Request for Additional Information (Batch 2) - Nonproprietary

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

RAI 4-1

Provide the calculations and analysis results for cases when cyclic vacuum drying is used.

Section 4.5.2.3 of the FSAR states, "If the peak cladding temperature cannot be maintained below the ISG-11, Revision 3 limit under vacuum condition of infinite duration, cycles of vacuum drying resulting in heatup followed with cooling helium are performed until drying criteria specified in Chapter 9 is achieved". The applicant provided a summary of the methodology and assumptions for cyclic vacuum drying. However, the application does n ot include any calculations or analysis results to show how the calculations are performed for multiple cycles. The staff needs this information to verify cyclic vacuum drying will not result in temperatures exceeding the criteria specified in ISG-11, Rev. 3 for multiple drying cycles.

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

<u>Holtec Response:</u>

To address staff's comment, an example thermal analysis is performed following the methodology described in Section 4.5.2.3 of the FSAR. Cyclic drying calculations are performed for the most limiting thermal scenario i.e. short MPC-37 loaded with HBF under heat load pattern A. The thermal model described in Section 4.5.2.3 of the FSAR is adopted for the transient calculations and analysis results summarized in Section 4.5.2.3 and Table 4.5.25 of the FSAR. Since drying times are cask heat load specific, an example calculation adopting design basis maximum heat load is performed and included in the FSAR.

As mentioned above, an example calculation is performed for MPC-37 at design maximum heat load. This methodology can be adopted for all approved canisters and allowable decay heat in the FSAR. For reasons outlined below, cyclic drying response of MPC-89 is bounded by that of MPC-37.

1) MPC-37 (minimum height) under heat load pattern A is the most limiting canister (Tables 4.4.2 and 4.4.3 of the FSAR) since it results in the highest PCT.
2) MPC-37 with short fuel length has the lowest thermal inertia as presented in Table 4.5.3 of the FSAR.

The variation of peak cladding temperature with time during cyclic drying is presented in Figure 4.5.1 of FSAR. The temperature versus time behavior in cycle 1 cooldown and cycle 2 heatup repeats itself in subsequent cycles. Also, Table 4.5.25 of the FSAR summarizes the cycle durations for heatup and cooldown operations.

Holtec Report HI-2043317 (Attachment 7 to Letter 5018073) is also revised to include the above evaluations. All input and output files supporting these calculations are provided to the staff for review (Attachment 9 to Letter 5018073).

Chapter 6 – Shielding

RAI 6-3

[Proprietary information withheld in Accordance with 10 CFR 2.390].

Holtec Response:

[Proprietary information withheld in Accordance with 10 CFR 2.390].

RAI 6-5

Revise the dose and dose rate evaluations to include the particle (both neutron and gamma) streaming effects through the annulus between the HI-TRAC VW and the MPC, or update Chapter 9 of the SAR to include the lead snakes needed to reduce streaming effects for all applicable MPCs.

Note to SAR Table 5.1.1, "Maximum Dose Rates from the HI-TRAC VW for Normal conditions MPC-37 Design Basis Fuel Regionalized Loading Based on figures 1.2.3 through 1.2.5," as well as Table 5.1.2a and b, states," Streaming may occur through the annulus. However, during handling/operations the annulus is filled with water and lead snakes are typically present to reduce the streaming effects. Further, operators are not present on top of the transfer cask." These statements are inconsistent with those from Chapter 11, "Radiation protection," and Chapter 9, "Operating Procedures," The staff did not find in Chapter 9 where lead snakes were to be sued to reduce streaming effects. The staff requests that the applicant revised the dose and dose rate evaluations to include particles (both gamma and neutron) streaming effects through the annulus or update Chapter 9 of the SAR to include lead snakes as a required supplemental shielding device to reduce the radiation level on the HI-TRAC VW.

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 meets the dose limits as prescribed in 10 CFR 72.104 and 106.

Holtec Response:

We apologize for the confusion. The lead snakes, used as a supplemental shielding device to reduce the streaming effects, have been already discussed in Chapter 9 under the name of "annulus shield". For operations procedures involving the annulus shield, please see Subsections 9.2.1, 9.2.4, 9.4.3, etc. It should be noted that the annulus shield (in the form of lead snakes) is included in the HI-TRAC delivery for each client.

RAI 6-6

Provide information on how the non-fuel hardware (NFH) is considered within the fuel qualification analyses.

The applicant updated Table 2.1.1a of the SAR to state that the minimum cooling time for non-fuel hardware within the MPC-37 is reduced from 3 to 2 years. The staff requests that the applicant provide information on how this change to the allowable non-fuel hardware was considered within the shielding evaluation. The applicant did not submit any changes to Section 5.4.4 of the SAR which discusses how non-fuel hardware was considered within the evaluation. This section discusses how non-fuel hardware was considered in the evaluation. This section states, “All dose rates with NFH in this chapter therefore assume BPRA in every assembly.” “… burnup and cooling time combinations for BPRAs in Table 2.1.25 of the HI-STORM 100 FSAR are conservative.” Table 2.1.25 of the HI-STORM 100 FSAR Revision 18 (ML 19150A405) states that the minimum cooling time used for the BPRAs is 3 years, and 5 years for NSA (neutron source assembly), Guide Tube Hardware or Control components and APSRs. Based on the dose rate tables within the SAR, most of the dose rate for the HI-TRAC VW, HI-TRAC VW Version V2, and the HI-STORM FW overpack come from the gamma contributions making the presence of non-fuel hardware significant for estimating dose rates. In addition, Co-60 is a significant radiation source for non-fuel hardware, which has a half-life of 5.27 years and would be a significant gamma source for the cooling times allowed. As such, the staff is concerned that the gamma source from non-fuel hardware may impact the required minimum cooling times of the fuel.

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 meets the dose limits as prescribed in 10 CFR 72.104 and 106.

Holtec Response:

We apologize for the confusion. In Table 2.1.1a the post-irradiation cooling time for non-fuel hardware (NFH) was incorrectly changed from 3 to 2 years, while in fact the value of 3 years was still used in the analysis. With respect to the qualification of NFH compared to fuel, all analyses used the same design basis NFH activities (same cooling time) regardless of the cooling time of the fuel assemblies.

Nonetheless, with the ongoing preparations for unloading of the spent fuel pools we have determined that a minimum cooling time of 3 years for NFH may result in inefficient loading configurations. Therefore, a minimum cooling time has been further reduced to as low as 1 year for BPRAs, TPDs, etc. and to as low as 2 years for control components and NSA. This has been discussed in Subsections 5.2.3 and 5.4.4 and all shielding evaluations for MPC-37 have been updated using the BPRAs at 1 year cooling, unless noted otherwise. The post-irradiation cooling time limits for non-fuel hardware have been updated in Table 2.1.1a.

RAI 6-8

State why accident condition dose rates for MPC-89 use the loading pattern from figure 1.2.7 of the SAR rather than the loading pattern from Figure 1.2.6 of the SAR.

The applicant proposes two loading patterns for the MPC-89, figures 1.2.6 and 1.2.7 of the SAR. Table 5.1.4b of the SAR contains the accident condition dose rates for the MPC-89 based on the loading pattern in figure 1.2.6 of the SAR. However, based on normal condition dose rates in Tables .5.1.2a and 5.1.2b of the SAR, the MPC-89 with the loading pattern in Figure 1.2.7 of the SAR has higher dose rates. The staff requests that the applicant explain why accident

condition dose rates are based on the loading pattern in figure 1.2.6 rather than 1.2.7 of the SAR.

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 meets the dose limits as prescribed in 10 CFR 72.104 and 106.

Holtec Response:

Initially it was considered that the dose rates from the MPC-89 loading pattern from Figure 1.2.6 is sufficiently conservative to illustrate the impact of the design basis accident. To ensure that the bounding dose rates have been established and reported in the FSAR, both MPC-89 loading patterns from Figures 1.2.6 and 1.2.7 have been evaluated for the accident conditions dose rates and the results are presented in Tables 5.1.4b and 5.1.4c, respectively. The maximum dose from HI-TRAC VW under accident conditions is provided in Table 5.1.9.

RAI 6-9

Revise the maximum allowable Technical specification dose rate at the lid or the location for the measurement so that they are consistent and appropriate for all HI-STORM FW lids.

The maximum dose rate allowed by TS in Section 5.3.4a of appendix A of the CoC is in line with the maximum dose rate evaluated by the applicant in Table 5.1.5, 5.1.6a and 5.1.6b of the SAR which is located at the “mid” section of the lid above the vertical section of the outlet vent. However, the location at which the measurement is required to be taken does not correspond to this location where the TS dose limit is calculated. Section 5.3.8 of appendix A of the CoC states,” A dose rate measurement shall be taken on the top of the OVERPACK at approximately the center of the lid.” Tables 5.1.5, 5.1.6a and 5.1.6b of the SAR shows that for the ”center” of the lid or the “outer” part of the lid (as defined in the notes to the above tables), the evaluated dose rate is less than a third of the TS limit. The applicant needs to modify Section 5.3.4.a of CoC appendix A to either reduce the maximum allowable dose rate at the lid to be in line with the doe rate values at the “center” according to Tables 5.1.5, 5.1.6a, and 5.1.6b of the SAR or modify the location at which the measurement is taken as specified by Section 5.3.8.a of CoC appendix A to coincide with the location of the maximum dose rate values from Tables 5.1.5, 5.1.6.a and 5.1.6.b of the SAR (i.e. the “mid’ section of the lid above the vertical section of the outlet vent).

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 meets the dose limits as prescribed in 10 CFR 72.104 and 106.

Holtec Response:

The dose rate limits in Section 5.3.4 of the CoC Appendix A have been updated to correspond with the calculated dose rates in Section 5.1 of the FSAR. The dose rate limit for the measurement location on the top of the overpack has been changed to comply with the maximum calculated dose rate at the center of the lid.

RAI 6-10

Justify the source term used for shielding design of the HI-STORM FW storage system for the MPC-89 canister under design basis accident conditions.

The applicant shows the accident condition source terms for the MPC-89 in Tables 5.2.5 and 5.2.14 of the SAR for gammas and neutrons, respectively. This includes a single burnup and cooling time, and the corresponding enrichment from Tables 5.1.4a and 5.1.4b of the SAR. The current amendment proposes two regionalized loading patterns for the MPC-89. The single burnup/cooling time/enrichment combination is not bounding for all source terms allowed by the loading patterns in Figures 1.2.6 and 1.2.7 of the SAR. Per the equation in Section 2.1.6.1 of the SAR and the correlation coefficients in Table 1.2.9 from the SAR, the cooling time is not Conservative for the locations with allowable decay heat for 0.32, 0.5 and 0.75kW.

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 meets the dose limits as prescribed in 10 CFR 72.104 and 106.

Holtec Response:

As already discussed in the response to the RAI #6-2, Section 5.1 of the FSAR has been updated with the description of the methodology and specification of the analyzed limiting loading patterns and source terms used for shielding evaluations. The selected burnup, enrichment and cooling time combinations from Tables 5.0.3 and 5.0.4 were used in the shielding calculations for both normal and accident conditions, and the bounding combination of the region-specific source terms, which results in the maximum dose rate, have been determined for each particular dose rate location. Since it is not practical to provide the gamma/neutron spectra for all combinations analyzed in the FSAR, the representative source terms only have been presented in Section 5.2 of the FSAR. For additional details about the bounding combinations of the source terms, which were considered for various loading patterns, storage regions and dose rate locations, the reviewer is referred to Supplement 2 of HI-2094431.

RAI 6-12

[Proprietary information withheld in Accordance with 10 CFR 2.390].

Holtec Response:

[Proprietary information withheld in Accordance with 10 CFR 2.390].

RAI 6-14

Justify the higher Co-60 level in BLEU fuel.

The staff is not aware of any additional fission products or actinides that decay to Co-60 from the down blending of higher enriched uranium or there is a special need for the fuel assemblies made form BLEU fuel to have higher Co-60 in the fuel hardware. Therefore, the staff is requesting that the applicant explain the additional source of Co-60 so that the staff may evaluate the source term.

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 meets the dose limits as prescribed in 10 CFR 72.104 and 106.

Holtec Response:

Blended low-enriched uranium (BLEU) is utilized by TVA in the commercial nuclear reactors. Information about BLEU fuel is summarized in the TVA environmental assessment report [6-14.1]. The interagency agreement [6-14.2] between TVA and DOE specifies allowable concentration of impurities in BLEU fuel material provided to TVA. Although the other elements are within normal fuel specification, some minor variations in metals are allowable. The agreement [6-14.2] ensures that the BLEU material at TVA will not differ substantially from the commercial fuel.

Holtec evaluated the impact of allowed impurity elements on the source terms. It is concluded that 80 ppm of Cobalt present in the BLEU material impacts gamma source terms of spent BLEU fuel. Therefore, the impact of loading BLEU fuel into HI-STORM FW on dose rates around the cask has been evaluated in Appendix C of Supplement 2 to the shielding calculation package HI-2094431 [6-14.3]. Based on this evaluation, the cooling time (Ct) requirement in Section 2.1.6.1 of the FSAR is increased by 1 year for BLEU fuel (in comparison with the design basis fuel) to compensate the increased gamma source term due to Cobalt impurity. An appropriate note has been added to Table 2.1.10.

[6-14.1] Environmental Assessment, Additional use of blended low enriched uranium (BLEU) in reactors at TVA's Browns Ferry and Sequoyah Nuclear Plants, TVA, May 2011.
[6-14.2] Interagency Agreement, DE-SA09-01 SR18976/TVA NO. P-01 N8A-249655-001.
[6-14.3] HI-STORM FW and HI-TRAC VW Shielding Analysis, HI-2094431, Revision 21.

RAI 8-2

Provide cladding, MPC components and HI-TRAC Version V component temperatures for a blocked vent accident for the HI-TARC version V transfer cask.

The applicant provided information on cladding, HI-TRAC and MPC component temperatures for blocked vents on the HI-TRAC Version V2 in Table 4.6.10. It is not clear from Table 4.6.10 (e.g., no footnote) or FSAR Section 4.6.2.7 whether the cladding and component temperatures calculated for the Version V2 bound the temperatures for the Version V. FSAR Table 4.6.7 which provides accident pressures for blocked vents on the Version V2 indicates, via a footnote, that the pressure values for the Version V2 bound Version V. No such information is provided in Table 4.6.10.

The staff needs this information to proceed with its review to determine if the amendment application meets the regulatory requirements of 10 CFR 72.236(b), (c) and (f).

Holtec Response:

Section 4.6.2.7 of the FSAR [1] evaluates the 100% air inlet vent blockage of HI-TRAC VW Version V2,

[Proprietary information withheld in Accordance with 10 CFR 2.390].

Based on this conservative approach, duration for duct blockage was established in Table 4.6.9 of the FSAR and results were reported in Tables 4.6.7 and 4.6.10 of the FSAR.

A 100% inlet vent blockage accident event of HI-TRAC VW Version V2 bounds HI-TRAC VW Version V due to the differences in cask designs as described below. The primary differences between the two design versions are described below:

[Proprietary information withheld in Accordance with 10 CFR 2.390]

Thermal model of Versions V and V2 described in Section 4.5.2.1 of the FSAR are adopted to evaluate the impact of 100% blockage of inlet vents.

[Proprietary information withheld in Accordance with 10 CFR 2.390]

Based on the CFD calculations, the allowable time for 100% duct blockage is set as 16 hours for Version V2 and 72 hours for Version V. Technical Specification LCO 3.1.4 has been revised for consistency. The temperature and pressure results presented in Tables 4.6.10, 4.6.8 and 4.6.7 of the FSAR confirm that Version V2 bounds Version V.

Holtec Report HI-2043317 (Attachment 7 to Letter 5018073) is also revised to include the above evaluations. All input and output files supporting these calculations are provided to the staff for review (Attachment 9 to Letter 5018073).

RAI 11-1

[Proprietary information withheld in Accordance with 10 CFR 2.390].

Holtec Response:

[Proprietary information withheld in Accordance with 10 CFR 2.390].

RAI 11-2

Compare the operation of decontaminating and fastening the neutron shield canister (NSC) to the HI-TRAC VW Version V2 to that of filling the neutron shield of the HI-TRAC VW in order to justify dose estimates in Table 11.3.2 of the SAR.

Page 1-45 of the SAR states that for the Version V2 transfer cask that the neutron shield cylinder is removable and "…the detachable NSC is fastened to the cask body at the earliest point in the loading evaluation when the lift capacity and geometric constraints are no longer controlling." Page 9-8 of the SAR states: "For HI-TRAC VW Version V2, following decontamination, HI-TRAC VW is loaded into the Neutron shield Cylinder (NSC) Assembly in the preparation area and attached to the NSC via fasteners/bolts." Section 9.2.4 of the SAR step1.j states: "For HI-TRAC VW Version V2, the HI-TRAC is placed in the NSC assembly and attached to the NSC using fasteners after decontamination of the HI-TRAC outer surfaces."

In RSI 11-1, the staff requested that the applicant update SAR Chapter 11, “Radiation Protection,” with revised doses to workers considering the HI-TRAC VW Version V2 loading procedures. The applicant listed some reasons why it believes that doses for the HI-TRAC VW Version V2 would be lower in dose and why updating the Table 11.3.2 of the SAR was not necessary. However, the applicant did not provide information sufficient for the staff to evaluate how the applicant considered the decontamination of and attaching of the neutron shield cylinder to the HI-TRAC VW Version V2, which would be different than filling the neutron shield for the previously approved HI-TRAC VW. The staff requests that the applicant provide comparison of the operation of decontaminating and fastening the NSC to the H-TRAC VW Version V2 to that of filling the neutron shield of the HI-TRAC VW including locations of personnel and estimated time to complete the evolution so that I can determine if the loading operations and dose estimates in Table 11.3.2 of the SAR are appropriate for the HI-TRAC VW Version V2.

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 ALARS and to evaluate the capability of the cask system to meet annual dose limits in 10 CFR 71.104 and 106 and to evaluate compliance with 10 CFR 72.236(d).

Holtec Response:

A comparison of the dose rates between the standard HI-TRAC VW and HI-TRAC VW Version V2 under normal conditions (Tables 5.1.2b and 5.1.10) and flooded with no neutron shield conditions (Tables 5.4.4b and 5.4.17) shows that the shielding performance of these overpacks is very similar, though the slightly higher dose rates are observed from the standard HI-TRAC VW cask for most of the dose rate locations.

From the operational perspective, the only substantial differences between loading of the standard HI-TRAC VW and HI-TRAC VW Version V2 are decontamination and fastening of the neutron shield cylinder (NSC), which are further discussed below:

- A decontamination procedure for HI-TRAC VW Version V2 is improved in comparison with the standard HI-TRAC VW, since decontamination of the cask and insertion into NSC are performed from about 3 times larger distance, while a total duration of decontamination and insertion as well as a number of involved personnel remain the same;
- The operation of fastening of NSC, i.e. installing 10 bolts between HI-TRAC and NSC, is performed on scaffold by the same number of personnel as during filling the water jacket of the standard HI-TRAC VW cask. However, a total duration of this operation is reduced by about of factor 2.

In summary, the loading operations considered for the standard HI-TRAC cask are applicable and bounding with respect to HI-TRAC VW Version V2. Hence the occupational doses presented in Table 11.3.2 are applicable and representative of both HI-TRAC designs.

RAI 11-3 Update Table 11.3.2 or Chapter 9 of the operating procedures to be consistent with the use of additional/auxiliary shielding.

Several steps in Table 11.3.2 of the SAR include additional and/or auxiliary shielding; however, Chapter 9 of the SAR does not state when and where the additional or auxiliary shielding is to

be used. The staff requests that the applicant either update Table 11.3.2 of the SAR to include dose to workers when additional/auxiliary shielding is not used or include within the steps of Chapter 9 of the SAR where and when additional/auxiliary shielding is required.

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 71.104 and 106 and to evaluate compliance with 10 CFR 72.236(d).

Holtec Response:

The following auxiliary shielding devices have been included in Table 11.3.2: annulus shield ring, welding machine pedestal, lead blankets, water shields and mating device. However, the shielding effect for none of these devices (except the HI-TRAC water jacket) has been credited in the shielding analyses, while the contribution to the operation duration due to installation/removal is conservatively included to the occupational dose analysis in Table 11.3.2. The installation and/or removal of these devices have been discussed in Chapter 9. Particularly, the annulus shield ring is discussed in various subsections of Section 9.2, the welding machine pedestal, which is a part of the Automated Welding System (AWS), is discussed in Subsection 9.2.4 and the mating device is discussed in Subsection 9.2.6.