Certificate of Compliance Renewal Application for the HI-STORM 100 Dry Storage System

Certificate of Compliance No. 1014, Docket Number 72-1014

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Glossary

Aging Management Program (AMP) is a program for addressing aging effects that may include prevention, mitigation, condition monitoring, and performance monitoring.

ALARA is an acronym for As Low As Reasonably Achievable.

All Metamic Fuel Baskets or AMFBs refers to those baskets in which both the structural and neutron absorption functions are rendered by panels made from Metamic-HT. There is no separate neutron absorber or stainless steel in AMFBs.

Alloy X Fuel Baskets refers to those baskets that employ neutron absorber panels affixed to the Alloy X grid- plate in an irremovable configuration. Duplex steel is a type of Alloy X steel that may be used for the MPC shell but not for the fuel basket components.

Ancillary or Ancillary Equipment is the generic name of a device used to carry out Short -term Operations.

Boral is a generic term to denote an aluminum-boron carbide cermet manufactured in accordance with U.S. Patent No. 4027377. The individual material supplier may use another trade name to refer to the same product.

Boral™ means Boral manufactured by AAR Advanced Structures.

BWR is an acronym for boiling water reactor.

Cavity Enclosure Container (CEC) means a thick walled cylindrical steel weldment that defines the storage cavity for the MPCs

CoC is an acronym for Certificate of Compliance.

Commercial Spent Fuel or CSF refers to nuclear fuel used to produce energy in a commercial nuclear power plant.

Confinement Boundary means the outline formed by the all-welded cylindrical enclosure of the Multi-Purpose Canister (MPC) shell, MPC baseplate, MPC lid, MPC port cover plates, and the MPC closure ring which provides redundant sealing.

Confinement System means the Multi-Purpose Canister (MPC) which encloses and confines the spent nuclear fuel during storage.

Critical Characteristic means a feature of a component or assembly that is necessary for the proper safety function of the component or assembly. Critical characteristics of a material are those attributes that have been identified, in the associated material specification, as necessary to render the material’s intended function.

DCSS is an acronym for Dry Cask Storage System.

Damaged Fuel Assembly is a fuel assembly with known or suspected cladding defects, as determined by review of records, greater than pinhole leaks or hairline cracks, empty fuel rod locations that are not replaced with dummy fuel rods, missing structural components such as grid spacers, whose structural integrity has been impaired such that geometric rearrangement of fuel or gross failure of the cladding is expected based on engineering evaluations, or those that cannot be handled by normal means. Fuel assemblies that cannot be handled by normal means due to fuel cladding damage are considered fuel debris.

Damaged Fuel Container (or Canister) or DFC means a specially designed enclosure for damaged fuel or fuel debris which permits flow of gaseous and liquid media to escape while minimizing dispersal of gross particulates.

Damaged Fuel Isolator (DFI) means specially designed endcaps for a basket cell to enclose damaged fuel that can be handled by normal means.

Design Life is the minimum duration for which the component is engineered to perform its intended function set forth in this FSAR, if operated and maintained in accordance with this FSAR.

Enclosure Vessel (or MPC Enclosure Vessel) means the pressure vessel defined by the cylindrical shell, baseplate, port cover plates, lid, closure ring, and associated welds that provides confinement for the contents within the MPC. The Enclosure Vessel (EV) and the fuel basket together constitute the multi-purpose canister.

Equivalent (or Equal) Material is a material with critical characteristics (see definition above) that meet or exceed those specified for the designated material.

FSAR is an acronym for Final Safety Analysis Report (10CFR72).

Fuel Basket means a honeycombed structural weldment with square openings which can accept a fuel assembly of the type for which it is designed.

Fuel Debris is ruptured fuel rods, severed rods, loose fuel pellets, containers or structures that are supporting these loose fuel assembly parts, or fuel assemblies with known or suspected defects which cannot be handled by normal means due to fuel cladding damage.

Fuel Spacer or Fuel Shim is a metallic part interposed in the space between the fuel and the MPC cavity at either the top or the bottom (or both) ends of the fuel to minimize the axial displacement of the SNF within the MPC due to longitudinal inertia forces.

High Burnup Fuel, or HBF is a commercial spent fuel assembly with an average burnup greater than 45,000 MWD/MTU.

HI-TRAC is an acronym for **H**oltec **I**nternational **T**ransfer **C**ask.

HI-TRAC transfer cask or HI-TRAC means the transfer cask used to house the MPC during MPC fuel loading, unloading, drying, sealing, and on-site transfer operations to a HI-STORM storage overpack or HI-STAR storage/transportation overpack. The HI-TRAC shields and protects the loaded MPC. The term HI-TRAC is used as a generic term to refer to all HI-TRAC transfer cask designs, unless the discussion requires distinguishing among the designs..

HI-STORM overpack or storage overpack means the cask that receives and contains the sealed multi-purpose canisters containing spent nuclear fuel for long term storage. It provides the gamma and neutron shielding, ventilation passages, missile protection, and protection against natural phenomena and accidents for the MPC. The term “overpack” as used in this application refers to all models of the HI-STORM 100 (including, for example, the HI-STORM 100S and HI-STORM 100S Version B and Version E).

HI-STORM 100 System consists of any loaded MPC model placed within any design variant of the HI-STORM overpack.

Holtite*TM* is the trade name for all present and future neutron shielding materials formulated under Holtec International’s R&D program dedicated to developing shielding materials for application in dry storage and transport systems. The Holtite development program is an ongoing experimentation effort to identify neutron shielding materials with enhanced shielding and temperature tolerance characteristics. Holtite-A and Holtite-B are candidate neutron shield materials qualified under the Holtite R&D program.

Important to Safety (ITS) means a function or condition required to store spent nuclear fuel safely; to prevent damage to spent nuclear fuel during handling and storage, and to provide reasonable assurance that spent nuclear fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public. ITS is further divided into categories A, B, and C in accordance with NUREG/CR-6407.

Independent Spent Fuel Storage Installation (ISFSI) means a facility designed, constructed, and licensed for the interim storage of spent nuclear fuel and other radioactive materials associated with spent fuel storage in accordance with 10CFR72.

Intact Fuel Assembly is defined as a fuel assembly without known or suspected cladding defects greater than pinhole leaks and hairline cracks, and which can be handled by normal means. Fuel assemblies without fuel rods in fuel rod locations shall not be classified as Intact Fuel Assemblies unless dummy fuel rods are used to displace an amount of water greater than or equal to that displaced by the fuel rod(s).

License Life means the duration for which the system is authorized by virtue of its certification by the U.S. NRC.

METAMIC® is a trade name for an aluminum/boron carbide composite neutron absorber material qualified for use in the MPCs and in wet storage applications.

METAMIC-HT is a trade name for the metal matrix composite made by imbedding nano-particles of aluminum oxide and fine boron carbide powder on the grain boundaries of aluminum resulting in improve structural strength properties at elevated temperatures.

METCONTM is a trade name for the HI-STORM overpack structure. The trademark is derived from the **met**al-**con**crete composition of the HI-STORM overpack.

Moderate Burnup Fuel, or MBF is a commercial spent fuel assembly with an average burnup less than or equal to 45,000 MWD/MTU.

Multi-Purpose Canister (MPC) means the sealed canister consisting of a honeycombed fuel basket for spent nuclear fuel storage, contained in a cylindrical canister shell (the MPC Enclosure Vessel). There are different MPCs with different fuel basket geometries for storing PWR or BWR fuel, but all MPCs have identical exterior diameters. The MPC is the confinement boundary for storage conditions.

Neutron Absorber Material is a generic term to indicate any neutron absorber material qualified for use in the HI-STORM 100 System.

Neutron Shielding means a material used to thermalize and capture neutrons emanating from the radioactive spent nuclear fuel.

Non-Fuel Hardware (NFH) is defined as Burnable Poison Rod Assemblies (BPRAs), Thimble Plug Devices (TPDs), Control Rod Assemblies (CRAs), Axial Power Shaping Rods (APSRs), Wet Annular Burnable Absorbers (WABAs), Rod Cluster Control Assemblies (RCCAs), Control Element Assemblies (CEAs), Neutron Source Assemblies (NSAs), water displacement guide tube plugs, orifice rod assemblies, instrument tube tie-rods (ITTRs), vibration suppressor inserts, and components of these devices such as individual rods.

Plain Concrete is concrete that is unreinforced.

PWR is an acronym for pressurized water reactor

SAR is an acronym for Safety Analysis Report.

SER is an acronym for Safety Evaluation Report, issued by the NRC.

Service Life means the duration for which the component is reasonably expected to perform its intended function, if operated and maintained in accordance with the provisions of this FSAR. Service Life may be much longer than the Design Life because of the conservatism inherent in the codes, standards, and procedures used to design, fabricate, operate, and maintain the component.

SNF is an acronym for spent nuclear fuel.

SSC is an acronym for Structures, Systems and Components.

Stainless Steel Fuel Baskets or SSFBs refer to fuel baskets that employ stainless steel for structural function, and neutron absorption capability is provided by a discrete panel of Metamic or an equivalent neutron absorber. MPC-68 contains an SSFB.(See also “Alloy X Fuel Basket “)

Time-Limited Aging Analysis (TLAA) is a licensee or CoC holder calculation or analysis that has all of the following attributes: involves SSCs important to safety within the scope of license or CoC renewal; considers the effects of aging; involves time-limited assumptions defined by the current operating term; was determined to be relevant by the licensee or CoC holder in making a safety determination; involves conclusions or provides the basis for conclusions related to the capability of the SSCs to perform their intended safety functions; and is contained or incorporated by reference in the design bases

Undamaged Fuel Assembly is: a) a fuel assembly without known or suspected cladding defects greater than pinhole leaks or hairline cracks and which can be handled by normal means; or b) a BWR fuel assembly with an intact channel, a maximum planar average initial of 3.3 wt% U-235, without known or suspected grossly breached spent fuel rods, and which can be handled by normal means. An undamaged fuel assembly may be a repaired/reconstituted fuel assembly.

VVM is an acronym for Vertical Ventilated Module

ZR means any zirconium-based fuel cladding material authorized for use in a commercial nuclear power plant reactor. Any reference to Zircaloy fuel cladding in this FSAR applies to any zirconium-based fuel cladding material.

CHAPTER 1: GENERAL INFORMATION

1.0 Introduction

The HI-STORM 100 System Certificate of Compliance (CoC) No. 72-1014 was first approved for storage of spent nuclear fuel by the NRC on May 31, 2000, under the provisions of 10CFR 72 for use by general licensees. In accordance with 10 CFR 72.240(a) and as the certificate holder of CoC 1014, Holtec International is applying for a renewal of CoC 1014 for an additional term of 40 years.

This renewal application includes the Safety Analysis Report (SAR) information required by 10 CFR 72.240(c). The content of this application is based on the guidance provided in NUREG-1927 [2.1.1]. Additional guidance on content and format of this application is also provided in NEI-14-03 [1.1.3].

In accordance with the guidance in NUREG-1927, this renewal application is based on the continuation of the existing licensing basis throughout the period of extended operation and is based on maintaining the intended safety function of the structures, systems, and components (SSCs) important to safety. The existing licensing basis for the HI-STORM 100 Certificate of Compliance, consists primarily of:

a. CoC 1014 including appendices for each approved amendment
b. Safety Evaluation Reports (SERs) issued for each approved amendment
c. The Final Safety Analysis Reports corresponding to each approved amendment
d. Any other Docketed Licensing Correspondence, as applicable

1.1 HI-STORM 100 System Description

This section provides a brief description of the HI-STORM 100 storage system. Full details of the system are contained in the FSAR referenced herein.

1.1.1 General System Description

The HI-STORM 100 system is a canister based system for the storage of spent nuclear fuel (SNF) comprised of three discrete components: the multi-purpose canister (MPC), the storage overpack (HI-STORM), and the transfer cask (HI-TRAC). Its design features are intended to simplify and reduce on-site SNF loading, handling, and monitoring operations, and to provide for radiological protection, criticality control, and maintenance of structural and thermal safety margins.

1.1.2 Principle Components of the HI-STORM 100 System

1.1.2.1 Multi-Purpose Canister (MPC)

The MPC is a multi-purpose SNF storage device both with respect to the type of fuel assemblies and its versatility of use. The MPC is engineered as a cylindrical prismatic structure with square cross section storage cavities (fuel basket). The number of storage locations depends on the type of fuel. Regardless of the storage cell count, the construction of the MPC is fundamentally the same; it is built as a honeycomb of cellular elements positioned within a circumscribing cylindrical canister shell. The manner of cell-to-cell weld-up and cell-to-canister shell interface employed in the MPC imparts extremely high structural stiffness to the assemblage, which is an important attribute for mechanical accident events. The MPC provides the confinement boundary for the stored fuel. The confinement boundary is a seal-welded enclosure constructed entirely of stainless steel.

The HI-STORM 100 System is designed to accommodate a wide variety of spent nuclear fuel assemblies in a single basic overpack design by utilizing different MPCs. The external diameters of all MPCs are identical to allow the use of a single overpack. Each of the MPCs has different internals (baskets) to accommodate distinct fuel characteristics. Each MPC is identified by the maximum quantity of fuel assemblies it is capable of receiving. The MPC-24, MPC-24E, and MPC-24EF contain a maximum of 24 PWR fuel assemblies; the MPC-32 and MPC-32F contain a maximum of 32 PWR fuel assemblies; and the MPC-68, MPC-68M, MPC-68F, and MPC-68FF contain a maximum of 68 BWR fuel assemblies.

The PWR MPC-24, MPC-24E and MPC-24EF differ in construction from the MPC-32 (including the MPC-32F) and the MPC-68 (including the MPC-68M, MPC-68F and MPC-68FF) in one important aspect: the fuel storage cells in the MPC-24 series are physically separated from one another by a "flux trap", for criticality control. The PWR MPC-32 and -32F are designed similar to the MPC-68 (without flux traps) and their design includes credit for soluble boron in the MPC water during wet fuel loading and unloading operations for criticality control. The MPC-68M is similar to the MPC-68 but utilizes the Metamic-HT material for both structural basket and criticality control. Similarly the MPC-32M, follows the MPC-32 design without flux traps, but utilizes Metamic-HT. The "Version 1" variants of MPC-32 and -68 are identical in materials and environments, but simply have a thicker baseplate and are therefore not further differentiated in this application.

The MPC fuel basket is positioned and supported within the MPC shell by a set of basket supports welded to the inside of the MPC shell. In addition, the MPC fuel basket may also be positioned and supported within the MPC shell by a set of basket shims welded directly to the MPC fuel basket.

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

The top end of the MPC incorporates a redundant closure system. The MPC lid is a circular plate edge-welded to the MPC outer shell. This lid is equipped with vent and drain ports which are utilized to remove moisture and air from the MPC, and backfill the MPC with a specified pressure of inert gas (helium). The vent and drain ports are covered and welded before the closure ring is installed. The closure ring is a circular ring edge-welded to the MPC shell and lid. The MPC lid provides sufficient rigidity to allow the entire MPC loaded with SNF to be lifted by threaded holes in the MPC lid.

For fuel assemblies that are shorter than the design basis length, upper and lower fuel spacers (as appropriate) maintain the axial position of the fuel assembly within the MPC basket. The upper and lower fuel spacers are designed to withstand normal, off-normal, and accident conditions of storage.

The MPC confinement boundary is constructed entirely from stainless steel alloy materials. The confinement boundary lid to shell weld is covered with a redundant closure and is not exposed. All MPC components that may come into contact with spent fuel pool water or the ambient environment (with the exception of neutron absorber, aluminum seals on vent and drain port caps, and optional aluminum heat conduction elements) must be constructed from stainless steel alloy materials. Concerns regarding interaction of coated carbon steel materials and various MPC operating environments [1.1.1] are not applicable to the MPC. All structural components in a MPC shall be made of Alloy X, a full description of Alloy X is contained in the HI-STORM 100 FSAR [1.1.2].

1.1.2.2 HI-STORM 100 Overpack

The HI-STORM 100 overpacks are rugged, heavy-walled cylindrical vessels. There are a variety of overpack design variants including the HI-STORM 100S and HI-STORM 100A. The HI-STORM 100A overpack design is an anchored variant, and is identified by name only when the discussion specifically applies to the anchored overpack. The main structural function of the storage overpack is provided by carbon steel, and the main shielding function is provided by plain concrete. The overpack plain concrete is enclosed by cylindrical steel shells, a thick steel baseplate, and a top plate. The overpack lid has appropriate concrete shielding to provide neutron and gamma attenuation in the vertical direction.

The storage overpack provides an internal cylindrical cavity of sufficient height and diameter for housing an MPC. The storage system has air ducts to allow for passive natural convection cooling of the contained MPC. The location of the air outlets in the HI-STORM 100 and the HI-STORM 100S (including Version B and Version E) design differ. The air outlet ducts in the HI-STORM 100S and -100S Version B are integral to the lid assembly and are not in vertical alignment with the inlet ducts. In the Version E, the inlet vents have penetrations in different heights in the overpack inner and outer shells. In all designs, the air inlets and outlets are covered by a screen to reduce the potential for blockage. Routine inspection of the screens (or, alternatively, temperature monitoring) ensures that blockage of the screens themselves will be detected and removed in a timely manner.

The air inlets and outlets are penetrations through the thick concrete shielding provided by the HI-STORM 100 overpack. Within the air inlets and outlets, an array of gamma shield cross plates are installed, which are designed to scatter any radiation traveling through the ducts. The result of scattering the radiation in the ducts is a significant decrease in local dose rates around the air inlets and outlets.

Four treaded anchor blocks at the top of the overpack are provided for lifting. The anchor blocks are integrally welded to the radial plates, which are in turn full-length welded to the overpack inner shell, outer shell, and baseplate or inlet air duct horizontal plates.

The plain concrete between the overpack inner and outer shells is specified to provide the necessary shielding properties and compressive strength. The principal function of the concrete is to provide shielding against gamma and neutron radiation.

1.1.2.3 <u>HI-TRAC</u>

Like the storage overpack, the HI-TRAC transfer cask is a rugged, heavy-walled cylindrical vessel. The main structural function of the transfer cask is provided by carbon steel, and the main neutron and gamma shielding functions are provided by water and lead, respectively. The transfer cask is a steel, lead, steel layered cylinder with a water jacket attached to the exterior. The HI-TRAC design variants used with the HI-STORM 100 system include the HI-TRAC-100, -125, -100D, -125D, and HI-TRAC MS All HI-TRACs are principally made of carbon steel and lead.

The transfer cask provides an internal cylindrical cavity of sufficient size for housing an MPC. The MPC access hole through the HI-TRAC top lid is provided to allow the lowering/raising of the MPC between the HI-TRAC transfer cask and the storage or transport overpack.

In the standard design, trunnions are provided for lifting and rotating the transfer cask body between vertical and horizontal positions. The lifting trunnions are located just below the top flange and the pocket trunnions are located above the bottom flange. The two lifting trunnions are provided to lift and vertically handle the HI-TRAC, and the pocket trunnions (in the HI-TRAC 100/125 only) provide a pivot point for the rotation of the HI-TRAC for downending or upending. With the HI-TRAC-100D, 125D, and HI-TRAC MS designs, a mating device ancillary, which is not part of the HI-STORM CoC may be utilized during transfer.

1.1.2.4 Other Structures, Systems, and Components

Fuel Assemblies

The HI-STORM 100 system is designed to store spent fuel assemblies as described in Chapter 2 of the HI-STORM 100 FSAR [1.1.2], and authorized in Appendix B of the CoC.

Fuel Transfer and Auxiliary Equipment

Auxiliary equipment used for loading of MPCs and cask movement (e.g., drying system, cask transporter, welding equipment, etc.) are not included as part of the HI-STORM 100 CoC, and as such are not described in detail in the FSAR, nor are they within scope for aging management.

ISFSI Pad

The pad is a reinforced concrete structure where the HI-STORM 100 casks are stored. The ISFSI Pad is not a “licensed component,” of the HI-STORM 100 System. The CoC explicitly lists three components of the HI-STORM 100 Cask System (MPC, overpack, and transfer cask), and does not include the ISFSI pad. The CoC requirement is that the cask storage pad be verified by analysis to limit cask deceleration during both the design basis drop and non-mechanistic tipover event to ≤45 g’s at the top of the MPC fuel basket. The CoC also requires that the ISFSI pad meet an equation based on coefficient of friction values. These analyses shall be performed using methodologies consistent with those described in the HI-STORM 100 FSAR. Previous amendments of the CoC required specific pad properties in the CoC to be met by the users to ensure that the cask deceleration was within limits.

1.2 Background

The HI-STORM 100 System was originally approved by the NRC on May 31, 2000. Subsequently amendments 1 through 14 were approved by the NRC, with a 15th amendment under NRC review at time of the initial renewal application. These amendments were requested by Holtec International to address continuing needs of utilities to store different types of PWR or BWR fuel, with revised heat loads, enrichments, or other parameters. The HI-STORM 100 MPCs are also approved for transportation under 10 CFR Part 71, but that CoC is not part of this storage renewal application. Based on timing of this renewal application, Holtec has chosen to include the information from the amendments 15 in progress, as they are likely to be issued while the renewal is under review.

Table 1.2-1 lists each of the approved HI-STORM 100 storage amendments. The table provides a description of the scope of the amendment, its approval time, identification of the FSAR which provides the licensing basis, and a pointer to where the AMPs for different amendments are located in this application. Note, that because the FSAR is updated for each amendment, the latest FSAR contains the full licensing basis for all previous amendments.

Table 1.2-1: HI-STORM 100 CoC Amendments

Amendment Number	Description of Changes	Approval Date	FSAR Basis	Location of AMPs
0	Initial Issue	5/31/2000	HI-2002444, Rev 0	Appendix A
1	• Add new MPCs: MPC-24E, MPC-24EF, MPC-32 for PWR fuel and MPC-68FF for BWR fuel • Add damaged fuel containers • Add HI-STORM 100S and 100A/SA anchored overpacks • Allow storage of high burnup fuel • Revise thermal analysis • Revise helium backfill requirements • Allow FHD system • Require soluble boron • Allow storage of selected non-fuel hardware • Move special requirement for first system in places to CoC	7/15/2002	HI-2002444, Rev 1 or 2	Appendix A
2	• Add use of Metamic as an alternate neutron absorber material • Allow storage of damaged fuel in MPC-32 and MPC-32F • Include appropriate values for soluble boron for MPC-32 and MPC-32F • Clarify that heat conduction elements are no longer used • Revise CoC to reflect changes in MPC cavity drying • Revise the TS to remove the helium leakage test requirement • Relocate the helium backfilling requirements to new table in the TS • Revise requirements for ensuring MPC cavity bulk helium temperature • Add new TS Program for radiation protection • Add other components to non-fuel hardware	6/7/2005	HI-2002444, Rev 3 or 4	Appendix A

Amendment Number	Description of Changes	Approval Date	FSAR Basis	Location of AMPs
2 (continued)	• Increase initial enrichment for PWR damaged fuel/fuel debris to 5.0 wt% • Revise burn-up as a function of cooling time and fuel array/class • Modify completion times for blocked duct LCO • Add new limits for burnup as a function of decay heat, enrichment, cooling time, fuel class • Revise maximum allowable uranium masses • Revise maximum allowable burn-up for non-fuel hardware • Update ASME Code alternatives • Revise App B in accordance with ISG-11 Rev 3 • Increase off-normal design pressure and temperature limit for overpack lid • Move FSAR appendices 3.B through 3.AS to calculation package • Remove three-ducts blocked condition • Revise discussion of QA program • Editorial corrections in CoC • Modify CoC condition 11 • Modify drying acceptance criterion for FHD • Include maximum boron carbide content in Metamic • Add language incorporating FSAR Section 9.1.5.3 by reference • Clarify the equation for free-standing casks • Modification of design temperatures of MPC shell, overpack concrete, and Holtite • Modify Code applicability for MPC basket and basket angle supports • Add FHD failure and SCS power failure as off-normal events and SCS failure as accident event • Add new requirement to address degraded cask/pad interface friction			

Amendment Number	Description of Changes	Approval Date	FSAR Basis	Location of AMPs
3	• Minor editorial changes to CoC • Modify the TS to eliminate the requirement to perform helium leak rate testing on vent and drain port cover plates if the associated welds are performed with at least a two weld pass and liquid penetrant examinations of the root and final weld passes • Modify the TS to eliminate cooling of the MPC cavity prior to reflood during unloading. The requirement is now on MPC cavity pressure. • Modify the TS to allow linear interpolation between minimum soluble boron concentrations of 4.1 wt% and 5.0 wt% enrichment in the MPC-32/32F • Modify the definition of fuel debris to permit containers/structures that provide support to loose fuel assembly parts and non-fuel hardware to be stored as fuel debris in DFCs • Modify the definition of non-fuel hardware to include neutron source assemblies • Modify the TS to permit storage of PWR fuel assemblies with annular fuel pellets in the top and bottom 12 in of active fuel length • Modify the definition of damaged fuel	5/29/2007	HI-2002444, Rev 5	Appendix A
4	• Indian Point Unit 1 options added to CoC: o Shortening of the HI-STORM 100S Ver B, MPC-32,-32F, and HI-TRAC 100D o TS Definition of Transport Operations o Soluble boron requirements for 14x14E IP1 fuel o Helium gas backfill requirements for 14x14E IP1 fuel o Addition of another DFC design o Addition of separate burnup cooling time, and decay heat limits for 14x14E IP1 fuel	1/8/2008	HI-2002444, Rev 6	Appendix A

Amendment Number	Description of Changes	Approval Date	FSAR Basis	Location of AMPs
	o Addition of antimony-beryllium secondary sources as approved contents o Loading of all IP1 fuel assemblies in DFCs o Preclusion of loading of IP1 fuel debris in MPC-32 or -32F o The reduction of maximum enrichment for 14x14E IP1 fuel from 5.0 to 4.5 wt% o Changes to licensing drawings to differentiate the IP1 MPC-32 and -32F • Replace all UST&D references with HMD			
5	• Deletion of the requirement to perform thermal validation tests • An increase in the design basis maximum decay heat loads and addition of regionalized loading scheme • Increase in the maximum BWR fuel assembly weight from 700 to 730 lb • Changes to PWR 16x16 fuel assembly • Change in storage location for fuel with APSRs in the MPC-32 and in the MPC-24, -24E, and -32 for fuel with CRAs, RCCAs, and CEAs • Elimination of restriction that fuel debris can only be loaded into the MPC-24EF,-32F, -68F, and -68FF • Requirement that MPC confinement boundary components and MPC components exposed to spent fuel pool water or ambient environment be made of stainless steel, or for MPC internals, neutron absorber or aluminum • Addition of a threshold heat load below which SCS is not required • Editorial changes • Modification of the definition of non-fuel hardware	7/14/2008	HI-2002444, Rev 7	Appendix A
6	• Modify TS for editorial changes • Modify TS to allow ITTRs in MPC-24 and -32	8/17/2009	HI-2002444, Rev 8	Appendix A

Amendment Number	Description of Changes	Approval Date	FSAR Basis	Location of AMPs
7	• Addition of HI-STORM 100U System, with separate CoC appendices • Upgrade all thermal simulations to utilize a 3D model • Reinstating decay heat limits for damaged fuel and fuel debris from Amd 3 that had been inadvertently deleted from Amds 5 and 6	12/28/2009	HI-2002444, Rev 9 or 10	Appendix A
8, 8R1	• Addition of new MPC-68M with two new BWR fuel array classes • Addition of new PWR fuel array class • Revised Condition 3 to perform helium leak test on base material • Editorial changes <u>Rev 1 Changes</u> • Change to burnup/cooling time limits for TPDs • Changes to Metamic-HT testing requirements • Changes to Metamic-HT MGVs • Update fuel definitions to allow BWR fuel affected by certain corrosion mechanisms within specific guidelines to be classified as undamaged fuel	5/2/2012 Rev 1: 2/16/2016	HI-2002444, Rev 11 Rev 1: HI-2002444, Rev 11.1	Appendix A
9, 9R1	• Broadening the subgrade requirements for the HI-STORM 100U part of the HI-STORM 100 Cask System • Update the HI-TRAC thermal methodology from 2-D to 3-D <u>Rev 1 Changes</u> • Change to burnup/cooling time limits for TPDs • Changes to Metamic-HT testing requirements • Changes to Metamic-HT MGVs • Update fuel definitions to allow BWR fuel affected by certain corrosion mechanisms within specific guidelines to be classified as undamaged fuel	3/11/2014 Rev 1: 3/21/2016	HI-2002444, Rev 12 Rev 1: HI-2002444, Rev 13	Appendix A
10	• Addition of new 16x16B and C fuel classes • Addition of ASME Code Alternative for SA-516/516A material	5/31/2016	HI-2002444, Rev 14 or 15	Appendix A

Amendment Number	Description of Changes	Approval Date	FSAR Basis	Location of AMPs
	• Revision to Condition 9			
11	• Increase the per-storage location weight limit for cells authorized for damaged fuel container (DFC) in MPC-68 series • Change surveillance requirements for cask with certain heat load in the Technical Specifications • Allow the storage of higher average initial enrichment wt.% U-235 fuel with low enriched CRUD-induced localized corrosion (CILC) fuel • Increase the enrichment limit for the 10x10G BWR fuel assembly from 4.6 wt% U-235 to 4.75 wt% U-235 • Change the minimum soluble boron concentration limits for the 17x17A PWR fuel assemblies in MPC-32 • Increase the burnup limit to accommodate NFH, including neutron source assembly in combination with other control components • Add thoria rods/canister as contents for the MPC-68M • Add a second permissible composition for thoria rods for all MPC-68 models • Editorial clarifications	2/25/2019	HI-2002444 Rev 16	Appendix A
12	• Addition of a new regionalized quarter-symmetric heat load (QSHL) pattern for MPC-68M and allow fuel that has been cooled for at least 2 years to be stored in the MPC-68M • Allow the storage of damaged fuel and fuel debris in DFC under the new regionalized QSHL pattern • Add a new duplex stainless steel as an allowed material for the MPC confinement boundary in the HI-STORM 100 system • Add cyclic vacuum drying for all MPCs • Update coefficients for burnup calculation equation for fuel assembly with cooling time of 2 through 40 years.	2/24/2019	HI-2002444 Rev 17	Appendix A

Amendment Number	Description of Changes	Approval Date	FSAR Basis	Location of AMPs
13	• Update the initial uranium weight for the 16x16B and 16x16C fuel assembly classes to match the value for 16x16A in HI-STORM 100 CoC Appendix B	5/13/2019	HI-2002444 Rev 18	Appendix A
14	• Add three new regionalized QSHL loading patterns for the MPC-68M • Reduce cooling time to 1 year for all fuel types for storage in the MPC-68M • Used damaged fuel isolator (DFI) for damaged fuel stored in the MPC-68M • Modify the description of the vents in the overpack in the COC	TBD (Submitted Oct 31, 2018)	To be issued after amendment becomes effective	Appendix A
15	• New version of transfer cask called HI-TRAC MS • Inclusion of MPC-32M as new canister • Inclusion of MPC-32 and MPC-68 Version 1 canisters • Addition of HI-STORM 100 Version E overpack • Inclusion of three new BWR fuel types • Addition of HI-DRIP and Dry Ice Jacket ancillary system • Allowance for partial gadolinium credit for BWR fuel assemblies • Removal of dose rate from accident analysis of non-mechanistic tip-over • Allowance for canisters previously loaded under other helium leak test requirements to be upgraded • Editorial drawing changes	TBD (Submitted March 20, 2019)	To be issued after amendment becomes effective	Appendix A

1.3 References

[1.1.1] U.S. NRC Information Notice 96-34, "Hydrogen Gas Ignition During Closure Welding of a VSC-24 Multi-Assembly Sealed Basket."

[1.1.2] HI-STORM 100 Final Safety Analysis Report, Revision 18, Holtec International, May 16, 2019

[1.1.3] NEI 14-03, "Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management," Rev 1, September 2015

CHAPTER 2: SCOPING EVALUATION

2.0 Introduction

Chapter 2 describes the evaluation process and methodology used to identify the structures, systems, and components (SSCs) of the HI-STORM 100 System and the subcomponents thereof that are within the scope of the license renewal.

2.1 Scoping Evaluation Process and Methodology

The scoping evaluation of the HI-STORM 100 System is performed based on the two-step process described in NUREG-1927 [2.1.1]. The first step in the process is a screening evaluation to determine which systems, structures, and component (SSC) are within the scope of the license renewal. Per NUREG-1927, Section 2.4.2, structures, systems, and components (SSC) are considered to be within the scope of the renewal if they satisfy either of the following criteria:

1) They are classified as Important-To-Safety (ITS), as they are relied on to do one of the following functions:

> i. Maintain the conditions required by the regulation or specific license to store spent fuel safely;
>
> ii. Prevent damage to the spent fuel during handling and storage; or
>
> iii. Provide reasonable assurance that spent fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public.

These SSCs ensure that important safety functions are met for:

1) Confinement
2) Radiation Shielding
3) Sub-Criticality Control
4) Heat-Removal Capability
5) Structural Integrity,
6) Retrievability

2) They are classified as Not-Important-To-Safety (NITS), but, according to the design bases, their failure could prevent fulfillment of a function that is ITS.

Any SSC that meets either Scoping Criterion 1 or 2 above is considered within the scope of license renewal (in-scope), and the function(s) it is required to perform during the extended term is identified. The results of the scoping evaluation are presented in Section 2.2.

As stated above, the HI-STORM 100 renewal is based on the continuation of the existing Current Licensing Basis (CLB) throughout the period of extended operation and maintenance of the intended safety functions of the SSC ITS. Accordingly, the sources of information reviewed in the scoping evaluation that describe the CLB and the intended safety functions of the SSC ITS are the HI-STORM 100 FSAR [1.1.2], Certificate of Compliance, and Safety Evaluation Report. Note that the reference information for these documents are contained in Section 2.3, as more than one revision of each may be utilized throughout the document.

2.2 Results of Scoping Evaluation

As discussed in Section 1.2, the HI-STORM 100 system includes the following major components:

- MPC
- HI-STORM 100 Overpack
- Fuel Assembly
- HI-TRAC Transfer Cask
- ISFSI Pad
- ISFSI Security Equipment
- Fuel Transfer and Auxiliary Equipment

The following sections include brief descriptions of the components, detailed descriptions can be found in Reference [2.1.2] through [2.1.21]. Table 2.2-1 summarizes the results of the scoping evaluation, listing the SSC that are identified as within scope and the criteria upon which they are determined to be within scope. Classifications are listed for the overall component, but some subcomponents are NITS. The categorizations are consistent with Reference [2.1.40].

2.2.1 Description of SSC

2.2.1.1 MPC

The MPC (including fuel basket) is constructed primarily of stainless steel, with supplemented Metamic® or Boral™ neutron absorbers. The functions of the MPC (including fuel basket) are confinement, structural integrity, criticality control, heat transfer, shielding, and retrievability. The MPC is classified as ITS-A, with individual subcomponents shown in Table 2.2-2.

2.2.1.2 HI-STORM 100 Overpack

The HI-STORM 100 overpacks are rugged, heavy-walled cylindrical vessels. The overpack consists primarily of concrete enclosed by cylindrical steel shells, and a closure lid. The storage system has air ducts to allow for passive natural convection cooling of the contained MPC. The functions of the HI-STORM Overpack are structural integrity, heat transfer, and shielding. The overpack is classified as ITS-B, with individual subcomponents shown in Table 2.2-3.

2.2.1.3 HI-TRAC Transfer Cask

Like the storage overpack, the HI-TRAC transfer cask is a rugged, heavy-walled cylindrical vessel. The main structural function of the transfer cask is provided by carbon steel, and the main neutron and gamma shielding functions are provided by water and lead, respectively. The transfer cask is a steel, lead, steel layered cylinder with a water jacket attached to the exterior. The functions of the HI-TRAC are structural integrity, heat transfer, and shielding. The HI-TRAC is classified as ITS-A, with individual subcomponents shown in Table 2.2-4.

2.2.1.4 Fuel Assembly

The HI-STORM 100 system is designed to store spent fuel assemblies as described in Chapter 2 of the HI-STORM 100 FSAR. Parts of the fuel assembly are credited for criticality control, confinement, and structural integrity. The fuel assemblies are classified as ITS-A, with individual subcomponents shown in Table 2.2-5.

2.2.1.5 ISFSI Pad

The ISFSI Pad is a facility within the perimeter fence, designed for the storage of loaded HI-STORM 100 overpacks. Though not described in detail in the FSAR, basic requirements for the storage pad are defined to ensure there is no operational impact to the overpacks or spent fuel contained within. The ISFSI Pad is not defined as important to safety in the FSAR and its failure does not prevent any ITS function from being fulfilled, since impacts to the overpack from non-mechanistic tipover on the pad are evaluated in the FSAR and determined to be acceptable. Therefore, the Pad is not considered in scope. Note that this refers to the ISFSI pad for the above ground systems, for the HI-STORM 100U, the pad is part of the overall system, and is considered in-scope.

2.2.1.6 ISFSI Security Equipment (Physical Protection)

The HI-STORM 100 ISFSI Security Equipment is not part of the HI-STORM 100 storage CoC, and as such, is not described in detail in the FSAR. The site will have programs and procedures to ensure that the ISFSI security equipment requirements are met, and potential failure of the ISFSI security equipment would not prevent the stored casks from performing their intended functions, and therefore the equipment is not considered in scope, in accordance with NUREG-1927.

2.2.1.7 Fuel Transfer and Auxiliary Equipment

Auxiliary equipment used for loading of MPCs and cask movement (e.g., drying system, cask transporter (VCT), Cask Transfer Facility (CTF), welding equipment, lifting equipment, mating device, etc.) are not included as part of the HI-STORM 100 CoC, and as such are not described in detail in the FSAR, nor are they within scope for aging management, in accordance with NUREG-1927.

2.2.2 <u>SSC’s Within the Scope of CoC Renewal</u>

The SSCs determined to be within the scope of the license renewal are the MPC, Overpack, HI-TRAC, and Fuel Assembly as shown in Table 2.2-1. Note that the fuel assembly hardware and cladding which supports the retrievability of the spent fuel are considered in scope.

2.2.3 <u>SSC’s Not Within the Scope of CoC Renewal</u>

As shown in Table 2.2-1, the ISFSI Pad, ISFSI Security Equipment, and Fuel Transfer and Auxiliary Equipment do not meet the criteria for being within scope of the license renewal. Note that the fuel pellets within the assemblies are not considered in the original safety analysis, and are not relied upon to meet retrievability or confinement functions.

Table 2.2-1 – Summary of Scoping Evaluation Results (Applies to all HI-STORM 100 Amendments approved and under review)			
Structure, System, or Component (SSC)	Scoping Results		In-Scope SSC
	Criterion 1[1]	Criterion 2[2]	
MPC	Yes	N/A	Yes
HI-STORM 100 Overpack	Yes	N/A	Yes
HI-TRAC Transfer Cask	Yes	N/A	Yes
Fuel Assembly[3]	Yes	N/A	Yes
ISFSI Pad	No	No	No
ISFSI Security Equipment	No	No	No
Fuel Transfer and Auxiliary Equipment	No	No	No

Notes:

1 SSC is Important-to-Safety (ITS)
2 SSC is Not Important-to-Safety (NITS), but its failure could prevent an ITS function from being fulfilled
3 Fuel pellets not included, per NUREG-1927.

Table 2.2-2 – Intended Safety Functions of MPC Subcomponents

Subcomponent	Intended Function Note 1,2	MPC Model	Safety Class	Licensing Drawing Number
Shell	Confinement, Structural Integrity, Heat Transfer, Shielding	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	[PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390]
Baseplate	Confinement, Structural Integrity, Heat Transfer, Shielding	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	
Lid	Confinement, Structural Integrity, Heat Transfer, Shielding, Retrievability	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	
Closure Ring	Confinement	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	
Port Cover Plates	Confinement	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	
Basket Cell Spacer Block	Structural Integrity, Criticality Control	24,24 Ver A, 24E/EF	ITS	
Basket Center Column	Structural Integrity, Criticality Control	24,24 Ver A, 24E/EF	ITS	
Basket Cell Plates	Structural Integrity, Criticality Control	68,68F,68FF,24,24 Ver A, 24E/EF, 32	ITS	
Short Cell Spacer Plates	N/A	24,24 Ver A, 24E/EF	NITS	
Flux Gap Cover	Criticality Control	24,24 Ver A, 24E/EF	ITS	
Flux Gap Plate	Criticality Control	24,24 Ver A, 24E/EF	ITS	
Basket Cover Angle	Criticality Control	24,24 Ver A, 24E/EF	ITS	
Basket Cell Angle	Criticality Control, Structural Integrity	24,24 Ver A, 24E/EF	ITS	
Basket Cell Channel	Criticality Control, Structural Integrity	24,24 Ver A, 24E/EF	ITS	
Neutron Absorber	Criticality Control	68,68F,68FF,24,24 Ver A, 24E/EF, 32	ITS	
Drain and Vent Shield Block	Shielding	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	
Plugs for Drilled Holes	Shielding	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	NITS	

Subcomponent	Intended Function Note 1,2	MPC Model	Safety Class	Licensing Drawing Number
Heat Conduction Elements (Optional)	Heat Transfer	68,68F,68FF,24,24 Ver A, 24E/EF	ITS	[PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390]
Upper Fuel Spacer Column	Structural Integrity	68,68F,68FF, 68M, 32	ITS	
Upper Fuel Spacer Pipe	Structural Integrity	24,24 Ver A, 24E/EF	ITS	
Sheathing	Structural Integrity	68,68F,68FF,24,24 Ver A, 24E/EF, 32	ITS	
Shims	Structural Integrity, Heat Transfer	68,68F,68FF,24,24 Ver A, 24E/EF, 32, 32M	NITS	
Basket Supports (Angled Plates and Parallel Plates with connecting end shims)	Structural Integrity	68,68F,68FF	ITS	
Basket Supports (Angled Plates and Parallel Plates, if Basket Shims are not used)	Structural Integrity	32	ITS	
Basket Supports (Flat Plates)	Structural Integrity	68,68F,68FF,32	NITS	
Basket Supports (if Basket Shims are used)	Structural Integrity	32	NITS	
Basket Shims	Structural Integrity	32	ITS	
Lift Lug	N/A – used only with unloaded MPC	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	
Lift Lug Baseplate	N/A – used only with unloaded MPC	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	
Upper Fuel Spacer Bolt	Structural Integrity	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	NITS	
Upper Fuel Spacer End Plate	Structural Integrity	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	
Lower Fuel Spacer Column	Structural Integrity	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	

Subcomponent	**Intended Function** Note 1,2	**MPC Model**	**Safety Class**	**Licensing Drawing Number**
Lower Fuel Spacer End Plate	Structural Integrity	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	[PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390]
Vent Shield Block Spacer	Structural Integrity	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	
Vent and Drain Tube	N/A	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	
Vent and Drain Cap	N/A	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	
Vent and Drain Sleeve Inserts	N/A	68,68F,68FF, 68M	ITS	
Vent and Drain Cap Seal Washer	N/A	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	
Vent and Drain Cap Seal Washer Bolt	N/A	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	NITS	
Vent and Drain Cap Lock Washer	N/A	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	NITS	
Reducer/Coupling	N/A	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	NITS	
Drain Line	N/A	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	NITS	
Damaged Fuel Container	Criticality Control	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	
Basket Sub-Panel	Criticality Control	68M, 32M	ITS	
Basket Shims	Structural Integrity, Heat Transfer	68M, 32M	ITS	
Solid Shims	Structural Integrity, Heat Transfer	68M, 32M	ITS	
Damaged Fuel Isolator	Criticality Control	68,68F,68FF, 68M, 24,24 Ver A, 24E/EF, 32, 32M	ITS	

(1) Intended Functions are based on Section 2.1, Criterion 1 – Criticality control, heat transfer, radiation shielding, confinement, structural integrity, and retrievability. These intended functions are for the renewal period.

(2) N/A means the component does not have a function in the period of extended operation and is NITS. These components are not included in the aging management review tables in Chapter 3.
/

Table 2.2-3 – Intended Safety Functions of HI-STORM Overpack Subcomponents

Subcomponent	Intended Function[Note 1,3]	Overpack Model[Note 2]	Safety Class	Licensing Drawing Number
Radial Shield	Shielding	100, 100S	ITS	[PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390]
Shield Block Ring & Shell	Shielding	100, 100S	ITS	
Pedestal Shield	Shielding	100, 100S, 100S Ver C	ITS	
Lid Shield	Shielding	100, 100S	ITS	
Shield Shell	Shielding	100	ITS	
Shield Block	Shielding	100, 100S, 100S Ver B	ITS	
Gamma Shield Cross Plates & Tabs	Shielding	100, 100S, 100S Ver B, 100S Ver C	ITS	
Baseplate	Structural Integrity, Shielding	100, 100S	ITS	
Outer Shell	Structural Integrity, Shielding	100, 100S, 100S Ver B, 100S Ver E	ITS	
Inner Shell	Structural Integrity, Shielding	100, 100S, 100S Ver B, 100S Ver E	ITS	
Pedestal Shell	Structural Integrity	100, 100S	ITS	
Pedestal Baseplate	Structural Integrity	100S	ITS	
Lid Bottom Plate	Structural Integrity	100, 100S	ITS	
Lid Shell	Structural Integrity, Shielding	100	ITS	
Inlet Vent Vertical & Horizontal Plates	Structural Integrity, Heat Transfer	100, 100S	ITS	
Exit Vent Vertical & Horizontal Plates	Structural Integrity, Heat Transfer	100, 100S	ITS	
Top Plate	Structural Integrity, Shielding	100, 100S, 100S Ver B, 100S Ver C	ITS	
Lid Top Plate	Structural Integrity, Shielding	100, 100S, 100S Ver E	ITS	
Lid Shield Ring	Structural Integrity	100S, 100S Ver B, 100S Ver C	ITS	
Lid Vent Side Plate	Structural Integrity	100S	ITS	
Lid Shield Block	Structural Integrity, Shielding	100S	ITS	

Subcomponent	Intended Function Note 1,3	Overpack Model Note 2	Safety Class	Licensing Drawing Number
Radial Plate	Structural Integrity	100, 100S, 100S Ver B , 100S Ver C, 100S Ver E	ITS	[PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390]
Lid Stud, Tee Handle Bolt & Nut	Structural Integrity	100, 100S	ITS	
Bolt Anchor Block	Structural Integrity	100, 100S, 100S Ver B, 100S Ver C	ITS	
Channel or Guide Tube	Structural Integrity	100, 100S, 100S Ver B, 100S Ver E	ITS	
Pedestal Platform	Structural Integrity	100, 100S, 100S Ver C	ITS	
Shear Ring	Structural Integrity	100S, 100S Ver B, 100S Ver C	ITS	
Storage Marking Nameplate	N/A	100, 100S, 100S Ver B, 100S Ver C	NITS	
Exit Vent Screen Sheet	N/A	100	NITS	
Drain Pipe	N/A	100	NITS	
Exit & Inlet Screen Frame	N/A	100	NITS	
Stud Tube	N/A	100S	NITS	
Screens	N/A	100, 100S, 100S Ver B, 100S Ver C	NITS	
Screen Bolts	N/A	100S	NITS	
Compression Fitting, Protection Head, Bushing, Coupling, and Hex Nipple for Thermocouple	N/A	100	NITS	
Conduit Connection	N/A	100	NITS	
Screws for Screen Fit-Up	N/A	100, 100S Ver B	NITS	
Lid Washer	N/A	100, 100S	NITS	
Channel Mounts	Structural Integrity	100, 100S	ITS	
Pedestal Shims	N/A	100	NITS	
Screen Bar	N/A	100	NITS	
Vent Frames	N/A	100, 100S, 100S Ver C	NITS	
Strap Block (Grounding Lugs)	N/A	100, 100S, 100S Ver B, 100S Ver C	NITS	
Radial Weld Plate	Structural Integrity	100, 100S	ITS	

Subcomponent	Intended Function Note 1,3	Overpack Model Note 2	Safety Class	Licensing Drawing Number
Heat Shield	Heat Transfer	100	ITS	[PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390]
Heat Shield Ring	Heat Transfer	100	ITS	
Lug Support Ring	Structural Integrity	100A, 100SA only	ITS	
Gusset	Structural Integrity	100A, 100SA only	ITS	
Stud with Nut	Structural Integrity	100A, 100SA only	ITS	
Washer	N/A	100A, 100SA only	NITS	
Bottom Plate	Structural Integrity	100S Ver B, 100S Ver C	ITS	
Spacer Block	Structural Integrity	100S Ver B	ITS	
Top Plate	Structural Integrity	100S Ver B, 100S Ver C	ITS	
MPC Support	Structural Integrity	100S Ver B	ITS	
Base and Lid Screen Mounts	N/A	100S Ver B	NITS	
Base and Lid Lift Plug	N/A	100S Ver B, 100S Ver C	NITS	
Shield Concrete	Shielding	100S Ver B, 100S Ver C	ITS	
MPC Guide	N/A	100S Ver B	NITS	
Lid Outer Ring	Structural Integrity	100S Ver B, 100S Ver C	ITS	
Lid Inner Ring	Structural Integrity	100S Ver B, 100S Ver C	ITS	
Lid Stud Pipe	N/A	100S Ver B, 100S Ver C	NITS	
Lid Stud Spacer	N/A	100S Ver B, 100S Ver C	NITS	
Lid Stud Ring	N/A	100S Ver B, 100S Ver C	NITS	
Lid Lift Block	Structural Integrity	100S Ver B, 100S Ver C	ITS	
Lid Lift Ring	N/A	100S Ver B100S, Ver C	NITS	
Lid Vent Shield	Shielding	100S Ver B, 100S Ver C	ITS	
Lid Shield Concrete	Shielding	100S Ver B, 100S Ver C	ITS	
Lid Stud	Structural Integrity	100S Ver B, 100S Ver C	ITS	
Lid Closure Bolt	Structural Integrity	100S Ver B, 100S Ver C	ITS	
Lid Bolt Handle	N/A	100S Ver B, 100S Ver C	NITS	

Subcomponent	Intended Function Note 1,3	Overpack Model Note 2	Safety Class	Licensing Drawing Number
Lid Stud Washer	N/A	100S Ver B, 100S Ver C	ITS	[PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390]
Lid Hex Nut	Structural Integrity	100S Ver B, 100S Ver C	ITS	
Lid Stud Cap	N/A	100S Ver B, 100S Ver C	NITS	
Lid Vent Seal	N/A	100S Ver B	NITS	
Cask Radial Gusset	Structural Integrity	100S Ver B	ITS	
Radial Rib	Structural Integrity	100S Ver C	ITS	
Lid Shim	N/A	100S Ver C	NITS	
Closure Lid Concrete	Shielding	100U	ITS	
Closure Lid Steel	Structural Integrity, Shielding	100U	ITS	
Container Shell Bottom Plate	Structural Integrity	100U	ITS	
Container Flange	Structural Integrity	100U	ITS	
Divider Shell and Divider Shell Restraints	Heat Transfer	100U	ITS	
Upper and Lower MPC Guides	Structural Integrity	100U	ITS	
MPC Bearing Pads	Structural Integrity	100U	ITS	
Insulation	Structural Integrity	100U	ITS	
Reinforced Concrete; VVM Interface Pad, Top Surface Pad	Structural Integrity	100U	ITS	
Retaining Wall, Support Foundation Pad	Structural Integrity, Shielding	100U	ITS	
Lid Rib	Structural Integrity	100S Ver E	ITS	
MPC Bottom Support Guides	Structural Integrity	100S Ver E	ITS	

(1) Intended Functions are based on Section 2.1, Criterion 1 – Criticality control, heat transfer, radiation shielding, confinement, and structural integrity. These intended functions are for the renewal period.

(2) Unless otherwise noted, 100 denotes both the HI-STORM 100 and 100A, and 100S denotes both the HI-STORM 100S (Versions B, C, and E) and 100SA

(3) N/A means the component does not have a function in the period of extended operation and is NITS. These components are not included in the aging management review tables in Chapter 3./

Table 2.2-4 – Intended Safety Functions of HI-TRAC Transfer Cask Subcomponents

Subcomponent	Intended Function[Note 1,2]	Transfer Cask Model	Safety Class	Licensing Drawing Number
Radial Lead Shield	Shielding	100, 100D, 125, 125D, MS	ITS	[PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390]
Pool Lid Lead Shielding	Shielding	100, 100D, 125, 125D	ITS	
Top Lid Shielding	Shielding	100, 100D, 125, 125D	ITS	
Outer Shell	Structural Integrity	100, 100D, 125, 125D, MS	ITS	
Inner Shell	Structural Integrity	100, 100D, 125, 125D, MS	ITS	
Enclosure Shell Panels	Structural Integrity	100, 100D, 125, 125D	ITS	
Water Jacket End Plate	Structural Integrity, Shielding	100, 100D, 125, 125D	ITS	
Top Flange	Structural Integrity, Shielding	100, 100D, 125, 125D, MS	ITS	
Lower Water Jacket Shell	Structural Integrity, Shielding	100, 100D, 125, 125D, MS	ITS	
Water Jacket Bottom Ring	Structural Integrity, Shielding	100, 100D, 125, 125D	ITS	
Water Jacket Top Plates	Structural Integrity, Shielding	100, 100D, 125, 125D	ITS	
Bottom Flange	Structural Integrity, Shielding	100, 100D, 125, 125D, MS	ITS	
Bottom Flange Washer	N/A	100, 100D, 125, 125D	NITS	
Pool Lid Outer Ring	Structural Integrity	100, 100D, 125, 125D	ITS	
Pool Lid Top Plate	Structural Integrity	100, 100D, 125, 125D	ITS	
Top Lid Outer Ring	Structural Integrity	100, 100D, 125, 125D	ITS	
Top Lid Inner Ring	Structural Integrity	100, 100D, 125, 125D	ITS	

Subcomponent	Intended Function[Note 1,2]	Transfer Cask Model	Safety Class	Licensing Drawing Number
Top Lid Top Plate	Structural Integrity	100, 100D, 125, 125D	ITS	[PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390]
Top Lid Bottom Plate	Structural Integrity	100, 100D, 125, 125D	ITS	
Fill Port Caps	N/A	100, 100D, 125, 125D	ITS	
Pool Lid Bolt	Structural Integrity	100, 100D, 125, 125D, MS	ITS	
Lifting Trunnion Block	Structural Integrity	100, 100D, 125, 125D	ITS	
Lifting Trunnion and End Cap	Structural Integrity	100, 100D, 125, 125D	ITS	
Pocket Trunnion	Structural Integrity	100, 125	ITS	
Dowel Pins	Structural Integrity	100, 100D, 125, 125D	ITS	
Water Jacket Bottom Plate	Structural Integrity	100, 100D, 125, 125D	ITS	
Pool Lid Bottom Plate	Structural Integrity	100, 100D, 125, 125D, MS	ITS	
Top Lid Lifting Block	Structural Integrity	100, 100D, 125, 125D	ITS	
Thermal Expansion Foam	N/A	100, 100D, 125, 125D	NITS	
Top Lid Stud/Bolt	Structural Integrity	100, 100D, 125, 125D	ITS	
Top Lid Nut/Washer	Structural Integrity	100, 100D, 125, 125D	ITS	
Pool Lid Gasket	N/A	100, 100D, 125, 125D	NITS	
End Cap Bolts	N/A	100, 100D, 125, 125D, MS	NITS	
Drain Pipes	N/A	100, 100D, 125, 125D	NITS	
Drain Bolt	N/A	100, 100D, 125, 125D	NITS	
Lifting Trunnion Pad Bolt	N/A	100, 100D, 125, 125D	NITS	

Subcomponent	Intended Function[Note 1,2]	Transfer Cask Model	Safety Class	Licensing Drawing Number
Couplings, Valves, and Vent Plug	N/A	100, 100D, 125, 125D, MS	NITS	[PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390]
Transfer Lid Side Lead Shield	Shielding	100, 125	ITS	
Transfer Lid Door Lead Shield	Shielding	100,125	ITS	
Transfer Lid Door Shielding	Shielding	100,125	ITS	
Transfer Lid Top Plate	Structural Integrity	100,125	ITS	
Transfer Lid Bottom Plate	Structural Integrity	100,125	ITS	
Transfer Lid Intermediate Plate	Structural Integrity	100,125	ITS	
Transfer Lid Lead Cover Plate	Structural Integrity	100,125	ITS	
Transfer Lid Lead Cover Side Plate	Structural Integrity	100,125	ITS	
Transfer Lid Door Top Plate	Structural Integrity	100,125	ITS	
Transfer Lid Door Middle Plate	Structural Integrity	100,125	ITS	
Transfer Lid Door Bottom Plate	Structural Integrity	100,125	ITS	
Transfer Lid Door Wheel Housing	Structural Integrity	100,125	ITS	
Transfer Lid Door Interface Plate	Structural Integrity	100,125	ITS	
Transfer Lid Door Side Plate	Structural Integrity	100,125	ITS	
Transfer Lid Wheel Shaft	Structural Integrity	100,125	ITS	
Transfer Lid Shaft Cover Plate	Structural Integrity	100,125	ITS	
Transfer Lid Housing Stiffener	Structural Integrity	100,125	ITS	
Transfer Lid Door Lock Bolt	Structural Integrity	100,125	ITS	
Transfer Lid Door End Plate	Structural Integrity	100,125	ITS	
Transfer Lid Lifting Lug and Pad	Structural Integrity	100,125	ITS	

Subcomponent	Intended Function[Note 1,2]	Transfer Cask Model	Safety Class	Licensing Drawing Number
Transfer Lid Wheel Track	N/A	100,125	ITS	[PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390]
Transfer Lid Door Handle	N/A	100,125	NITS	
Transfer Lid Door Wheels	N/A	100,125	NITS	
Transfer Lid Door Stop Block	N/A	100,125	ITS	
Transfer Lid Door Stop Block Bolt	N/A	100,125	ITS	
Hydraulic System	N/A	100, 125	NITS	
Short Rib	Structural Integrity, Heat Transfer	MS	ITS	
Extended Rib	Structural Integrity, Heat Transfer	MS	ITS	

(1) Intended Functions are based on Section 2.1, Criterion 1 – Criticality control, heat transfer, radiation shielding, confinement, and structural integrity. These intended functions are for the renewal period.

(2) N/A means the component does not have a function in the period of extended operation and is NITS. These components are not included in the aging management review tables in Chapter 3.

Table 2.2-5 – Intended Safety Functions of Fuel Assembly Subcomponents

Item No.	Subcomponent	Intended Function[Note 1,2]
1	Fuel Pellets	N/A
2	Fuel Cladding	Criticality Control, Confinement, Structural Integrity
3	Spacer Grid Assemblies	Criticality Control, Structural Integrity
4	Upper End Fitting	Structural Integrity
5	Lower End Fitting	Structural Integrity
6	Guide Tubes	Structural Integrity
7	Hold-down Spring & Upper End Plugs	N/A
8	Control Components	N/A
9	Channels for BWR fuel	N/A

Notes:

(1) Intended Functions are based on Section 2.1, Criterion 1 – Criticality control, heat transfer, radiation shielding, confinement, and structural integrity

(2) N/A means the subcomponent does not have a function in the period of extended operation. These components are not included in the aging management review tables in Chapter 3.

2.3 References

[2.1.1] NUREG-1927, "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel," Revision 1. US NRC, June 2016.

[2.1.2] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 0, dated July 12, 2000

[2.1.3] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 1, dated September 17, 2002

[2.1.4] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 2, dated February 17, 2004

[2.1.5] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 3, dated May 26, 2005

[2.1.6] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 4, dated April 10, 2006

[2.1.7] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 5, date June 20, 2007

[2.1.8] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 6, dated February 7, 2008

[2.1.9] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 7, dated August 8, 2008

[2.1.10] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 8, dated January 18, 2010

[2.1.11] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 9, dated February 13, 2010

[2.1.12] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 10, dated April 24, 2012

[2.1.13] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 11, dated July 27, 2013

[2.1.14] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 11.1, dated February 26, 2016

[2.1.15] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 12, dated March 12, 2014

[2.1.16] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 13, dated March 31, 2016

[2.1.17] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 14, dated November 18, 2016

[2.1.18] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 15, dated April 27, 2018

[2.1.19] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 16, dated April 18, 2019

[2.1.20] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 17, dated May 3, 2019

[2.1.21] Holtec Report, HI-2002444, HI-STORM 100 FSAR Rev 18, dated May 16, 2019

[2.1.22] HI-STORM 100 CoC 72-1014 Amd 0, dated May 31, 2000

[2.1.23] HI-STORM 100 CoC 72-1014 Amd 1, dated July 15, 2002

[2.1.24] HI-STORM 100 CoC 72-1014 Amd 2, dated June 7, 2005

[2.1.25] HI-STORM 100 CoC 72-1014 Amd 3, dated May 29, 2007

[2.1.26] HI-STORM 100 CoC 72-1014 Amd 4, dated January 8, 2008

[2.1.27] HI-STORM 100 CoC 72-1014 Amd 5, dated July 14, 2008

[2.1.28] HI-STORM 100 CoC 72-1014 Amd 6, dated August 17, 2009

[2.1.29] HI-STORM 100 CoC 72-1014 Amd 7, dated December 28, 2009

[2.1.30] HI-STORM 100 CoC 72-1014 Amd 8, dated November 16, 2012 (corrected, then superseded by Rev 1)

[2.1.31] HI-STORM 100 CoC 72-1014 Amd 8R1, dated February 16, 2016

[2.1.32] HI-STORM 100 CoC 72-1014 Amd 9, dated March 11, 2014 (then superseded by Rev 1)

[2.1.33] HI-STORM 100 CoC 72-1014 Amd 9R1, dated March 21, 2016 (corrected)

[2.1.34] HI-STORM 100 CoC 72-1014 Amd 10, dated May 31, 2016 (corrected)

[2.1.35] HI-STORM 100 CoC 72-1014 Amd 11, dated February 25, 2019 (corrected)

[2.1.36] HI-STORM 100 CoC 72-1014 Amd 12, dated February 25, 2019 (corrected)

[2.1.37] HI-STORM 100 CoC 72-1014 Amd 13, dated May 13, 2019 (corrected)

[2.1.38] HI-STORM 100 CoC 72-1014 Amd 14, dated December 17, 2019 (corrected)

[2.1.39] HI-STORM 100 CoC 72-1014 Amd 15 (under review at time of renewal application)

[2.1.40] HI-992332, “ITS Categorization of HI-STAR 100, HI-STORM 100, and Cask Transfer Facility System Components,” latest revision.

CHAPTER 3: AGING MANAGEMENT REVIEW

3 Introduction

The HI-STORM 100 dry storage system, US NRC Certificate of Compliance (CoC) 1014, has a life that is broken down into three classifications. The first classification, the license life of the system, is the amount of time that the system has been licensed by the NRC for use in dry storage. The second classification, a design life of 60 years is the length of time for which the storage system has been engineered to perform all of its design functions. The final classification is the minimum service life of 100 years, which is contingent upon at least two license renewals beyond the original license life.

Because the HI-STORM 100 dry storage system is nearing the end of its initial 20 year license life and the US NRC requires an aging management program be put in place in order to complete the license renewal for the next 40 year license life, this chapter presents the Aging Management Review (AMR) for the HI-STORM 100 system. The purpose of the AMR is to assess the aging effects and mechanisms that could adversely affect the ability of the system, structures, or components (SSC), determined to be within the scope of the license renewal, to perform their intended functions during the period of extended storage. The aging management program must take into account the intended function of each SSC, its material, and the environment in which it was used to determine what activities are needed. The US NRC guidance for the aging management program is contained in NUREG-1927 [2.1.1]. Additional guidance is contained in the NRC's MAPS Report, NUREG-2214, and is reflected in the information in this section.

3.1 Operating Experience Review

3.1.1 Holtec Operating Experience

Holtec has prepared a report of manufacturing deviations and of engineering change orders (ECOs) that have happened over the life of the system [3.1.1] and [3.1.2]. These reports document specific items that were considered in the development of aging management activities.

3.1.2 User Operating Experience

A survey of the users of the HI-STORM 100 system was performed to evaluate if there was any operating experience or inspection results that would impact the aging of the system. This survey found the following items:

- Overpack Coatings Degraded:
    - Dime size rust on the lift block
    - Quarter size rust below the top vent
    - Minor discoloration on the gamma shield
    - Minor visible rust under degraded coating at bottom of cask
    - Rust streaks below the vent screens
    - Rust around weep holes on cask lids

  - Minor rust spots (approximately ½" by 3", or 1" by 4") due to chipped paint
  - Threaded hole area rust
- Minor Overpack Concrete Degradation
  - Small evidence of degradation near vents due to use of de-icer
  - Shrinkage cracks, typically 0.004 inches or less
  - Minor spalling
  - Minor surface damage
  - Minor paint loss
  - Small scratches
- HI-TRAC
  - Minor paint degradation
  - Minor paint loss
- MPC
  - Marks (fabrication marks / dog marks) found on exterior of MPC, evaluated at site and determined to be acceptable
  - Minor blemishes due to potential carbon steel contamination, which were removed by Scotchbrite
  - Other carbon steel contamination near welds

All conditions previously seen are monitored by the aging management programs described for the applicable components. The types of corrosion previously seen were utilized in determining the criteria for future inspections. Trending of these conditions and corrective actions, as necessary, are also part of the aging management programs. Note that the reviewed operating experience is about the in scope subcomponents, out of scope components listed in Section 2 were not evaluated. Additional operating experience was gathered from some system inspections as described in Appendix C.

The aging management programs in Appendix A were developed including consideration for this operating experience.

3.1.3 User Exemption Requests

This section evaluates the exemption requests granted to specific sites that were identified to Holtec at the time of writing of this application. Users should consider any other or future exemption requests and their impact on aging management.

One user applied for and was granted an exemption from 10 CFR 72.212 and 214 which allowed for storage of specific fuel types. That exemption was approved in 2001, and subsequently the fuel types were added to the generic CoC. Therefore, no specific aging management considerations are needed for this exemption. Similarly, an exemption was issued for specific fuel heat loading plans in 2018, which were subsequently incorporated into the generic CoC, and no specific aging management considerations are needed.

An exemption was requested and granted for the storage of a thoria rod canister in an MPC-68M. These thoria rods were added during a subsequent amendment to the CoC and therefore, no specific aging management considerations are needed for this exemption.

An exemption was granted related to fuel that released some radioactive gases during drying, to allow the canister to be placed into storage that includes fuel that may have cladding damage not in a damaged fuel container (DFC). This exemption only impacts the fuel within the canister's inert helium environment and does not change the aging management programs.

Additionally an exemption was requested and granted regarding the location of dose rate measurements on the HI-STORM 100 overpack. This related to a one time, post-loading surveillance and does not impact the aging of the system.

3.2 Aging Management Review Methodology

As described in NUREG-1927 [2.1.1], the aging management review process is broken down into a number of steps. The first step is determining the in-scope SSC subcomponents that require aging management review, followed by identification of the aging effects requiring management, and finally identification of the necessary management activities for each affected subcomponent. Aging management activities can either be Time Limited Aging Analyses (TLAAs) or Aging Management Programs (AMPs) depending on the component material, service environment, and existing licensing basis calculations.

3.2.1 Identification of In-Scope SSC's Requiring Aging Management Review

As discussed in Chapter 2, all SSC subcomponents that perform or support any of the identified, intended functions in a passive manner are in-scope for license renewal and are therefore, in-scope for aging management review. These subcomponents are presented in Table 3.3-1 through Table 3.3-5.

Any SSC subcomponents that do not perform or support an intended function or already have their condition monitored at some established frequency are excluded from further evaluation in the aging management review.

3.2.2 Identification of Materials and Environments

A detailed description of the HI-STORM 100 system and the materials used in the SSC's are described in the HI-STORM 100 FSAR. A breakdown of each SSC subcomponent in-scope for aging management, with its intended function, material, and service environment is contained in Table 3.3-1 through Table 3.3-5. Note that subcomponents which do not have a safety function or support a safety function are not required to undergo aging management. A summary of the materials used in the aging management assessment is provided in Table 3.2-1.

A generic description of the four basic environments is provided below.

3.2.2.1 Helium

The helium environment refers to the inside of the MPC, which is backfilled with inert helium gas. Based on the canister drying process, the environment has negligible amounts of oxygen or moisture. The helium environment is exposed to the range of temperatures calculated for the MPC and significant radiation impacts from the stored fuel.

3.2.2.2 Sheltered Environment

The term sheltered environment refers to environments that may include ambient air, but are shielded from sunlight, rain, or wind exposure. One sheltered environment in the HI-STORM 100 System design is the annular space between the overpack and the MPC. The ambient air contains moisture, salinity, or other contaminants typical for the site where it is stored. The temperature of the sheltered environment is within the limits of the air temperature passing through the annular space.

Additionally, the term sheltered is used to refer to the interior of a storage building, which provides protection from direct sunlight, rain, and wind. However the building air may not be conditioned by HVAC equipment.

3.2.2.3 Embedded Environment

The embedded environment applies to materials that are embedded or sealed inside another material. Items in this environment include the internal metal items of the overpack. The embedded items are exposed to the temperatures of the components in which they are embedded.

3.2.2.4 Air-Outdoor Environment

The term "Air-Outdoor" environment is used for exterior surfaces that are exposed to direct sunlight, wind, rain, and other weather aspects. Items in an air-outdoor environment in the HI-STORM 100 System are the overpacks. The air-outdoor environment has temperature ranges equivalent to the site ambient temperature ranges.

3.2.3 Identification of Aging Effects Requiring Management

After the materials and environments have been identified, the next step involves determining the aging effects requiring management. Aging effects requiring management during the renewed license period are those that could cause a loss of SSC intended function. If degradation of a subcomponent would be insufficient to cause a loss of function or the relevant conditions do not exist for the aging effect to occur and propagate, then no aging management is required. These aging effects were determined based on the combination of materials and environments and a review of known literature, NRC MAPS report (NUREG-2214) [3.0.1], industry operating experience, and maintenance and inspection records from general licensees (such as condition reports and inspection reports). Both potential aging effects that could theoretically occur, as well as aging effects that have actually occurred based upon industry operating experience were considered.

Aging effects occur due to aging mechanisms. In order to manage aging effects, the aging mechanism that could be at work based on material and environment, must be determined. Therefore, the AMR process identifies both aging effects and the aging mechanism causing that effect. The aging effects and mechanisms for each SSC are broken down by subcomponent in Table 3.3-1 through Table 3.3-5. Since the tables in Chapter 2 already determine which subcomponents have ITS related functions into the extended storage period, and the subcomponents that do not have not been included in these tables.

3.2.4 Determination of Aging Management Activity Required

The final step in the AMR process is to determine the aging management activity or program to manage the effect of aging. As much as possible, existing ISFSI programs and activities were credited to manage aging effects that could cause a loss of intended function during the renewed license period.

As described in NUREG-1927 [Ref. 2.1.1], there are two options for managing aging effects on components; a time-limited aging analysis (TLAA) or an aging management program (AMP).

3.2.4.1 Time-Limited Aging Analysis (TLAA)

A Time-Limited Aging Analysis (TLAA) is a licensee or CoC holder calculation or analysis that meets all of the following attributes, as defined in 10CFR72.3:

- Involves SSCs important to safety within the scope of license or CoC renewal,
- Considers the effects of aging,
- Involves time-limited assumptions defined by the current operating term
- Was determined to be relevant by the licensee or CoC holder in making a safety determination
- Involves conclusions or provides the basis for conclusions related to the capability of the SSCs to perform their intended safety functions, and
- Is contained or incorporated by reference in the design bases.

3.2.4.2 Aging Management Program (AMP)

An Aging Management Program (AMP) is a program conducted by the licensee or Certificate of Compliance (CoC) user for the purposes of addressing the aging effects in accordance with NUREG-1927. The program may include prevention, mitigation, condition monitoring, and/or performance monitoring. These AMPs are to be started as the HI-STORM 100 systems reach the end of their initial license life and intended to support the HI-STORM 100 systems during their renewed license periods. The use of an AMP to address these aging mechanisms does not always mean that the specific subcomponent is inspected under the AMP, but that the information gained from the applicable AMP used as a whole provides reasonable assurance that the listed subcomponents maintain their function.

Table 3.2-1 Summary of Materials

Term	Usage in this Document
Aluminum	Includes pure aluminum and alloys
Boral	A laminate composite that is used as a neutron poison material. It consists of a core of aluminum and boron-carbide powder sandwiched between sheets of aluminum.
Metamic	Aluminum metal-matrix composite for neutron poison applications, produced by cold isostatic pressing followed by vacuum sintering.
Metamic-HT	A successor to the Metamic composite material. It possesses the necessary mechanical properties for structural fuel basket applications by strengthening its aluminum matrix with nanoparticles of aluminum oxide.
Concrete	A mixture of hydraulic cement, aggregates, and water, with or without admixtures, fibers, or other cementitious materials.
Holtite-A	A neutron shielding material consisting of epoxy polymer, B_4C added as a finely divided powder, and aluminum hydroxide.
Nickel Alloy	Includes Inconel, which is a family of austenitic nickel-chromium-based super alloys.
Alloy X	Stainless or duplex steel as defined in Appendix 1.A of the HI-STORM 100 FSAR
Zirconium-based alloys	Materials of construction of fuel cladding and fuel assembly hardware. Various zirconium-based materials have been used in commercial reactor applications because of their low neutron cross section and excellent corrosion resistance to a variety of environmental conditions. This category includes (but is not limited to) Zircaloy-2, Zircaloy-4, ZIRLO, and M5.
Carbon Steel	Various carbon steels including ASTM A36, ASTM A320, SA193-Gr. B7, SA516-Gr. 70

3.3 Aging Management Review Results

3.3.1 Aging Management Review Results – MPC

Table 3.3-1 summarizes the results of the aging management review for the MPC subcomponents previously determined to be in the scope of the license renewal.

Additional description of the MPC subcomponents is provided in Section 3.3.1.1, while Sections 3.3.1.2 and 3.3.1.3 present the materials and environments for the specified subcomponents. The aging effects requiring management and the proposed activities required to manage these effects are discussed in Sections 3.3.1.4 and 3.3.1.5, respectively.

3.3.1.1 Description of MPC Subcomponents

MPC Enclosure Vessel

The MPC enclosure vessel is a welded cylindrical structure with flat ends that provides confinement of the spent nuclear fuel during storage operations. The confinement boundary, comprised of a baseplate, shell, lid, port covers, and a closure ring, is constructed entirely of stainless steel. The MPC lid is a circular plate edge-welded to the MPC shell. Access to the MPC cavity for the purposes of moisture removal and subsequent backfilling with a specified amount of inert gas (helium) is achieved via two penetrations (i.e., vent and drain ports) in the MPC lid. Circular cover plates are seal welded over the vent and drain ports, completing the primary closure system. A circular closure ring is welded to the MPC shell and lid, providing a redundant closure system at the top end of the MPC. A more detailed description is included in paragraph 1.1.2.1 of this report.

MPC Fuel Basket

Within each MPC enclosure vessel is a honeycombed fuel basket responsible for maintaining the spent nuclear fuel in a subcritical condition. The number of fuel storage cells will vary depending on the type of fuel to be stored. The fuel basket is positioned and supported within the enclosure vessel by “basket shims” located in the space between the inside of the shell and the basket. Upper and lower fuel spacers, as appropriate, are utilized to maintain the axial position of the fuel assembly within the MPC basket.

Damaged Fuel Container (DFC) / Damaged Fuel Isolators (DFI)

The damaged fuel container is designed to contain damaged fuel or fuel debris. The internal opening accommodates a fuel assembly, and the outside dimensions allow the DFC to fit in the MPC Fuel Basket storage cells. The shells and lids of the DFCs are fabricated from stainless steel or aluminum. The ends have screened vent holes which enable moisture removal from the canister and expose the contents of the DFC to the helium atmosphere of the MPC.

The damaged fuel isolators (DFI) are provided to contain damaged fuel that can be handled by normal means, and have similar screens to enable moisture removal.

3.3.1.2 MPC Materials

With the exception of the neutron absorbers which are constructed of either Boral™ or Metamic®, the basket in the MPC-68M/32M which is Metamic-HT, and some DFC/DFI designs which are constructed of aluminum, all other MPC subcomponents in the scope of the license renewal are constructed of stainless steel. Additional material details for the MPC subcomponents are provided in Table 3.3-1.

3.3.1.3 MPC Environments

The environments that affect the subcomponents of each MPC, both externally and internally, are described below.

3.3.1.3.1 External

Each MPC is stored in a vertical, ventilated overpack. Based on this design, the external surface of each MPC is exposed to the same environment as the inside of the overpack (described in Subsection 3.3.2), which is a sheltered environment protected from precipitation and wetting. This sheltered environment includes ambient air, but not direct sunlight, rain, or wind exposure. The ambient air may contain some moisture and contaminants. The normal operating temperature of the outside MPC surface is highest at the top. Maximum surface temperature limits are unchanged. While these temperatures may vary across the amendments of the HI-STORM 100 CoC, the variation in temperature does not change the potential aging mechanisms, and therefore does not change the programs needed to manage them.

3.3.1.3.2 Internal

The internal environment of the MPC is a helium environment that is completely filled with the inert helium gas. The previously licensed maximum surface temperature limits are assumed to continue into the license renewal period. While these temperatures may vary across the amendments of the HI-STORM 100 CoC, the variation in temperature does not change the potential aging mechanisms, and therefore does not change the programs needed to manage them.

3.3.1.4 Aging Effects Requiring Management (MPC)

Based on the MPC materials of construction and the environments experienced during the period of extended storage at the ISFSI, the aging effects requiring management are loss of material, cracking (due to corrosion and stress corrosion cracking on the external MPC surfaces) and radiation effects on the neutron absorber and steel components.

3.3.1.5 Aging Management Activities (MPC)

Based on the aging management review of the MPC subcomponents documented in Table 3.3-1, an AMP is required for the aging management activities of the MPC and a TLAA is required specifically for the effects of radiation on the neutron absorber and steel components. These aging management activities are discussed in detail in Sections 3.4 and 3.5.

3.3.2 Aging Management Review Results – HI-STORM 100 Overpack

Table 3.3-2 summarizes the results of the aging management review for the HI-STORM 100 overpack subcomponents previously determined to be in the scope of the license renewal.

Additional description of the overpack subcomponents is provided in Section 3.3.2.1, while Sections 3.3.2.2 and 3.3.2.3 present the materials and environments for the specified subcomponents. The aging effects requiring management and the proposed activities required to manage these effects are discussed in Sections 3.3.2.4 and 3.3.2.5, respectively.

3.3.2.1 Description of Overpack Subcomponents

The overpack provides structural support, shielding, and natural circulation cooling for the MPC. The overpack is ventilated by internal air flow paths which allow the decay heat to be removed by natural circulation around the metal MPC wall. An airflow path is formed by the openings at the bottom (air entrance), the air inlet ducts, the gap between the MPC exterior and the overpack interior, and the air outlet ducts at the top. The internal cavity of the overpack is formed by a coated steel liner and bottom plate. The steel and concrete walls of the overpack are designed to minimize side surface radiation dose rates. The steel liner is coated to promote radiant heat dissipation and to minimize corrosion. The overpack lid is fabricated from steel and concrete and provides additional gamma attenuation in the upward direction, reducing both direct radiation and skyshine. The overpack lid is bolted in place, and also protects the MPC from the environment and postulated tornado missiles. A more detailed description is included in paragraph 1.1.2.2 of this report. The list of subcomponents evaluated under the overpack aging management review also includes the components of the HI-STORM 100U.

3.3.2.2 Overpack Materials

The HI-STORM 100 overpack is constructed of carbon steel, with exposed surfaces coated to protect against corrosion, and filled with concrete. The concrete in the cask shell is in direct contact with steel. Concrete has been used with steels in many commercial applications including Reactor Containment Buildings (e.g., carbon steel reinforcement, stainless steel liner). Similarly, as concrete is a standard construction material used for civil projects such as dams, buildings, and bridges that are exposed to severe environmental conditions, no adverse concrete reactions associated with weather are anticipated.

Internal and external surfaces are painted (except for bolt location that have protective coating). Thermaline 405 or a functionally equivalent paint/coating is used to coat the overpack. The coating also prevents the carbon steel in the overpack from coming in contact with the stainless steel MPC.

Additional material details for the HI-STORM 100 overpack subcomponents are provided in Table 3.3-2.

3.3.2.3 Overpack Environments

The HI-STORM 100 overpacks are located outdoors at their storage site. The temperatures for the overpacks are bounded by the temperatures in Table 2.2.2 of the HI-STORM FSAR [2.1.21]. The interior components of the overpacks are exposed to a sheltered environment. This environment includes ambient air through the air passages, but does not include sun, rain, or wind exposure. The ambient air may contain moisture, salinity, or other contaminants.

The metal components of the overpack that are in contact with concrete, such as the outer surface of the inner shell, are considered to be in an embedded environment. The primary concern for embedded environments is the potential chemical reaction between the two materials. The interactions between materials of the HI-STORM 100 overpack subcomponents are described in Section 3.3.2.2, and are not considered to be of concern for the extended storage period.

The exterior surfaces of the overpacks are exposed to all weather-related effects, including insolation, wind, rain, snow, ice, ambient air, and other environmental debris at their storage sites, and are considered to be in an air-outdoor environment. Additionally, the overpacks are exposed to radiation effects from the MPCs stored inside.

3.3.2.4 Aging Effects Requiring Management (Overpack)

Based on a review of the overpack materials of construction and the environments experienced during the period of extended storage at the ISFSI sites the main aging effects requiring management are loss of material due to corrosion, loss of fracture toughness (due to radiation impacts) for the metal components, and concrete aging issues caused by freeze thaw cycles, alkali-silica reaction, and/or calcium hydroxide leaching.

3.3.2.5 Aging Management Activities (Overpack)

Based on the aging management review of the overpack subcomponents documented in Table 3.3-2, it has been determined that the aging management activities required for the overpack are an AMP for the overpack and a separate AMP for the HI-STORM 100U components (if used). These aging management activities are discussed in detail in Section 3.5. For those components potentially impacted by radiation, the radiation impacts have been evaluated and determined that no additional aging management activities beyond those in the Overpack AMP are needed. A TLAA is not required by definition since this analysis was not part of the initial licensing basis.

3.3.3 Aging Management Review Results – Fuel Assembly

Table 3.3-3 summarizes the results of the aging management review for the Fuel Assembly subcomponents previously determined to be in the scope of the license renewal.

Additional description of the fuel assembly subcomponents is provided in Section 3.3.3.1, while Sections 3.3.3.2 and 3.3.3.3 present the materials and environments for the specified subcomponents. The aging effects requiring management and the proposed activities required to manage these effects are discussed in Sections 3.3.3.4 and 3.3.3.5, respectively.

3.3.3.1 Description of Fuel Assembly

Depending on the MPC model being used, the fuel contained within consists of either 24 PWR fuel assemblies, 32 PWR fuel assemblies, or 68 BWR fuel assemblies. The maximum heat loads, minimum cooling times, and maximum burnups vary based on the selected MPC and loading options, however, this application evaluates the bounding information if necessary.

The cladding of the fuel assembly provides the primary confinement barrier, while the physical structure of the fuel assembly maintains the axial distribution of the radiological source and its position within the gridwork of the fuel basket. The fuel pellets, hold-down springs and upper end plugs, and control components were excluded from further aging management review because they do not support or impact the intended function of the fuel assemblies during the extended storage period.

3.3.3.2 Fuel Assembly Materials

The fuel assembly subcomponents included in the aging management review are made from zircaloy, stainless steel, and/or Inconel. Additional material details for the Fuel Assembly subcomponents are provided in Table 3.3-3.

3.3.3.3 Fuel Assembly Environments

Because the MPC is sealed, dried, and backfilled with helium prior to entering storage, the fuel assemblies are maintained in a very low moisture, helium environment. The temperatures range from the maximum value corresponding to the short term limit for a maximum canister heat load to the minimum ambient air temperature as the heat load reduces over time.

3.3.3.4 Aging Effects Requiring Management (Fuel Assembly)

The fuel assemblies stored in the HI-STORM 100 system are classified as moderate-burnup fuel (≤45,000 MWd/MTU) or high-burnup fuel (>45,000 MWd/MTU).

For the moderate-burnup fuel, cladding embrittlement due to irradiation damage or hydride formation is not a concern. A report prepared by Pacific Northwest National Laboratory (PNNL-14390 [3.3.1]), documenting research conducted by EPRI and the US Department of Energy, confirms that similar, nonhigh-burnup fuel assemblies stored in a helium environment, like the one present inside the MPC, do not exhibit detectable degradation of the cladding or more than negligible release of gaseous fission products during storage. Therefore, no aging effects requiring management are identified for the low burnup fuel assemblies.

For the high burnup fuel, the acceptability of storage for the initial 20 years is based on ISG-11, Rev 3 [3.3.2]. This basis may not be applicable for high burnup fuel storage beyond 20 years, due to the potential for further cooldown in the high burnup fuel cladding temperature during the extended 60-year renewal period. As the high burnup fuel cools down below the ductile-to-brittle transition temperature (DBTT), the formation of radial hydrides may provide an additional embrittlement mechanism to alter the acceptance criteria of ISG-11 for storage of high burnup fuel. This embrittlement is considered an aging effect that requires management into the extended storage period.

3.3.3.5 Aging Management Activities (Fuel Assembly)

Based on the above review, it is determined that an AMP is needed for high burnup fuel. NRC ISG-24 [3.3.3] provides guidance for the storage of high burnup fuel for periods greater than 20 years, and specifies that the applicant may use the results of a completed or an ongoing demonstration, in conjunction with an actively updated AMP, as an acceptable means for confirming that the canister contents satisfy the applicable regulations. ISG-24 further specifies that the high burnup fuel AMP should be periodically reviewed and updated whenever new data from the demonstration program or other short term tests or modeling indicate potential degradation of the fuel or deviation from the assumptions of the AMP.

The Fuel Assembly AMP is described in Appendix A. Consistent with the guidance provided in NUREG-1927, the AMP takes credit for the DOE/EPRI High Burnup Dry Storage Cask Research and Development Project (HDRP).

3.3.4 Aging Management Review Results – HI-TRAC Transfer Cask

Table 3.3-4 summarizes the results of the aging management review for the HI-TRAC Transfer Cask, previously determined to be in the scope of the license renewal.

Additional description of the HI-TRAC is provided in Section 3.3.4.1, while Sections 3.3.4.2 and 3.3.4.3 present the materials and environments. The aging effects requiring management and the proposed activities required to manage these effects are discussed in Sections 3.3.4.4 and 3.3.4.5, respectively.

3.3.4.1 Description of HI-TRAC Transfer Cask

The transfer cask is a steel, lead, steel layered cylinder with a water jacket attached to the exterior. The transfer cask provides an internal cylindrical cavity of sufficient size for housing an MPC, and is equipped with a seal designed to hold clean demineralized water in the inner cavity. This design prevents contamination of the exterior of the MPC by contaminated fuel pool water. The transfer cask is equipped with lifting trunnions, and in the case of the standard design HI-TRAC, with pocket trunnions to allow rotation of the HI-TRAC (see Paragraph 1.1.2.3).

3.3.4.2 HI-TRAC Transfer Cask Materials

The HI-TRAC structure is fabricated from carbon steel. Other materials included in the HI-TRAC design are lead (for gamma shielding), Inconel (for lifting trunnions), Holtite (in transfer lid for standard designs), and elastomer (in the seal). The Holtite and lead shielding materials are completely enclosed, and therefore there are no significant galvanic or chemical reactions between these materials and the air or borated water. As identified in the HI-STORM 100 FSAR [2.1.21], the exposed carbon steel surfaces are coated in accordance with Appendix 1.C of the FSAR. This coating prevents corrosion and aids in surface decontamination.

The material of each Transfer Cask subcomponent is identified in Table 3.3-4.

3.3.4.3HI-TRAC Transfer Cask Environments

The exterior of the HI-TRAC is exposed to water or borated water (PWR) during fuel loading (while the HI-TRAC was in an SFP), and to demineralized water in the annulus. Following fuel loading of the MPC, the HI-TRAC is removed from the SFP.

The HI-TRAC is exposed to either a sheltered environment, if stackup is performed in the building or an air-outdoor environment if stackup is performed outside. The relatively brief exposure of the HI-TRAC to borated and demineralized water while in the SFP and the outside environment during transfer and loading operations (if applicable), does not significantly contribute to the aging of the HI-TRAC during the renewal period. It is the prolonged or frequently recurring exposure to environmental conditions and stresses that must be evaluated for aging effects, such as those encountered during storage.

The environment to which the HI-TRAC is exposed during storage between use for MPC loading and transfers is usually sheltered within a building, but to be conservative and bound any sites which may store the HI-TRAC outside, the environment is considered to be ambient air.

3.3.4.4 Aging Effects Requiring Management for HI-TRAC

Based on a review of the HI-TRAC materials of construction and the environments experienced during the period of extended storage at the ISFSI, the main aging effect requiring management is loss of material due to corrosion.

3.3.4.5 Aging Management Activities for HI-TRAC

Based on the aging management review of the HI-TRAC subcomponents documented in Table 3.3-4, the aging management activities required for the HI-TRAC are an AMP for the HI-TRAC, and a TLAA for the HI-TRAC trunnions.

The Holtite material used in the HI-TRAC also has an aging mechanism of concern related to its thermal and radiation aging. The current licensing basis does not include a specific time based evaluation of the material, so there is no analysis to meet the requirements to be classified a TLAA. However, testing has been performed on the material and documented in [3.3.4], which show that no material damage or change in the properties of the material occurs over the service life of the transfer cask. Therefore, no AMP or TLAA is required.

3.4 Time-Limited Aging Analyses (TLAA)

Using the TLAA-identification criteria discussed in Section 3.2.4.1, the CoC, SER, Technical Specifications were reviewed and the following TLAA's were identified for further evaluation and disposition:

1. Neutron Absorber Boron Depletion
2. HI-TRAC Trunnions
3. MPC Fatigue
4. Fuel Cladding Integrity

3.5 Aging Management Programs (AMP)

Based on the results of the aging management reviews for systems, structures, and components (SSC) previously determined to be within the scope of the license renewal, presented above, the following AMP's are required:

1. MPC AMP
2. Overpack AMP
3. HI-TRAC AMP
4. Fuel Assembly AMP
5. 100U Concrete AMP

The full details of these AMPs are presented in Appendix A.

3.6 References

[3.0.1] NUREG-2214, "Managing Aging Process in Storage (MAPS) Report," July 2019.

[3.1.1] HI-2188453 SMDR Evaluation Report

[3.1.2] HI-2188468, ECO Evaluation Report

[3.3.1] PNNL-14390, "Dry Storage Demonstration for High-Burnup Spent Nuclear Fuel – Feasibility Study, August 2003.

[3.3.2] ISG-11, “Cladding Considerations for the Transportation and Storage of Spent Fuel,” Revision 3, November 2003

[3.3.3] ISG-24, “The Use of a Demonstration Program as a Surveillance Tool for Confirmation of Integrity for Continued Storage of High Burnup Fuel Beyond 20 Years,” Revision 0, July 2014

[3.3.4] Holtec Report HI-2002420, “Holtite-A: Results of Pre- and Post-Irradiation Tests and Measurements,” Revision 1.

Table 3.3-1: Aging Management Review of MPC Enclosure Vessel Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1]**	**Aging Effects Requiring Management**	**Aging Mechanism**	**Aging Management Activity**
Shell	Confinement/ Structural Integrity	Alloy X	Helium	Fatigue	Cracking	MPC Fatigue TLAA
			Sheltered	Loss of Material	Corrosion	MPC AMP
				Cracking	Stress Corrosion Cracking	MPC AMP
				Loss of Fracture Toughness	Radiation	Not needed per [3.0.1]
				Fatigue	Cracking	MPC Fatigue TLAA
Baseplate	Confinement/ Structural Integrity	Alloy X	Helium	Fatigue	Cracking	MPC Fatigue TLAA
			Sheltered	Loss of Material	Corrosion	MPC AMP
				Cracking	Stress Corrosion Cracking	MPC AMP
				Loss of Fracture Toughness	Radiation	Not needed per [3.0.1]
				Fatigue	Cracking	MPC Fatigue TLAA
Lid	Confinement/ Structural Integrity	Alloy X (one-piece design and top portion of optional two piece design)	Helium	Fatigue	Cracking	MPC Fatigue TLAA
			Sheltered	Loss of Material	Corrosion	MPC AMP
				Cracking	Stress Corrosion Cracking	MPC AMP
				Loss of Fracture Toughness	Radiation	Not needed per [3.0.1]
				Fatigue	Cracking	MPC Fatigue TLAA

Table 3.3-1: Aging Management Review of MPC Enclosure Vessel Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1]**	**Aging Effects Requiring Management**	**Aging Mechanism**	**Aging Management Activity**
Lid (bottom piece)	Structural Integrity	Alloy X or Carbon Steel (bottom piece of optional two piece design)	Helium	None identified per [3.0.1]	None identified per [3.0.1]	N/A
			Embedded	None identified per [3.0.1]	None identified per [3.0.1]	N/A
Closure Ring	Confinement	Alloy X	Sheltered	Loss of Material	Microbiologically influenced corrosion	Not needed per [3.0.1]
				Cracking	Stress Corrosion Cracking	MPC AMP
				Loss of Fracture Toughness	Radiation	Not needed per [3.0.1]
Port Cover Plates	Confinement	Alloy X	Helium	None Identified per [3.0.1]	None Identified per [3.0.1]	None Required
			Embedded	Loss of Fracture Toughness	Radiation	Not needed per [3.0.1]
Basket Cell Spacer Block	Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Basket Center Column	Criticality Control	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Basket Cell Plates	Criticality Control, Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required

Table 3.3-1: Aging Management Review of MPC Enclosure Vessel Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1]**	**Aging Effects Requiring Management**	**Aging Mechanism**	**Aging Management Activity**
Flux Gap Cover	Criticality Control	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Flux Gap Plate	Criticality Control	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Basket Cover Angle	Criticality Control	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Basket Cell Angle	Criticality Control, Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Basket Cell Channel	Criticality Control, Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Neutron Absorber	Criticality Control	Boral or Metamic	Helium	Loss of material properties	Radiation	TLAA- Neutron Absorber Depletion Evaluation
Drain and Vent Shield Block	Shielding	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Plugs for Drilled Holes	Shielding	SA 193B8 (or equivalent)	Embedded	None identified per [3.0.1]	None identified per [3.0.1]	None Required
			Sheltered	Loss of Material	Microbiologically influenced corrosion / pitting and crevice corrosion	None

Table 3.3-1: Aging Management Review of MPC Enclosure Vessel Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1]**	**Aging Effects Requiring Management**	**Aging Mechanism**	**Aging Management Activity**
				Cracking	Stress Corrosion Cracking	MPC AMP
				Loss of Fracture Toughness	Radiation	Not needed per [3.0.1]
Heat Conduction Elements (Optional)	Heat Transfer	Aluminum	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Upper Fuel Spacer Column	Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Upper Fuel Spacer Pipe	Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Sheathing	Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Shims	Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Basket Supports (Angled Plates and Parallel Plates with connecting end shims)	Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Basket Supports (Angled Plates and Parallel Plates, if Basket Shims are not used)	Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Basket Supports (Flat Plates)	Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Basket Supports (if Basket Shims are used)	Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Basket Shims	Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required

Table 3.3-1: Aging Management Review of MPC Enclosure Vessel Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1]**	**Aging Effects Requiring Management**	**Aging Mechanism**	**Aging Management Activity**
Upper Fuel Spacer Bolt	Structural Integrity	A192-B8 or equivalent	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Upper Fuel Spacer End Plate	Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Lower Fuel Spacer Column	Structural Integrity	Stainless Steel [2]	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Lower Fuel Spacer End Plate	Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Vent Shield Block Spacer	Structural Integrity	Alloy X	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Damaged Fuel Container	Criticality Control	Alloy X/ Aluminum	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Basket Sub-Panel (MPC-68M/32M)	Criticality Control	Metamic-HT	Helium	Loss of material properties	Boron Depletion	TLAA- Neutron Absorber Depletion Evaluation
Basket Shims (MPC-68M/32M)	Heat Transfer	Aluminum	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Solid Shims (MPC-68M/32M)	Heat Transfer	Aluminum	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Damaged Fuel Isolator	Criticality Control	Aluminum	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required

Notes:

1) Where more than one environment is listed the subcomponent is exposed to one environment on the inside and a second environment on the outside.

2) See FSAR [2.1.10] Table 2.2.6

Table 3.3-2: Aging Management Review of HI-STORM 100 Overpack Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1,2]**	**Aging Effects Requiring Management**	**Aging Mechanism[3]**	**Aging Management Activity**
Radial Shield	Shielding	Concrete	Embedded (steel)	Loss of Material Properties	Radiation	Not needed per [3.0.1]
Shield Block Ring & Shell	Shielding	SA-516-70 or SA-515-70	Sheltered	Loss of Material	General Corrosion / Pitting and Crevice Corrosion	Overpack AMP
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Pedestal Shield	Shielding	Concrete	Sheltered	Loss of Material Properties	Radiation	Not needed per [3.0.1]
Lid Shield	Shielding	Concrete	Embedded	Loss of Material Properties	Radiation	N/A, see Section 3.4
Shield Shell (for early versions only)	Shielding	SA-516-70	Sheltered	Loss of Material Properties	Radiation	Not needed per [3.0.1]
Shield Block	Shielding	Concrete	Embedded	Loss of Material Properties	Radiation	Not needed per [3.0.1]
Gamma Shield Cross Plates & Tabs	Shielding	SA240-304	Sheltered	Loss of Material	Pitting and Crevice Corrosion	Overpack AMP
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Baseplate	Structural Integrity	SA-516-70	Sheltered	Loss of Material	General Corrosion / Pitting and	Overpack AMP

Table 3.3-2: Aging Management Review of HI-STORM 100 Overpack Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1,2]**	**Aging Effects Requiring Management**	**Aging Mechanism[3]**	**Aging Management Activity**
					Crevice Corrosion	
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Outer Shell	Structural Integrity	SA 516-70	Air-Outdoor	Loss of Material	General Corrosion / Pitting and Crevice Corrosion	Overpack AMP
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Inner Shell	Structural Integrity	SA-516 Gr. 70	Sheltered	Loss of Material	General Corrosion / Pitting and Crevice Corrosion	Overpack AMP
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Pedestal Shell	Structural Integrity	SA516-70	Sheltered	Loss of Material	General Corrosion / Pitting and Crevice Corrosion	Overpack AMP
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Pedestal Baseplate	Structural Integrity	SA-516-70 or SA-515-70	Air-Outdoor	Loss of Material	General Corrosion / Pitting and	Overpack AMP

Table 3.3-2: Aging Management Review of HI-STORM 100 Overpack Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1,2]**	**Aging Effects Requiring Management**	**Aging Mechanism[3]**	**Aging Management Activity**
					Crevice Corrosion	
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Lid Bottom Plate	Structural Integrity	SA516-70	Sheltered	Loss of Material	General Corrosion / Pitting and Crevice Corrosion	Overpack AMP
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Lid Shell	Structural Integrity	SA-516-70	Air-Outdoor	Loss of Material	General Corrosion / Pitting and Crevice Corrosion	Overpack AMP
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Inlet Vent Vertical & Horizontal Plates	Structural Integrity	SA-516-70	Air-Outdoor	Loss of Material	General Corrosion / Pitting and Crevice Corrosion	Overpack AMP
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Exit Vent Vertical & Horizontal Plates	Structural Integrity	SA-516-70	Air-Outdoor	Loss of Material	General Corrosion / Pitting and	Overpack AMP

Table 3.3-2: Aging Management Review of HI-STORM 100 Overpack Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1,2]**	**Aging Effects Requiring Management**	**Aging Mechanism[3]**	**Aging Management Activity**
					Crevice Corrosion	
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Top Plate	Structural Integrity	SA516-70	Sheltered	Loss of Material	General Corrosion / Pitting and Crevice Corrosion	Overpack AMP
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Lid Top Plate	Structural Integrity	SA516-70	Sheltered	Loss of Material	General Corrosion / Pitting and Crevice Corrosion	Overpack AMP
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Lid Shield Ring	Structural Integrity	SA516-70	Sheltered	Loss of Material	General Corrosion / Pitting and Crevice Corrosion	Overpack AMP
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Lid Vent Side Plate	Structural Integrity	SA516-70	Sheltered	Loss of Material	General Corrosion / Pitting and	Overpack AMP

Table 3.3-2: Aging Management Review of HI-STORM 100 Overpack Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1,2]**	**Aging Effects Requiring Management**	**Aging Mechanism[3]**	**Aging Management Activity**
					Crevice Corrosion	
				Loss of Material Properties	Radiation	Not needed per [3.0.1]
Lid Shield Block	Shielding	Concrete	Embedded	Loss of Material Properties	Radiation	Not needed per [3.0.1]
Radial Plate	Structural Integrity	SA516-70	Embedded	None Identified	None Identified	N/A
Lid Stud, Tee Handle Bolt & Nut	Structural Integrity	SA-194 SA-564-640 SA193-B7	Sheltered	Loss of Material	General Corrosion / Pitting and Crevice Corrosion	Overpack AMP
Bolt Anchor Block	Structural Integrity	SA 350 / SA 203	Embedded	None Identified	None Identified	N/A
Channel	Structural Integrity	SA 516-70 / SA 240	Sheltered	Loss of Material	General Corrosion / Pitting and Crevice Corrosion	Overpack AMP
Pedestal Platform	Structural Integrity	A36	Sheltered	Loss of Material	General Corrosion / Pitting and Crevice Corrosion	Overpack AMP

Table 3.3-2: Aging Management Review of HI-STORM 100 Overpack Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1,2]**	**Aging Effects Requiring Management**	**Aging Mechanism[3]**	**Aging Management Activity**
Shear Ring	Structural Integrity	SA 516-70	Sheltered	Loss of Material	General Corrosion / Pitting and Crevice Corrosion	Overpack AMP
Channel Mounts	Structural Integrity	A36	Sheltered	Loss of Material	Corrosion	Overpack AMP
Radial Weld Plate	Structural Integrity	SA 516-70	Sheltered	Loss of Material	Corrosion	Overpack AMP
Heat Shield	Heat Transfer	Carbon Steel	Sheltered	Loss of Material	Corrosion	Overpack AMP
Heat Shield Ring	Heat Transfer	Carbon Steel	Sheltered	Loss of Material	Corrosion	Overpack AMP
Lug Support Ring	Structural Integrity	Steel	Air-Outdoor	Loss of Material	Corrosion	Overpack AMP
Gusset	Structural Integrity	Steel	Air-Outdoor	Loss of Material	Corrosion	Overpack AMP
Stud with Nut	Structural Integrity	Steel	Air-Outdoor	Loss of Material	Corrosion	Overpack AMP
Bottom Plate	Structural Integrity	Steel	Sheltered	Loss of Material	Corrosion	Overpack AMP
Spacer Block	Structural Integrity	Steel	Sheltered	Loss of Material	Corrosion	Overpack AMP
Top Plate	Structural Integrity	Steel	Sheltered	Loss of Material	Corrosion	Overpack AMP
MPC Support	Structural Integrity	Steel	Sheltered	Loss of Material	Corrosion	Overpack AMP

Table 3.3-2: Aging Management Review of HI-STORM 100 Overpack Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1,2]**	**Aging Effects Requiring Management**	**Aging Mechanism[3]**	**Aging Management Activity**
Shield Concrete	Shielding	Concrete	Embedded	Loss of Material Properties	Radiation	Not needed per [3.0.1]
Lid Outer Ring	Structural Integrity	Steel	Air-Outdoor	Loss of Material	Corrosion	Overpack AMP
Lid Inner Ring	Structural Integrity	Steel	Embedded	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
Lid Lift Block	Structural Integrity	Steel	Air-Outdoor	Loss of Material	Corrosion	Overpack AMP
Lid Shield Concrete	Shielding	Concrete	Embedded	Loss of Material Properties	Radiation	Not needed per [3.0.1]
Lid Stud	Structural Integrity	Steel	Air-Outdoor	Loss of Material	Corrosion	Overpack AMP
Lid Closure Bolt	Structural Integrity	Steel	Air-Outdoor	Loss of Material	Corrosion	Overpack AMP
Lid Hex Nut	Structural Integrity	Steel	Air-Outdoor	Loss of Material	Corrosion	Overpack AMP
Cask Radial Gusset	Structural Integrity	Steel	Embedded	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
Radial Rib	Structural Integrity	Steel	Embedded	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
Closure Lid Concrete	Shielding	Concrete	Embedded	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
Closure Lid Steel	Structural Integrity, Shielding	Steel	Sheltered	Loss of material	General Corrosion / Pitting and Crevice corrosion	Overpack AMP

Table 3.3-2: Aging Management Review of HI-STORM 100 Overpack Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1,2]**	**Aging Effects Requiring Management**	**Aging Mechanism[3]**	**Aging Management Activity**
			Air – Outdoor	Loss of material	General Corrosion / Pitting and Crevice corrosion	Overpack AMP
Container Shell Bottom Plate	Structural Integrity	Steel	Embedded (Concrete)	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
Container Flange	Structural Integrity	Steel	Air – Outdoor	Loss of material	General Corrosion / Pitting and Crevice corrosion	Overpack AMP
Divider Shell and Divider Shell Restraints	Heat Transfer	Steel	Sheltered	Loss of material	General Corrosion / Pitting and Crevice corrosion	Overpack AMP
Upper and Lower MPC Guides	Structural Integrity	Steel	Sheltered	Loss of material	General Corrosion / Pitting and Crevice corrosion	Overpack AMP
MPC Bearing Pads	Structural Integrity	Steel	Sheltered	Loss of material	General Corrosion / Pitting and Crevice corrosion	Overpack AMP

Table 3.3-2: Aging Management Review of HI-STORM 100 Overpack Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1,2]**	**Aging Effects Requiring Management**	**Aging Mechanism[3]**	**Aging Management Activity**
Insulation	Heat Transfer	Insulator material	Embedded (Steel)	None identified per [3.0.1]	None identified per [3.0.1]	N/A
Reinforced Concrete; VVM Interface Pad, Top Surface Pad	Structural Integrity	Concrete	Air - Outdoor	Cracking / Loss of strength / loss of material / reduction of concrete pH	Aggressive chemical attack	100U Concrete AMP
				Cracking / Loss of Material (spalling, scaling)	Freeze and thaw	100U Concrete AMP
				Cracking / Loss of Strength	Reaction with aggregates	100U Concrete AMP
				Loss of Material	Salt scaling	100U Concrete AMP
				Loss of strength / Increase in porosity and permeability / Reduction of concrete pH	Leaching of calcium hydroxide	100U Concrete AMP
			Embedded (soil)	Cracking / Loss of strength / loss of material / Reduction of concrete pH	Aggressive Chemical Attack	100U Concrete AMP
				Cracking	Differential Settlement	100U Concrete AMP
				Cracking / Loss of Material	Freeze and thaw	100U Concrete AMP

Table 3.3-2: Aging Management Review of HI-STORM 100 Overpack Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1,2]**	**Aging Effects Requiring Management**	**Aging Mechanism[3]**	**Aging Management Activity**
				Loss of strength / Loss of material / Increase in porosity and permeability / Reduction of concrete pH	Microbiological degradation	100U Concrete AMP
				Cracking / Loss of strength	Reaction with aggregates	100U Concrete AMP
				Loss of material	Salt Scaling	100U Concrete AMP
				Loss of strength / Increase in porosity and permeability / Reduction of concrete pH	Leaching of calcium hydroxide	100U Concrete AMP
Retaining Wall, Support Foundation Pad	Structural Integrity, Shielding	Concrete	Embedded (Soil)	Cracking / Loss of strength / loss of material / reduction of concrete pH	Aggressive Chemical Attack	100U Concrete AMP
				Cracking	Differential Settlement	100U Concrete AMP
				Loss of Strength / Loss of Material / Increase in porosity and permeability / reduction of concrete pH	Microbiological degradation	100U Concrete AMP

Table 3.3-2: Aging Management Review of HI-STORM 100 Overpack Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment[1,2]**	**Aging Effects Requiring Management**	**Aging Mechanism[3]**	**Aging Management Activity**
				Cracking / Loss of strength	Reaction with aggregates	100U Concrete AMP
				Loss of strength / Increase in porosity and permeability / reduction of concrete pH	Leaching of calcium hydroxide	100U Concrete AMP
Lid Rib	Structural Integrity	Steel	Embedded (Concrete)	None identified per [3.0.1]	None identified per [3.0.1]	N/A
MPC Bottom Support Guides	Structural Integrity	Steel	Sheltered	Loss of material	General Corrosion / Pitting and Crevice corrosion	Overpack AMP

Table 3.3-3: Aging Management Review of Fuel Assembly Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment**	**Aging Effects Requiring Management**	**Aging Mechanism**	**Aging Management Activity**
Fuel Cladding	Criticality Control, Radiation Shielding, Confinement Structural Integrity	Zircaloy	Helium	Embrittlement (High Burnup Fuel only)	Hydride Re-orientation (High Burnup Fuel only)	High Burnup Fuel AMP
Spacer Grid Assemblies	Criticality Control, Structural Integrity	Zircaloy	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Upper End Fitting	Structural Integrity	Stainless Steel Inconel	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Lower End Fitting	Structural Integrity	Stainless Steel Inconel	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required
Guide Tubes	Structural Integrity	Zircaloy / Stainless Steel	Helium	None identified per [3.0.1]	None identified per [3.0.1]	None Required

Table 3.3-4: Aging Management Review of HI-TRAC Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment**	**Aging Effects Requiring Management**	**Aging Mechanism**	**Aging Management Activity**
Radial Lead Shield	Shielding	ASTM B29 Lead	Embedded	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
Pool Lid Lead Shielding	Shielding	ASTM B29 Lead	Embedded	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
Top Lid Shielding	Shielding	Holtite A	Embedded	Radiation Embrittlement	Cracking	See Paragraph 3.3.4.5
				Thermal Aging	Loss of ductility and fracture toughness	See Paragraph 3.3.4.5
				Boron Depletion	Loss of Shielding	See Paragraph 3.3.4.5
Outer Shell	Structural Integrity	Steel	Embedded (Lead / Water, when water jacket filled)	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
Inner Shell	Structural Integrity	Steel	Embedded	Loss of Material Properties	Radiation	Not needed per [3.0.1]
			Air	Loss of Material	Corrosion	HI-TRAC AMP
Radial Ribs	Structural Integrity	Steel	Water (when water jacket filled)	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
Enclosure Shell Panels	Structural Integrity	Steel	Water (when water jacket filled)	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
			Air	Loss of Material	Corrosion	HI-TRAC AMP

Table 3.3-4: Aging Management Review of HI-TRAC Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment**	**Aging Effects Requiring Management**	**Aging Mechanism**	**Aging Management Activity**
Water Jacket End Plate	Structural Integrity	Steel	Water (when water jacket filled, may have contained glycol)	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
			Air	Loss of Material	Corrosion	HI-TRAC AMP
Top Flange	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Lower Water Jacket Shell	Structural Integrity	Steel	Water (when water jacket filled)	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
			Air	Loss of Material	Corrosion	HI-TRAC AMP
Water Jacket Bottom Ring	Structural Integrity	Steel	Water (when water jacket filled)	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
			Air	Loss of Material	Corrosion	HI-TRAC AMP
Water Jacket Top Plates	Structural Integrity	Steel	Water (when water jacket filled)	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
			Air	Loss of Material	Corrosion	HI-TRAC AMP
Bottom Flange	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Pool Lid Outer Ring	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Pool Lid Top Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Top Lid Outer Ring	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP

Table 3.3-4: Aging Management Review of HI-TRAC Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment**	**Aging Effects Requiring Management**	**Aging Mechanism**	**Aging Management Activity**
Top Lid Inner Ring	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Top Lid Top Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Top Lid Bottom Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Pool Lid Bolt	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Lifting Trunnion Block	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Lifting Trunnion	Structural Integrity	Nickel Alloy / Stainless Steel	Air	Loss of Material	Wear	HI-TRAC AMP
Pocket Trunnion	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Dowel Pins	Structural Integrity	Stainless Steel	Air	None Identified per [3.0.1]	None Identified per [3.0.1]	None Required
Water Jacket Bottom Plate	Structural Integrity	Steel	Water (when water jacket filled)	None Identified per [3.0.1]	None Identified per [3.0.1]	N/A
			Air	Loss of Material	Corrosion	HI-TRAC AMP
Pool Lid Bottom Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Top Lid Lifting Block	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Top Lid Stud/Bolt	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP

Table 3.3-4: Aging Management Review of HI-TRAC Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment**	**Aging Effects Requiring Management**	**Aging Mechanism**	**Aging Management Activity**
Top Lid Nut/Washer	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Side Lead Shield	Shielding	Lead	Embedded	None Identified per [3.0.1]	None Identified per [3.0.1]	None Required
Transfer Lid Door Lead Shield	Shielding	Lead	Embedded	None Identified per [3.0.1]	None Identified per [3.0.1]	None Required
Transfer Lid Door Shielding	Shielding	Holtite A	Embedded	Radiation Embrittlement	Cracking	HI-TRAC Holtite Material TLAA
				Thermal Aging	Loss of ductility and fracture toughness	HI-TRAC Holtite Material TLAA
				Boron Depletion	Loss of Shielding	HI-TRAC Holtite Material TLAA
Transfer Lid Top Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Bottom Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Intermediate Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Lead Cover Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Lead Cover Side Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Door Top Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Door Middle Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP

Table 3.3-4: Aging Management Review of HI-TRAC Subcomponents						
Subcomponent	**Intended Function**	**Material**	**Environment**	**Aging Effects Requiring Management**	**Aging Mechanism**	**Aging Management Activity**
Transfer Lid Door Bottom Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Door Wheel Housing	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Door Interface Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Door Side Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Wheel Shaft	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Shaft Cover Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Housing Stiffener	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Door Lock Bolt	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Door End Plate	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Transfer Lid Lifting Lug and Pad	Structural Integrity	Steel	Air	Loss of Material	Corrosion	HI-TRAC AMP
Short Rib	Structural Integrity, Heat Transfer	Steel	Embedded	None identified per [3.0.1]	None identified per [3.0.1]	N/A
Extended Rib	Structural Integrity, Heat Transfer	Steel	Embedded	None identified per [3.0.1]	None identified per [3.0.1]	N/A

CHAPTER 4: AGING MANAGEMENT TOLLGATES

4.0 Introduction

NEI 14-03 [1.1.3] introduced the concept of tollgates to be included as part of an operations-based aging management program. The tollgate concept provides a structured way for licensees to pause and formally assess aggregated feedback at specific points in time during the period of extended storage.

Tollgates are established as requirements in the generic CoC renewed application, and implemented by ISFSI general licensees to evaluate aging management feedback and perform a safety assessment that confirms the safe storage of spent nuclear fuel. The impact of the aggregate feedback will be assessed by the site as it pertains to components at the site's ISFSI and actions taken as necessary, such as:

- Adjustment of aging-related degradation monitoring and inspection programs in AMPs described in Appendix A (e.g. scope, frequency)
- Modification of TLAAs described in Appendix B
- Performance of mitigation activities

Each tollgate assessment will address the following elements as applicable:

- Summary of research findings, operating experience, monitoring data, and inspection results made available since last assessment
- Aggregate impact of findings, including any trends
- Consistency of data with the assumptions and inputs in the TLAAs
- Effectiveness of AMPs
- Corrective actions, including any changes to AMPs
- Summary and conclusions

Sites will have access to the ISFSI Aging Management INPO Database to facilitate the aggregation and dissemination of aging-related information for the completion of these tollgate assessments. Generic tollgates are shown in Table 4-1. Note that the implementation of these tollgates does not infer that general licensees will wait until one of these designated times to evaluate information. Sites will continue to follow existing processes for addressing emergent issues, including the use of the corrective action program on site. These tollgates are specific times where an aggregate of information will be evaluated as a whole.

Table 4-1: Tollgate Assessments for General Licensees

Tollgate	Year	Assessment
1	Year of first canister loading + 25 years	Evaluate information from the following sources (as available) and perform a written assessment of the aggregate impact of the information, including but not limited to trends, corrective actions required, and the effectiveness of the AMPs with which they are associated: • Results, if any, of research and development programs focused specifically on aging-related degradation mechanisms identified as potentially affecting the storage system and ISFSI site. One example of such research and development would be EPRI Chloride-Induced Stress Corrosion Cracking (CISCC) research. • Relevant results of other domestic and international research, which may include non-nuclear research • Relevant domestic and international operating experience, which may include non-nuclear operating experience • Relevant results of domestic and international ISFSI and dry storage system performance monitoring Much of this information can be gathered from the Aging Management INPO Database (AMID).
2	Year of first canister loading + 30 years	Evaluate additional information gained from the sources listed in Tollgate 1 along with any new relevant sources and perform a written assessment of the aggregate impact of the information. This evaluation should be informed by the results of Tollgate 1. The aging effects and mechanisms evaluated at this tollgate and the time at which it is conducted may be adjusted based on the results of the Tollgate 1 assessment.
3	Year of first canister loading + 35 years	Same as Tollgate 2 as informed by the results of Tollgates 1 and 2
4	Year of first canister loading + 40 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, and 3
5	Year of first canister loading + 45 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, and 4
6	Year of first canister loading + 50 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, 4, and 5
7	Year of first canister loading + 55 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, 4, 5, and 6
8	Year of first canister loading + 60 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, 4, 5, 6, and 7

APPENDIX A: HI-STORM 100 AGING MANAGEMENT PROGRAMS

A.0 Introduction

Section 3.5 identifies the following needed AMPs:

1. MPC AMP
2. Overpack AMP
3. HI-TRAC AMP
4. Fuel Assembly AMP
5. 100U Concrete AMP

This appendix contains the 10 elements of the AMPs, following the guidance of NUREG-1927 Revision 1.

MPC AMP

Element	Description
1. Scope of Program	This program covers MPCs stored under the HI-STORM 100 CoC, and the subcomponents identified in Table 3.3-1.
2. Preventative Actions	This AMP uses condition monitoring to manage aging effects. Preventative actions to minimize corrosion and stress corrosion cracking were taken during fabrication. Namely, stainless steel material was used to provide corrosion resistance, and fabrication controls were in place at the time of manufacture. These preventative actions minimize the likelihood of aging effects, but do not replace the need for condition monitoring during the extended storage period. No new preventative actions are included in this AMP.
3. Parameters Monitored / Inspected	The MPC AMP uses inspections as described below to look for visual evidence of discontinuities and imperfections, such as localized corrosion, including pitting corrosion and stress corrosion cracking of the accessible canister welds and weld heat affected zones. The inspections also look for the appearance and location of deposits on the canister surfaces.
4. Detection of Aging Effects	A visual inspection of the MPC surface shall be performed using a boroscope (or equivalent). The boroscope (or equivalent) inspection shall look at the accessible areas of the MPC surface, while the MPC remains in the overpack with the overpack lid installed. This visual inspection shall meet the requirements of a VT-3 Examination, as given in the ASME Boiler & Pressure Vessel Code (B&PVC) Section XI, Article IWA-2200, to the extent practical. The inspection shall be performed on one canister at each site that uses the HI-STORM 100 System. Note that if a site has more than one type of canister (for example, MPC-68 and MPC-68Ms), only one canister needs to be inspected. The selection criteria for choosing the canister to inspect should consider the following: • EPRI Susceptibility Criteria (Technical Report 3002005371) • Canister Age • Canister with Lowest Heat Load • Canister with specific previously identified manufacturing deviation Alternatively, a site may choose to take credit for an inspection done at a different site, as long as the inspection can be shown to have been performed on a reasonably comparable or bounding canister based on the same criteria listed above.

	The inspection shall be performed by a qualified individual on one canister at a site at a frequency of 5 years (+/- 1.25 years). The first inspection should occur within 365 days of the 20^{th} anniversary of initial overpack loading at the site or within 365 days of the issuance of the renewed license, whichever is later. It is recommended that the same canister be used for each inspection to allow for the best continued monitoring and trending. It is recommended that sites schedule the MPC inspection concurrently with the Overpack Interior Inspection for ALARA purposes. At the discretion of the inspector, the inspection of selected areas on the MPC may be upgraded to the VT-1 standard, as described in ASME Section XI, Article IWA-2200, to the extent practical.
5. Monitoring and Trending	The documented inspection results should provide the ability to monitor and trend the appearance of the canister, it is recommended that the inspection video / photos be retained for comparison in subsequent examinations. Changes to the size and location of any areas of discoloration, localized corrosion, and/or stress corrosion cracking should be identified and documented for subsequent inspections.
6. Acceptance Criteria	<u>Inspection Results Requiring No Further Evaluation</u> No indication of localized corrosion pits, etching, stress corrosion cracking, red-orange colored corrosion products in the vicinity of canister welds. Minor surface corrosion (not pitting) is acceptable. <u>Inspection Results Requiring Additional Evaluation</u> Indications of interest that are subject to additional examination and disposition through the corrective action program include: • Localized corrosion pits, stress corrosion cracking, and etching; deposits or corrosion products • Discrete red-orange colored corrosion products especially those adjacent to fabrication welds, closure welds, locations where temporary attachments may have been welded to and subsequently removed from the MPC and the weld heat affected zones of these areas • Linear appearance of any color of corrosion products of any size parallel to or traversing fabrication welds, closure welds, and the weld heat affected zones of these areas.

	• Red-orange colored corrosion products greater than 1 mm in diameter combined with deposit accumulations in any location of the stainless steel canister • Red-orange colored corrosion tubercles of any size Alternatively, a general licensee may use acceptance criteria in an ASME Code for canister inspections that has been endorsed by the NRC. If indications requiring additional evaluation are found, issue would be entered into the site's corrective action program and an engineering evaluation would be performed to determine the extent and impact of the corrosion on the component's ability to perform its intended function.
7. Corrective Actions	The corrective actions performed based on any detected aging effects are in accordance with the site's Quality Assurance (QA) program. The QA Program ensures that corrective actions are completed. The QA program and corrective action program will determine any necessary actions, identify any changes to the existing AMP, and determine if the condition is reportable, as applicable. The corrective actions will also identify any actions needed to be taken for increased sample size, scope, or frequency of inspections as necessary, based on any detected aging effects. The corrective action program will also identify any dispositions needed from Holtec.
8. Confirmation Process	The confirmation process will be commensurate with the site QA program. The QA program ensures that inspections, evaluations, and corrective actions are completed and extent of condition is considered.
9. Administrative Controls	The site QA program and implementing procedures for this AMP will address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. This AMP will be updated, as necessary, based on the toll gate assessments described in Section 4 of this application. Inspection results will be documented and made available for NRC inspection as necessary.
10. Operating Experience	<u>Previous Operating Experience</u> No cases of chloride induced stress corrosion cracking for stainless steel dry storage canisters have been reported. Inspections of dry storage canisters after 20 years in service have been conducted at a few ISFSI sites [C.1.1 and C.1.2]. No evidence of localized corrosion

	was identified but some amount of chloride-containing salts were determined to be present and corrosion products believed to be related to iron contamination were identified. Section 3.1.2 of this application summarizes HI-STORM 100 MPC operating experience, which indicates very minimal corrosion detected to date. <u>Future Operating Experience</u> As the MPC inspections are performed, sites will upload information into the INPO AMID database to be shared with other users.

Overpack AMP

Element	Description
1. Scope of Program	This program covers the subcomponents of the HI-STORM 100 and HI-STORM 100U Overpacks identified in Table 3.3-2, which require the Overpack AMP to ensure their continued operation into the extended storage period. The AMP has two main parts: one for the internal areas and one for the external areas of the cask.
2. Preventative Actions	This AMP uses condition monitoring to manage aging effects. The design of the system is intended to minimize aging effects, but this AMP focuses on condition monitoring. No new preventative actions are included in this AMP.
3. Parameters Monitored / Inspected	<u>Overpack External</u> The overpack exposed surfaces are visually examined for indication of surface deterioration. Degradation could affect the ability of the overpack to provide support to the MPCs, to provide radiation shielding, to provide missile shielding, or to provide a path for heat transfer. The items inspected should cover (but are not limited to) those listed below: • Lid studs and nuts or lid closure bolts, as accessible • The accessible overpack body and lid painted surfaces • Vents • Anchor hardware, if used <u>Overpack Internal</u> The internal surfaces of the overpack are inspected for indications of corrosion and coating degradation. These indications may impact the long term ability of the cask to meet its intended function.
4. Detection of Aging Effects	<u>Overpack External</u> The overpack external AMP is a visual inspection in order to detect any aging effects. The visual survey performed on all overpacks annually will identify the source of any staining or corrosion-related activity and the degree of damage. The visual survey is performed in accordance with site implementing procedures, and may be satisfied by continuing the overpack external surface (accessible) visual examination in the HI-STORM FSAR Table 9.2.1. <u>Overpack Internal</u> A visual inspection of the overpack annular space and the interior areas of the vents shall be performed using a boroscope (or equivalent). This visual inspection shall meet the requirements of a

	VT-3 Examination, as given in the ASME Boiler & Pressure Vessel Code (B&PVC) Section XI, Article IWA-2200, to the extent practical. The internal inspection shall be performed on one overpack at each site at a frequency of 5 years (+/- 1.25 years). The first inspection should occur within 365 days of the 20th anniversary of initial overpack loading at the site or within 365 days of the issuance of the renewed license, whichever is later. For ALARA reasons, it is recommended that the site use the overpack that contains the MPC used for the MPC AMP. Alternatively, a site may choose to take credit for an internal inspection done at a different site, as long as the inspection can be shown to have been performed on a reasonably comparable or bounding canister based on the same criteria listed above. The inspection shall be documented, including a detailed description of the surface condition and location of areas showing surface degradation.
5. Monitoring and Trending	The inspections and surveillances described for both the internal and external subcomponents of the overpack are performed periodically in order to identify areas of degradation. The results will be evaluated by a qualified individual, and areas of degradation not meeting established criteria will be entered into the corrective action program for resolution or more detailed evaluation. The results will be compared against previous inspections in order to monitor and trend the progression of the aging effects over time.
6. Acceptance Criteria	<u>Overpack External</u> The external metallic surfaces of the overpack are coated, and significant corrosion is not anticipated. Minor surface corrosion of the carbon steel surface is possible and does not require further evaluation. Corrosion such as pitting requires additional evaluation. Minor rust spots or indications of degraded coatings do not require further evaluation since they do not compromise the ability of the overpack to maintain its function, but should be identified for trending purposes. Vents shall be free from obstructions. Overpack lid shall be relatively free of dents, scratches, gouges or other damage. <u>Overpack Internal</u> The internal metallic surfaces of the overpack are coated, and significant corrosion is not anticipated. Minor surface corrosion of the carbon steel surface is possible and does not require further

	evaluation. Corrosion such as pitting requires additional evaluation. Minor rust spots or indications of degraded coatings do not require further evaluation since they do not compromise the ability of the overpack to maintain its function, but should be identified for trending purposes. If indications requiring additional evaluation are found, issue would be entered into the site's corrective action program and an engineering evaluation would be performed to determine the extent and impact of the corrosion on the component's ability to perform its intended function.
7. Corrective Actions	The corrective actions performed based on any detected aging effects are in accordance with the site's Quality Assurance (QA) program. The QA Program ensures that corrective actions are completed. The QA program and corrective action program will determine any necessary actions, identify any changes to the existing AMP, and determine if the condition is reportable, as applicable. The corrective actions will also identify any actions needed to be taken for increased scope or frequency of inspections as necessary, based on any detected aging effects. The corrective action program will also identify any dispositions needed from Holtec.
8. Confirmation Process	The confirmation process will be commensurate with the site QA program. The QA program ensures that inspections, evaluations, and corrective actions are completed.
9. Administrative Controls	The site QA program and implementing procedures for this AMP will address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. This AMP will be updated, as necessary, based on the toll gate assessments described in Section 4 of this application. Inspection results will be documented and made available for NRC inspection as necessary.
10. Operating Experience	<u>Previous Operating Experience</u> Section 3.1.2 of this application summarizes HI-STORM 100 operating experience, which indicates very minimal corrosion detected to date, mostly limited to small rust spots and coating degradation. That operating experience has been incorporated into the guidance on inspections and acceptance criteria contained in this AMP.

	Future Operating Experience As the overpack inspections are performed, sites will upload information into the INPO AMID database to be shared with other users.

Transfer Cask AMP

Element	Description
1. Scope of Program	The program covers the subcomponents of the Transfer Cask identified in Table 3.3-5 which require the Transfer Casks AMP, to operate into the extended storage period.
2. Preventative Actions	The Transfer Cask AMP utilizes inspections to ensure that the equipment maintains its intended function through the extended storage period. The design and materials of construction of the Transfer Cask were implemented to minimize aging effects, but no new preventative actions are included as part of this AMP.
3. Parameters Monitored / Inspected	The parameter inspected by the Transfer Cask AMP is visual evidence of degradation of external surfaces of the Transfer Cask and trunnions.
4. Detection of Aging Effects	The Transfer Cask AMP manages loss of material due to corrosion, predominately for coated steel components. The below lists provides the areas to be covered by the visual inspection, which will be implemented via detailed inspection procedures. • Painted surfaces • Lid surfaces • Lifting trunnions • Water jacket • Other accessible surfaces The inspection shall be performed prior to use of any Transfer Cask that has been in service longer than 20 years and at a minimum once a year while in use. Because the Transfer Cask is not used while loadings and unloadings are not occurring, pre-use inspections are most appropriate for the Transfer Cask. Periodic inspections when the Transfer Cask is not in use are not needed.
5. Monitoring and Trending	Visual inspections will determine the existence of loss of material on the external surfaces of the Transfer Cask, and observations regarding the material condition are recorded in accordance with inspection procedures and are corrected or evaluated as satisfactory before use of the Transfer Cask. Evaluation of this information during the preparations for MPC transfers provides adequate predictability and allows for corrective

	actions if necessary, prior to the need for the intended function of the component to be performed.
6. Acceptance Criteria	The Transfer Cask AMP consists of visual inspections as described above. The following results do not require further evaluation • All painted surfaces shall be free of degradation and chipped, cracked, or blistered paint • All lid surfaces shall be relatively free of dents, scratches, gouges, or other damage • Lifting trunnions shall be free of deformation, cracks, damage, corrosion, and excessive galling • The water jacket shall be free of leaks • All other accessible surfaces shall be free of dents, scratches, gouges, or other damage If degradation of material beyond the above is detected on any of the identified subcomponents within the Transfer Cask, the issue would be entered into the site's corrective action program and an engineering evaluation would be performed to determine the extent and impact of the corrosion on the Transfer Cask's ability to perform its intended function
7. Corrective Actions	If the engineering evaluation described above shows that the Transfer Cask has indications that exceed acceptable limits for the Transfer Cask to perform its intended function, the issue will be entered into the corrective action process. This process may result in supplemental inspections such as non-destructive examinations (NDE) being performed. The corrective action program will determine any necessary actions, identify any changes to the existing AMP, and determine if the condition is reportable, as applicable. The corrective actions will also identify actions needed for increased scope or frequency of inspections, as necessary, based on any detected aging effects.
8. Confirmation Process	The confirmation process will be commensurate with the site QA program. The QA program ensures that inspections, evaluations, and corrective actions are completed in accordance with the program.
9. Administrative Controls	The QA program and implementing procedures for this AMP will address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control.

	This AMP will be updated, as necessary, based on the toll gate assessments described in Section 4 of this application. Inspection results will be documented and made available for NRC inspection as necessary.
10. Operating Experience	<u>Previous Operating Experience</u> Section 3.1.2 of this application summarizes HI-STORM 100 operating experience, which indicates very minimal corrosion detected to date, mostly limited to coating degradation. That operating experience has been incorporated into the guidance on inspections and acceptance criteria contained in this AMP. <u>Future Operating Experience</u> As the transfer cask inspections are performed, sites will upload information into the INPO AMID database to be shared with other users

High Burnup Fuel Assembly AMP

Element	Description
1. Scope of Program	The scope of the program covers the components identified in Table 3.3-4 which require the High Burnup Fuel Assembly AMP, to operate into the extended storage period. This program is not applicable at sites that do not have high burnup fuel stored. Fuel stored in the HI-STORM 100 MPCs is limited to a burnup of 68,200 MWD/MTU (PWR) and 65,000 MWD/MTU (BWR). The cladding materials for the high burnup fuel are zirconium based and the fuel is stored in a dry helium environment. The program relies on the joint EPRI and DOE High Burnup Dry Storage Cask Research and Development Project (HDRP) conducted in accordance with the guidance in Appendix D of NUREG-1927, Rev 1, as a surrogate demonstration program that monitors the performance of high burnup fuel in dry storage. The HDRP is a program designed to collect data from an SNF storage system containing high burnup fuel in a dry helium environment. The program entails loading and storing a bolted lid cask (the "Research Project Cask"), with intact high burnup fuel of nominal burnups between 53 GWd/MTU and 58 GWD/MTU. The fuel to be used in the program includes four kinds of zirconium based cladding. The Research Project Cask is to be licensed to the temperature limits contained in ISG-11 Rev 3, and is loaded to reach temperatures as close to the limit as practicable. The parameters of the surrogate demonstration program are applicable to the HI-STORM 100 high burnup fuel, since the system burnup limits are approximately those being tested, the cladding is of the same type as those being tested, and the temperature limits of the fuel are the same as those being tested.
2. Preventative Actions	During the initial loading operations of the HI-STORM 100 system, the technical specifications require that the fuel be stored in a dry, inert environment. These requirements ensure that the high burnup fuel is stored in an inert environment, preventing cladding degradation due to oxidation mechanisms. The canisters are also loaded in accordance with the temperature criteria of ISG-11, which minimizes

	the impacts of degradation mechanisms on the fuel. There are no additional specific preventative actions included as part of the AMP.
3. Parameters Monitored / Inspected	The surrogate demonstration program monitors and inspects fuel parameters as described in the HDRP.
4. Detection of Aging Effects	The surrogate demonstration program detects aging effects as described in the HDRP.
5. Monitoring and Trending	As information / data from the HDRP become available, the site will monitor, evaluate, and trend the information via its operating experience program and /or corrective action program to determine what actions should be taken. The site will evaluate the information / data from the HDRP to determine whether the acceptance criteria in Element 6 of this AMP are met. • If all of the acceptance criteria are met, no further assessment is needed. • If any of the acceptance criteria are not met, the licensee must conduct additional assessments and implement appropriate corrective actions (see Element 7 of this AMP). Note that the site may use evaluations/assessments provided by Holtec to determine whether the acceptance criteria are met. Formal evaluations of the aggregate information from the HDRP, available operating experience, NRC-generated communications, and other information will be performed at specific points as described in Chapter 4 of this application.
6. Acceptance Criteria	The HDRP acceptance criteria are: • Hydrogen content – Maximum hydrogen content of the cover gas over the approved storage period should be extrapolated from the gas measurements to be less than the design-bases limit for hydrogen content • Moisture content – the moisture content in the canister (accounting for measurement uncertainty) should be determined to be acceptable • Fuel condition / performance – nondestructive and destructive examinations should confirm the design-bases fuel condition (i.e., no changes to the analyzed fuel configuration considered in the safety analyses of the approved design bases

	Note that because the cask design to be used in the HDRP is different from the HI-STORM 100, the acceptance criteria will be based on the Research Cask design bases. If the fuel in the Research Cask meets the applicable design bases, the fuel in the HI-STORM 100 should also meet its design bases, as described in Element 1.
7. Corrective Actions	If the acceptance criteria described above are not met, the issue will be entered into the corrective action process. The corrective action program will determine any necessary actions, identify any changes to the existing AMP, and determine if the condition is reportable, as applicable. The corrective actions will also identify actions needed for increased scope or frequency of inspections, as necessary, based on any detected aging effects.
8. Confirmation Process	The confirmation process will be commensurate with the site QA program. The QA program ensures that inspections, evaluations, and corrective actions are completed in accordance with the program.
9. Administrative Controls	The QA program and implementing procedures for this AMP will address record retention requirements and document control. This AMP will be updated, as necessary, based on the toll gate assessments described in Section 4 of this application. Inspection results will be documented and made available for NRC inspection as necessary.
10. Operating Experience	<u>Future Operating Experience</u> As the HDRP continues information will be uploaded into the INPO AMID database

100U Concrete AMP

Element	Description
1. Scope of Program	The program covers the 100U concrete identified in Table 3.3-2 which require the 100U Concrete AMP.
2. Preventive Actions	This AMP uses condition monitoring to manage aging effects. The design of the system is intended to minimize aging effects, but this AMP focuses on condition monitoring. No new preventive actions are included in this AMP.
3. Parameters Monitored / Inspected	The accessible and exposed surfaces are visually examined for indication of surface deterioration. Degradation could affect the ability of the concrete to provide support to the VVMs, to provide radiation shielding, to provide missile shielding, or to provide a path for heat transfer. The inlet and outlet vents are monitored by visual inspection to ensure they are not obstructed. For inaccessible areas, groundwater monitoring is performed every 5 years for evidence of concrete degradation.
4. Detection of Aging Effects	The AMP is a visual inspection in order to detect any aging effects. The visual survey will identify the source of any staining or corrosion-related activity and the degree of damage. This visual inspection identifies the current condition of the structure and can identify the extent and cause of any aging effect noted. This visual inspection is conducted annually by an individual meeting the qualification requirements of per ACI-349, and includes all accessible areas on the pad. Settlement of the pad will be confirmed to be within the design basis using methodology from ACI349.3R-02. Groundwater monitoring performed every 5 years will determine if any degradation of the system from inaccessible areas is occurring. Data from all inspection and monitoring activities, including evidence of degradation and its extent and location, shall be documented on a checklist or inspection form. The results for the inspection will be documented, including descriptions of observed aging effects and supporting sketches, photographs or video.
5. Monitoring and Trending	Monitoring and trending methods are commensurate with consensus defect evaluation guides and standards. These may include standards such as ACI 201.1R, ACI 207.3R, ACI 364.1R, ACI 562, or ACI 224.1R, as applicable. The inspections and surveillances described for reinforced concrete are performed periodically in order to identify areas of degradation. The results will be evaluated by a qualified individual, and areas of degradation not meeting established criteria will be entered into the site's CAP for resolution or more detailed evaluation. The results from both the visual inspection and groundwater monitoring will be compared against previous inspections in order to monitor and trend the progression of the aging effects over time.
6. Acceptance Criteria	American Concrete Institute Standard 349.3R-02 includes quantitative three-tier acceptance criteria for visual inspections of concrete surfaces, namely (1) acceptance without further evaluation, (2) acceptance after review, and (3)

	acceptance requiring further evaluation. Acceptable signifies that a component is free of significant deficiencies or degradation that could lead to the loss of structural integrity. Acceptable after review signifies that a component contains deficiencies or degradation but will remain able to perform its design basis function until the next inspection or repair. Acceptance requiring further evaluation signifies that a component contains deficiencies or degradation that could prevent (or could prevent prior to the next inspection) the ability to perform its design basis function. Degradations or conditions meeting the ACI349.3R-02 Tier 2 and 3 criteria will be entered into the site's CAP for evaluation and resolution. The loss of material due to age-related degradation of ISFSI pad subcomponents will be evaluated by a qualified person in accordance with ACI 349.3R-02. A technical basis will be provided for any deviation from ACI349.3R-02 acceptance criteria. Any groundwater indications of concrete degradation will be entered into the corrective action program.
7. Corrective Actions	Corrective actions performed based on unacceptable effects will be in accordance with the ISFSI Quality Assurance (QA) program. The QA Program ensures that corrective actions are completed within the ISFSI Corrective Action Program (CAP). As applicable per the CAP program, ISFSI staff will determine any necessary actions, identify any changes to the existing AMP, and determine if the condition is reportable. Corrective actions will also identify the actions needed for increased scope or frequency of inspections, as necessary, based on any detected aging effects.
8. Confirmation Process	The confirmation process will be commensurate with the ISFSI QA Program. The QA program ensures that inspections, evaluations, and corrective actions are completed in accordance with the ISFSI CAP.
9. Administrative Controls	The ISFSI QA program and implementing procedures for this AMP will address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. This AMP will be updated periodically, as necessary, based on the tollgate assessments described in Chapter 4 of this application. Inspection results will be documented and made available for NRC inspectors to view upon request.
10. Operating Experience	The ISFSI pad will be inspected before the CEC is placed in accordance with existing operating procedures. The overall effectiveness of these inspections in maintaining the condition and functionality of the ISFSI Pad.

APPENDIX B: HI-STORM 100 TLAAs

B.0 Introduction

This appendix outlines the Time Limited Aging Analyses (TLAA) for the HI-STORM 100 System. A TLAA meets the all of the following criteria:

(1) Involve SSCs important to safety within the scope of the specific-license renewal, as delineated in Subpart F of 10 CFR Part 72, or within the scope of the spent fuel storage CoC renewal, as delineated in Subpart L of 10 CFR Part 72, respectively.
(2) Consider the effects of aging.
(3) Involve time-limited assumptions defined by the current operating term.
(4) Were determined to be relevant by the specific licensee or certificate holder in making a safety determination
(5) Involve conclusions or provide the basis of conclusions related to the capability of SSCs to perform their intended safety functions.
(6) Are contained or incorporated by reference in the design bases.

B.1 Identification of HI-STORM 100 TLAAs

Using the TLAA-identification criteria discussed in Section 3.2.4.1, the CoC, SER, Technical Specifications were reviewed and the following TLAA's were identified for further evaluation and disposition:

1. Neutron Absorber Depletion
2. HI-TRAC Trunnions
3. MPC Fatigue
4. Fuel Cladding Integrity

B.2 Neutron Absorber Depletion

Section 6.3.2 of the HI-STORM 100 FSAR describes the boron depletion of the fixed neutron absorber within the MPC. The original analysis demonstrated that the boron depletion of the neutron absorbing material is negligible over a 50 year duration. The same analysis was re-performed in support of this license renewal request, as documented in Ref. B.2.1.

The analysis concludes that the total depletion of B-10 in Boral over a 500 year period is negligible (less than 1 ppm of total B-10 atoms depleted). Therefore, the TLAA for neutron absorber depletion shows that the neutron absorber will perform its intended function well beyond the extended storage period and that no aging management program is needed to manage the neutron absorber aging. The evaluation for Boral bounds the evaluation for the use of Metamic.

B.3 HI-TRAC Trunnions

The HI-STORM 100 FSAR Section 3.1.2.4 states that fatigue is not a concern for the HI-STORM 100 system, including the HI-TRAC. The same section relies on the inspection of the trunnions to ensure damaged components are not utilized. Similarly, the aging management review of the HI-TRAC, documented in Chapter 3 of this report, relies on the HI-TRAC AMP (including trunnion inspections) for managing any aging effects, and therefore no further analysis of the trunnions is needed.

B.4 MPC Fatigue

The HI-STORM FSAR, Subsection 3.1.2.4 discussion of MPC fatigue indicates that the low stress, high-cycle conditions of ambient temperature and insolation cycling during normal dry storage conditions cannot lead to a fatigue failure of the MPC, with endurance limits well in excess of 20,000 psi. However, it is possible that repeated lifting of the MPC might cause increased stresses and therefore lower the fatigue life of the MPC. To determine the maximum number of lifting cycles, the lifting points are evaluated against allowables from NUREG-0612, ANSI N14.6, and RG 3.61, with the maximum applicable stress limit for MPC components set as the secondary stress limit from ASME Code Section III Subsection NB. The detailed calculation is described in Ref. B.4.1. The calculation concludes that the allowable number of lifting cycles of the MPC, as shown in Table B-1 in this section, greatly exceeds the amount of lifts of an MPC that would be necessary over the 60 year extended storage of the MPC.

B.5 Fuel Cladding Integrity

Early amendments of the HI-STORM 100 system provided an analysis of the integrity of the fuel to be stored, which includes a time-based assumption, and could be considered a TLAA. However, subsequently, the NRC issued ISG-11, Revision 3 which provides temperature limits for fuel. If fuel is maintained under those limits, there is no concern with time-based degradation. That ISG is now the licensing basis, and previous amendments meet those temperature limits. Therefore, the analysis is not re-performed for the extended period of operation, since the ISG provides the technical information which supports storage of fuel in the HI-STORM 100 system. Note, additional aging management activities for High Burnup Fuel are covered under the High Burnup Fuel AMP.

B.6 References

B.2.1 HI-951322R24, “HI-STAR 100 Shielding Design and Analysis for Transport and Storage,” Appendix 3

B.4.1 B.1.1 HI-2012787R22, “Structural Calculation Package for MPC,” Supplement 68

Table B-1 Lifting Cycles

Component	Allowable Number of Lifting Cycles
MPC	6750
Transfer Cask	3730

APPENDIX C: SYSTEM INSPECTIONS

C.0 Introduction

There are two types of initial storage system inspections related to the HI-STORM 100 CoC renewal applications and initial AMP implementation, respectively. The first type, known as a pre-application inspection is intended to gather information to inform the development of the renewal application in general, and AMPs for specific SSCs in particular. The second, known as a baseline inspection, is essentially the first AMP inspection of the SSC, which is performed at a particular ISFSI at approximately the time when the storage system enters the period of extended storage.

C.1 Pre-application Inspections

Although a pre-application inspection is not a regulatory requirement, the HI-STORM 100 System has undergone a number of previous demonstrations which have informed the AMPs included in this application.

C.1.1 MPC / Overpack Internal

During the week of November 18, 2013, proof of concept investigations were performed on two of the oldest loaded dry fuel storage canisters placed on the PSEG Nuclear Independent Spent Fuel Storage Installation (ISFSI). The inspection was a collaborative effort between PSEG Nuclear, Holtec International, EPRI, and a number of the national labs. The intent of the inspection was to support an industry wide initiative to collect data on the canister surface conditions associated with extended exposure to marine atmospheric conditions. All results were documented in Reference [C.1.1]. Degradation was not the focus of the investigation, but no unexpected evidence of degradation was found. The inspection also opportunistically took pictures of the condition of the internal overpack shell, which showed no signs of significant degradation. The equipment used in this inspection was able to see a large portion of the canister surface.

An additional investigation was performed at Diablo Canyon Nuclear Power Plant [C.1.2]. The conclusions were similar to those found at PSEG. Although Diablo Canyon maintains its own site-specific license, the design is the same as the HI-STORM 100 system and therefore the demonstration provided information to support the AMPs contained in this license.

The lessons learned from this inspection were incorporated into this application and AMPs, in the acceptance criteria and in the tooling techniques that will be used to perform the inspections.

C.1.2 Overpack External

The HI-STORM 100 system FSAR already required an annual visual external examination, in Table 9.2.1. The results from a number of these examinations have been identified in Section 3.1.2 of this application. These previous inspections lessons learned have been incorporated into the acceptance criteria in the AMP in this application.

C.1.3 Transfer Cask

Transfer casks in use at existing sites have been examined over the course of their use. The results from a number of these examinations have been identified in Section 3.1.2 of this application. These previous inspections lessons learned have been incorporated into the acceptance criteria in the AMP in this application.

C.2 Baseline Inspections

Baseline inspections are the first AMP inspections conducted at an ISFSI site at the approximate time the ISFSI enters the period of extended storage (i.e., 20 years after the first HI-STORM 100 system was placed in service). The baseline inspection for the site meets the criteria defined in the AMPs in Appendix A. This first (baseline) inspection should occur within 365 days of the 20^{th} anniversary of the initial overpack loading at the site or within 365 days of the issuance of the renewed license, whichever is later. All future inspections will occur with a 5 year frequency (+/- 1.25 years) starting from the baseline date. This schedule applies to the canister external inspection, overpack internal inspections, and groundwater monitoring for the HI-STORM 100U. For the overpack external inspections and HI-STORM 100U concrete inspections, the first (baseline) inspection should occur within 365 days of the 20^{th} anniversary of the initial overpack loading at the site or within 365 days of the issuance of the renewed license, whichever is later. All future inspections will occur with a 1 year frequency (+/- 0.25 years) starting from the baseline date. Since the other AMP inspections are pre-use type inspections they will occur before the first use of the applicable component once it has been in service more than 20 years. Note that the High Burnup Fuel AMP does not have an inspection component and the schedule is based on the demonstration project as described in the AMP in Appendix A.

C.3 References

[C.1.1] HI-2146300, “MPC Surface Inspection at Hope Creek Nuclear Generating Station,” Revision 1, May 8, 2015.

[C.1.2] HI-2146301, “MPC Surface Inspection at Diablo Canyon Power Plant,” Revision 09-2, May 8, 2015.

APPENDIX D: AGING MANAGEMENT FSAR CHANGES

The proposed FSAR changes are shown in context in the attached “track change” pages.

1.2.1.4 Lifting Devices

Lifting of the HI-STORM 100 System may be accomplished either by attachment at the top of the storage overpack ("top lift"), as would typically be done with a crane, or by attachment at the bottom ("bottom lift"), as would be effected by a number of lifting/handling devices.

For a top lift, the storage overpack is equipped with four threaded anchor blocks arranged circumferentially around the overpack. These anchor blocks are used for overpack lifting as well as securing the overpack lid to the overpack body. The storage overpack may be lifted with a lifting device that engages the anchor blocks with threaded studs and connects to a crane or similar equipment.

A bottom lift of the HI-STORM 100 storage overpack is affected by the insertion of four hydraulic jacks underneath the inlet vent horizontal plates (Figure 1.2.1). A slot in the overpack baseplate allows the hydraulic jacks to be placed underneath the inlet vent horizontal plate. The hydraulic jacks lift the loaded overpack to provide clearance for inserting or removing a device for transportation.

The standard design HI-TRAC transfer cask is equipped with two lifting trunnions and two pocket trunnions. The HI-TRAC 100D and 125D are equipped with only lifting trunnions. The lifting trunnions are positioned just below the top forging. The two pocket trunnions are located above the bottom forging and attached to the outer shell. The pocket trunnions are designed to allow rotation of the HI-TRAC. All trunnions are built from a high strength alloy with proven corrosion and non-galling characteristics. The lifting trunnions are designed in accordance with NUREG-0612 and ANSI N14.6. The lifting trunnions are installed by threading into tapped holes just below the top forging.

The top of the MPC lid is equipped with four threaded holes that allow lifting of the loaded MPC. These holes allow the loaded MPC to be raised/lowered through the HI-TRAC transfer cask using lifting cleats. The threaded holes in the MPC lid are designed in accordance with NUREG-0612 and ANSI N14.6.

1.2.1.5 Design Life

The design life of the HI-STORM 100 System is 60 years. This is accomplished by using material of construction with a long proven history in the nuclear industry and specifying materials known to withstand their operating environments with little to no degradation. A maintenance program, as specified in Chapter 9, is also implemented to ensure the HI-STORM 100 System will exceed its design life of 60 years. The design considerations that assure the HI-STORM 100 System performs as designed throughout the service life include the following:

HI-STORM Overpack and HI-TRAC Transfer Cask

- Exposure to Environmental Effects
- Material Degradation

Table 1.2.2

KEY PARAMETERS FOR HI-STORM 100 MULTI-PURPOSE CANISTERS

	PWR	BWR
Pre-disposal service life (years)	60	60
Design temperature, max./min. (°F)	725°† /-40°††	725°† /-40°††
Design internal pressure (psig) Normal conditions Off-normal/Short-term conditions Accident Conditions	 100 110 200	 100 110 200
Total heat load, max. (kW)††††	36.9	36.9
Maximum permissible peak fuel cladding temperature: Long Term Normal (°F) Short Term Operations (°F) Off-normal and Accident (°F)	 752 752 or 1058††† 1058	 752 752 or 1058††† 1058

† Maximum normal condition design temperatures for the MPC fuel basket. A complete listing of design temperatures for all components is provided in Table 2.2.3.

†† Temperature based on off-normal minimum environmental temperatures specified in Section 2.2.2.2 and no fuel decay heat load.

††† See Section 4.5 for discussion of the applicability of the 1058°F temperature limit during MPC drying.

†††† Maximum heat load shown is for regionalized loading.

CHAPTER 2†: PRINCIPAL DESIGN CRITERIA

This chapter contains a compilation of design criteria applicable to the HI-STORM 100 System. The loadings and conditions prescribed herein for the MPC, particularly those pertaining to mechanical accidents, are far more severe in most cases than those required for 10CFR72 compliance. The MPC is designed to be in compliance with both 10CFR72 and 10CFR71 and therefore certain design criteria are overly conservative for storage. This chapter sets forth the loading conditions and relevant acceptance criteria; it does not provide results of any analyses. The analyses and results carried out to demonstrate compliance with the design criteria are presented in the subsequent chapters of this report.

This chapter is in full compliance with NUREG-1536, except for the exceptions and clarifications provided in Table 1.0.2. Table 1.0.2 provides the NUREG-1536 review guidance, the justification for the exception or clarification, and the Holtec approach to meet the intent of the NUREG-1536 guidance.

2.0 PRINCIPAL DESIGN CRITERIA

The design criteria for the MPC, HI-STORM overpack, and HI-TRAC transfer cask are summarized in Tables 2.0.1, 2.0.2, and 2.0.3, respectively, and described in the sections that follow.

2.0.1 MPC Design Criteria

General

The MPC is designed for 60 years of service, while satisfying the requirements of 10CFR72. The adequacy of the MPC design for the design life is discussed in Section 3.4.12.

Structural

The MPC is classified as important to safety. The MPC structural components include the internal fuel basket and the enclosure vessel. The fuel basket is designed and fabricated as a core support structure, in accordance with the applicable requirements of Section III, Subsection NG of the ASME Code, with certain NRC-approved alternatives, as discussed in Section 2.2.4. The enclosure vessel is designed and fabricated as a Class 1 component pressure vessel in accordance with Section III, Subsection NB of the ASME Code, with certain NRC-approved alternatives, as discussed in Section 2.2.4. The principal exception is the MPC lid, vent and drain port cover plates, and closure ring welds to the MPC lid and shell, as discussed in Section 2.2.4. In addition, the threaded holes in

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

baseplate welds and shell to shell weld is performed on the unloaded MPC.

Operations

There are no radioactive effluents that result from storage or transfer operations. Effluents generated during MPC loading are handled by the plant's radwaste system and procedures.

Generic operating procedures for the HI-STORM 100 System are provided in Chapter 8. Detailed operating procedures will be developed by the licensee based on Chapter 8, site-specific requirements that comply with the 10CFR50 Technical Specifications for the plant, and the HI-STORM 100 System CoC.

Acceptance Tests and Maintenance

The fabrication acceptance basis and maintenance program to be applied to the MPCs are described in Chapter 9. The operational controls and limits to be applied to the MPCs are discussed in Chapter 12. Application of these requirements will assure that the MPC is fabricated, operated, and maintained in a manner that satisfies the design criteria defined in this chapter.

Decommissioning

The MPCs are designed to be transportable in the HI-STAR overpack and are not required to be unloaded prior to shipment off-site. Decommissioning of the HI-STORM 100 System is addressed in Section 2.4.

2.0.2 HI-STORM Overpack Design Criteria

General

The HI-STORM overpack is designed for 60 years of service, while satisfying the requirements of 10CFR72. The adequacy of the overpack design for the design life is discussed in Section 3.4.11.

Structural

The HI-STORM overpack includes both concrete and structural steel components that are classified as important to safety.

The concrete material is defined as important to safety because of its importance to the shielding analysis. The primary function of the HI-STORM overpack concrete is shielding of the gamma and neutron radiation emitted by the spent nuclear fuel.

Unlike other concrete storage casks, the HI-STORM overpack concrete is enclosed in steel inner and outer shells connected to each other by radial ribs, and top and bottom plates. Where typical concrete storage casks are reinforced by rebar, the HI-STORM overpack is supported by the inner and outer shells connected by radial ribs. As the HI-STORM overpack concrete is not reinforced, the structural

Decommissioning

Decommissioning considerations for the HI-STORM 100 System, including the overpack, are addressed in Section 2.4.

2.0.3 HI-TRAC Transfer Cask Design Criteria

General

The HI-TRAC transfer cask is designed for 60 years of service, while satisfying the requirements of 10CFR72. The adequacy of the HI-TRAC design for the design life is discussed in Section 3.4.11.

Structural

The HI-TRAC transfer cask includes both structural and non-structural biological shielding components that are classified as important to safety. The structural steel components of the HI-TRAC, with the exception of the lifting trunnions, are designed and fabricated in accordance with the applicable requirements of Section III, Subsection NF, of the ASME Code with certain NRC-approved alternatives, as discussed in Section 2.2.4. The lifting trunnions and associated attachments are designed in accordance with the requirements of NUREG-0612 and Regulatory Guide 3.61 for non-redundant lifting devices.

The HI-TRAC transfer cask is designed for all normal, off-normal, and design basis accident condition loadings, as defined in Section 2.2. At a minimum, the HI-TRAC transfer cask must protect the MPC from deformation, provide continued adequate performance, and allow the retrieval of the MPC under all conditions. These design loadings include a side drop from the maximum allowable handling height, consistent with the technical specifications. The load combinations for which the HI-TRAC is designed are defined in Section 2.2.7. The physical characteristics of each MPC for which the HI-TRAC is designed are defined in Chapter 1.

Thermal

The allowable temperatures for the HI-TRAC transfer cask structural steel components are based on the maximum temperature for material properties and allowable stress values provided in Section II of the ASME Code. The top lids of the HI-TRAC 125 and HI-TRAC 125D incorporate Holtite-A shielding material. This material has a maximum allowable temperature in accordance with the manufacturer's test data. The specific allowable temperatures for the structural steel and shielding components of the HI-TRAC are provided in Table 2.2.3. The HI-TRAC is designed for off-normal environmental cold conditions, as discussed in Section 2.2.2.2. The structural steel materials susceptible to brittle fracture are discussed in Section 3.1.2.3.

The HI-TRAC is designed for the maximum heat load analyzed for storage operations. When the MPC contains any high burnup fuel assemblies and the MPC decay heat is greater than the threshold heat load defined in Table 4.5.4, the Supplemental Cooling System (SCS) will be required for certain time periods while the MPC is inside the HI-TRAC transfer cask (see Section 4.5). The design

The Cask Transfer Facility shall be constructed to have a minimum design life of 60 years.{1}

P. Testing Requirements

In addition to testing recommended in NUREG-0612 (1980), a structural adequacy test of the CTF structure at 125% of its operating load prior to its first use in a cask loading campaign shall be performed. This test should be performed in accordance with the guidance provided in the CMAA Specification 70 [2.2.16]. {1}

Q. Quality Assurance Requirements

All components of the CTF shall be manufactured in full compliance with the quality assurance requirements applicable to the ITS category of the component as set forth in the Holtec QA program. {1, 2, 3}

R. Documentation Requirements

i. O&M Manual: An Operations and Maintenance Manual shall be prepared which contains, at minimum, the following items of information: {1, 2, 3}

- Maintenance Drawings
- Operating Procedures

ii. Design Report: if required by the safety classification, a QA-validated design report documenting full compliance with the provisions of this specification shall be prepared and archived for future reference in accordance with the provisions of the Holtec QA program. {1, 2, 3}

2.3.3.2 Instrumentation

As a consequence of the passive nature of the HI-STORM 100 System, instrumentation which is important to safety is not necessary. No instrumentation is required or provided for HI-STORM 100 storage operations, other than normal security service instruments and TLDs.

However, in lieu of performing the periodic inspection of the HI-STORM overpack vent screens, temperature elements may be installed in two of the overpack exit vents to continuously monitor the air temperature. If the temperature elements and associated temperature monitoring instrumentation are used, they shall be designated important to safety as specified in Table 2.2.6.

The temperature elements and associated temperature monitoring instrumentation provided to monitor the air outlet temperature shall be suitable for a temperature range of -40°F to 500°F. At a

2.4 DECOMMISSIONING CONSIDERATIONS

Efficient decommissioning of the ISFSI is a paramount objective of the HI-STORM 100 System. The HI-STORM 100 System is ideally configured to facilitate rapid, safe, and economical decommissioning of the storage site.

The MPC is being licensed for transport off-site in the HI-STAR 100 dual-purpose cask system (Reference Docket No. 71-9261). No further handling of the SNF stored in the MPC is required prior to transport to a licensed centralized storage facility or licensed repository.

The MPC which holds the SNF assemblies is engineered to be suitable as a waste package for permanent internment in a deep Mined Geological Disposal System (MGDS). The materials of construction permitted for the MPC are known to be highly resistant to severe environmental conditions. No carbon steel, paint, or coatings are used or permitted in the MPC in areas where they could be exposed to spent fuel pool water or the ambient environment. Therefore, the SNF assemblies stored in the MPC should not need to be removed. However, to ensure a practical, feasible method to defuel the MPC, the top of the MPC is equipped with sufficient gamma shielding and markings locating the drain and vent locations to enable semiautomatic (or remotely actuated) boring of the MPC lid to provide access to the MPC vent and drain. The circumferential welds of the MPC lid closure ring can be removed by semiautomatic or remotely actuated means, providing access to the SNF.

Likewise, the overpack consists of steel and concrete rendering it suitable for permanent burial. Alternatively, the MPC can be removed from the overpack, and the latter reused for storage of other MPCs.

In either case, the overpack would be expected to have no interior or exterior radioactive surface contamination. Any neutron activation of the steel and concrete is expected to be extremely small, and the assembly would qualify as Class A waste in a stable form based on definitions and requirements in 10CFR61.55. As such, the material would be suitable for burial in a near-surface disposal site as Low Specific Activity (LSA) material.

If the MPC needs to be opened and separated from the SNF before the fuel is placed into the MGDS, the MPC interior metal surfaces will be decontaminated using existing mechanical or chemical methods. This will be facilitated by the MPC fuel basket and interior structures' smooth metal surfaces designed to minimize crud traps. After the surface contamination is removed, the MPC radioactivity will be diminished significantly, allowing near-surface burial or secondary applications at the licensee's facility.

It is also likely that both the overpack and MPC, or extensive portions of both, can be further decontaminated to allow recycle or reuse options. After decontamination, the only radiological hazard the HI-STORM 100 System may pose is slight activation of the HI-STORM 100 materials caused by irradiation over a 60-year storage period.

Due to the design of the HI-STORM 100 System, no residual contamination is expected to be left behind on the concrete ISFSI pad. The base pad, fence, and peripheral utility structures will require no decontamination or special handling after the last overpack is removed.

To evaluate the effects on the MPC and HI-STORM overpack caused by irradiation over a 40-year storage period, the following analysis is provided. Table 2.4.1 provides the conservatively determined quantities of the major nuclides after 40 years of irradiation. The calculation of the material activation is based on the following:

- Beyond design basis fuel assemblies (B&W 15x15, 4.8% enrichment, 70,000 MWD/MTU, and five-year cooling time) stored for 40 years. A constant source term for 40 years was used with no decrease in the neutron source term. This bounds the source term associated with the limiting PWR burnup of 68,200 MWD/MTU.

- Material quantities based on the drawings in Section 1.5.

- A constant flux equal to the initial loading condition is conservatively assumed for the full 40 years.

- Material activation is based on MCNP-4A calculations.

As can be seen from the material activation results presented in Table 2.4.1, the MPC and HI-STORM overpack activation is very low, even including the very conservative assumption of a constant flux for 40 years. The results for the concrete in the HI-STORM overpack can be conservatively applied to the ISFSI pad. This is extremely conservative because the overpack shields most of the flux from the fuel and, therefore, the ISFSI pad will experience a minimal flux.

This calculation was based on 40 years and based on the minimal activation along with the guidance in NUREG-2214 that indicates radiation impacts over 60 years are negligible, the results are assumed to be similar for a 60 year storage period.

In any case, the HI-STORM 100 System would not impose any additional decommissioning requirements on the licensee of the ISFSI facility per 10CFR72.30, since the HI-STORM 100 System could eventually be shipped from the site.

Total area for an array of twelve CECs: 4,944 ft^2
Bare CEC metal exposed: 4,944 ft^2 x 0.085 or 420 ft^2
Current required: 420 ft^2 x 1 mA/ft^2 or 420 mA

The following is additional data applicable to Figure 2.I.1.

Approximate Anode quantity: 11
Approximate Anode size: 5 in dia. x 120 in. long
Approximate Backfill quantity: 6,000 lbs of carbonaceous backfill

The total number of anodes required is determined primarily by the total current requirements of the CEC metal to be protected and the optimum current density of the anode material selected.

Graphite is a semi-consumable anode. Graphite typically has experienced corrosion rates of 1.5 to 2.16 lbs /amp year [2.I.3] or as determined by experiment, 0.08 grams per square meter of anode per amp-hour of current (at 30 C, 40 mA/cm^2 anode current density) [2.I.4]. A computed anode life of less than 60 years is acceptable as long as appropriate measures are taken to facilitate the replacement of anodes during the design phase and appropriate maintenance planning measures are implemented. Use of carbonaceous backfill should be considered since it can substantially lengthen the anode life. Inert (non-consumable) platinized anodes may also be considered.

v. Concrete Encasement (Corrosion Mitigation Measure)

If concrete encasement is used, it shall be implemented in accordance with the requirements in Supplement 3.I, Subsection 3.I.4.1 and appropriate references.

The following points shall also be taken into consideration:

- The effect of the concrete encasement on the ICCPS, if an ICCPS is also implemented.
- The concrete encasement should not interfere with the settlement of the TSP (which provides the transporter support surface) without appropriate evaluation.

vi. Retaining Wall

Because the subgrade within and around an operating 100U ISFSI serves a principal shielding function, it is essential that any excavation activity adjacent to the ISFSI (e.g., to build an extension of the ISFSI), must not disturb the soil in the Radiation Protection Space (RPS) shown in the licensing drawings (Section 1.I.5).

The extent of the RPS is set down to ensure, with sufficient margin of safety, that the ISFSI will continue to meet all relevant safety criteria under all applicable conditions of storage including normal, off-normal, extreme environmental phenomena and accident conditions. For example, the RPS must provide sufficient buffer so that design basis projectiles (large, medium, and penetrant missiles) will not access an MPC stored in a VVM cavity. In this case, as explained in Supplement 3.I, the incident missile is assumed to act when a deep cavity has been excavated contiguous to the

HI-STORM 100S, Version B since the structural material at the top of the cask that would be locally deformed after a tipover event is essentially the same.

3.4.11 Storage Overpack and HI-TRAC Transfer Cask Service Life

The term of the 10CFR72, Subpart L C of C, granted by the NRC is 20 years, renewed for an additional 40 years; therefore, the License Life (please see glossary) of all components is 60 years. The HI-STORM 100 and 100S Storage overpacks and the HI-TRAC transfer cask are engineered for 60 years of design life, while satisfying the conservative design requirements defined in Chapter 2, including the regulatory requirements of 10CFR72. In addition, the storage overpack and HI-TRAC are designed, fabricated, and inspected under the comprehensive Quality Assurance Program discussed in Chapter 13 and in accordance with the applicable requirements of the ACI and ASME Codes. This assures high design margins, high quality fabrication, and verification of compliance through rigorous inspection and testing, as describe in Chapter 9 and the design drawings in Section 1.5. Technical Specifications defined in Chapter 12 assure that the integrity of the cask and the contained MPC are maintained throughout the components' design life. The design life of a component, as defined in the Glossary, is the minimum duration for which the equipment or system is engineered to perform its intended function if operated and maintained in accordance with the FSAR. The design life is essentially the lower bound value of the service life, which is the expected functioning life of the component or system. Therefore, component longevity should be: licensed life < design life < service life. (The licensed life, enunciated by the USNRC, is the most pessimistic estimate of a component's life span.) For purposes of further discussion, we principally focus on the service life of the HI-STORM 100 System components that, as stated earlier, is the reasonable expectation of equipment's functioning life span.

The service life of the storage overpack and HI-TRAC transfer cask is further discussed in the following sections.

3.4.11.1 Storage Overpack

The principal design considerations that bear on the adequacy of the storage overpack for the service life are addressed as follows:

Exposure to Environmental Effects

In the following text, all references to HI-STORM 100 also apply to HI-STORM 100S and to the HI-STORM 100S Version B. All exposed surfaces of HI-STORM 100 are made from ferritic steels that are readily painted. Concrete, which serves strictly as a shielding material, is completely encased in steel. Therefore, the potential of environmental vagaries such as spalling of concrete, are ruled out for HI-STORM 100. Under normal storage conditions, the bulk temperature of the HI-STORM 100 storage overpack will, because of its large thermal inertia, change very gradually with time. Therefore, material degradation from rapid thermal ramping conditions is not credible for the HI-STORM 100 storage overpack. Similarly, corrosion of structural steel embedded in the concrete structures due to salinity in the environment at coastal sites is not a concern for HI-STORM 100 because HI-STORM 100 does not rely on rebars (indeed, it contains no rebars). As discussed in Appendix 1.D, the aggregates, cement and water used in the storage cask concrete are carefully controlled to provide high durability and resistance to temperature effects. The configuration of the storage overpack assures resistance to freeze-thaw degradation. In addition, the storage overpack is specifically designed for a full range of enveloping design basis natural phenomena that could occur over the 60-year design life of the storage overpack as defined in Subsection 2.2.3 and evaluated in Chapter 11.

Material Degradation

The relatively low neutron flux to which the storage overpack is subjected cannot produce measurable degradation of the cask's material properties and impair its intended safety function. Exposed carbon steel components are coated to prevent corrosion. The controlled environment of the ISFSI storage pad mitigates damage due to direct exposure to corrosive chemicals that may be present in other industrial applications.

Maintenance and Inspection Provisions

The requirements for periodic inspection and maintenance of the storage overpack throughout the 60-year design life are defined in Chapter 9. These requirements include provisions for routine inspection of the storage overpack exterior and periodic visual verification that the ventilation flow paths of the storage overpack are free and clear of debris. ISFSIs located in areas subject to atmospheric conditions that may degrade the storage cask or canister should be evaluated by the licensee on a site-specific basis to determine the frequency for such inspections to assure long-term performance. In addition, the HI-STORM 100 System is designed for easy retrieval of the MPC from the storage overpack should it become necessary to perform more detailed inspections and repairs on the storage overpack.

The above findings are consistent with those of the NRC's Waste Confidence Decision Review [3.4.11], which concluded that dry storage systems designed, fabricated, inspected, and operate in accordance with such requirements are adequate for a 100-year service life while satisfying the requirements of 10CFR72.

3.4.11.2 Transfer Cask

The principal design considerations that bear on the adequacy of the HI-TRAC Transfer Cask for the service life are addressed as follows:

Exposure to Environmental Effects

All transfer cask materials that come in contact with the spent fuel pool are coated to facilitate decontamination. The HI-TRAC is designed for repeated normal condition handling operations with high factor of safety, particularly for the lifting trunnions, to assure structural integrity. The resulting cyclic loading produces stresses that are well below the endurance limit of the trunnion material, and therefore, will not lead to a fatigue failure in the transfer cask. All other off-normal or postulated accident conditions are infrequent or one-time occurrences that do not contribute significantly to fatigue. In addition, the transfer cask utilizes materials that are not susceptible to brittle fracture during the lowest temperature permitted for loading, as discussed in Chapter 12.

Material Degradation

All transfer cask materials that are susceptible to corrosion are coated. The controlled environment in which the HI-TRAC is used mitigates damage due to direct exposure to corrosive chemicals that may be present in other industrial applications. The infrequent use and relatively low neutron flux to which the HI-TRAC materials are subjected do not result in radiation embrittlement or degradation of the HI-TRAC's shielding materials that could impair the HI-TRAC's intended safety function. The HI-TRAC transfer cask materials are selected for durability and wear resistance for their deployment.

Maintenance and Inspection Provisions

The requirements for periodic inspection and maintenance of the HI-TRAC transfer cask throughout the 60-year design life are defined in Chapter 9. These requirements include provisions for routine inspection of the HI-TRAC transfer cask for damage prior to each use, including an annual inspection of the lifting trunnions. Precautions are taken during lid handling operations to protect the sealing surfaces of the pool lid. The leak tightness of the liquid neutron shield is verified periodically. The water jacket pressure relief valves and other fittings used can be easily removed.

3.4.12 MPC Service Life

The term of the 10CFR72, Subpart L C of C, granted by the NRC (i.e., licensed life) is 20 years, renewed for an additional 40 years. The HI-STORM 100 MPC is designed for 60 years of design life, while satisfying the conservative design requirements defined in Chapter 2, including the regulatory requirements of 10CFR72. Additional assurance of the integrity of the MPC and the contained SNF assemblies throughout the 60-year life of the MPC is provided through the following:

- Design, fabrication, and inspection in accordance with the applicable requirements of the ASME Code as described in Chapter 2 assures high design margins.

- Fabrication and inspection performed in accordance with the comprehensive Quality Assurance program discussed in Chapter 13 assures competent compliance with the fabrication requirements.

- Use of materials with known characteristics, verified through rigorous inspection and testing, as described in Chapter 9, assures component compliance with design requirements.

- Use of welding procedures in full compliance with Section III of the ASME Code ensures high-quality weld joints.

Technical Specifications, as defined in Chapter 12, have been developed and imposed on the MPC that assure that the integrity of the MPC and the contained SNF assemblies are maintained throughout the 60-year design life of the MPC.

The principal design considerations bearing on the adequacy of the MPC for the service life are summarized below.

Corrosion

All MPC materials are fabricated from corrosion-resistant austenitic stainless steel and passivated aluminum. The corrosion-resistant characteristics of such materials for dry SNF storage canister applications, as well as the protection offered by these materials against other material degradation effects, are well established in the nuclear industry. The moisture in the MPC is removed to eliminate all oxidizing liquids and gases and the MPC cavity is backfilled with dry inert helium at the time of closure to maintain an atmosphere in the MPC that provides corrosion protection for the SNF cladding throughout the dry storage period. The preservation of this non-corrosive atmosphere is assured by the inherent sealworthiness of the MPC confinement boundary integrity (there are no gasketed joints in the MPC).

Structural Fatigue

The passive non-cyclic nature of dry storage conditions does not subject the MPC to conditions that might lead to structural fatigue failure. Ambient temperature and insolation cycling during normal dry storage conditions and the resulting fluctuations in MPC thermal gradients and internal pressure is the only mechanism for fatigue. These low-stress, high-cycle conditions cannot lead to a fatigue failure of the MPC that is made from stainless alloy stock (endurnce limit well in excess of 20,000 psi). All other off-normal or postulated accident conditions are infrequent or one-time occurrences, which cannot produce fatigue failures. Finally, the MPC uses materials that are not susceptible to brittle fracture.

Maintenance of Helium Atmosphere

The inert helium atmosphere in the MPC provides a non-oxidizing environment for the SNF cladding to assure its integrity during long-term storage. The preservation of the helium atmosphere in the MPC is assured by the robust design of the MPC confinement boundary described in Section 7.1. Maintaining an inert environment in the MPC mitigates conditions that might otherwise lead to SNF cladding failures. The required mass quantity of helium backfilled into the canister at the time of closure and the associated fabrication and closure requirements for the canister are specifically set down to assure that an inert helium atmosphere is maintained in the canister throughout the 60-year design life.

Allowable Fuel Cladding Temperatures

The helium atmosphere in the MPC promotes heat removal and thus reduces SNF cladding temperatures during dry storage. In addition, the SNF decay heat will substantially attenuate over a 60-year dry storage period. Maintaining the fuel cladding temperatures below allowable levels during long-term dry storage mitigates the damage mechanism that might otherwise lead to SNF cladding failures. The allowable long-term SNF cladding temperatures used for thermal acceptance of the MPC design are conservatively determined, as discussed in Section 4.3.

Neutron Absorber Boron Depletion

The effectiveness of the fixed borated neutron absorbing material used in the MPC fuel basket design requires that sufficient concentrations of boron be present to assure criticality safety during worst case design basis conditions over the 60-year design life of the MPC. Information on the characteristics of the borated neutron absorbing material used in the MPC fuel basket is provided in Subsection 1.2.1.3.1. The relatively low neutron flux, which will continue to decay over time, to which this borated material is subjected, does not result in significant depletion of the material's available boron to perform its intended safety function. In addition, the boron content of the material used in the criticality safety analysis is conservatively based on the minimum specified boron areal density (rather than the nominal), which is further reduced by 25% for analysis purposes, as described in Section 6.1. Analysis discussed in Section 6.3.2 demonstrates that the boron depletion in the neutron absorber material is negligible over a 50-year duration. To support license renewal, the evaluation of boron depletion was re-performed and found to be negligible for time frames well beyond the 60 year license renewal time period. Thus, sufficient levels of boron are present in the fuel basket neutron absorbing material to maintain criticality safety functions over the 60-year design life of the MPC.

The above findings are consistent with those of the NRC's Waste Confidence Decision Review, which concluded that dry storage systems designed, fabricated, inspected, and operated in the manner of the requirements set down in this document are adequate for a 100-year service life, while satisfying the requirements of 10CFR72.

3.4.13 Design and Service Life

The discussion in the preceding sections seeks to provide the logical underpinnings for setting the design life of the storage overpacks, the HI-TRAC transfer cask, and the MPCs as sixty years. Design life, as stated earlier, is a lower bound value for the expected performance life of a component (service life). If operated and maintained in accordance with this Final Safety Analysis Report, Holtec International expects the service life of its HI-STORM 100 and HI-STORM 100S Version's components to substantially exceed their design life values.

Section 3.4 contains all required information associated with the MPCs and with the HI-TRAC transfer cask and is not repeated here. Results reported in this supplement section are generally applicable only to the HI-STORM 100U VVM.

3.I.4.1 Chemical and Galvanic Reactions

In order to provide reasonable assurance that the VVM will meet its intended Design Life of 60 years (the License Life is 60 years) and perform its intended safety function(s), chemical and galvanic reactions and other potentially degrading mechanisms must be accounted for in its design and construction.

The HI-STORM 100U VVM is a buried structure and as such chemical and galvanic reactions and other potentially degrading factors are, in some respects, more challenging than for aboveground models. Although the CEC is not a part of the MPC containment boundary, it should not corrode to the extent where localized in-leakage of water occurs or where gross general corrosion prevents the component from performing its primary safety function. In the following, considerations in the VVM's design and construction consistent with the applicable guidance provided in ISG-15 [3.I.3] are summarized.

All VVM components are galvanically compatible. Except for the CEC exterior surfaces, all steel surfaces of the VVM are lined and coated with the same surface preservative that is used in the aboveground HI-STORM overpacks. (The surface preservative used to protect HI-STORM 100S steel surfaces is a proven zinc rich inorganic/metallic material that protects galvanically and has self healing characteristics for added assurance). All exposed surfaces interior to the VVM, as stated in Supplement 1.I, are accessible for the reapplication of surface preservative, if necessary.

The steel Divider Shell requires insulation to perform its primary thermal function. The insulation selected shall be suitable for high temperature and high humidity operation and shall be foil faced, jacketed or otherwise made water resistant to ensure the required thermal resistance is maintained in accordance with Supplement 4.I. The high zinc content in the coating of the Divider Shell provides protection for both the Divider Shell and the jacketing or foil from any potential galvanic corrosion concerns. With respect to radiation resistance, the insulation blanket does not contain any organic binders. The damage threshold for ceramics is known to be approximately 1×10^{10} Rads. Chloride corrosion is not a concern since chloride leachables are limited and sufficiently low and the Divider Shell is not made from stainless steel [3.I.20]. Stress corrosion cracking of the foil or jacketing, whether made from stainless steel or other material is not an applicable corrosion mechanism due to minimal stresses derived from self-weight. The foil or jacketing and attachment hardware shall either have sufficient corrosion resistance (e.g. stainless steel, aluminum or galvanized steel) or shall be protected with a suitable surface preservative. The insulation is adequately secured to prevent significant blockage of the ventilation passages in case of failure of a single attachment (strap, clamp, bolt or other attachment hardware). The following table provides the acceptance criteria for the selection of insulation material for the Divider Shell and ranks them in order of importance.

Acceptance Criteria for the Selection of the Insulation Material	
Rank	**Criteria**
1	Adequate thermal resistance
2	Adequate high temperature resistance
3	Adequate humidity resistance
4	Adequate radiation resistance
5	Adequate resistance to the ambient environment
6	Sufficiently low chloride leachables
7	Adequate integrity and resistance to degradation and corrosion during long-term storage

Kaowool® ceramic fiber insulation [3.I.20] is selected as one that satisfies the acceptance criteria to the maximum degree. The Kaowool® insulation material provides excellent resistance to chemical attack and is not degraded by oil or water. Alternatively, a Holtec approved equivalent that meets the acceptance criteria set forth in the table above may be used.

The CEC Container Shell, which is exposed to the substrate, requires additional pre-emptive measures to prevent corrosion, if the substrate is of aggressive chemistry. This subsection provides a description of corrosion mitigation measures required to be implemented to protect the HI-STORM 100 VVM. Because the guiding principle in the HI-STORM Systems is to target a service life of 100 years so as to guarantee a design life of 60 years, these corrosion prevention measures are in addition to the preemptively incorporated standard corrosion allowance of 1/8-inch applied to the subterranean parts of the CEC in direct contact with the surrounding substrate. Calculation of the required CEC Container Shell and Bottom Plate thicknesses on a site-specific basis may indicate the availability of an additional corrosion reserve.

Soil Corrosivity and Corrosion Mitigation Measures for the Exterior of the CEC

Corrosion mitigation of the exterior of the CEC warrants special consideration for the following reasons: (i) inaccessibility of the exterior coated surface after installation (ii) potential for a highly aggressive (i.e., corrosive) soil environment at certain sites, and (iii) potential for a high radiation field. Since the buried configuration will not allow for the reapplication of surface preservative, corrosion mitigation measures shall be determined after careful evaluation of the soil's corrosivity at the user's ISFSI site.

To evaluate soil corrosivity, a "10 point" soil-test evaluation procedure, in accordance with the guidelines of Appendix A of ANSI/AWWA C105/A21 [3.I.4], will be utilized. The classical soil evaluation criteria in the aforementioned standard focuses on parameters such as: 1) resistivity, 2) pH, 3) redox (oxidation-reduction) potential, 4) sulfides, 5) moisture content, 6) potential for stray current, and 7) experience with existing installations in the area. Using the procedure outlined in ref. [3.I.4], the ISFSI soil environment corrosivity is categorized as either "mild" for a soil test evaluation resulting in 9 points or less or "aggressive" for a soil test evaluation resulting in 10

Acceptance Criteria for the Selection of Coatings	
Rank	**Criteria**
2a	compatible with the ICCPS (if used) • adequate dielectric strength • adequate resistance to cathodic disbondment
2b	compatible with concrete encasement (if used) • adequate resistance to high alkalinity
3	adequate radiation resistance
4	adequate adhesion to steel
5	adequate bendability/ductility/cracking resistance/abrasion resistance
6	adequate strength to resist handling abuse and substrate stress

The Keeler & Long polyamide-epoxy coating is selected as one that satisfies the acceptance criteria to the maximum degree. Alternatively, a Holtec approved equivalent that meets the acceptance criteria set forth in the table above may be used.

ii. Concrete Encasement

The CEC concrete encasement shall provide a minimum of 5 inches of cover to provide a pH buffering effect for additional corrosion mitigation. The above concrete cover thickness has been conservatively determined for a 100-year service life in a strongly aggressive environment based on the concrete corrosion/degradation data provided in the literature [3.I.12, Table 5.3] (1.2 mm/yr surface depth failure rate). The required 5 inch minimum thickness is more conservative than that recommended in ACI Codes, such as ACI 318 [3.3.2], which call for up to 3 inches of concrete cover over steel reinforcement in aggressive environments. Considering that the concrete encasement is restricted to mild soil environments (unless used in conjunction with cathodic protection) and has a non-structural role, the 5 inch concrete encasement thickness is considered more than sufficient to provide reasonable assurance that a 60 year service life can be achieved. The lowest part of the CEC sits in a recessed region of the Support Foundation with an annular gap normally filled with substrate. If present, the CEC concrete encasement slurry will fill this annular gap during construction.

The function of the concrete encasement is for corrosion mitigation only; however, cracks larger than hairline cracks may significantly reduce its effectiveness. To control size and population of cracks, concrete reinforcement is included. The following reinforcement methods may be applied:

a. Fiber reinforcement: Fiber reinforcement may be of several materials, including steel, glass and plastic (polypropylene). The selection of the fiber reinforcement material shall be such that adequate resistance to radiation and high alkalinity is maintained. If using steel fibers, adequate damage protection of the CEC coating shall be ensured during concrete placement per written procedures. Steel fiber shall be implemented using written procedures and the applicable guidance from ACI 544.3R [3.I.25] or a similar consensus code or standard.

3.I.4.8.2 Tornado Missile Protection during Construction

The number of VVMs in a HI-STORM 100U ISFSI may vary depending on a user's need. While there is a minimum spacing (pitch) requirement (see licensing drawing in Subsection 1.I.5), there is no limitation on the maximum spacing. Furthermore, a module array may have a non-rectangular external contour such as shown in the licensing drawing with a trapezoidal contour. Finally, an ISFSI may be constructed in multiple campaigns to allow the user to align the VVM cavity construction schedule with the plant's fuel storage needs. Any ISFSI constructed in one campaign shall have the following mandatory perimeter protection features:

i. The Radiation Protection Space (RPS) shall extend to an appropriate distance beyond the outer surface of the CEC shell (see licensing drawing in Subsection 1.I.5). Calculations have been performed [3.I.27] that confirm that a 10' distance beyond the outer surface of the CEC shell is sufficient to prevent the 8" diameter rigid cylindrical missile (defined in Table 2.I.1 and is the most penetrating of the missile types considered in this FSAR) from contacting the CEC shell should this missile strike the exposed cut from the adjacent construction. The penetration analysis conservatively assumed a subgrade with minimum resistance to missile penetration and the formulation described in [3.I.30].
ii. Unless a retaining wall (see licensing drawing) has been built to confine and retain the subgrade at the boundary of the RPS (or beyond) in the particular direction of excavation, an Excavation Exclusion Zone (EEZ) shall be defined within which any excavation activity during an operating ISFSI is prohibited (see Subsection 2.I.2). The retaining wall is the EEZ boundary if the retaining wall is located at or beyond the RPS.

3.I.4.9 HI-STORM 100U VVM Service Life

The VVM is engineered for 40 years of design life, while satisfying the conservative design requirements defined in Supplement 2.I. For information supporting the 40 year design life addressing chemical and galvanic reactions as well as other potentially degrading factors see Subsection 3.I.4.1. Requirements for periodic inspection and maintenance of the HI-STORM 100U VVM throughout the 60-year design life are defined in Supplement 9.I. The VVM is designed, fabricated, and inspected under the comprehensive Quality Assurance Program discussed in Chapter 13.

3.I.5 FUEL RODS

No new analysis of fuel rods is required for storage of an MPC in a HI-STORM 100U VVM.

3.I.6 SUPPLEMENTAL DATA

3.I.6.1 Additional Codes and Standards Referenced in HI-STORM 100 System Design and Fabrication

No additional Codes and Standards are added for the HI-STORM 100U system.

The creep effect would tend to shorten the fuel basket under the self-weight of the basket. An illustrative calculation of the cumulative reduction of the basket length is presented below to demonstrate the insignificant role of creep in the MPC-68M fuel basket.

The in-plane compressive stress, σ, at height x in the basket panel is given by

$$\sigma = \rho(H-x) \tag{3.III.1}$$

where:
ρ = weight density of Metamic-HT
H = height of the fuel basket

Using the above stress equation, the total creep shrinkage, δ, is given by

$$\delta = \int_{o}^{H} f(\sigma, T)dx \tag{3.III.2}$$

where:
T = panel's metal temperature (conservatively assumed to be 375°C for a period of 60 years)
H = height of the basket (conservatively assumed to be 200 inches)

Using the creep equation (provided in [1.III.3]) and performing the above integration numerically yields δ = 0.138 inch. In other words, the computed shrinkage of the basket is less than 0.069% of its original length. Therefore, it is concluded that for the vertical storage configuration the creep effects of the MPC-68M fuel basket are insignificant due to absence of any meaningful loads on the panels. Therefore, creep in the Metamic-HT fuel basket is not a matter of safety concern.

ii) Fuel Basket Boron Depletion

The similarities between Metamic-HT and Metamic (classic) neutron absorbers and their exposure to the same long-term conditions of storage in the HI-STORM 100 system provide a logical basis to expect negligible neutron absorber boron depletion in Metamic-HT. Thus, sufficient levels of boron are present in the fuel basket to maintain criticality safety over the 60-year design life of the MPC.

3.III.4.12.2 Basket Shim Considerations:

i) Basket Shim Creep

Like the fuel basket, the basket shims are not subject to any significant loading during storage. The ability of the basket shims (made of a creep resistant aluminum alloy) has been evaluated and qualified in Docket No. 71-9325 [2.III.6.2] for transport applications where the stress level (in horizontal configuration) is significant. Therefore, in light of the minuscule stress levels from self-weight in long-term storage, creep is ruled out as a viable concern for the basket shims.

6.1 DISCUSSION AND RESULTS

In conformance with the principles established in NUREG-1536 [6.1.1], 10CFR72.124 [6.1.2], and NUREG-0800 Section 9.1.2 [6.1.3], the results in this chapter demonstrate that the effective multiplication factor (k_{eff}) of the HI-STORM 100 System, including all biases and uncertainties evaluated with a 95% probability at the 95% confidence level, does not exceed 0.95 under all credible normal, off-normal, and accident conditions. Moreover, these results demonstrate that the HI-STORM 100 System is designed and maintained such that at least two unlikely, independent, and concurrent or sequential changes must occur to the conditions essential to criticality safety before a nuclear criticality accident is possible. These criteria provide a large subcritical margin, sufficient to assure the criticality safety of the HI-STORM 100 System when fully loaded with fuel of the highest permissible reactivity.

Criticality safety of the HI-STORM 100 System depends on the following four principal design parameters:

1. The inherent geometry of the fuel basket designs within the MPC (and the flux-trap water gaps in the MPC-24 and MPC-24E);

2. The incorporation of permanent fixed neutron-absorbing panels in the fuel basket structure;

3. An administrative limit on the maximum enrichment for PWR fuel and maximum planar-average enrichment for BWR fuel; and

4. An administrative limit on the minimum soluble boron concentration in the water for loading/unloading fuel with higher enrichments in the MPC-24 and MPC-24E, and for loading/unloading fuel in the MPC-32.

The off-normal and accident conditions defined in Chapter 2 and considered in Chapter 11 have no adverse effect on the design parameters important to criticality safety, and thus, the off-normal and accident conditions are identical to those for normal conditions.

The HI-STORM 100 System is designed such that the fixed neutron absorber will remain effective for a storage period greater than 60 years, and there are no credible means to lose it. Therefore, in accordance with 10CFR72.124(b), there is no need to provide a surveillance or monitoring program to verify the continued efficacy of the neutron absorber.

manufacturing tolerances are not assembly dependent, these dimensional assumptions were employed for the criticality analyses.

As demonstrated in this section, design parameters important to criticality safety are: fuel enrichment, the inherent geometry of the fuel basket structure, the fixed neutron absorbing panels and the soluble boron concentration in the water during loading/unloading operations. As shown in Chapter 11, none of these parameters are affected during any of the design basis off-normal or accident conditions involving handling, packaging, transfer or storage.

The MPC-32 criticality model uses a sheathing thickness of 0.075 inches, whereas the actual MPC-32 design uses a sheathing thickness of 0.035 inches. For the minimum cell pitch of 9.158 inches, the thicker sheathing results in a slightly smaller cell ID of 8.69 inches (minimum), compared to 8.73 inches (minimum) for the thinner sheathing. To demonstrate that the dimensions used in the criticality model are acceptable and conservative, calculations were performed for both sheathing thicknesses and the results are compared in Table 6.3.5. To bound various soluble boron levels, two comparisons were performed. The first comparison uses the bounding case for the MPC-32 (see Table 6.1.6), which is for assembly class 15x15F at 5 wt% ^{235}U and a soluble boron level of 2600 ppm. To bound lower soluble boron levels, the second comparison uses the same assembly class (15x15F), 0 ppm soluble boron (i.e. pure water), and an arbitrary enrichment of 1.7 wt% ^{235}U. In both comparisons, the results of the 0.075 inch sheathing are slightly higher, i.e. more conservative, than the results for 0.035 inch sheathing, although the differences are within the statistical uncertainties. Using a sheathing thickness of 0.075 inches in the criticality models of the MPC-32 is therefore acceptable, and potentially more conservative, than using the actual value of 0.035 inches. This validates the choice of the dimensional assumptions for the MPC-32 shown in Table 6.3.3, which are used for all further MPC-32 criticality calculations, unless otherwise noted.

6.3.2 Cask Regional Densities

Composition of the various components of the principal designs of the HI-STORM 100 System are listed in Table 6.3.4.

The HI-STORM 100 System is designed such that the fixed neutron absorber will remain effective for a storage period greater than 60 years, and there are no credible means to lose it. A detailed physical description, historical applications, unique characteristics, service experience, and manufacturing quality assurance of fixed neutron absorber are provided in Section 1.2.1.3.1.

The continued efficacy of the fixed neutron absorber is assured by acceptance testing, documented in Section 9.1.5.3, to validate the ^{10}B (poison) concentration in the fixed neutron absorber. To demonstrate that the neutron flux from the irradiated fuel results in a negligible depletion of the poison material over the storage period, an MCNP4a calculation of the number of neutrons absorbed in the ^{10}B was performed, and is shown in Subsection 3.4.12, and shows that the reduction

6.6 REGULATORY COMPLIANCE

This chapter documents the criticality evaluation of the HI-STORM 100 System for the storage of spent nuclear fuel. This evaluation demonstrates that the HI-STORM 100 System is in full compliance with the criticality requirements of 10CFR72 and NUREG-1536.

Structures, systems, and components important to criticality safety, as well as the limiting fuel characteristics, are described in sufficient detail in this chapter to enable an evaluation of their effectiveness.

The HI-STORM 100 System is designed to be subcritical under all credible conditions. The criticality design is based on favorable geometry and fixed neutron poisons (Boral). An appraisal of the fixed neutron poisons has shown that they will remain effective for a storage period greater than 60 years, and there is no credible way to lose it, therefore there is no need to provide a positive means to verify their continued efficacy as required by 10CFR72.124(b).

The criticality evaluation has demonstrated that the cask will enable the storage of spent fuel for a minimum of 60 years with an adequate margin of safety. Further, the evaluation has demonstrated that the design basis accidents have no adverse effect on the design parameters important to criticality safety, and therefore, the HI-STORM 100 System is in full compliance with the double contingency requirements of 10CRF72.124. Therefore, it is concluded that the criticality design features for the HI-STORM 100 System are in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria have been satisfied. The criticality evaluation provides reasonable assurance that the HI-STORM 100 System will allow safe storage of spent fuel.

Appendix 9.A Aging Management Program

In accordance with the renewed HI-STORM 100 license, sites must implement an aging management program. An aging management assessment of the components of the HI-STORM 100 system was performed. This review identified inspection and monitoring activities necessary to provide reasonable assurance that system components within the scope of license renewal continue to perform their intended functions consistent with the current licensing basis for the renewed operating period. This section describes those aging management programs.

9.A.1 Aging Management Programs

The following apply to Amendments 0 through 15.

9.A.1.1 MPC AMP

The MPC AMP uses inspections to look for visual evidence of discontinuities and imperfects, such as localized corrosion, including pitting corrosion and stress corrosion cracking of the canister welds and heat affected zones. The full program is described in Table 9.A.1-1.

9.A.1.2 Overpack AMP

The Overpack AMP uses inspections to look for indication of deterioration that might affect the ability of the overpack to perform its important to safety function. The full program is described in Table 9.A.1-2.

9.A.1.3 Transfer Cask AMP

The Transfer Cask AMP utilizes inspections to ensure that the equipment maintains its intended function through the extended storage period. The full program is described in Table 9.A.1-3.

9.A.1.4 High Burnup Fuel Assembly AMP

The high burnup fuel assembly AMP only applies to systems that store high burnup fuel. The AMP relies on the EPRI and DOE research project on high burnup fuel. The full program is described in Table 9.A.1-4.

9.A.1.5 100U Concrete AMP

The 100U Concrete AMP only applies to sites that utilize the HI-STORM 100U system. The AMP uses condition monitoring to manage aging effects above and below ground. The full program is described in Table 9.A.1-5.

Table 9.A.1-1 MPC AMP

Element	**Description**
1. Scope of Program	This program covers MPCs stored under the HI-STORM 100 CoC, and the subcomponents identified in Table 3.3-1.
2. Preventative Actions	This AMP uses condition monitoring to manage aging effects. Preventative actions to minimize corrosion and stress corrosion cracking were taken during fabrication. Namely, stainless steel material was used to provide corrosion resistance, and fabrication controls were in place at the time of manufacture. These preventative actions minimize the likelihood of aging effects, but do not replace the need for condition monitoring during the extended storage period. No new preventative actions are included in this AMP.
3. Parameters Monitored / Inspected	The MPC AMP uses inspections as described below to look for visual evidence of discontinuities and imperfections, such as localized corrosion, including pitting corrosion and stress corrosion cracking of the accessible canister welds and weld heat affected zones. The inspections also look for the appearance and location of deposits on the canister surfaces.
4. Detection of Aging Effects	A visual inspection of the MPC surface shall be performed using a boroscope (or equivalent). The boroscope (or equivalent) inspection shall look at the accessible areas of the MPC surface, while the MPC remains in the overpack with the overpack lid installed. This visual inspection shall meet the requirements of a VT-3 Examination, as given in the ASME Boiler & Pressure Vessel Code (B&PVC) Section XI, Article IWA-2200, to the extent practical. The inspection shall be performed on one canister at each site that uses the HI-STORM 100 System. Note that if a site has more than one type of canister (for example, MPC-68 and MPC-68Ms), only one canister needs to be inspected. The selection criteria for choosing the canister to inspect should consider the following: • EPRI Susceptibility Criteria (Technical Report 3002005371) • Canister Age • Canister with Lowest Heat Load • Canister with specific previously identified manufacturing deviation Alternatively, a site may choose to take credit for an inspection done at a different site, as long as the inspection can be shown to have been performed on a reasonably comparable or bounding canister based on the same criteria listed above.

	The inspection shall be performed by a qualified individual on one canister at a site at a frequency of 5 years (+/- 1.25 years). The first inspection should occur within 365 days of the 20th anniversary of initial overpack loading at the site or within 365 days of the issuance of the renewed license, whichever is later. It is recommended that the same canister be used for each inspection to allow for the best continued monitoring and trending. It is recommended that sites schedule the MPC inspection concurrently with the Overpack Interior Inspection for ALARA purposes. At the discretion of the inspector, the inspection of selected areas on the MPC may be upgraded to the VT-1 standard, as described in ASME Section XI, Article IWA-2200, to the extent practical.
5. Monitoring and Trending	The documented inspection results should provide the ability to monitor and trend the appearance of the canister, it is recommended that the inspection video / photos be retained for comparison in subsequent examinations. Changes to the size and location of any areas of discoloration, localized corrosion, and/or stress corrosion cracking should be identified and documented for subsequent inspections.
6. Acceptance Criteria	Inspection Results Requiring No Further Evaluation No indication of localized corrosion pits, etching, stress corrosion cracking, red-orange colored corrosion products in the vicinity of canister welds. Minor surface corrosion (not pitting) is acceptable. Inspection Results Requiring Additional Evaluation Indications of interest that are subject to additional examination and disposition through the corrective action program include: • Localized corrosion pits, stress corrosion cracking, and etching; deposits or corrosion products • Discrete red-orange colored corrosion products especially those adjacent to fabrication welds, closure welds, locations where temporary attachments may have been welded to and subsequently removed from the MPC and the weld heat affected zones of these areas • Linear appearance of any color of corrosion products of any size parallel to or traversing fabrication welds, closure welds, and the weld heat affected zones of these areas. • Red-orange colored corrosion products greater than 1 mm in

	diameter combined with deposit accumulations in any location of the stainless steel canister • Red-orange colored corrosion tubercles of any size Alternatively, a general licensee may use acceptance criteria in an ASME Code for canister inspections that has been endorsed by the NRC. If indications requiring additional evaluation are found, issue would be entered into the site's corrective action program and an engineering evaluation would be performed to determine the extent and impact of the corrosion on the component's ability to perform its intended function.
7. Corrective Actions	The corrective actions performed based on any detected aging effects are in accordance with the site's Quality Assurance (QA) program. The QA Program ensures that corrective actions are completed. The QA program and corrective action program will determine any necessary actions, identify any changes to the existing AMP, and determine if the condition is reportable, as applicable. The corrective actions will also identify any actions needed to be taken for increased sample size, scope, or frequency of inspections as necessary, based on any detected aging effects. The corrective action program will also identify any dispositions needed from Holtec.
8. Confirmation Process	The confirmation process will be commensurate with the site QA program. The QA program ensures that inspections, evaluations, and corrective actions are completed and extent of condition is considered.
9. Administrative Controls	The site QA program and implementing procedures for this AMP will address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. This AMP will be updated, as necessary, based on the toll gate assessments described in Section 4 of this application. Inspection results will be documented and made available for NRC inspection as necessary.
10. Operating Experience	Previous Operating Experience No cases of chloride induced stress corrosion cracking for stainless steel dry storage canisters have been reported. Inspections of dry storage

	canisters after 20 years in service have been conducted at a few ISFSI sites [C.1.1 and C.1.2]. No evidence of localized corrosion was identified but some amount of chloride-containing salts were determined to be present and corrosion products believed to be related to iron contamination were identified. Section 3.1.2 of this application summarizes HI-STORM 100 MPC operating experience, which indicates very minimal corrosion detected to date. Future Operating Experience As the MPC inspections are performed, sites will upload information into the INPO AMID database to be shared with other users.

Table 9.A.1-2 Overpack AMP

Element	**Description**
1. Scope of Program	This program covers the subcomponents of the HI-STORM 100 Overpack identified in Table 3.3-2, which require the Overpack AMP to ensure their continued operation into the extended storage period. The AMP has two main parts: one for the internal areas and one for the external areas of the cask.
2. Preventative Actions	This AMP uses condition monitoring to manage aging effects. The design of the system is intended to minimize aging effects, but this AMP focuses on condition monitoring. No new preventative actions are included in this AMP.
3. Parameters Monitored / Inspected	Overpack External The overpack exposed surfaces are visually examined for indication of surface deterioration. Degradation could affect the ability of the overpack to provide support to the MPCs, to provide radiation shielding, to provide missile shielding, or to provide a path for heat transfer. The items inspected should cover (but are not limited to) those listed below: • Lid studs and nuts or lid closure bolts, as accessible • The accessible overpack body and lid painted surfaces • Vents • Anchor hardware, if used Overpack Internal The internal surfaces of the overpack are inspected for indications of corrosion and coating degradation. These indications may impact the long term ability of the cask to meet its intended function.
4. Detection of Aging Effects	Overpack External The overpack external AMP is a visual inspection in order to detect any aging effects. The visual survey performed on all overpacks annually will identify the source of any staining or corrosion-related activity and the degree of damage. The visual survey is performed in accordance with site implementing procedures, and may be satisfied by continuing the overpack external surface (accessible) visual examination in the HI-STORM FSAR Table 9.2.1. Overpack Internal A visual inspection of the overpack annular space and the interior areas of the vents shall be performed using a boroscope (or equivalent). This visual inspection shall meet the requirements of a VT-3 Examination, as

	given in the ASME Boiler & Pressure Vessel Code (B&PVC) Section XI, Article IWA-2200, to the extent practical. The internal inspection shall be performed on one overpack at each site at a frequency of 5 years (+/- 1.25 years). The first inspection should occur within 365 days of the 20th anniversary of initial overpack loading at the site or within 365 days of the issuance of the renewed license, whichever is later. For ALARA reasons, it is recommended that the site use the overpack that contains the MPC used for the MPC AMP. Alternatively, a site may choose to take credit for an internal inspection done at a different site, as long as the inspection can be shown to have been performed on a reasonably comparable or bounding canister based on the same criteria listed above. The inspection shall be documented, including a detailed description of the surface condition and location of areas showing surface degradation.
5. Monitoring and Trending	The inspections and surveillances described for both the internal and external subcomponents of the overpack are performed periodically in order to identify areas of degradation. The results will be evaluated by a qualified individual, and areas of degradation not meeting established criteria will be entered into the corrective action program for resolution or more detailed evaluation. The results will be compared against previous inspections in order to monitor and trend the progression of the aging effects over time.
6. Acceptance Criteria	Overpack External The external metallic surfaces of the overpack are coated, and significant corrosion is not anticipated. Minor surface corrosion of the carbon steel surface is possible and does not require further evaluation. Corrosion such as pitting requires additional evaluation. Minor rust spots or indications of degraded coatings do not require further evaluation since they do not compromise the ability of the overpack to maintain its function, but should be identified for trending purposes. Vents shall be free from obstructions. Overpack lid shall be relatively free of dents, scratches, gouges or other damage. Overpack Internal The internal metallic surfaces of the overpack are coated, and significant corrosion is not anticipated. Minor surface corrosion of the carbon steel surface is possible and does not require further evaluation. Corrosion

	such as pitting requires additional evaluation. Minor rust spots or indications of degraded coatings do not require further evaluation since they do not compromise the ability of the overpack to maintain its function, but should be identified for trending purposes. If indications requiring additional evaluation are found, issue would be entered into the site's corrective action program and an engineering evaluation would be performed to determine the extent and impact of the corrosion on the component's ability to perform its intended function.
7. Corrective Actions	The corrective actions performed based on any detected aging effects are in accordance with the site's Quality Assurance (QA) program. The QA Program ensures that corrective actions are completed. The QA program and corrective action program will determine any necessary actions, identify any changes to the existing AMP, and determine if the condition is reportable, as applicable. The corrective actions will also identify any actions needed to be taken for increased scope or frequency of inspections as necessary, based on any detected aging effects. The corrective action program will also identify any dispositions needed from Holtec.
8. Confirmation Process	The confirmation process will be commensurate with the site QA program. The QA program ensures that inspections, evaluations, and corrective actions are completed.
9. Administrative Controls	The site QA program and implementing procedures for this AMP will address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. This AMP will be updated, as necessary, based on the toll gate assessments described in Section 4 of this application. Inspection results will be documented and made available for NRC inspection as necessary.
10. Operating Experience	Previous Operating Experience Section 3.1.2 of this application summarizes HI-STORM 100 operating experience, which indicates very minimal corrosion detected to date, mostly limited to small rust spots and coating degradation. That operating experience has been incorporated into the guidance on inspections and acceptance criteria contained in this AMP.

	Future Operating Experience As the overpack inspections are performed, sites will upload information into the INPO AMID database to be shared with other users.

Table 9.A.1-3 Transfer Cask AMP

Element	**Description**
1. Scope of Program	The program covers the subcomponents of the Transfer Cask identified in Table 3.3-5 which require the Transfer Casks AMP, to operate into the extended storage period.
2. Preventative Actions	The Transfer Cask AMP utilizes inspections to ensure that the equipment maintains its intended function through the extended storage period. The design and materials of construction of the Transfer Cask were implemented to minimize aging effects, but no new preventative actions are included as part of this AMP.
3. Parameters Monitored / Inspected	The parameter inspected by the Transfer Cask AMP is visual evidence of degradation of external surfaces of the Transfer Cask and trunnions.
4. Detection of Aging Effects	The Transfer Cask AMP manages loss of material due to corrosion, predominately for coated steel components. The below lists provides the areas to be covered by the visual inspection, which will be implemented via detailed inspection procedures. • Painted surfaces • Lid surfaces • Lifting trunnions • Water jacket • Other accessible surfaces The inspection shall be performed prior to use of any Transfer Cask that has been in service longer than 20 years and at a minimum once a year while in use. Because the Transfer Cask is not used while loadings and unloadings are not occurring, pre-use inspections are most appropriate for the Transfer Cask. Periodic inspections when the Transfer Cask is not in use are not needed.
5. Monitoring and Trending	Visual inspections will determine the existence of loss of material on the external surfaces of the Transfer Cask, and observations regarding the material condition are recorded in accordance with inspection procedures and are corrected or evaluated as satisfactory before use of the Transfer Cask. Evaluation of this information during the preparations for MPC transfers provides adequate predictability and allows for corrective actions if

	necessary, prior to the need for the intended function of the component to be performed.
6. Acceptance Criteria	The Transfer Cask AMP consists of visual inspections as described above. The following results do not require further evaluation • All painted surfaces shall be free of degradation and chipped, cracked, or blistered paint • All lid surfaces shall be relatively free of dents, scratches, gouges, or other damage • Lifting trunnions shall be free of deformation, cracks, damage, corrosion, and excessive galling • The water jacket shall be free of leaks • All other accessible surfaces shall be free of dents, scratches, gouges, or other damage If degradation of material beyond the above is detected on any of the identified subcomponents within the Transfer Cask, the issue would be entered into the site's corrective action program and an engineering evaluation would be performed to determine the extent and impact of the corrosion on the Transfer Cask's ability to perform its intended function
7. Corrective Actions	If the engineering evaluation described above shows that the Transfer Cask has indications that exceed acceptable limits for the Transfer Cask to perform its intended function, the issue will be entered into the corrective action process. This process may result in supplemental inspections such as non-destructive examinations (NDE) being performed. The corrective action program will determine any necessary actions, identify any changes to the existing AMP, and determine if the condition is reportable, as applicable. The corrective actions will also identify actions needed for increased scope or frequency of inspections, as necessary, based on any detected aging effects.
8. Confirmation Process	The confirmation process will be commensurate with the site QA program. The QA program ensures that inspections, evaluations, and corrective actions are completed in accordance with the program.

9. Administrative Controls	The QA program and implementing procedures for this AMP will address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. This AMP will be updated, as necessary, based on the toll gate assessments described in Section 4 of this application. Inspection results will be documented and made available for NRC inspection as necessary.
10. Operating Experience	Previous Operating Experience Section 3.1.2 of this application summarizes HI-STORM 100 operating experience, which indicates very minimal corrosion detected to date, mostly limited to coating degradation. That operating experience has been incorporated into the guidance on inspections and acceptance criteria contained in this AMP. Future Operating Experience As the transfer cask inspections are performed, sites will upload information into the INPO AMID database to be shared with other users

Table 9.A.1-4 High Burnup Fuel Assembly AMP

Element	**Description**
1. Scope of Program	The scope of the program covers the components identified in Table 3.3-4 which require the High Burnup Fuel Assembly AMP, to operate into the extended storage period. This program is not applicable at sites that do not have high burnup fuel stored. Fuel stored in the HI-STORM 100 MPCs is limited to a burnup of 68,200 MWD/MTU (PWR) and 65,000 MWD/MTU (BWR). The cladding materials for the high burnup fuel are zirconium based and the fuel is stored in a dry helium environment. The program relies on the joint EPRI and DOE High Burnup Dry Storage Cask Research and Development Project (HDRP) conducted in accordance with the guidance in Appendix D of NUREG-1927, Rev 1, as a surrogate demonstration program that monitors the performance of high burnup fuel in dry storage. The HDRP is a program designed to collect data from an SNF storage system containing high burnup fuel in a dry helium environment. The program entails loading and storing a bolted lid cask (the "Research Project Cask"), with intact high burnup fuel of nominal burnups between 53 GWd/MTU and 58 GWD/MTU. The fuel to be used in the program includes four kinds of zirconium based cladding. The Research Project Cask is to be licensed to the temperature limits contained in ISG-11 Rev 3, and is loaded to reach temperatures as close to the limit as practicable. The parameters of the surrogate demonstration program are applicable to the HI-STORM 100 high burnup fuel, since the system burnup limits are approximately those being tested, the cladding is of the same type as those being tested, and the temperature limits of the fuel are the same as those being tested.
2. Preventative Actions	During the initial loading operations of the HI-STORM 100 system, the technical specifications require that the fuel be stored in a dry, inert environment. These requirements ensure that the high burnup fuel is stored in an inert environment, preventing cladding degradation due to oxidation mechanisms. The canisters are also loaded in accordance with

	the temperature criteria of ISG-11, which minimizes the impacts of degradation mechanisms on the fuel. There are no additional specific preventative actions included as part of the AMP.
3. Parameters Monitored / Inspected	The surrogate demonstration program monitors and inspects fuel parameters as described in the HDRP.
4. Detection of Aging Effects	The surrogate demonstration program detects aging effects as described in the HDRP.
5. Monitoring and Trending	As information / data from the HDRP become available, the site will monitor, evaluate, and trend the information via its operating experience program and /or corrective action program to determine what actions should be taken. The site will evaluate the information / data from the HDRP to determine whether the acceptance criteria in Element 6 of this AMP are met. • If all of the acceptance criteria are met, no further assessment is needed. • If any of the acceptance criteria are not met, the licensee must conduct additional assessments and implement appropriate corrective actions (see Element 7 of this AMP). Note that the site may use evaluations/assessments provided by Holtec to determine whether the acceptance criteria are met. Formal evaluations of the aggregate information from the HDRP, available operating experience, NRC-generated communications, and other information will be performed at specific points as described in Chapter 4 of this application.
6. Acceptance Criteria	The HDRP acceptance criteria are: • Hydrogen content – Maximum hydrogen content of the cover gas over the approved storage period should be extrapolated from the gas measurements to be less than the design-bases limit for hydrogen content • Moisture content – the moisture content in the canister (accounting for measurement uncertainty) should be determined to be acceptable • Fuel condition / performance – nondestructive and destructive examinations should confirm the design-bases fuel condition

	(i.e., no changes to the analyzed fuel configuration considered in the safety analyses of the approved design bases Note that because the cask design to be used in the HDRP is different from the HI-STORM 100, the acceptance criteria will be based on the Research Cask design bases. If the fuel in the Research Cask meets the applicable design bases, the fuel in the HI-STORM 100 should also meet its design bases, as described in Element 1.
7. Corrective Actions	If the acceptance criteria described above are not met, the issue will be entered into the corrective action process. The corrective action program will determine any necessary actions, identify any changes to the existing AMP, and determine if the condition is reportable, as applicable. The corrective actions will also identify actions needed for increased scope or frequency of inspections, as necessary, based on any detected aging effects.
8. Confirmation Process	The confirmation process will be commensurate with the site QA program. The QA program ensures that inspections, evaluations, and corrective actions are completed in accordance with the program.
9. Administrative Controls	The QA program and implementing procedures for this AMP will address record retention requirements and document control. This AMP will be updated, as necessary, based on the toll gate assessments described in Section 4 of this application. Inspection results will be documented and made available for NRC inspection as necessary.
10. Operating Experience	Future Operating Experience As the HDRP continues information will be uploaded into the INPO AMID database

Table 9.A.1-5 100U Concrete AMP

Element	**Description**
1. Scope of Program	The program covers the 100U concrete identified in Table 3.3-2 which require the 100U Concrete AMP.
2. Preventive Actions	This AMP uses condition monitoring to manage aging effects. The design of the system is intended to minimize aging effects, but this AMP focuses on condition monitoring. No new preventive actions are included in this AMP.
3. Parameters Monitored / Inspected	The accessible and exposed surfaces are visually examined for indication of surface deterioration. Degradation could affect the ability of the concrete to provide support to the VVMs, to provide radiation shielding, to provide missile shielding, or to provide a path for heat transfer. The inlet and outlet vents are monitored by visual inspection to ensure they are not obstructed. For inaccessible areas, groundwater monitoring is performed every 5 years for evidence of concrete degradation.
4. Detection of Aging Effects	The AMP is a visual inspection in order to detect any aging effects. The visual survey will identify the source of any staining or corrosion-related activity and the degree of damage. This visual inspection identifies the current condition of the structure and can identify the extent and cause of any aging effect noted. This visual inspection is conducted annually by an individual meeting the qualification requirements of per ACI-349, and includes all accessible areas on the pad. Settlement of the pad will be confirmed to be within the design basis using methodology from ACI349.3R-02. Groundwater monitoring performed every 5 years will determine if any degradation of the system from inaccessible areas is occurring. Data from all inspection and monitoring activities, including evidence of degradation and its extent and location, shall be documented on a checklist or inspection form. The results for the inspection will be documented, including descriptions of observed aging effects and supporting sketches, photographs or video.
5. Monitoring and Trending	Monitoring and trending methods are commensurate with consensus defect evaluation guides and standards. These may include standards such as ACI 201.1R, ACI 207.3R, ACI 364.1R, ACI 562, or ACI 224.1R, as applicable. The inspections and surveillances described for reinforced concrete are performed periodically in order to identify areas of degradation. The results will be evaluated by a qualified individual, and areas of degradation

	not meeting established criteria will be entered into the site's CAP for resolution or more detailed evaluation. The results from both the visual inspection and groundwater monitoring will be compared against previous inspections in order to monitor and trend the progression of the aging effects over time.
6. Acceptance Criteria	American Concrete Institute Standard 349.3R-02 includes quantitative three-tier acceptance criteria for visual inspections of concrete surfaces, namely (1) acceptance without further evaluation, (2) acceptance after review, and (3) acceptance requiring further evaluation. Acceptable signifies that a component is free of significant deficiencies or degradation that could lead to the loss of structural integrity. Acceptable after review signifies that a component contains deficiencies or degradation but will remain able to perform its design basis function until the next inspection or repair. Acceptance requiring further evaluation signifies that a component contains deficiencies or degradation that could prevent (or could prevent prior to the next inspection) the ability to perform its design basis function. Degradations or conditions meeting the ACI349.3R-02 Tier 2 and 3 criteria will be entered into the site's CAP for evaluation and resolution. The loss of material due to age-related degradation of ISFSI pad subcomponents will be evaluated by a qualified person in accordance with ACI 349.3R-02. A technical basis will be provided for any deviation from ACI349.3R-02 acceptance criteria. Any groundwater indications of concrete degradation will be entered into the corrective action program.
7. Corrective Actions	Corrective actions performed based on unacceptable effects will be in accordance with the ISFSI Quality Assurance (QA) program. The QA Program ensures that corrective actions are completed within the ISFSI Corrective Action Program (CAP). As applicable per the CAP program, ISFSI staff will determine any necessary actions, identify any changes to the existing AMP, and determine if the condition is reportable. Corrective actions will also identify the actions needed for increased scope or frequency of inspections, as necessary, based on any detected aging effects.
8. Confirmation Process	The confirmation process will be commensurate with the ISFSI QA Program. The QA program ensures that inspections, evaluations, and corrective actions are completed in accordance with the ISFSI CAP.

9. Administrative Controls	The ISFSI QA program and implementing procedures for this AMP will address instrument calibration and maintenance, inspector requirements, record retention requirements, and document control. This AMP will be updated periodically, as necessary, based on the tollgate assessments described in Chapter 4 of this application. Inspection results will be documented and made available for NRC inspectors to view upon request.
10. Operating Experience	The ISFSI pad will be inspected before the CEC is placed in accordance with existing operating procedures. The overall effectiveness of these inspections in maintaining the condition and functionality of the ISFSI Pad.

9.A.2 Tollgates

Tollgates are established as requirements in the renewed CoC, and implemented by ISFSI generic licensees to evaluate aging management feedback and perform a safety assessment that confirms the safe storage of spent nuclear fuel. The impact of the aggregate feedback will be assessed by the site as it pertains to components at the site's ISFSI and actions taken as necessary, such as:

- Adjustment of aging-related degradation monitoring and inspection programs in AMPs
- Modification of TLAAs
- Performance of mitigation activities

Each tollgate assessment will address the following elements as applicable:

- Summary of research findings, operating experience, monitoring data, and inspection results made available since last assessment
- Aggregate impact of findings, including any trends
- Consistency of data with the assumptions and inputs in the TLAAs
- Effectiveness of AMPs
- Corrective actions, including any changes to AMPs
- Summary and conclusions

A schedule for these tollgate assessments is shown in Table 9.A.2-1.

Table 9.A.2-1: Tollgate Assessments for General Licensees

Tollgate	Year	Assessment
1	Year of first canister loading + 25 years	Evaluate information from the following sources (as available) and perform a written assessment of the aggregate impact of the information, including but not limited to trends, corrective actions required, and the effectiveness of the AMPs with which they are associated: • Results, if any, of research and development programs focused specifically on aging-related degradation mechanisms identified as potentially affecting the storage system and ISFSI site. One example of such research and development would be EPRI Chloride-Induced Stress Corrosion Cracking (CISCC) research. • Relevant results of other domestic and international research, which may include non-nuclear research • Relevant domestic and international operating experience, which may include non-nuclear operating experience • Relevant results of domestic and international ISFSI and dry storage system performance monitoring Much of this information can be gathered from the Aging Management INPO Database (AMID).
2	Year of first canister loading + 30 years	Evaluate additional information gained from the sources listed in Tollgate 1 along with any new relevant sources and perform a written assessment of the aggregate impact of the information. This evaluation should be informed by the results of Tollgate 1. The aging effects and mechanisms evaluated at this tollgate and the time at which it is conducted may be adjusted based on the results of the Tollgate 1 assessment.
3	Year of first canister loading + 35 years	Same as Tollgate 2 as informed by the results of Tollgates 1 and 2
4	Year of first canister loading + 40 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, and 3
5	Year of first canister loading + 45 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, and 4
6	Year of first canister loading + 50 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, 4, and 5
7	Year of first canister loading + 55 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, 4, 5, and 6
8	Year of first canister loading + 60 years	Same as Tollgate 2 as informed by the results of Tollgates 1, 2, 3, 4, 5, 6, and 7

APPENDIX E: AGING MANAGEMENT CoC CHANGES

The proposed changes to the HI-STORM 100 CoC as a result of the renewal are shown in the attached. Note that they are only applied to the Amendment 15 CoC for convenience, but the same changes will be applied to all amendments being renewed.

CERTIFICATE OF COMPLIANCE FOR SPENT FUEL STORAGE CASKS

The U.S. Nuclear Regulatory Commission is issuing this Certificate of Compliance pursuant to Title 10 of the *Code of Federal Regulations*, Part 72, "Licensing Requirements for Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste" (10 CFR Part 72). This certificate is issued in accordance with 10 CFR 72.238, certifying that the storage design and contents described below meet the applicable safety standards set forth in 10 CFR Part 72, Subpart L, and on the basis of the Final Safety Analysis Report (FSAR) of the cask design. This certificate is conditional upon fulfilling the requirements of 10 CFR Part 72, as applicable, and the conditions specified below.

Certificate No.	Effective Date	Expiration Date	Docket No.	Amendment No.	Amendment Effective Date	Package Identification No.
1014	05/31/00	05/31/20	72-1014	15	TBD	USA/72-1014
	Renewed Effective Date TBD	Renewed Expiration Date TBD		Revision No. 0	Revision Effective Date NA	

Issued To: (Name/Address)

Holtec International
Holtec Technology Campus
One Holtec Blvd
Camden, NJ 081074

Safety Analysis Report Title

Holtec International Inc.,
Final Safety Analysis Report for the
HI-STORM 100 Cask System

CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 72, as applicable, the attached Appendix A (Technical Specifications) and Appendix B (Approved Contents and Design Features) for aboveground systems except Version E, HI-TRAC MS, MPC-32M, and Version 1 of MPC-32 and MPC-68; the attached Appendix C (Technical Specifications) and Appendix D (Approved Contents and Design Features) for the HI-STORM 100S Version E, HI-TRAC MS, MPC-32M, and Version 1 of MPC-32 and MPC-68M; or the attached Appendix A-100U (Technical Specifications) and Appendix B-100U (Approved Contents and Design Features) for underground systems, and the conditions specified below:

1. CASK

   a. Model No.: HI-STORM 100 Cask System

   The HI-STORM 100 Cask System (the cask) consists of the following components: (1) interchangeable multi-purpose canisters (MPCs), which contain the fuel; (2) a storage overpack (HI-STORM), which contains the MPC during storage; and (3) a transfer cask (HI-TRAC), which contains the MPC during loading, unloading and transfer operations. The cask stores up to 32 pressurized water reactor fuel assemblies or 68 boiling water reactor fuel assemblies.

   b. Description

   The HI-STORM 100 Cask System is certified as described in the Final Safety Analysis Report (FSAR) and in the U.S. Nuclear Regulatory Commission's (NRC) Safety Evaluation Report (SER) accompanying the Certificate of Compliance (CoC). The cask comprises three discrete components: the MPC, the HI-TRAC transfer cask, and the HI-STORM storage overpack.

   The MPC is the confinement system for the stored fuel. It is a welded, cylindrical canister with a honeycombed fuel basket, a baseplate, a lid, a closure ring, and the canister shell. All MPC components that may come into contact with spent fuel pool water or the ambient environment are made entirely of stainless steel or passivated aluminum/aluminum alloys such as the neutron absorbers. The canister shell, baseplate, lid, vent and drain port cover plates, and closure ring are the main confinement boundary components. All confinement boundary components are made entirely of stainless steel. The honeycombed basket, which contains neutron absorbing material, provides criticality control.

1. b. Description (continued)

There are twelve types of MPCs: the MPC-24, MPC-24E, MPC-24EF, MPC-32, MPC-32F, MPC-32 Version 1, MPC-32M, MPC-68, MPC-68 Version 1, MPC-68F, MPC-68FF, and MPC-68M. The number suffix indicates the maximum number of fuel assemblies permitted to be loaded in the MPC. All nine MPC models have the same external diameter.

The HI-TRAC transfer cask provides shielding and structural protection of the MPC during loading, unloading, and movement of the MPC from the spent fuel pool to the storage overpack. The transfer cask is a multi-walled (carbon steel/lead/carbon steel) cylindrical vessel with a neutron shield jacket attached to the exterior. All transfer cask sizes have identical cavity diameters. The higher weight HI-TRAC transfer casks have thicker shielding and larger outer dimensions than the lighter HI-TRAC transfer casks.

Above Ground Systems

The HI-STORM 100 or 100S storage overpack provides shielding and structural protection of the MPC during storage. The HI-STORM 100S is a variation of the HI-STORM 100 overpack design. The overpack is a heavy-walled steel and concrete, cylindrical vessel. Its side wall consists of plain (un-reinforced) concrete that is enclosed between inner and outer carbon steel shells. The overpack has air vents at the bottom and at the top to allow air to circulate naturally through the cavity to cool the MPC inside. A loaded MPC is stored within the HI-STORM 100 or 100S storage overpack in a vertical orientation. The HI-STORM 100A and 100SA are variants of the HI-STORM 100 family and are outfitted with an extended baseplate and gussets to enable the overpack to be anchored to the concrete storage pad in high seismic applications. The Version E can be arrayed in a free standing or anchored configuration

Underground Systems

The HI-STORM 100U System is an underground storage system identified with the HI-STORM 100 Cask System. The HI-STORM 100U storage Vertical Ventilated Module (VVM) utilizes a storage design identified as an air-cooled vault or caisson. The HI-STORM 100U storage VVM relies on vertical ventilation instead of conduction through the soil, as it is essentially a below-grade storage cavity. Air inlets and outlets allow air to circulate naturally through the cavity to cool the MPC inside. The subterranean steel structure is seal welded to prevent ingress of any groundwater from the surrounding subgrade, and it is mounted on a stiff foundation. The surrounding subgrade and a top surface pad provide significant radiation shielding. A loaded MPC is stored within the HI-STORM 100U storage VVM in the vertical orientation.

2. OPERATING PROCEDURES

Written operating procedures shall be prepared for cask handling, loading, movement, surveillance, and maintenance. The user's site-specific written operating procedures shall be consistent with the technical basis described in Chapter 8 of the FSAR.

3. ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

Written cask acceptance tests and maintenance program shall be prepared consistent with the technical basis described in Chapter 9 of the FSAR. 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. In the field, a helium leak test shall be performed on the vent and drain port confinement welds and cover plate base metal. 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 loaded prior to July 1, 2009, to Amendment Nos. 2 through 7 are grandfathered and therefore not required to comply with the above helium leak test requirements. For these casks the following applies:

- *For tests of the lid base metal, the casks must meet the requirements of the amendment to which they were initially loaded.*
- *Casks fabricated before July 1, 2009, do not require a leak test after shell to baseplate welding*
- *For casks fabricated after July 1, 2009, a helium leak test at completion of welding the MPC shell*

baseplate must be performed in accordance with the above requirements.

4. QUALITY ASSURANCE

Activities in the areas of design, purchase, fabrication, assembly, inspection, testing, operation, maintenance, repair, modification of structures, systems and components, and decommissioning that are important to safety shall be conducted in accordance with a Commission-approved quality assurance program which satisfies the applicable requirements of 10 CFR Part 72, Subpart G, and which is established, maintained, and executed with regard to the cask system.

5. HEAVY LOADS REQUIREMENTS

Each lift of an MPC, a HI-TRAC transfer cask, or any HI-STORM overpack must be made in accordance to the existing heavy loads requirements and procedures of the licensed facility at which the lift is made. A plant-specific review (under 10 CFR 50.59 or 10 CFR 72.48, if applicable) is required to show operational compliance with existing plant specific heavy loads requirements. Lifting operations outside of structures governed by 10 CFR Part 50 must be in accordance with Section 5.5 of Appendix A or Section 5.2 of Appendix C and Sections 3.4.6 and 3.5 (if applicable) of Appendix B or D, for above ground systems, section 5.5 of Appendix A-100U for the underground systems.

6. APPROVED CONTENTS

Contents of the HI-STORM 100 Cask System must meet the fuel specifications given in Appendices B or D as applicable for aboveground systems or B-100U for underground systems to this certificate.

7. DESIGN FEATURES

Features or characteristics for the site, cask or ancillary equipment must be in accordance with Appendices B or D, as applicable, for aboveground systems or B-100U for underground systems to this certificate.

8. CHANGES TO THE CERTIFICATE OF COMPLIANCE

The holder of this certificate who desires to make changes to the certificate, which includes Appendices A, C, and A-100U (Technical Specifications) and Appendices B, D, and B-100U (Approved Contents and Design Features), shall submit an application for amendment of the certificate.

9. SPECIAL REQUIREMENTS FOR FIRST SYSTEMS IN PLACE

a. For the storage configuration, each user of a HI-STORM 100 Cask and HI-STORM 100U Cask with a heat load equal to or greater than 20 kW shall perform a thermal validation test in which the user measures the total air mass flow rate through the cask system using direct measurements of air velocity in the inlet vents. The user shall then perform an analysis of the cask with the taken measurements to demonstrate that the measurements validate the analytic methods described in Chapter 4 of the FSAR. The thermal validation test and analysis results shall be submitted in a letter report to the NRC pursuant to 10 CFR 72.4 within 180 days of the user's loading of the first cask with heat load equal to or greater than 20 kW. To satisfy condition 9(a) for casks of the same system type (i.e., HI-STORM 100 casks, HI-STORM 100U casks), in lieu of additional submittals pursuant to 10 CFR 72.4, users may document in their 72.212 report a previously performed test and analysis submitted by letter report to the NRC that demonstrates validation of the analytic methods described in Chapter 4 of the FSAR.

b. For transfer configuration, each user of the HI-STORM 100 Cask and HI-STORM 100U Cask shall procure, if necessary, a Supplemental Cooling System (SCS) capable of providing the thermal-hydraulic characteristics (coolant temperature at the annulus inlet, coolant temperature located at the annulus outlet, and coolant flow rate) that will ensure that thermal limits (described in Appendix 2.C of the FSAR) are not exceeded during transfer operations. The thermal-hydraulic characteristics of the SCS shall be determined using the analytical methods described in Chapter 4 for the transfer configuration. For the transfer configuration, each first time user shall measure the SCS thermal-hydraulic characteristics to validate the performance of the SCS. The SCS analysis and validation shall be documented in an update to the 72.212 report within 180 days of the user's first transfer operation with the SCS. Condition 9(b) does not apply to the MPC-68M or the MPC-32M.

10. PRE-OPERATIONAL TESTING AND TRAINING EXERCISE

A dry run training exercise of the loading, closure, handling, unloading, and transfer of the HI-STORM 100 Cask System shall be conducted by the licensee prior to the first use of the system to load spent fuel assemblies. The training exercise shall not be conducted with spent fuel in the MPC. The dry run may be performed in an alternate step sequence from the actual procedures, but all steps must be performed. The dry run shall include, but is not limited to the following:

a. Moving the MPC and the transfer cask into the spent fuel pool or cask loading pool.

b. Preparation of the HI-STORM 100 Cask System for fuel loading.

c. Selection and verification of specific fuel assemblies to ensure type conformance.

d. Loading specific assemblies and placing assemblies into the MPC (using a dummy fuel assembly), including appropriate independent verification.

e. Remote installation of the MPC lid and removal of the MPC and transfer cask from the spent fuel pool or cask loading pool.

f. MPC welding, NDE inspections, pressure testing, draining, moisture removal (by vacuum drying or forced helium dehydration, as applicable), and helium backfilling. (A mockup may be used for this dry-run exercise.)

g. Operation of the HI-STORM 100 SCS or equivalent system, if applicable.

h. Transfer cask upending/downending on the horizontal transfer trailer or other transfer device, as applicable to the site's cask handling arrangement.

i. Transfer of the MPC from the transfer cask to the overpack/VVM.

j. Placement of the HI-STORM 100 Cask System at the ISFSI, for aboveground systems only.

k. HI-STORM 100 Cask System unloading, including flooding MPC cavity, removing MPC lid welds. (A mockup may be used for this dry-run exercise.)

11. The NRC has approved an exemption request by the CoC applicant from the requirements of 10 CFR 72.236(f), to allow a Supplemental Cooling System to provide for decay heat removal in accordance with Section 3.1.4 of Appendices A, C, and A-100U.

12. AUTHORIZATION

The HI-STORM 100 Cask System, which is authorized by this certificate, is hereby approved for general use by holders of 10 CFR Part 50 licenses for nuclear reactors at reactor sites under the general license issued pursuant to 10 CFR 72.210, subject to the conditions specified by 10 CFR 72.212, this certificate, and the attached Appendices A, B, A-100U, B-100U, C, and D as applicable. The HI-STORM 100 Cask System may be fabricated and used in accordance with any approved amendment to CoC No. 1014 listed in 10 CFR 72.214. Each of the licensed HI-STORM 100 System components (i.e., the MPC, overpack, and transfer cask), if fabricated in accordance with any of the approved CoC Amendments, may be used with one another provided an assessment is performed by the CoC holder that demonstrates design compatibility.

13. FSAR UPDATE FOR RENEWED COC

The CoC holder shall submit an updated FSAR to the Commission, in accordance with 10 CFR 72.4, within 90 days of the effective date of the renewal. The updated FSAR shall reflect the changes and CoC holder commitments resulting from the review and approval of the renewal of the CoC.

14. 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:

a. 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.

b. 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

c. 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.

15. AMENDMENTS AND REVISIONS FOR RENEWED COC

All future amendments and revisions to this CoC shall include evaluations of the impacts to aging management activities (i.e., time limited aging analyses and aging management programs to assure they remain adequate for any changes to SSCs within the scope of renewal.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

TBD, Chief
Licensing Branch
Division of Fuel Management
Office of Nuclear Material Safety
and Safeguards
Washington, DC 20555

Dated TBD

Attachments:

1. Appendix A
2. Appendix B
3. Appendix A-100U
4. Appendix B-100U
5. Appendix C
6. Appendix D

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ADMINISTRATIVE CONTROLS AND PROGRAMS

5.7 Radiation Protection Program (cont'd)

d. A minimum of five (5) dose rate measurements shall be taken on the top of the OVERPACK. One dose rate measurement shall be taken at approximately the center of the lid and four measurements shall be taken at locations on the top concrete shield, approximately half way between the center and the edge of the top concrete shield, 90 degrees apart around the circumference of the lid.

e. A dose rate measurement shall be taken on contact at the surface of each inlet and outlet vent duct screen of the OVERPACK.

5.8 Aging Management Program

Each general licensee shall have a program to establish, implement, and maintain written procedures for each AMP described in the FSAR. The program shall include provisions for changing AMP elements, as necessary, and within the limitations of the approved licensing bases to address new information on aging effects based on inspection findings and/or industry operating experience provided to the general licensee during the renewal period.

The general licensee shall establish and implement these written procedures within 365 days of the effective date of the renewal of the CoC or 365 days of the 20th anniversary of the loading of the first dry storage system at its site, whichever is later.

Each general licensee shall perform tollgate assessments as described in Chapter 9 of the FSAR.

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ADMINISTRATIVE CONTROLS AND PROGRAMS

5.4 Aging Management Program

Each general licensee shall have a program to establish, implement, and maintain written procedures for each AMP described in the FSAR. The program shall include provisions for changing AMP elements, as necessary, and within the limitations of the approved licensing bases to address new information on aging effects based on inspection findings and/or industry operating experience provided to the general licensee during the renewal period.

The general licensee shall establish and implement these written procedures within 365 days of the effective date of the renewal of the CoC or 365 days of the 20th anniversary of the loading of the first dry storage system at its site, whichever is later.

Each general licensee shall perform tollgate assessments as described in Chapter 9 of the FSAR.