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Mr. John Goshen
c/o Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

January 9, 2009

Subject: Comments on Draft Safety Evaluation Report, Certificate of Compliance, and Technical Specifications for HI-STORM 100 System CoC Amendment 6.
USNRC Docket No. 72-1014; TAC No. L24085

Dear Mr. Goshen:

Thank you for providing us the opportunity to review the draft Safety Evaluation Report (SER), Certificate of Compliance (CoC), and associated Technical Specifications (TS) for Amendment 6 to the HI-STORM 100 CoC. Enclosure 1 contains a marked up copy of the draft documents.

Thank you for your continued effort toward timely approval of this amendment to support anticipated utility needs.

Feel free to contact me if you have any questions.

Kindest regards,

Tammy Morin
Acting Licensing Manager
Holtec International

cc (letter only): Mr. Eric Benner, USNRC
Mr. Nader Mamish, USNRC
Holtec Group 1

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SAFETY EVALUATION REPORT

DOCKET NO. 72-1014

HOLTEC INTERNATIONAL

HI-STORM 100 CASK SYSTEM

CERTIFICATE OF COMPLIANCE NO. 1014

AMENDMENT NO. 6

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SUMMARY

By letter dated April 15,2008, as supplemented August 1, November 17, and November 26, 2008, Holtec International (Holtec) submitted an application to the United States Nuclear Regulatory Commission (NRC) to amend Certificate of Compliance (CoC) No. 1014 for the HI-STORM 100 Cask System (License Amendment Request (LAR) 1014-7, Revision 0), in accordance with U.S. Code of Federal Regulations, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste and Reactor-Related Greater than Class C Waste," Title 10, Part 72 (10 CFR Part 72). By letter dated August 19, 2008, the NRC staff, hereafter referred to as the staff, informed Holtec that the LAR 1014-7 application contained sufficient information for the staff to begin a technical review.

The amendment proposed to:

1. Modify the Technical Specifications (TS) to incorporate minor editorial changes.
2. Modify the TS to allow the use of instrument tube tie rods (ITTRs) to the approved contents of the MPC-24 and MPC-32 models presently included in the HI-STORM 100 CoC.

Certain PWR fuel assemblies with thimble tube sleeves manufactured from 304 stainless steel are susceptible to intergranular stress corrosion cracking (IGSCC) in the bulge region just below the top nozzle. This corrosion could result in the top nozzle separating from the fuel assembly when the assembly is lifted. Westinghouse Electric Corporation, LLC (Westinghouse), has developed the instrument tube tie rod (ITTR) to repair these types of assemblies. The ITTR is a stainless steel tube inserted into the central instrument tube. It extends from the top nozzle adapter plate to the bottom nozzle and reinforces the connection between the top nozzle and the rest of the fuel assembly. It is designed to carry the weight of the entire assembly to allow the fuel assembly to be handled with the standard fuel handling tool. Assemblies with the IGSCC that would otherwise be contained in Damaged Fuel Canisters (DFCs) and classified as "Damaged Fuel Assemblies" can be classified as ~~normal~~ fuel assemblies after installation of the ITTRs. However, fuel considered damaged because of ~~IGSCC, in addition to~~ other conditions such as cladding defects, would still be housed in DFCs ~~in addition to~~ containi~~ng~~ an ITTR. The ITTR is ~~applicable to~~ only the PWR 15x15 and 17x17 fuel types.

The HI-STORM 100 cask system is approved for eight different multi-purpose canisters (MPCs) that contain the fuel. Five of these MPCs are designed to contain 15x15 and/or 17x17 PWR fuel. These designs will include the ITTRs as part of the approved contents. These five designs are MPC-24, MPC-24E, MPC-24EF, MPC-32, and MPC-32F.

This Safety Evaluation Report (SER) documents the review and evaluation of the amended FSAR, supplemental materials, response to the staffs request noted above, and proposed CoC changes. The FSAR follows the format similar to that of the NRC, "Standard Review Plan for

Dry Cask Storage Systems," NUREG-1536, January 1997 (NUREG-1536) with differences implemented for clarity and consistency.

I. REVIEW CRITERIA

The staff's evaluations of the proposed changes are based on whether the applicant meets the applicable requirements of 10 CFR Part 72 for independent storage of spent fuel and of 10 CFR Part 20 for radiation protection. The staff's evaluation focused only on modifications requested in the LAR 1014-7 and did not reassess previously approved portions of the CoC, TS, and the FSAR or those areas of the FSAR modified by Holtec as allowed by 10 CFR 72.48. The technical objectives for the following review disciplines are as described below for each of the proposed changes.

Structural

The objective of the structural review is to assess the safety analysis of the structural design features, the structural design criteria, and the structural analysis methodology used to evaluate the expected structural performance capabilities under normal operations, off-normal operations, accident conditions and natural phenomena events for those structures, systems and components important to safety included in this amendment.

The review was conducted against the appropriate regulations as described in 10 CFR 72.236 that identify the specific requirements for spent fuel storage cask approval and fabrication. The unique characteristics of the spent fuel to be stored are identified as required by 10 CFR 72.236(a) so that the design basis and the design criteria that must be provided for the structures, systems, and components important to safety can be assessed under the requirements of 10 CFR 72.236(b). The proposed change was found to have an impact on the structural criteria of the contents of the HI STORM 100 Cask System.

Criticality

The objective of the criticality review is to ensure that the spent fuel will remain subcritical under all credible normal, off-normal, and accident conditions encountered during handling, packaging, transfer, and storage. The objective includes a review of the changes to the criticality design criteria, features and fuel specifications, verification and review of the configuration and material properties for the HI-STORM 100 Cask System, and a review of the criticality analyses that might include computer programs, benchmark comparisons, and multiplication factors proposed in LAR 1014-7.

The applicant proposed to modify the allowable contents to the HI-STORM 100 Cask System design and CoC. The staff reviewed the proposed changes to the HI-STORM 100 Cask System criticality safety analysis to ensure that all credible normal, off-normal, and accident conditions have been identified and their potential consequences on criticality considered such that the HI-STORM 100 Cask System, as revised, meets the following regulatory requirements: 10 CFR 72.124(a), 72.124(b), 72.236(c), and 72.236(g). The staff's review also involved a determination on whether the cask system fulfills the acceptance criteria listed in Section 6 of NUREG-1536.

II. GENERAL DESCRIPTION OF THE CASK DESIGN

The HI-STORM 100 Cask System is a dry cask storage system for spent light water reactor fuel. The system comprises three discrete components: the multi-purpose canister (MPC), the

HI-TRAC Transfer Cask, and the HI-STORM 100 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, with the exception of neutron absorber, aluminum seals on vent and drain port caps, and optional aluminum heat conduction elements, are constructed of stainless steel. The canister shell, baseplate, lid, vent and drain port cover plates, and closure ring are the main confinement boundary components. The honeycombed basket, which is equipped with neutron absorbers, provides criticality control. There are eight approved MPC designs; MPC-24, MPC-24E, and MPC-24EF which can contain a maximum of 24 pressurized water reactor (PWR) fuel assemblies; the MPC-32 and MPC-32F which can contain a maximum of 32 PWR fuel assemblies; and the MPC-68, MPC-68F, and MPC-68FF which can contain a maximum of 68 boiling water reactor (BWR) fuel assemblies. Vibration suppressors are considered integral non-fuel hardware consisting of zircaloy or stainless steel tubes.

The HI-TRAC transfer cask (TC) 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 HI-TRAC was previously reviewed and approved by the staff for the original application. No significant design changes were made to the HI-TRAC, as such the staff only reviewed the HI-TRAC with respect to whether it was affected by the proposed changes.

The HI-STORM 100 overpack provides shielding and structural protection of the MPC during storage. The overpack is a heavy-walled, steel and concrete, cylindrical vessel. In addition to the HI-STORM 100 overpack, there are three additional approved variations including the HI-STORM 100S, HI-STORM 100A, and the HI-STORM 100SA, and one proposed variation, the HI-STORM 100U currently under review by the staff (LAR 1014-6). The HI-STORM 100S is a shorter version of the HI-STORM 100. To accommodate the height change, the location of the air ducts and MPC pedestal height was modified. The HI-STORM 100A and 100SA are similar to the HI-STORM 100 and 100S overpacks except that they have a baseplate that is anchored to the concrete pad at the independent spent fuel storage installation (ISFSI). The HI-STORM 100A and 100SA overpacks may be used to store fuel in high seismic areas. The HI-STORM 100S, 100A, and 100SA overpacks were approved under Amendment 1 to CoC 1014.

The basic sequence of operations for the HI-STORM 100 Cask System is as follows: (1) the transfer cask, with the MPC inside, is lowered into the spent fuel pool and the MPC is loaded with spent nuclear fuel; (2) the transfer cask and loaded MPC are removed from the spent fuel pool and the MPC is drained, dried, welded closed, inspected, and backfilled with an inert gas; (3) the transfer cask is placed on top of the overpack and the MPC is lowered into the overpack; and (4) if necessary the overpack, with the MPC inside, is moved to the storage pad. A loaded HI-TRAC transfer cask can be handled vertically or horizontally. A loaded HI-STORM 100, 100S, 100A, and 100SA, overpack can only be moved vertically. The proposed HI-STORM 100U design can only be loaded in situ. MPC transfer between the transfer cask and overpack can be performed inside or outside a 10 CFR Part 50 controlled structure (e.g., a reactor building).

III. FINDINGS

The proposed changes were reviewed to the criteria and regulations described in Section II of this SER and a discussion of the staff review and findings are described for each below.

Proposed Change No. 1

The applicant proposed to modify the HI-STORM 100 Cask System No. 1014 Appendices A and B TS to make editorial corrections as follows:

a. TS Appendix A, Section 3.1.1, LCO 3.1.1, Required Action C.2 should be C.2.1.

b. TS Appendix B, Table 2.1-1, ~~IILA.1.e~~ III.A.1.e (currently the first e) - section should be changed to III.A.1.d ~~IILA.1.d~~ and the burnup units listed in ~~IILA.1.d.i~~ III.A.1.d (as corrected) should read ~~"(MWDIMTIHM)"~~ "(MWD/MTIHM)" instead of "(MTU/MTIHM)".

c. TS Appendix B, Table 2.1-1, ~~IILA.1.e.i~~ III.A.1.e.i (currently the second e) -the "6x6b" should be "6x6B".

d. TS Appendix B, Table 2.1-1, IV.A.1.g and V.A.1.g should be modified to remove the two instances of "and DFC" in each statement.

e. TS Appendix B, Table 2.1-1, V.A.2.d.ii - "Section 2.3" should be "Section 2.4"

Based on the NRC staff's review of information provided in the HI-STORM 100 Cask System LAR 1014-7, these modifications to the HI-STORM 100 Cask System CoC are editorial and have no affect on the applicable design and acceptance criteria.

Proposed Change No. 2.

Structural Evaluation

The Staff has reviewed LAR 1014-7 to the HI-STORM 100 and noted that the applicant proposes to add ITTRs, designed and fabricated by Westinghouse, to maintain the structural integrity of the fuel assembly, to the approved contents. The applicant has reviewed the classical stress calculations provided by Westinghouse (reference 7) that demonstrated the acceptability of the ITTR to support the dead load of the fuel assembly during lifting operations.

The staff reviewed the calculation and the relevant factors of safety and determined that the applicant has demonstrated that the structural performance of the ITTR is acceptable.

The applicant has met the requirements 10 CFR 72.122, "Overall Requirements," with regard to inclusion of the following provisions in the structural design:

- Structural designs that are compatible with ready retrievability of spent fuel.

Criticality Evaluation

The addition of the ITTR affects the criticality analyses of the HI-STORM 100 cask system because the volume of the central instrument tube is now displaced with the ITTR. This could be non-conservative for MPC designs that require a minimum soluble boron concentration. All applicable MPCs require a minimum soluble boron concentration under certain conditions. The boron concentration required for the affected MPC and fuel lattices is summarized in Table 1.

Table 1: Minimum Boron Concentration Requirements for the HI-STORM 100 15x15 and 17x17 PWR Fuel

MPC	Fuel Lattice	Intact/Damaged Assemblies	Enrichment limit in wt %	Minimum Boron Concentration (ppm)
MPC-24	15x15, 17x17	Intact Only	5.0	400
MPC-24E MPC-24EF	15x15, 17x17	Intact Only	5.0	300
MPC-24E MPC-24EF	15x15, 17x17	One or more Damaged	5.0	600
MPC-32 MPC-32F	15x15 A/B/C/G	Intact Only	4.1	1800
MPC-32 MPC-32F	15x15 A/B/C/G	Intact Only	5.0	2500
MPC-32 MPC-32F	15x15 D/E/F/H	Intact Only	4.1	1900
MPC-32 MPC-32F	15x15 D/E/F/H	Intact Only	5.0	2600
MPC-32 MPC-32F	17x17 A/B/C	Intact Only	4.1	1900
MPC-32 MPC-32F	17x17 A/B/C	Intact Only	5.0	2600
MPC-32 MPC-32F	15x15 A/B/C/G	One or more damaged	4.1	1900
MPC-32 MPC-32F	15x15 A/B/C/G	One or more damaged	5.0	2700
MPC-32 MPC-32F	15x15 D/E/F/H	One or more damaged	4.1	2100
MPC-32 MPC-32F	15x15 D/E/F/H	One or more damaged	5.0	2900
MPC-32 MPC-32F	17x17 A/B/C	One or more damaged	4.1	2100
MPC-32 MPC-32F	17x17 A/B/C	One or more damaged	5.0	2900

The information in Table 1 is from References 3 and 4. Conditions not requiring soluble boron are not shown in Table 1.

Section 6.4.8 of the applicant's Final Safety Analysis Report (FSAR) (Reference 2) provides a discussion on "Non-fuel Hardware in PWR Fuel Assemblies." In this section, the applicant states that the current analyses of record were performed with the instrument tube filled with borated water.

This section of the FSAR includes a discussion on calculations performed by the applicant with the guide tubes voided to show the effect of the displaced boron on reactivity. For the MPC-24 with 400 ppm and the MPC-32 with 1900 ppm, the applicant finds that voiding the guide tubes results in a reduction in reactivity. However, in some of the cases for the MPC-32 with 2600ppm boron, the applicant found that the voided guide tubes produced a higher reactivity than the filled guide tubes, but noted that this effect was not consistent for all assembly classes.

In Reference 5, the applicant provided a summary of the analyses performed to determine that the addition of the ITTR in the instrument tube results in a lower or statistically equivalent reactivity.

The applicant states that any increase in reactivity is only applicable for the cases with high boron concentration. Therefore, the applicant chose the MPC-32 with 5% enriched assemblies as the most limiting, and this case was selected as the representative configuration for performing the analyses in justifying the change. The staff agrees with this assessment.

To study the reactivity effects of adding the ITTR in the instrument tube, the applicant chose three cases and voided the instrument tubes. These are the 15x15B, 15x15F, and 17x17C assemblies. As shown in above, these are representative of the three highest boron concentrations for the affected configurations. The staff finds that voiding the instrument tube is an acceptable means of evaluating the ITTRs because the voided tube is likely to bound that of the actual stainless steel tube which may have some neutron absorption properties and will still contain borated water in the center of the tube.

In Reference 5, all of these cases show a reactivity decrease with the voided instrument tube, with the exception of the 15x15B which shows an increase that is within 2σ of the calculation. The staff finds that this justifies the applicant's conclusion that the addition of the ITTR results in a lower or statistically equivalent reactivity.

Since an ITTR can be installed in an assembly housed in a DFC, the applicant supplemented their application with Reference 6, explaining how the current analyses for the damaged fuel bounds the addition of the ITTR. The staff found these configurations of particular concern since they have the highest boron concentrations. The applicant models damaged fuel as a bare pellet array, neglecting all cladding and structural materials and any neutron absorption of these materials. The FSAR shows, for the 15x15F bare array with 2900 ppm boron in the MPC-32, that decreasing water density (and decreasing boron) decreases k_{eff}. This shows, for this configuration, that adding an ITTR (and displacing boron) would not have an adverse effect. Since this is a high concentration of boron and the bare pellet array is conservative, the staff has reasonable assurance that the addition of the ITTR for the damaged fuel would not increase k_{eff}.

In Revision 7 to the FSAR, the applicant added a paragraph on the effect of assuming an ITTR in the instrument tube. The revised FSAR states that studies of some representative PWR assemblies were performed with voided instrument tubes and the results show that this is bounded by the condition with flooded instrument tubes and that the current analyses are applicable to those with an ITTR. The staff agrees with this assessment and finds the addition of the ITTR acceptable to the MPC-24 and MPC-32 with 15x15 and 17x17 fuel lattices for both intact and damaged fuel assemblies. The staff reviewed and accepts the changes to the TS, as described in Reference 3.

IV. CONCLUSIONS

The staff has reviewed the proposed changes to the HI-STORM 100 Cask System CoC TS. No technical changes to the certificate itself are required by this amendment. Based on documentation provided in references 1 through 7, and the conditions given in the CoC as amended, the staff finds that the HI-STORM 100 Cask System, as amended, meets the requirements of 10 CFR Part 72.

The staff finds that, unless otherwise noted in this SER, the analytical methods used by the applicant that provide the basis for design modifications and the addition to the list of approved cask contents for the HI-STORM 100 Cask System proposed in LAR 1014-7, are acceptable. However, for the purposes of the LAR 1014-7 review, the staff did not revisit any previously approved methodologies used in the original HI-STORM 100 Cask System application and subsequent approved amendments, and did not make any new determination on the adequacy of those methodologies, unless the methodology was used as the basis for a proposed LAR 1014-7 change.

Issued with Certificate of Compliance No. 1014,

TBD

V. REFERENCES

1. Letter from T.S. Morin to US NRC, "License Amendment Request #7 (LAR 1014-7) to HI-STORM 100 Certificate of Compliance," April 15, 2008, ADAMS Accession No. ML081120518

2. Attachment 3 to Letter from T.S. Morin (Holtec) to US NRC, "License Amendment Request #7 (LAR 1014-7) to HI-STORM 100 Certificate of Compliance, Proposed Revised FSAR," April 15, 2008, ADAMS Accession No. ML081120529

3. Attachment 2 to Letter from T.S. Morin (Holtec) to US NRC, "License Amendment Request #7 (LAR 1014-7) to HI-STORM 100 Certificate of Compliance, Proposed Revised CoC/TS in Markup Format," April 15, 2008, ADAMS Accession No. ML081120528

4. X US NRC, "Certificate of Compliance No. 1014, Appendix A, Technical Specifications for the HI-STORM 100 Cask System," ~~January 1~~ July 14, 2008, ADAMS Accession No. ~~ML080110507~~ ML082030221

5. Attachment 1 to Letter from T.S. Morin (Holtec) to US NRC, "License Amendment Request #7 (LAR 1014-7) to HI-STORM 100 Certificate of Compliance – Updated Summary of Proposed Changes," August 1, 2008, ADAMS Accession No. ML0802190506

6. Attachment 3 to Letter from T.S. Morin (Holtec) to J. Goshen (US NRC), "Response to RAI for License Amendment Request #7 (LAR 1014-7) to HI-STORM Certificate of Compliance," November 17, 2008, ADAMS Accession No. ML083370526

7. Westinghouse Electric Corporation, LLC, CN-NFPE-07 -55, "Stress Analysis of use of the Instrument Tube Tie Rod at the Farley Plant," Proprietary, ADAMS Accession No. ML083370526

ACTIONS
(continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. MPC cavity vacuum drying acceptance criteria not met during allowable time.	B.1 Backfill the MPC cavity with helium to a pressure of at least 0.5 atm.	6 hours
C. MPC helium backfill limit not met.	C.1 Perform an engineering evaluation to determine the impact of helium differential.	72 hours
	<u>AND</u>	
	C.2.1 Develop and initiate corrective actions necessary to return the MPC to an analyzed condition by adding helium to or removing helium from the MPC.	14 Days
	<u>OR</u>	
	C.2.2 Develop and initiate corrective actions necessary to demonstrate through analysis, using the models and methods from the HI-STORM FSAR, that all limits for cask components and contents will be met.	

1.0 Definitions (continued)

FUEL DEBRIS	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.
INTACT FUEL ASSEMBLY	INTACT FUEL ASSEMBLIES are fuel assemblies without known or suspected cladding defects greater than pinhole leaks or 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).
LOADING OPERATIONS	LOADING OPERATIONS include all licensed activities on an OVERPACK or TRANSFER CASK while it is being loaded with fuel assemblies. LOADING OPERATIONS begin when the first fuel assembly is placed in the MPC and end when the OVERPACK or TRANSFER CASK is suspended from or secured on the transporter. LOADING OPERATIONS does not included MPC transfer between the TRANSFER CASK and the OVERPACK.
MINIMUM ENRICHMENT	MINIMUM ENRICHMENT is the minimum assembly average enrichment. Natural uranium blankets are not considered in determining minimum enrichment.
MULTI-PURPOSE CANISTER (MPC)	MPCs are the sealed spent nuclear fuel canisters which consist of a honeycombed fuel basket contained in a cylindrical canister shell which is welded to a baseplate, lid with welded port cover plates, and closure ring. The MPC provides the confinement boundary for the contained radioactive materials.
NON-FUEL HARDWARE	NON-FUEL HARDWARE 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), and vibration suppressor inserts, and components of these devices such as individual rods.

(continued)

Table 2.1-1 (page 2 of 24)
Fuel Assembly Limits

I. MPC MODEL: MPC-24 (continued)

A. Allowable Contents (continued)

d. Decay Heat Per Fuel Storage Location:

i. Array/Classes 14x14D, 14x14E, and 15x15G	≤ 710 Watts
ii. All Other Array/Classes	As specified in Section 2.4.
e. Fuel Assembly Length:	≤ 176.8 inches (nominal design)
f. Fuel Assembly Width:	≤ 8.54 inches (nominal design)
g. Fuel Assembly Weight:	≤ 1,720 lbs (including NON-FUEL HARDWARE) for assemblies that do not require fuel spacers, otherwise ≤ 1,680 lbs (including NON-FUEL HARDWARE)

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

C. Deleted.

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

E. One NSA is authorized for loading into the MPC-24.

Note 1: Fuel assemblies containing BPRAs, TPDs, WABAs, water displacement guide tube plugs, orifice rod assemblies, or vibration suppressor inserts with or without ITTRs may be stored in any fuel storage location. Fuel assemblies containing APSRs or NSAs, may only be loaded in fuel storage locations 9, 10, 15, and/or 16. Fuel assemblies containing CRAs, RCCAs, or CEAs may only be stored in fuel storage locations 4, 5, 8-11, 14-17, 20, and/or 21 See Figure 2.1-1). These requirements are in addition to any other requirements specified for uniform or regionalized fuel loading.

Table 2.1-1 (page 11 of 24)
Fuel Assembly Limits

III. MPC MODEL: MPC-68 and MPC-68FF

A. Allowable Contents

1. Uranium oxide or MOX BWR INTACT FUEL ASSEMBLIES listed in table 2.1-3, with or without channels and meeting the following specifications:

a. Cladding Type:	ZR or Stainless Steel (SS) as specified in Table 2.1-3 for the applicable fuel assembly array/class.
b. Maximum PLANAR-AVERAGE INITIAL ENRICHMENT:	As specified in Table 2.1-3 for the applicable fuel assembly array/class.
c. Initial Maximum Rod Enrichment:	As specified in Table 2.1-3 for the applicable fuel assembly array/class.
d. Post-irradiation Cooling Time and Average Burnup Per Assembly:	
i. Array/Classes 6X6A, 6X6B, 6X6C, 7X7A, 8X8A	Cooling time ≥ 18 years and an average burnup ≤ 30,000 MWD/MTU (or MWD/MTIHM)
ii. Array/Class 8X8F	Cooling time ≥ 10 years and an average burnup ≤ 27,500 MWD/MTU
iii. Array/Classes 10X10D and 10X10E	Cooling time ≥ 10 years and an average burnup ≤ 27,500 MWD/MTU
iv. All Other Array/Classes	As specified in Section 2.4

Table 2.1-1 (page 12 of 24)
Fuel Assembly Limits

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

A. Allowable Contents (continued)

e. Decay Heat Per Assembly

i. Array/Classes 6X6A, 6X6B, 6X6C, 7X7A, 8X8A	≤ 115 Watts
ii. Array/Class 8X8F	≤ 183.5 Watts
iii. Array/Classes 10X10D and 10X10E	≤ 95 Watts
iv. All Other Array/Classes	As specified in Section 2.4

f. Fuel Assembly Length:

i. Array/Classes 6X6A, 6X6B, 6X6C, 7X7A, 8X8A	≤ 135.0 inches (nominal design)
ii. All Other Array/Classes	≤ 176.5 inches (nominal design)

g. Fuel Assembly Width:

i. Array/Classes 6X6A, 6X6B, 6X6C, 7X7A, 8X8A	≤ 4.70 inches (nominal design)
ii. All Other Array/Classes	≤ 5.85 inches (nominal design)

h. Fuel Assembly Weight:

i. Array/Classes 6X6A, 6X6B, 6X6C, 7X7A, 8X8A	≤ 550 lbs, including channels
ii. All Other Array/Classes	≤ 730 lbs, including channels

Table 2.1-1 (page 18 of 24)
Fuel Assembly Limits

IV MPC MODEL: MPC-24E and 24EF (continued)

A. Allowable Contents (continued)

d. Decay Heat Per Fuel Storage Location:	
i. Array/Classes 14x14D, 14x14E, and 15x15G	≤ 710 Watts
ii. All Other Array/Classes	As specified in Section 2.4.
e. Fuel Assembly Length:	≤ 176.8 inches (nominal design)
f. Fuel Assembly Width:	≤ 8.54 inches (nominal design)
g. Fuel Assembly Weight:	≤ 1,720 lbs (including NON-FUEL HARDWARE) for assemblies that do not require fuel spacers, otherwise ≤ 1,680 lbs (including NON-FUEL HARDWARE)

Table 2.1-1 (page 20 of 24)
Fuel Assembly Limits

IV MPC MODEL: MPC-24E and 24EF (continued)

A. Allowable Contents (continued)

d. Decay Heat Per Fuel Storage Location:

i. Array/Classes 14x14D, 14x14E, and 15x15G	≤ 710 Watts
ii. All Other Array/Classes	As specified in Section 2.4.
e. Fuel Assembly Length:	≤ 176.8 inches (nominal design)
f. Fuel Assembly Width:	≤ 8.54 inches (nominal design)
g. Fuel Assembly Weight:	≤ 1,720 lbs (including NON-FUEL HARDWARE) for assemblies that do not require fuel spacers, otherwise ≤ 1,680 lbs (including NON-FUEL HARDWARE)

and DFC

and DFC

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

C. Deleted.

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

E. One NSA is authorized for loading into the MPC-24.

See insert A next page

Note 1: Fuel assemblies containing BPRAs, TPDs, WABAs, water displacement guide tube plugs, orifice rod assemblies, or vibration suppressor inserts with or without ITTRs, may be stored in any fuel storage location. Fuel assemblies containing APSRs or NSAs, may only be loaded in fuel storage locations 9, 10, 15, and/or 16 (see Figure 2.1-2). Fuel assemblies containing CRAs, RCCAs, or CEAs may only be stored in fuel storage locations 4, 5, 8-11, 14-17, 20, and/or 21 (see Figure 2.1-2). These requirements are in addition to any other requirements specified for uniform or regionalized fuel loading.

F

-Amendment 6

Insert A (Consistent with latest amendment # 5)

B. Quantity per MPC: Up to four (4) DAMAGED FUEL ASSEMBLIES and/or FUEL DEBRIS in DAMAGED FUEL CONTAINERS, stored in fuel storage locations 3, 6, 19, and/or 22. The remaining fuel storage locations may be filled with PWR INTACT FUEL ASSEMBLIES meeting the applicable specifications.

C. One NSA is permitted for loading.

Table 2.1-1 (page 22 of 24)
Fuel Assembly Limits

V. MPC MODEL: MPC-32 and MPC-32F (continued)

A. Allowable Contents (continued)

d. Decay Heat Per Fuel Storage Location:	
i. Array/Classes 14x14D, 14x14E, and 15x15G	≤ 500 Watts
ii. All Other Array/Classes	As specified in Section 2.4.
e. Fuel Assembly Length	≤ 176.8 inches (nominal design)
f. Fuel Assembly Width	≤ 8.54 inches (nominal design)
g. Fuel Assembly Weight	≤ 1,720 lbs (including NON-FUEL HARDWARE) for assemblies that do not requre fuel spacers, otherwise ≤ 1,680 lbs (including NON-FUEL HARDWARE)

Table 2.1-1 (page 24 of 24)
Fuel Assembly Limits

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

A. Allowable Contents (continued)

d. Decay Heat Per Fuel Storage Location:	
i. Array/Classes 14x14D, 14X14E, and 15x15G	≤ 500 Watts
ii. All Other Array/Classes	As specified in Section 2.4.
e. Fuel Assembly Length	≤ 176.8 inches (nominal design)
f. Fuel Assembly Width	≤ 8.54 inches (nominal design)
g. Fuel Assembly Weight	≤ 1,720 lbs (including NON-FUEL HARDWARE and DFC) for assemblies that do not require fuel spacers, otherwise ≤ 1,680 lbs (including NON-FUEL HARDWARE and DFC)

B. Quantity per MPC: Up to eight (8) DAMAGED FUEL ASSEMBLIES and/or FUEL DEBRIS in DAMAGED FUEL CONTAINERS, stored in fuel storage locations 1, 4, 5, 10, 23, 28, 29, and/or 32. The remaining fuel storage locations may be filled with PWR INTACT FUEL ASSEMBLIES meeting the applicable specifications.

C. One NSA is authorized for loading.

Note 1: Fuel assemblies containing BPRAs, TPDs, WABAs, water displacement guide tube plugs, orifice rod assemblies, or vibration suppressor inserts with or without ITTRs, may be stored in any fuel storage location. Fuel assemblies containing NSAs, may only be loaded in fuel storage locations 13, 14, 19, and/or 20 (see Figure 2.1-3). Fuel assemblies containing CRAs, RCCAs, CEAs or APSRs may only be stored in fuel storage locations 7, 8, 12-15, 18-21, 25 and/or 26. (See Figure 2.1-3). These requirements are in addition to any other requirements specified for uniform or regionalized fuel loading.

Table 2.1-8
NON-FUEL HARDWARE COOLING AND AVERAGE BURNUP (Notes 1, 2, 3, and 8)

Post-irradiation Cooling Time (years)	INSERTS (Note 4) BURNUP (MWD/MTU)	NSA or GUIDE TUBE HARDWARE (Note 5) BURNUP (MWD/MTU)	CONTROL COMPONENT (Note 6) BURNUP (MWD/MTU)	APSR BURNUP (MWD/MTU)
≥ 3	≤ 24,635	NA (Note 7)	NA	NA
≥ 4	≤ 30,000	≤ 20,000	NA	NA
≥ 5	≤ 36,748	≤ 25,000	≤ 630,000	≤ 45,000
≥ 6	≤ 44,102	≤ 30,000	-	≤ 54,500
≥ 7	≤ 52,900	≤ 40,000	-	≤ 68,000
≥ 8	≤ 60,000	≤ 45,000	-	≤ 83,000
≥ 9	-	≤ 50,000	-	≤ 111,000
≥ 10	-	≤ 60,000	-	≤ 180,000
≥ 11	-	≤ 75,000	-	≤ 630,000
≥ 12	-	≤ 90,000	-	-
≥ 13	-	≤ 180,000	-	-
≥ 14	-	≤ 630,000	-	-

Notes:
1. Burnups for NON-FUEL HARDWARE are to be determined based on the burnup and uranium mass of the fuel assemblies in which the component was inserted during reactor operation.
2. Linear interpolation between points is permitted, except that NSA or Guide Tube Hardware and APSR burnups > 180,000 MWD/MTU and ≤ 630,000 MWD/MTU must be cooled ≥ 14 years and ≥ 11 years, respectively.
3. Applicable to uniform loading and regionalized loading.
4. Includes Burnable Poison Rod Assemblies (BPRAs), Wet Annular Burnable Absorbers (WABAs), and vibration suppressor inserts..
5. Includes Thimble Plug Devices (TPDs), water displacement guide tube plugs, and orifice rod assemblies.
6. Includes Control Rod Assemblies (CRAs), Control Element Assemblies (CEAs), and Rod Cluster Control Assemblies (RCCAs).
7. NA means not authorized for loading at this cooling time.
8. Non-Fuel hardware burnup and cooling times are not applicable to ITTRs since they are installed post-irradiation.