Request for Supplemental Information

Docket No. 72-1032
Certificate of Compliance No. 1032
Amendment No. 5 to the HI-STORM Flood/Wind (FW) Multipurpose Canister Storage System

Chapter 4 - Thermal Evaluation

4-1 Provide all supporting thermal analysis for any new or revised thermal evaluation provided in the amendment request.

The application includes addition of new heat load patterns for MPC-37 and MPC-89. However, the applicant did not provide the supporting thermal analysis input and output files for the new or revised thermal evaluations during storage and transient operations. Section 4.5.4.1 of NUREG-1536 states that any model used in the thermal evaluation should be clearly described. Section 4.5.4.7 of NUREG 1536 states that the application should be reviewed to ensure that the applicant made the correct assumptions and provided the correct input, and that the output is consistent with established physical (thermal) behavior. The staff needs the information to determine the adequacy of the thermal analysis and to determine applicable thermal limits are not exceeded.

This information is necessary to verify the requirements of 10 CFR 72.236(g), (l), and (m).

Holtec Response:

All thermal analysis input and output files supporting the new or revised thermal evaluations are provided as Attachment 8 to Letter No. 5018064.

Chapter 6 - Shielding Evaluation

6-1 Provide the neutron and gamma source terms for the new decay heat patterns.

The proposed technical specifications (TS) for the HI-STORM FW amendment contain new decay heat loading patterns. The applicant states in the Safety Analysis Report (SAR) that it used these decay heat limits to calculate the radiation source terms for dose and dose rate evaluations of the transfer cask and the storage system design. It is not clear to the staff what source term was used to perform these evaluations.

The applicant provided information starting at the bottom of page 5-6 of the changed SAR pages to justify its approach. The staff finds that the information presented is insufficient for the staff to review and make a finding as to whether or not the HI-STORM FW will be capable of meeting the regulatory requirements of 10 CFR 72.236(d). The staff requests that the applicant provide specific information on the parameters (burnup, enrichment, cooling time, and depletion assumptions) used to generate the source terms that were used to calculate doses for each ne loading pattern. Although the staff recognizes there is some information in Table 5.2.18 of the SAR, this table states that this is only applicable to loading patterns: 37C1, 37C2, 37C3, 37D1, 37D2, 37D3, 37E1,

37E2, 37E3, 89A1, and 89A2.

Section 6.5.2 "Radiation Source Definition" of NUREG-1536 states: *"The reviewer should examine the description of the design-basis fuel in Chapter 2, "Principal Design Criteria" of the SAR to verify that the applicant calculated the bounding source term. The review confirms that the applicant examined all fuel designs and burnup conditions for which the cask system is to be certified, to ensure that the bounding fuel type and values are used."*

This information is needed for the staff to evaluate the capability of the cask system to meet dose limits in 10 CFR 72.104 and 106 as required by 10 CFR 72.236(d).

Holtec Response:

Holtec is in the process of implementing the Fuel Qualification Tables (FQTs) approach as discussed with the NRC staff during recent conference calls and a meeting on March 19, 2019. The fuel permitted by the FQT will be used to determine the radiation source terms for dose and dose rate evaluations. The FSAR Chapters 2 and 6 will be revised to include this approach and the proposed changed pages will be submitted to the Staff by April 30, 2019 to complete our response to this RSI. The same approach is being implemented in HI-STORM FW Amendment 4 RAI 5-5 response, which will be submitted by April 15th. In summary, the approach for determining the neutron and gamma source terms for the new decay heat load patterns in amendment 5 and supporting calculations are as follows:

The design basis of the fuel permitted to be loaded into the system, in terms of burnups and cooling times, is not a single burnup and cooling time combination, but an equation that allows the calculation of the minimum cooling time as a function of the assembly burnup. While the equation has some technical background (its loosely related to heat loads), it is, for the purpose of the FSAR, an arbitrarily selected equation, and is validated through dose rate calculations showing the maximum (bounding) dose rates that would correspond to the design basis. For this validation, a sufficient number of burnup and cooling times are selected based on the equation, dose rate calculations are then performed for each combination, and the maximum dose rates are established. Note that the combination of burnup and cooling time that results in the highest dose rate could be different for different dose locations. In general, the number and the values of the combinations are selected so there is reasonable assurance that the condition at or close to the maximum is identified.

For the enrichments used in the calculations in the FSAR, conservatively low values are used, based on a database of actual fuel assemblies at US reactor sites. The low enrichments are based on [1] and [2]. To determine the enrichments, the data is separated in burnup bins spanning 5 GWd/mtU (i.e. 0 to 5, 5 to 10, 10 to 15, etc.). Then for each bin, an enrichment value is determined that presents a lower bound value for most of the assemblies in that bin.

SCALE 6.2.1, along with the above methodology, will be used to develop the source terms which will be used to the update the shielding evaluation.

The HI-STORM FW Amendment 5 FSAR will be revised to reflect this new approach. Due to the timing of the discussions between the Staff and Holtec, the proposed changes pages will be sent under separate letter by April 30, 2019.

References

[1] U.S. Energy Information Administration, Form GC-859, "Nuclear Fuel Data Survey" (2013).

[2] U.S. Energy Information Administration, Form GC-859, "Nuclear Fuel Data Survey" (2002).

6-2 Provide specifications for the damaged fuel and fuel debris to include the quantity limit, the geometric form, and how the fuel is confined and discuss how it is modeled within the shielding evaluation and justify that it is bounded.

The proposed HI-STORM FW amendment contains new loading patterns that include damaged fuel and fuel debris. The staff needs this information to evaluate the adequacy of the shielding analyses for casks with these loading patterns because damaged fuel and fuel debris may reconfigure under normal, off-normal, and accident conditions.

Section 6.5.3.1 of NUREG-1536 states: *"If the applicant has requested storage if damaged fuel assemblies, ensure that the applicant has adequately described the proposed damage assemblies. If the fuel assemblies are damaged to the extent that reconfiguration of the fuel into a geometry different from intact fuel assemblies can occur, ensure that the applicant provides appropriate [d]ose assessments for normal, off-normal, and accident conditions."*

This information is needed for the staff to evaluate the capability of the cask system to meet dose limits in 10 CFR 72.104 and 106 as required by 10 CFR 72.236(d).

Holtec Response:

Damaged Spent Nuclear Fuel and Fuel Debris specifications are described in Subsection 2.1.3 and in Table 2.1.1; damaged fuel and fuel debris are defined in the glossary. The quantity limits for fuel debris and damaged fuel must meet the same limits as undamaged fuel in Tables 2.1.2 and 2.1.3, as required in the "Fuel Type" row of Table 2.1.1a.

Subsection 5.4.2 discusses damaged fuel and fuel debris modeling from a shielding perspective under normal and accident conditions. Results from a shielding evaluation referenced in this section, demonstrate that damaged fuel and fuel debris under normal or accident conditions will not result in a significant increase in dose rates around the HI-TRAC. The DFCs, used to store the damaged fuel or fuel debris, minimize any significant reconfiguration and provide additional shielding.

While some reconfiguration of damaged fuel or fuel debris is possible, which could cause a small increase in dose rates in certain localized areas. It may be noted that the pitch of

fuel rods in undamaged assemblies has reasonably tight spacing, which physically restricts the amount of reconfiguration that can occur.

Chapter 8 - Materials Evaluation

8-1 Provide the following information for the damaged fuel isolators (DFI) described in SAR Section 1.2.3 and shown in Figure 1.2.9:

1. Provide engineering drawings that include tolerances, materials of construction, and the safety category for this component. Include information to describe how the DFI allow water to drain from the basket cells which are equipped with DFI. The description of the DFI provided in SAR Section 2.1.3

2. Clarify what type of damaged fuel assemblies may be stored in the MPC basket using DFI. SR Section 2.1.3, Damaged SNF and Fuel Debris Specification, states, *"[f]or damaged fuel assemblies that can be handled by normal means, the use of a Damaged Fuel isolator (SFI) (Figure 2.1.7) can be substituted for the use of the DFC."* However SAR Section 9.2.2, Preparation of HI-TRAC VW and MPC, Step 15 states, *"[i]f used, the DFC or DFI can be installed in those cells where damaged fuel or fuel debris will be positioned."* The description in the SAR Section 9.2.2 implies that the DFI may be used to store fuel debris that cannot be handled by normal means.

3. Explain how the DFI used for the storage of damaged fuel that undergoes geometric rearrangement will not lead to operational safety issues during loading or unloading operations. In the amendment TS, a damaged fuel assembly is defined as an assembly *'whose structural integrity has been impaired such that geometric rearrangement of fuel or gross failure of cladding is expected based on engineering evaluations."* It appears that a damaged fuel assembly may produce fuel debris during normal and off-normal conditions of storage. The TS indicate that fuel debris cannot be handled by normal means.

4. Provide the procedures that describe the loading and unloading steps for the damaged fuel assemblies using DFI. Based on a review of CoCs with similar components, the procedures for removing damaged or fuel debris require additional steps that are not included in HI-STORM FW SAR, Revision 6E, Section 9.4.4, MPC Unloading, which refers to 'applicable site procedures." Address, as necessary, the testing of fission gasses, radiation dose rates and ALARA practices, removal of top and bottom end caps, and the recovery of damaged fuel which may produce fuel debris that cannot be handled by normal means.

This information is necessary to ensure compliance with 10 CFR 72.236(a), (b), (c), (d), (f), (g), (h), and (m).

Holtec Response:

1. Section 2.1.3.1 and Table 2.1.9 were added and Figure 2.1.7 was revised to include the DFI material of construction, critical dimensions, and safety category. The DFI is constructed entirely of stainless steel or nickel alloy suitable for use within the high temperature environment of the MPC. Per the detail of Figure 2.1.10 and Table 2.1.9, the cap walls shall have perforation with a maximum size of 1mm. This allows for liquids and gases to permeate the walls.

2. Section 2.1.3 has been revised to clarify the type of damaged fuel which can be stored using DFIs. The following statement was added to section 2.1.3, " For damaged fuel assemblies that can be handled by normal means and whose structural integrity is such that geometric rearrangement of fuel is not expected, the use of a Damaged Fuel Isolator (DFI) (Figure 2.1.7) can be substituted for the use of the DFC." Fuel debris is not permitted to be stored using DFIs. Section 9.2.2 step 15 was clarified to permit the use of DFIs with damaged fuel which can be handled by normal means and not with fuel debris.

3. In the Tech Spec and CoC Appendices A and B, the damaged fuel which is allowed to be stored using DFIs is limited to fuel assemblies which can be handled by normal means. Clarification was added to Appendices A and B to clarify that DFIs can be used only with fuel assemblies that can be handled by normal means and whose structural integrity is such that geometric rearrangement of fuel is not expected. Damaged fuel that has the potential to undergo geometric rearrangement is not allowed to be stored using DFIs.

4. Fuel assemblies, which is allowed to be stored using DFIs, are limited to assemblies that can be handled by normal means and whose structural integrity is such that geometric rearrangement of fuel is not expected. The procedure steps currently outlined for loading and unloading the fuel assembly remain applicable to loading and unloading using the DFIs because the fuel assembly is handled by normal means. Steps for installing the bottom and top DFI during loading and for removing the top DFI during unloading are included. No additional changes are required to the loading and unloading procedure steps.

8-2 Provide TS and Bases for the vent monitoring of the HI-TRAC VW Version V and V2. HI-STORM FW SAR, Revision 6E, Section 9.2.4, MPC Closure, indicates a warning which states, *"A HI-TRAC VW Version V or V2 containing an MPC loaded with spent fuel assemblies shall NOT be left unattended to insure that blockage of the air flow paths does not occur."* Likewise, SAR Revision 6E, Section 9.4.2, HI-STORM FW Recovery from Storage, includes a warning which states, *"A HI-TRAC VW Version V or V2 containing an MPC loaded with spend fuel assemblies shall NOT be left unattended when the MPC does not contain water."* These warnings do not specify the frequency of vent inspections and imply that the vents must be continuously monitored. In addition, such surveillance requirement, including required actions, should be included in TS.

This information is necessary to assure compliance with 10 CFR 72.236(a), (b), and (f).

Holtec Response:

LCO 3.1.4 and SR 3.1.4 were added to HI-STORM FW CoC Appendix A to provide frequency of monitoring of the HI-TRAC VW Version V and V2 vents whenever the HI-TRAC contains an MPC loaded with spent fuel assemblies and MPC drying operations have been completed. The LCO and SR include the frequency of monitoring, required corrective actions and corresponding completion times. The basis of the frequency is supported by thermal evaluation provided in Section 4.6 of the FSAR. Chapter 4 was revised to include the evaluation the HI-TRAC vent blockage accident condition. FSAR Chapter 13 was revised to include the bases description for LCO 3.1.4. Additionally Chapter 11 was revised to include a discussion on this accident condition.

The notes in FSAR sections 9.2.4 and 9.4.2 were revised to include a statement for monitoring of the HI-TRAC VW Version V and V2 vents when containing an MPC loaded with spend fuel assemblies.

Chapter 11 – Radiation Protection Evaluation

11-1 Provide revised estimated doses to workers and the public from the HI-TRAC VW version V2.

The procedures for loading the HI-TRAC VW Version V2 are significantly different from the HI-TRAC VW, and the estimated dose rates for the dry MPC with neutron shield cylinder part of the process in Table 5.1.10 of the SAR are significantly higher than that of the HI-TRAC VW. The estimates to the doses received to personnel for loading, surveillance, and maintenance in Chapter 11, "Radiation Protection" need to be updated to reflect the HI-TRAC VW Version V2 loading procedures and estimated doses to workers as well as that to individuals at or beyond the controlled area.

Section 11.5.2, "Occupational Exposures," of NUREG-1536 states: *"The reviewer should verify that the applicant presents the rationale used to justify the bases for various exposure times personnel locations relative to the casks (including hot spots), number of personnel required, and appropriate gamma and neutron dose rates. In addition, the reviewer should verify that the calculated does are consistent with these estimates."* Section 11.5.3, "Exposures at or Beyond the Controlled Area Boundary" states: *"As required by 10 CFR 72.236(d), the application must demonstrate that the shielding and confinement features of the cask are sufficient to meet the requirements of real individuals in 10 CFR 72.104, and for DBA conditions in 10 CFR 72.106."*

This information is needed for the staff to (1) 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, (2) evaluate the capability of the cask system to meet dose limits in 10 CFR 71.104 and 106, and (3) evaluate compliance with 10 CFR 72.236(d).

Holtec Response:

The dose rate results of the HI-TRAC VW Version V2 in the current Table 5.1.10 when compared to the HI-TRAC VW dose rate results in Table 5.1.2 show that in dose locations 2 and 3 the HI-TRAC VW Version V2 have lower dose rates. Dose locations 2 and 3 (Figure 5.1.2) are the locations where workers are present for the longest durations of the HI-TRAC loading.

A steel shield ring pedestal may be used to further reduce dose rates as mentioned in the second note below the current Table 5.1.10. Also drawing 11283R0 allows for variable thicknesses of lead, Holtite-A, and steel to maximize shielding where possible while remaining in compliance with site-specific weight and dimensional restrictions.

While it is true that not all dose rates in the current Table 5.1.10 are bounded by Table 5.1.2, it is reasonable to conclude qualitatively that crew dose is expected to be less for the HI-TRAC VW Version V2 for the following five reasons:

- There are fewer operational steps required (no water jacket to fill)

- The HI-TRAC VW Version V2 has lower dose rates in the two dose locations where workers are present for the longest durations of the loading
- MPC welding operations remain essentially the same between HI-TRAC versions
- Supplemental shielding in the form of lead blankets or lead snakes are used in the vicinity of the MPC lid.
- Actual loadings of the HI-STORM FW System are usually significantly below the total exposure (person-rem) in Table 11.3.2.

For these reasons, we would prefer to leave Table 11.3.2 “as is”, since it continues to serve as a reasonable crew dose estimate.

Nevertheless, as discussed in the response to RSI 6-1, Table 5.1.10 results will be updated after implementing the Fuel Qualification Tables (FQTs). If after the update, the conclusion of comparison between Table 5.1.10 and Table 5.1.2 dose rates changes, Table 11.3.2 will be updated accordingly.