Request for Supplemental Information

Docket No. 72-1014
Certificate of Compliance No. 1014
Amendment No. 15 to the HI-STORM 100 Multipurpose Canister Storage System

Chapter 3 - Structural Evaluation

3-2 Confirm the information in Table 3.II..12 of Final Safety Analysis Report (FSAR) Supplement II.

Table 3.II.4.12 of FSAR Supplement II lists the maximum local plastic strains for different components during the non-mechanistic tipover analysis. It is similar to Table 9.1 in Report HI-2188448R0. Both tables have the same information but refer to different MPCs. Table 3.II.4.12 refers to MPC-32 whereas Table 9.1 refers to MPC-32M. Since there are multiple versions of MPC-32, confirm that the information in Table 3.II.4.12 is accurately reported.

This information is needed to determine compliance with the requirements of 10 CFR 72.236(l).

Holtec Response:

The numerical results in Table 3.II.4.12 of the FSAR are correct, but the MPC version is identified incorrectly in the table. The non-mechanistic tipover results presented in Table 3.II.4.12 are specific to the HI-STORM 100S Version E with a loaded MPC-32M inside, which is also the focus of Holtec Report HI-2188448R0. Accordingly, Table 3.II.4.12 has been updated to correct the typographical error and change “MPC 32” to “MPC-32M”.

3-3 Confirm baseplate thickness of MPC-32M, MPC-32 Version 1, and MPC-68 Version 1.

In proposed change #2 and #3, the applicant proposes the inclusion of the structural qualification for MPC-32M, MPC-32 Version 1, and MPC-68 Version 1. The applicant describes the new MPCs as modified versions of its classical counterparts with larger cell openings and “slightly thickened” vessel baseplate. Similar qualitative statements are found throughout FSAR Supplement II that provide no quantification of the additional thickness of these MPCs when compared to their previous counterparts. Since the enclosure vessel baseplate has load bearing function and is part of the confinement boundary, provide clear and quantitative descriptions of its characteristics and dimensions in appropriate sections of FSAR Supplement II.

This information is needed to determine compliance with the requirements of 10 CFR 72.236(l).

Holtec Response:

The baseplate thickness for all three MPC designs, namely the MPC-32M, the MPC-32 Version 1, and the MPC-68 Version 1, [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390], which is specified on Licensing Drawing 11572 (see Section 1.II.5 of Supplement II). The Enclosure Vessel Version 1, which is shown on Licensing Drawing 11572, is common to all three MPC designs. That is to say the fuel baskets for the MPC-32M (Licensing Drawing 11425), the MPC-32 Version 1 (Licensing Drawing 11574), and the MPC-68 Version 1 (Licensing Drawing 11578) are all loaded inside the same MPC enclosure vessel (i.e., Enclosure Vessel Version 1).

The baseplate thickness for Enclosure Vessel Version 1 is a [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390] than the licensed designs for the MPC-32, MPC-68, and MPC-68M. The motivation for the increased baseplate thickness is the higher design internal pressures for the Enclosure Vessel Version 1 versus the previously licensed MPC designs. For example, the Enclosure Vessel Version 1 has a design internal pressure of 110 psig under normal conditions (see Table 1.II.2.3) as compared to a design internal pressure of 100 psig for the MPC-32, MPC-68, and MPC-68M (see Table 2.2.1).

The stress analysis of the Enclosure Vessel Version 1 under the effects of dead load (i.e., lifted load) plus internal pressure is discussed in Subsection 3.II.4.3.2 of the FSAR. Similarly, the stress analysis of the Enclosure Vessel Version 1 under accident internal pressure is discussed in Subsection 3.II.4.4.1 of the FSAR. Both analyses are further described and documented in Supplement No. 7 of Holtec Report HI-2188402.

3-4 Confirm the weight and center of gravity for fuel types 10x10I, 10x10J, and 11x11A.

Proposed change #5 adds three (3) additional BWR fuel types, 10x10I, 10x10J, and 11x11A, to the approved contents of CoC No. 1014, Appendix B, for MPC-68M only. In order to qualify the added fuel types:

a. Confirm that the additional fuel types are bounded by the maximum allowable weight of the storage system components.
b. Confirm that the center of gravity of the storage systems is not changed by the addition of the new fuel types.

This information is needed to determine compliance with the requirements of 10 CFR 72.236(a) and (l).

Holtec Response:

a. No changes are being made to the maximum allowable weight limits for BWR fuel assemblies in Table 2.1.5 or 2.1.22 of FSAR Chapter 2. Note that if an assembly weight were to exceed the limits in these tables, it would not meet the requirements for loading.
b. No changes are being made to the fuel assembly length and width limits provided in Table 2.1.22 of FSAR Chapter 2, and therefore no changes are made to the CG of the system based on the new fuel types.

3-5 Clarify design basis limit deceleration for the non-mechanistic tipover analysis “Loading Case M-3; Non-Mechanistic Tip-Over” from FSAR Section 3.II.4.4.2 summarizes the analysis for the aforementioned event. If refers to FSAR Section 2.2.3.2 for description

of the loading case applicable to the HI-STORM Version E module. Section 2.2.3.2 of the loading case applicable to the HI-STORM Version E module. Section 2.2.3.2 provides a design limit of 45g's. Given the reported maximum rigid body deceleration of 81.6g at the top of the fuel assembly, as shown in Figure 15 of the non-mechanistic tipover calculation package, it is not clear to the staff if the design limits in FSAR Section 2.2.3.2 are applicable to the HI-STORM Version E. clarify the following information:

a. Address this apparent discrepancy and specify if there are deceleration design basis limits for the HI-STORM Version E.
b. Describe how the rigid body deceleration at the top of fuel assembly is used for evaluation.
c. Does the stress analysis method of evaluation (MOE) presented for this tipover analysis deviates from the subsection NG "stress category" approach as specified in ASME code Section III, Appendix F?

This information is needed to determine compliance with the requirements of 10 CFR 72.236(b) and (l).

Holtec Response:

The methodology and the acceptance criteria used for the non-mechanistic tipover analysis of the HI-STORM 100S Version E in this amendment are the same as those used previously for the non-mechanistic tipover analysis of the HI-STORM FW overpack under Docket No. 72-1032. This means that the HI-STORM 100S Version E, like the HI-STORM FW overpack, does not have a pre-established design basis deceleration limit. In other words, the impact deceleration may exceed 45g's so long as the acceptance criteria stated in Subsection 2.II.2.2 are met. Therefore, the reference to FSAR Section 2.2.3.2 is applicable to the HI-STORM 100S Version E only for its general description of the tipover event. The 45g deceleration limit specified in Table 3.1.2 does not apply to the non-mechanistic tipover of the HI-STORM 100S Version E.

Items a, b, and c from the above RAI are further clarified as follows:

a. There is no design basis deceleration limit for the HI-STORM 100S Version E under a non-mechanistic tipover event. To avoid confusion and address the discrepancy identified by the NRC staff, Subsection 3.II.4.4.2 has been revised to include a basic description of non-mechanistic tipover event and delete the reference to FSAR Section 2.2.3.2.

b. The rigid body deceleration at the top of the fuel assembly is provided for information only. It is not used as input to any subsequent structural analysis of the HI-STORM 100S Version E overpack or its contents.

c. Level D stress intensity limits per Subsection NG of the ASME Code, Section III are used to evaluate the MPC fuel baskets made from Alloy X stainless steel material (e.g., MPC-32, MPC-68, MPC-32 Version 1, and MPC-68 Version 1). For the MPC fuel baskets made from Metamic-HT (e.g., MPC-68M, MPC-32M), which is a non-ASME material, a deflection based acceptance criterion is used. This deflection based criterion was first introduced for the MPC-68M in Supplement III of FSAR (see Section 2.III.0.1), and the same criterion is used in this amendment for the MPC-32M.

Chapter 4 - Thermal Evaluation

4-1 Provide calculations and analysis results that show the dry ice jacket (DIJ) cooling capabilities can provide cooling function up to the time specified in the application. Section 2.2.1.7 of the FSAR states that calculations show that the DIJ can be sized for transfer casks to maintain their cooling function for a period specified in the FSAR. However, the application does not provide calculations that show how long cooling function could be maintained by the DIJ. The staff needs this information to verify that an adequate configuration of the transfer cask has been analyzed to demonstrate that predicted temperatures remain below applicable limits.

This information is needed to determine compliance with 10 CFR 72.236(b) and 72.236(f).

Holtec Response:

In order to address this concern, explicit evaluations are performed to demonstrate the methodology to size the DIJ such that the time duration specified in Section 2.2.1.7 of the HI-STORM FSAR is satisfied. [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]

The above calculations are documented in Appendix N of the thermal calculation package HI-2043317[PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]. HI-2043317 revision 40 is included as Attachment 8.

4-2 Clarify how the thermal conditions of the transfer cask are determined for cases where the HI-DRIP auxiliary cooling system were to fail during short-term operations. Section 2.2.1.8 of the FSAR states that if the plant's water supply system were to fail, the time-to-boil of the transfer cask is monitored. However, it is not clear from the application how the thermal conditions (initial conditions) of the transfer cask are determined and used in the calculation for the time-to-boil. The staff needs this information to verify that adequate time-to-boil values (based on realistic thermal conditions) are determined and properly applied to prevent MPC over-pressurization.

This information is needed to determine compliance with 10 CFR 72.236(b) and 72.236(f).

Holtec Response:

[PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]. The existing methodology in Section 4.5.2 will be adopted to determine time-to-boil with the measured MPC water temperature replacing the pool water temperature as the initial condition.

4-3 Provide calculations and analysis results for the case that HI-STORM 100S Version E overpack is used in a sheltered configuration. Section 1.II.2.1 of the FSAR states that like all other versions, Version E can be deployed in an unsheltered or sheltered storage mode. However, if the sheltered configuration is used then site-specific evaluations should be performed to ensure that the temperature profile (time averaged, as applicable) of the ventilation air entering the cask complies with the normal storage temperature limit set forth in Supplement 2.II (Principal Design Criteria) herein. However, the applicant did not provide any thermal models, calculations, and analysis results that demonstrate the

predicted temperatures would be below any applicable temperature limits for a sheltered configuration. The staff needs this information to make sure the HI-STORM 100S Version E overpack in a sheltered configuration will not results in temperatures exceeding the criteria specified in the FSAR.

This information is needed to determine compliance with 10 CFR 72.236(b) and 72.236(f).

Holtec Response:

As stated in the FSAR, site-specific evaluations shall be performed if the sheltered configuration is used. [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390].

The above description has been added in Section 4.II.4.7 of the HI-STORM 100 FSAR.

4-4 Add a note to FSAR Figures 2.II.1-2 and 2.II.1-3 to clarify that the maximum quadrant decay heat specified in Table 2.II.1.5 applies to these figures. Correct these figures to make them consistent with Appendix D of the Technical Specifications. FSAR Figures 2.II.1-2 and 2.II.1-3 show discrete heat load patterns A and B. However, the total heat load shown in these figures exceed the limits specified in Table 2.II.1.5. Also, reported values in FSAR figures 2.II.1-2 and 2.II.1-3 are not consistent to Figures 2.4-1 and 2.4-2 of Technical Specifications Appendix D. The staff needs assurance that any applicable limits have been adequately analyzed to demonstrate that predicted temperatures remain below applicable limits.

This information is needed to determine compliance with 10 CFR 72.236(b) and 72.236(f).

Holtec Response:

The heat load figures in the FSAR have been revised to state the quadrant decay heat limit and to be in alignment with the Technical Specifications.

4-5 Clarify how heat rejection by natural convection is implemented in the HI-STORM 100S Version E thermal model. Section 4.II.4.1 of the FSAR states that natural convection is modeled in the same manner as defined in the HI-STORM FW FSAR using the Jakob & Hawkins correlations references in the FSAR. However, staff's review of the HI-STORM 100S Version E thermal model does not indicate these correlations were used to perform the thermal analysis. The staff needs this information to have assurance predicted temperatures remain below allowable limits.

This information is needed to determine compliance with 10 CFR 72.236(b) and 72.236(f).

Holtec response:

The heat rejection from the overpack external surfaces, including the lid and baseplate surfaces, are modelled using the correlations provided in the FSAR Reference [4.II.5].

[PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390].

4-6 Perform additional sensitivity calculations and analysis results that show the loading patterns described in FSAR Section 4.II.4.3 are bounding. Section 4.II.4.3 of the FSAR states that two extreme cases are considered that reasonably bound discrete loading under cask aggregate and cell specific limits. The cases are described in FSAR. However, the applicant did not provide technical justification that explains why from all the different combinations for loading patterns, these two cases would result in maximum predicted temperatures. The applicant needs consider other patterns (for example, intermediate cases) that show the extreme loading cases are in fact bounding. The staff needs this information to have assurance predicted temperatures remain below allowable limits.

This information is needed to determine compliance with 10 CFR 72.236(b) and 72.236(f).

Holtec Response:

In order to address these concerns, explicit evaluations are performed for multiple loading scenarios that could arise from the loading patterns defined in HI-STORM 100 FSAR Chapter 2. [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390].

The validity of the above criteria is demonstrated via screening evaluations of additional loading scenarios. These additional screening evaluations are documented in Appendix R of Holtec Report HI-2043317 as well as Section 4.II.4.3 of the revised LAR. It is verified that the licensing basis scenario (Case 1 described in Section 4.II.4.3) is bounding for both peak cladding temperature as well as the MPC cavity pressure.

4-7 Provide calculations and analysis results for cases when cyclic vacuum drying is used. Section 4.II.5.3 of the FSAR provides a summary of a methodology and assumptions for cyclic vacuum drying for high burnup fuel but no predicted peak cladding temperatures were provided. The application does not include any calculations or analysis results to show how the calculations are performed for multiple cycles and results from each cycle. The staff needs this information to verify cyclic vacuum drying will not result in temperatures exceeding the criteria specified in ISG-11, Revision 3 for multiple drying cycles.

This information is needed to determine compliance with 10 CFR 72.236(b) and 72.236(f).

Holtec Response:

Explicit evaluations of the cyclic vacuum drying operations are performed to address this comment. Transient evaluations of MPC-32M under vacuum drying operations are performed following the methodology outlined in Section 4.II.5.3 of the FSAR. The bounding licensing basis heat load scenario is adopted for the cyclic vacuum drying evaluations and the results are presented in Table 4.II.5.5 of the HI-STORM 100 FSAR.

4-8 Provide calculation and analysis results for cask cooldown and reflood during fuel unloading operations. Section 4.II.5.3 of the FSAR states that during fuel unloading operations could lead to MPC over-pressurization if the rate of water addition is not controlled. However, the applicant did not provide any calculations to show how the rate of water addition is determined to control the MPC pressure. Surveillance Requirement

3.1.3.1 states that the MPC cavity pressure is ensured to be within limits via analysis or direct measurement. However, as stated above, the application does not include analysis to support SR 3.1.3.1. Other chapters may need to be revised to reflect the analysis results, when these become available (for example, Operating procedures, Technical Specifications Bases, etc.). The staff needs this information to verify MPC over-pressurization is avoided with adequate control of the rate of water addition to the MPC cavity.

This information is needed to determine compliance with 10 CFR 72.236(b) and 72.236(f).

Holtec Response:

[PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]. The reflood rate for the licensing basis heat load scenario is presented in Section 4.II.5.3 of the HI-STORM 100 FSAR to demonstrate the methodology.

[PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]. Similar to the time-to-boil evaluations, the demonstrated methodology shall be adopted to obtain reflood rates to support site-specific loading procedures.

Chapter 12 (SR 3.1.3) has been modified to reflect this requirement.

Chapter 5 - Confinement Evaluation

5-1 Clarify the following for the MPC enclosure vessels:

a. The thickness of the MPC-32M, MPC-32 Version 1 and MPC-68 Version 1 fuel baskets MC enclosure vessel baseplate and
b. The MPC enclosure vessel (MPC enclosure vessel or MPC enclosure vessel version 1) that can be used for the MPC-32M, MPC-32 Version 1, and MPC-38 Version 1 fuel baskets.

Proposed changes #2 and #3 describe that the MPC-32M, MPC-32 Version 1, and MPC-38 Version 1 enclosure vessel baseplate is slightly thickened to increase its pressure and load bearing capacity.

Supplement 7.II, “Confinement,” of the SAR, in the first paragraph, describes that the main body of Chapter 7, “Confinement,” of the FSAR remains fully applicable for the HI=-STORM 100 System using an MPC-32M, MPC-32 Version 1 or MPC-68 version 1, except as indicated below since the MPC-32M, MPC-32 Version 1 and MPC-68 Version 1 fuel baskets are used with the MPC enclosure vessel which is the confinement boundary of the system. The staff notes that the revised licensing drawing for the MPC enclosure vessel (Drawing No. 3923 sheet 3) showing the increased thickness of the enclosure vessel baseplate was not provided; however, it is not clear if the phase MPC enclosure vessel Version 1 could have been intended in the SAR, rather than use the phrase MPC enclosure vessel. Using an MPC enclosure vessel with a confinement boundary baseplate that is not sufficient for the pressure and load bearing capacity necessary for the associated fuel baskets is an unanalyzed condition.

Supplement 7.II of the SAR, in the last sentence of the first paragraph, refers to the drawing of the MPC enclosure vessel in Section 1.II.5 of the SAR. However, Section 1.II.5 describes

an MPC enclosure vessel Version 1. If the MPC enclosure vessel Version 1 is the containment boundary for the MPC-32M, MPC-32 Version 1, and MPC-68 Version 1fuel baskets, that should be clearly described in the application, rather than use the phrase MPC enclosure vessel.

This information is needed to determine compliance with 10 CFR 72.236(d).

Holtec Response:

a. The thickness of the MPC baseplate for all of the fuel baskets within the supplement is [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]. This is defined on drawing 11572R0 in Zone A5.

b. The MPC enclosure vessel used with MPC-32M, MPC-32 Version 1 and MPC-68 Version 1 is the Version 1 enclosure vessel. This enclosure vessel is drawing 11572R0 in section 1.II.5.

   Section 1.II.2.2 was revised to clearly state that MPC-32M, MPC-32 Version 1 and MPC-68 Version 1 utilize Enclosure Vessel Version 1 as defined in section 1.II.5. Section 7.II was revised to clearly state that the Version 1 enclosure vessel is the enclosure vessel used with MPC-32M, MPC-32 Version 1 and MPC-68 Version 1.

5-2 Provide clarification on the licensing drawings that the MPC enclosure vessel Version 1 confinement boundary components are ITS category A.

Section 2.II.0.5 of the SAR describes that the ITS category of each part for each component (Version E overpack, MPC-32M, Version 1 of MPC-32 and MPC-68, and HI-TRAC MS transfer cask) is provided in the respective component's Licensing Drawing in Section 1.II.5. Licensing drawing No. 11572 Revision 0, Sheet 1 of 2, for the MPC enclosure vessel Version 1 describes the safety category for each of the confinement boundary components as ITS but does not include the specific ITS category (category A). NUREG-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety," describes in Table 6, "Classification categories for dry spent fuel storage systems," that components that have a containment function are ITS category A, the highest ITS category classification for the important to safety confinement function. In addition, licensing drawing No. 3923 Revision 35, Sheet 1 of 9, Note 11 also describes that the safety category for the MPC enclosure vessel is ITS category A, and this is also shown in Table 2.2.6, "Materials and Components of the HI-STORM 100 System," of the SAR. Providing the ITS category for each of the MPC enclosure vessel Version 1 confinement boundary components on the licensing drawing No. 11572 Rev. 0 sheet 1 of 2 would be consistent with the previously approved licensing drawings and the licensing drawings that are part of this amendment request, and also clearly emphasize the highest ITS category classification for the important to safety confinement function. Providing the ITS category on the licensing drawing may also aide NRC staff in performing risk-informed inspection activities.

This information is needed to determine compliance with 10 CFR 72.236(d).

Holtec Response:

Table 2.II.2.10 has been added to Supplement 2.II, which includes a list of the MPC Version 1 components. The table predominately refers to the main FSAR Table 2.2.6 for consistency between MPCs, including the ITS Category.

5-3 Provide Table 1.A.6 of the SAR.

Table 1.A-6 is referenced for example in, Table 2.2.3, “Design Temperatures,” and Table 7.II.1.1, “Summary of Confinement Boundary Design Specifications,” of the SAR. However, the staff could not find Table 1.A.6 in the SAR (Attachments 7 and 8 of the amendment request).

This information is needed to determine compliance with 10 CFR 72.236(d).

Holtec Response:

Table 1.A-6 is provided as part of Attachment 6, for information, it is unchanged in this amendment from the previous revision of the FSAR.

5-4 Provide clarifications to the following from the proposed Certificate of Compliance (CoC) No. 1014, Appendix C of the Technical Specifications:

LCO 3.1.1 of the proposed CoC No.1014, Appendix C of the Technical Specifications should describe, with underlining shown for emphasis, that, “Table 3-1 provides decay heat and burnup limits for forced helium dehydration (FHD) and vacuum drying.” FHD and vacuum drying are described in Table 3-1 of the proposed CoC No. 1014, Appendix C of the Technical Specifications; therefore, vacuum drying should also be consistently described in LCO 3.1.1 of the proposed CoC No. 1014, Appendix C of the Technical Specifications.

Table 3-3, “Completions Time for Actions to Restore HI-STORM 100S Version E SFSC heat Removal System to Operable,” of the proposed CoC No. 1014, Appendix C of the Technical Specifications should describe with underlining shown for emphasis, that the MPC Type is the, “MPC-32 Version 1/ MPC-68 Version 1,” to explicitly avoid confusion with the MPC-32. The sue of MPC-32/68 Version 1 also occurs in SR 3.1.2 on page 3.1.2-2 and LCO 3.1.4, applicability c3 on page 3.1.4-2.

3.1.3 Supplemental Cooling System on page 3.1.4-2, should be renamed to, 3.1.4 Supplemental Cooling System because 3.1.3 is already named MPC Cavity Reflooding on page 3.1.3-1.

This information is needed to determine compliance with 10 CFR 72.234(a).

Holtec Response:

Clarification to proposed CoC No.1014 Appendix C was provided as follows:

1. Added the words “ and vacuum drying” to LCO 3.1.1 of CoC N0.1014 Appendix C on page 3.1.1-1.

2. Clarified which MPCs are being addressed by changing “MPC-32/68 Version 1” to “MPC-32 Version 1/ MPC-68 Version 1” in Table 3-3 on page 3.4-4, SR 3.1.2 on page 3.1.2-2 and LCO 3.1.4 applicability c3 on page 3.1.4-2 of CoC No. 1014 Appendix C.
3. Corrected the numbering on page 3.1.4-2 for the heading “3.1.3 Supplemental Cooling System” to “3.1.4 Supplemental Cooling System” of CoC No. 1014 Appendix C.

5-5 Provide clarifications to the following from the proposed CoC No. 1014, Appendix D of the Technical Specifications:

Page 3-4 of the proposed CoC No. 1014, Appendix D of the Technical specification, the row for NB-3100 and NF-3100, describes, “100 system FSAR, serving as the Design Specification, which establishes the service conditions and load combinations for the storage system. FSAR serving as the Design Specification, which establishes the service conditions and load combinations for the storage system.” The intended meaning of the previous sentence is not clear. In comparison, a clearer sentence is on Page 3-6 of the proposed CoC No. 1014, Appendix B of the Technical Specifications the first row describes, “These requirements are not applicable. The HI-STORM FSAR, serving as the Design Specification, establishes the service conditions and load combinations for the storage system.”

This information is needed to determine compliance with 10 CFR 72.234(a).

Holtec Response:

Clarified the description in the final column in the row for NB-3100 and NF-3100 on Table 3-1 on page 4-3 of the proposed CoC No. 1014 Appendix D. Changed the wording to match the description for the row for NB-3100, NG-3100 and NF-3100 on Table 3-1 page 3-6 of the proposed CoC No. 1014 Appendix B.

Chapter 6 - Shielding Evaluation

Introduction: Basket Loading Evaluation Approaches

Over time, various approaches have been introduced to evaluate the dose rates around the casks based on the approved content. In some cases, more than one set of approved content is applicable to an individual MPC, hence more than one evaluation approach may be presented for that MPC. Since this relates to several RAI responses, the different approaches are characterized below before the responses to the individual RAIs are presented

The following approaches have been used over time:

[PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]

6-1 Provide justification for using the MPC-68M as the bounding MPC for the HI-TRAC MS.

The staff was unable to find a basis for using the MPC-68M for all of the dose and dose rate evaluations for the HI-TRAC MS. The staff requests that the applicant provide justification that this MPC and its allowable contents would produce the highest surface and site boundary dose rates under both normal and accident conditions than all other MPCs allowed within the HI-TRAC MS.

This information is needed for the staff to determine that the cask system is capable of meeting regulatory requirements of 10 CFR 72.236(d) which requires a dry storage system to meet the dose limits in 10 CFR 72.104 and 106.

Holtec Response:

The initial goal of the shielding evaluations in Supplement 5.II was to show that the HI-TRAC Version MS has essentially the same performance as the 100-ton HI-TRAC cask analyzed in the main part of this chapter, and hence corresponding conclusions in the main part of Chapter 5 remain applicable.

In response to the RAI, additional calculations for HI-TRAC MS with MPC-24, MPC-32, MPC-32M and MPC-68M have been performed, [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]. Details of all calculations are documented in HI-2188253 Revision 2, with a summary presented in Section 5.II.1 of the FSAR.

6-2 Justify the burnup and cooling times assumed for the accident condition of the HI-TRAC Version MS.

Table 5.II.1.5 of the FSAR shows the accident condition dose rates for the HI-TRAC Version MS. This table states that the MPC-68M was used as the design basis MPC and that the source term includes fuel at 70,000 MWd/MTU and 6 years cooling for the dose rates at 1 meter, and 50,000 MWd/MTU and 3 years cooling for the dose rates at 100 meters. The staff requests that the applicant justify the use of these burnups and cooling times and the use of the MPC-68M as the design basis MPC for this table. It seems other MPCs and allowable assemblies would have more limiting design source terms for accident conditions. For example, Table 5.1.10 of the FSAR is based on the MPC-24 at 75,000 MWd/MTU and 5 years cooling; Table 2.1-4 of the Appendix D to the CoC allows for a 3.26 kW assembly at a burnup of 70,000 GWd/MTU and a minimum cooling time of 2.25 years; and for a 1.66kW assembly (allowed in loading patterns QSHL-2, QSHL-3, and QSHL-4 for the MPC-68M), Appendix B TS 2.4.3 allows a burnup of 67,000 MWd/MTU, enrichment of 4.2%, and cooling time of 2.25 years.

This information is needed for the staff to determine that the cask system is capable of meeting regulatory requirements of 10 CFR 72.236(d) which requires a dry storage system to meet the dose limits in 10 CFR 72.106.

Holtec Response:

The additional calculations discussed in the response to RAI 6-1 include calculations for both normal and accident conditions, including calculations equivalent to those presented in Table 5.1.10 and discrete loading including assemblies at a burnup [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]. Details of these calculations are also documented in HI-2188253 Revision 2, with a summary presented in Section 5.II.1 of the FSAR.

The loading patterns QSHL-2, QSHL-3, and QSHL-4 for MPC-68M have been evaluated using the 100-ton HI-TRAC cask in Supplement 5.III (in Amendment 14), and the results presented in Table 5.III.4 [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]. Since the results are well bounded, the conclusions

are considered applicable to the HI-STORM 100S Version E and HI-TRAC Version MS casks, and additional calculations for MPC-68M with these loading patterns are not considered necessary.

6-3 Provide the enrichment used for all calculations that involve the MPC-68M (or any MPC used in the design basis calculations for this amendment that is not the MPC-32M).

The staff has the minimum enrichment for a given burnup range for the MPC-32M; however, minimum enrichment is considered an input into the equation that provides burnup in Section 2.4.3 of the TS (Appendix B to the CoC) for all of the other MPCs. The staff requests that the applicant provide the enrichment so that it can verify the source term used and if the burnup and cooling time are appropriate.

This information is needed for the staff to determine that the cask system is capable of meeting regulatory requirements of 10 CFR 72.236(d) which requires a dry storage system to meet the dose limits in 10 CFR 72.104 and 106.

Holtec Response:

The fuel enrichments used in this supplement with the uniform burnup-cooling time combinations from Section 5.1 are those from Table 5.2.24 of the FSAR. A note is added in Section 5.II.0 to clarify this.

6-4 Clarify the burnup assumptions used for the MPC-32M for calculating the source term for non-fuel hardware.

Section 5.II.2.4 states that in order to qualify non-fuel hardware with the lower cooling time for the MPC-32M, the “BPRA and TPD with the minimum cooling time of 1 year, independent of the burnup” was considered. The staff requests that the applicant provide additional information on how this evaluation was performed “independent of the burnup.”

This information is needed for the staff to determine that the cask system is capable of meeting regulatory requirements of 10 CFR 72.236(d) which requires a dry storage system to meet the dose limits in 10 CFR 72.104 and 106.

Holtec Response:

The term “independent of the burnup” was chosen to indicate that, unlike before where the minimum cooling time was a function of the burnup, [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]. Subsection 5.II.2.4 has been expanded to clarify this.

6-5 Provide tolerances for components that are used for shielding of the MPC-32M and the MPC Enclosure Vessel, MPC-32M Version 1, MPC-68M and Version 1, and MPC Enclosure Vessel Version 1 and HI-STORM 100S Version E.

The applicant states in Section 5.II.3.1 of the SAR that nominal dimensions are used in the models. The applicant states that this is “*consistent with the main part of Chapter 5, unless stated otherwise. This is considered sufficient for the purpose of this supplement to demonstrate reasonable assurance of an adequate level of safety.*” Although the staff

agrees with the concept that nominal dimensions are considered sufficient to demonstrate *"reasonable assurance of an adequate level of safety,"* this statement is dependent upon whether the tolerances are small enough that a minimum dimension (rather than nominal one) would not drastically reduce shielding. The staff requests that the applicant provide tolerances for all components credited for shielding in drawings: 3923 Revision 40, 11371 Revision 0, 11381 Revision 0, 11425 Revision 0, and 11572 Revision 0. The staff requests that the applicant update the FSAR with this information and does not necessarily require updating the drawings as long as the applicant states where in the FSAR this information is located. The staff needs this information to determine if using nominal dimensions continues to demonstrate reasonable assurance of an adequate level of safety.

This information is needed for the staff to determine that the cask system is capable of meeting regulatory requirements of 10 CFR 72.236(d) which requires a dry storage system to meet the dose limits in 10 CFR 72.104 and 106.

Holtec Response:

For the staff's information, the following tolerances are standard manufacturing tolerances that are contained on Holtec fabrication drawings:

- The standard ASME Section II tolerances apply to stock dimensions;
- The following tables apply for all other tolerances

[PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]

These tolerances are controlled in manufacturing under Holtec's NRC approved QA program. The manufacturing drawings including these tolerances are similarly controlled, and any changes are evaluated under Holtec's process, which includes any necessary reviews by technical disciplines (i.e., shielding) and licensing.

These tightly controlled tolerances should provide reasonable assurance that there will be no drastic reduction in shielding, and keeping these tolerances on controlled manufacturing drawings and not in the FSAR is consistent across Holtec storage systems.

6-6 Provide additional information regarding the minimum concrete density specification for the HI-STORM 100S Version E.

The applicant states in Section 5.II.4.1 of the FSAR that *"… an increase of shielding performance for HI-STORM 100S Version E, … is mainly rendered by a concrete material with increased density."* Although the staff verified that the applicant used a higher concrete density for modeling this component, the minimum density requirement for this component is not clear. The staff requests that the applicant discuss how this requirement is specified. Table 3.II.2.4 of the FSAR shows the concrete density but this is not listed as a minimum, it is "Ref. concrete density," which the staff assumes means "reference." The staff was unable to locate the minimum concrete density for this component within the TS or the drawings.

This information is needed for the staff to determine that the cask system is capable of

meeting regulatory requirements of 10 CFR 72.236(d) which requires a dry storage system to meet the dose limits in 10 CFR 72.104.

Holtec Response:

The minimum density of the shielding concrete in the overpack body and top lid is provided in Table 1.II.2.4.

Note that the concrete density is not considered safety significant. Dose rates around the overpack are limited by the requirements in the TS (Section 5.7 of CoC Appendix A and Section 5.3 of CoC Appendix C), and the dose at the site boundary by 10 CFR 72.104.

6-7 Provide additional information demonstrating that the MPC-32M is the bounding canister for the HI-STORM 100S Version E overpack.

The applicant performed annual dose and dose rate calculations for the HI-STORM 100S Version E overpack using the MPC-32M; however, the staff did not find the basis for using this canister as the bounding canister when all other HI-STORM 100 canisters are to be used within this overpack.

This information is needed for the staff to determine that the cask system is capable of meeting regulatory requirements of 10 CFR 72.236(d) which requires a dry storage system to meet the dose limits in 10 CFR 72.104.

Holtec Response:

Similar to the calculation for HI-TRAC MS discussed in the response to RAI 6-1, additional calculations are performed for HI-STORM 100S Version E, with MPC-24, MPC-32, MPC-32M and MPC-68M. When considering the uniform burnup-cooling time combinations from the table in Section 5.1 of the FSAR, the results demonstrate that MPC-32 and MPC-32M are similar to the MPC-24 and MPC-68M baskets in terms of dose rates. [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390] With these conservative source terms, the MPC-32M becomes the bounding canister for the HI-STORM 100S Version E from a dose perspective and the corresponding bounding dose rates have been reported in the FSAR.

6-8 Provide additional information on how all of the allowable loading patterns are bounded for the MPC-32M in the dose rate evaluation.

In Section 5.II.1 of the FSAR, the applicant explains how it bounds the allowable uniform and regionalized/discrete loading patterns when representing the system for performing shielding evaluations. The staff requests additional clarifying information so that it can better understand this process and make a determination that all allowable loading patterns are reasonably bounded. The staff requests that the applicant state what loading pattern was determined to be the bounding one for the various analyzed configurations and what burnup/enrichment/cooling time was used in these patterns. The staff also requests additional clarifying information to supplement the discussion on page 5.II-4 of the SAR. Although the staff understands in principle that the 1.8 kW assemblies would be shielded by the peripheral assemblies, this may not be the case when evaluating the dose rate at the top of the transfer cask or overpack. The staff requests

that the applicant provide additional information on how the applicant has determined the bounding loading pattern.

This information is needed for the staff to determine that the cask system is capable of meeting regulatory requirements of 10 CFR 72.236(d) which requires a dry storage system to meet the dose limits in 10 CFR 72.104 and 106.

Holtec Response:

The arrangement of the [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390] regions within the MPC-32M basket is shown in Figure 5.II.2-1, with burnup, enrichment and cooling time combinations, determined from the loading curves in Table 2.II.1.6, presented in Table 5.II.2.5b. [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]. As an example, see Table B.3.5 in HI-2188253 Revision 2, which shows the normal condition dose rates at the various locations at the top, followed by the corresponding enrichment, burnup and cooling time combination for each region and each location. Additionally, following the same approach, the uniformly loaded MPC-32M is analyzed using the burnup, enrichment and cooling time combinations in Table 5.II.2.5a, determined from the uniform loading curve in Table 2.II.1.6.

Using this approach, any self-shielding, or lack thereof, is accounted for, and is considered independently for each dose location and cask condition.

Note that this methodology is similar to that utilized for qualification of MPC-37 and MPC-89 with loading curves in the HI-STORM FW FSAR for Amendment 5.

6-9 Provide additional information on the Version E top lid outer ring.

Section A.2.2.3 of HI-2188253 Revision 1 states that "*(s)ince the Version E top lid outer ring OD is not specified, a value of 131.75" is assumed*." The staff requests that the applicant provide additional information on the purpose of this component and if it is used in some way within the safety analyses for it to explain why it the outer diameter is not specified.

This information is needed for the staff to determine that the cask system is capable of meeting regulatory requirements of 10 CFR 72.236(d) which requires a dry storage system to meet the dose limits in 10 CFR 72.104 and 106.

Holtec Response:

We apologize for this confusion. The HI-STORM 100 Version E top lid outer ring dimension, discussed in Paragraph A.2.2.3 of HI-2188253 Revision 2, was initially not shown on the drawing, hence while the actual intended dimension was used in the analysis, it was stated as "assumed". However, the value is present in the final release of this drawing (see 11371R0, Sheet 1, Zone C2), so it is no longer characterized as "assumed" in the report.

Chapter 7 - Criticality Evaluation

7-1 Revise the application to provide the lengths of the partial length rods for the 10x10I, 10x10J and 11x11A fuel assembly classes.

Section 6.III.4.2 of the SAR discusses analyses performed by the applicant to determine the bounding condition of partial length rods in the various boiling water reactor (BWR) fuel assembly classes. For the 10x10I and 11x11A BWR assembly classes, the applicant demonstrates that it is conservative to assume that partial length rods are removed from the assembly. The staff needs the actual partial length rod active fuel lengths to confirm this conclusion. For the 10x10J, the applicant's analyses determine that the most conservative configuration is with the actual active lengths of the partial length rods. However, the SAR does not contain the partial length rod active fuel lengths for the staf to confirm.

This information is to ensure that the HI-STORM 100 cask system will continue to meet the criticality safety requirements of 10 CFR 72.236(c).

Holtec Response:

The following lengths of part-length rods were used in the analyses:

10x10I: 62.20"

10x10J: short 54.56", long 103.03"

11x11A: short 55.87", long 88.03"

These values were assumed and may or may not correspond to part length rod lengths of actual fuel assemblies. It is therefore important that the qualification of these assemblies from a criticality safety perspective is independent of the actual length of theses rods, so that users of the system will not have to verify any part rod lengths.

For 10x10I and 11x11A, the bounding cases are hypothetical configurations where the part length rods are assumed to be removed completely. This means that the actual length of these part length rods is not a critical parameter. For the 10x10J, where the configuration with the part length rods modeled at assumed length is bounding, this conclusion is not directly clear, i.e. it may be possible that variations in the lengths of the part length rods may have a relevant impact on the results, which would mean the actual lengths of these rods may become a critical parameter for criticality safety. To investigate this, an extended study is performed with a range lengths of the partial rods from complete removal to full length. Lengths are varied independently for the shorter and longer partial rods, i.e. each assumed lengths for the shorter rods is combined with all assumed length for the longer rods. The results of this study show that the reference value presented in Table 6.III.4.14 is, in fact, statistically equivalent (within 3 sigma) to the highest value, and other combinations of part rod lengths result in statistically equivalent or lower values. Based on that it is concluded that the configuration with the highest reactivity for any combination of part lengths rods has been identified, and that therefore, also for the 10x10J assembly class, the rod lengths are not critical parameters and therefore do not have to be verified by the user.

Please note that the reference case presented in Table 6.III.4.14 is designated as the design basis case for the 10x10J assembly class. This is considered acceptable because, as stated above, even though it has a lower k_{eff}, the reference case and the case with the highest k_{eff} value are statically equivalent.

7-2 Revise Holtec Report HI-2033039, “Critical Experiment Benchmark,” or the SAR, to include descriptions of the benchmark experiments included for keff bias and bias uncertainty determination relevant to the partial gadolinium credit analysis of the MPC-68M, with references provided for detailed descriptions.

Table C.2 of Appendix C of HI-2033039 provides a listing of input files and resulting keff values for an “extended set” of critical benchmarks used for benchmarking MCNP5-1.51 analyses of BWR fuel in the MPC-68M with partial gadolinium credit. However, the applicant did not provide relevant details of the critical experiments that include gadolinium for the staff to make a determination that the critical experiments selected are applicable. The staff requests that the applicant provide descriptions of the critical experiments analyzed, including references for more detailed descriptions, and confirmation that these experiments adequately represent cask and fuel features and parameters that are important to reactivity.

This information is needed to ensure that the HI-STORM 100 cask system will continue to meet the criticality safety requirements of 10 CFR 72.236(c).

Holtec Response:

Descriptions of the benchmark experiments included for k_{eff} bias and bias uncertainty determination relevant to the partial gadolinium credit analysis of the MPC-68M have been provided in HI-2033039 along with confirmation that these experiments adequately represent cask and fuel features and parameters that are important to reactivity. References are also provided for detailed descriptions.

Additional discussion on why the specific benchmark experiments included for k_{eff} bias and bias uncertainty determination relevant to the partial gadolinium credit analysis of the MPC-68M were selected and why they appropriately demonstrate MCNP5-1.51’s capability to analyze systems which incorporate Gd_2O_3 rods has been added to Subsection 6.A.1.1 of the FSAR.

7-3 Provide Holtec Report HI-2104790, “Nuclear Group Computer Code Benchmark Calculations,” referenced in HI-2033039.

This report is referenced in the benchmarking analysis in HI-2033039 but is not provided. This report is necessary for the staff to evaluate the applicant’s benchmarking analysis for partial gadolinium credit of BWR fuel in the MPC-68M canister. Staff requests that the applicant provide this reference.

This information is needed to ensure that the HI-STORM 100 cask system will continue to meet the criticality safety requirements of 10 CFR 72.236(c).

Holtec Response:

Holtec Report HI-2104790 revision 3, “Nuclear Group Computer Code Benchmark Calculations," has been provided as requested as Attachment 9.

7-4 Revise Figure 6.III.4.10 of the SAR to include the information for the 11x11A assembly class.

The title of Figure 6.III.4.10 indicates that the figure is supposed to be the reactivity differences from the design basis for two different gadolinium rod arrangements in the 11x11A fuel assembly class. However, the figure appears to be repeated from Figure 6.III.4.9 for the 10x10J fuel assembly class, axial segment 3. The staff requests that the applicant revise the figure to include the information for the 11x11A assembly class.

This information is needed to ensure that the HI-STORM 100 cask system will continue to meet the criticality safety requirements of 10 CFR 72.236(c).

Holtec Response:

Figure 6.III.4.10 of the SAR has been revised to include the information for the 11x11A assembly class.

Chapter 8 - Materials Evaluation

8-1 Clarify whether the HI-TRAC MS lift blocks and their attachment bolts are ITS SSCs and if so, identify the materials specification and mechanical properties used in the structural analysis.

FSAR Section 8.1.2 discusses HI-TRAC and HI-STORM receiving and handling operations. Amendment No.15 added an option to engage the lift yoke to the HI-TRAC MS via lift blocks that are attached to the transfer cask top forging with high strength bolts, as shown in FSAR figure 8.II.0-1. The staff notes that neither the FSAR text nor licensing drawing No. 11381, HI-TRAC Version MS, identifies the lift blocks and bolting material specification or ITS classification.

This information is needed to determine compliance with 10 CFR 72.140(a) and 10 CFR 72.236(b).

Holtec Response:

The HI-TRAC MS lift blocks and their attachment bolts are ITS components. As stated in FSAR section 1.2.1.5.2, all lifting appurtenances used with the HI-TRAC VW are designed in accordance with NUREG-0612 and ANSI N14.6, as applicable. The guidance in NUREG 0612 is specifically aimed at this application. The appurtenances or lifting devices themselves are ancillary components which are not included in licensing drawings, since design may vary from site to site.

Chapter 11 – Radiation Protection Evaluation

11-1 Provide additional clarifying information on how the dose rates in Table 10.II.3.1 of the FSAR were determined.

The applicant updated Chapter 10 of the FSAR to include information pertaining to radiation protection from the HI-TRAC MS. Table 10.II.3.1 of the FSAR shows the estimated occupational exposures. The title of this table states that fuel with 60,000 MWd/MTU with 3 years cooling time was used for these calculations. Table 10.II.4.2 shows the dose rates at 100, 200, and 300 meters for the HI-TRAC Version MS transfer cask. Sections 10.II.3 and 10.II.4 of the FSAR state that the values from Table 10.3.1b of

the FSAR for the 100-ton HI-TRAC were scaled to be applicable to the HI-TRAC MS. Appendix E of HI-2188253 Revision 1 explains the basis for this scaling. The staff requests that the applicant provide additional information so that it can confirm that the dose rates in Table 10.II.3.1 of the FSAR are appropriate.

a. The staff specifically requests that the applicant provide the source of data for "dose rate at operator location mrem/hr" from Table 10.3.1b of the FSAR. These values do not seem to match that of Table 5.1.7 of the FSAR for the 100-ton HI-TRAC. Although the staff is not reviewing this table as it is not part of the current amendment, it needs to understand the basis of these numbers as it appears that they are used to determine the appropriate dose rates for the HI-TRAC MS.

b. Tables 10.3.1b and 10.II.3.1 of the FSAR state that the occupational exposures are based on a burnup of 60,000 MWd/MTU and 3-year cooled PWR fuel. The staff requests that the applicant state which MPC was used in these evaluations and state the basis for the selected MPC and source term parameters (burnup, enrichment, and cooling time).

c. The method to calculate scaling factors in Appendix E of HI-2188253 Revision 1 indicates that the scaling factors were only calculated for dose rates at 1 meter. The staff requests that the applicant clarify if the scaling factors for the 1-meter dose rates were also used for all surface dose rates in Table 10.II.3.1b of the FSAR or if there are different scaling factors used for dose rate estimates at loading operations near the surface of the HI-TRAC MS.

This information is needed for the staff to evaluate the capability of the cask system to control and limit occupational exposures within the limits in 10 CFR Part 20 and to meet the objective of maintaining exposures ALARA, and to evaluate the capability of the cask system to meet dose limits in 10 CFR 72.104 and 106 to evaluate compliance with 10 CFR 72.236(d).

Holtec Response:

a) The calculations presented in Table 10.3.1b are based on the dose rates at operator locations around the HI-STORM and HI-TRAC overpacks with MPC-24 loaded with fuel at a burnup of [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390], which were determined for LAR 1014-3 and summarized in Appendix Y of HI-2012702 Rev.15 (see Page Y-results-29).

b) The calculations presented in Table 10.3.1b are performed using the 100-ton HI-TRAC with MPC-24 and the design basis fuel loading from a table in Section 5.1 of the FSAR. As discussed in Section 5.1, the 100-ton HI-TRAC with MPC-24 has higher normal condition dose rates, therefore it was initially used for the dose exposure estimates in Chapter 10. Operational doses in Table 10.II.3.1 are determined for the same loading conditions that were used for Table 10.3.1b. However, there are loading conditions for the MPC-32M basket, that would result in higher dose rates than those, specifically if the content would approach the limits of the loading curves, as discussed in Subsection 5.II.1.1 of the FSAR. [PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]. This would need to be specifically considered in the site-specific ALARA evaluations for the HI-STORM system. As discussed in

Section 10.II.3, an optimized HI-TRAC Version MS should be considered to offset such dose effects.

c) According to Figure 10.3.1 of the FSAR and Appendix Y of HI-2012702 Rev.15 (see Page Y-results-30), most of the points are located at a distance from the cask surface (from 1 foot to several meters). The only cask surface location selected as the operator location is 16D (see Tables E.2.1 and E.2.2 of HI-2188253 Revision 2). This is acceptable for HI-TRAC Version MS since as shown in Table C.2.5, the dose rate ratios to the reference 100-ton HI-TRAC are essentially the same between the surface dose location and at 1 m distance.