVERPACK and HI-TRAC TRANSFER CASK	NF-3320 NF-4720	NF-3324.6 and NF-4720 provide requirements for bolting	These Code requirements are applicable to linear structures wherein bolted joints carry axial, shear, as well as rotational (torsional) loads. The OVERPACK and TRANSFER CASK bolted connections in the structural load path are qualified by design based on the design loadings defined in the FSAR. Bolted joints in these components see no shear or torsional loads under normal storage conditions. Larger clearances between bolts and holes may be necessary to ensure shear interfaces located elsewhere in the structure engage prior to the bolts experiencing shear loadings (which occur only during side impact scenarios). Bolted joints that are subject to shear loads in accident conditions are qualified by appropriate stress analysis. Larger bolt-to-hole clearances help ensure more efficient operations in making these bolted connections, thereby minimizing time spent by operations personnel in a radiation area. Additionally, larger bolt-to-hole clearances allow interchangeability of the lids from one particular fabricated cask to another.
HI-STORM OVERPACK and HI-TRAC TRANSFER CASK	Section II, SA-516/516A	Table 1 – Chemical requirements	All SA-516 material used in the HI-STORM 100 system is required to meet the material composition described in ASME Code Section II, 2007 edition. This edition allows for a different manganese content from the 1995 edition, but does not change the structural or thermal properties of the material.