May 3, 2010

Ms. Tammy Morin,
Licensing Manager
Holtec International
Holtec Center
555 Lincoln Drive West
Marlton, NJ 08053

SUBJECT: FIRST REQUEST FOR ADDITIONAL INFORMATION FOR THE HOLTEC INTERNATIONAL HI-STORM FLOOD/WIND MULTIPURPOSE CANISTER STORAGE SYSTEM GENERAL LICENSE APPLICATION (TAC NO. L24321)

Dear Ms. Morin:

By letter dated September 18, 2009, Holtec International (Holtec) submitted a license application to the U. S. Nuclear Regulatory Commission (NRC) for the HI-STORM 100 Flood/Wind (FW) Multipurpose Canister (MPC) Storage System. The proposed application would license a new dry cask storage system under 10 CFR 72 Subpart L consisting of the HI-STORM FW overpack, the HI-STORM Variable Weight (VW) transfer cask, and two high capacity MPC models (MPC-37 and MPC-89). The NRC staff (staff) has reviewed your application and has determined that additional information is required to complete its detailed technical review.

The staff has determined that we need additional information identified in the enclosure to this letter. We request that you provide the information by June 4, 2010. Please inform us in writing at your earliest convenience, but no later than May 21, 2010, if you are not able to provide the information by the requested date. You should also include a new proposed submittal date and the reasons for the delay to assist us in re-scheduling your review.

Please reference Docket No. 72-1032 and TAC No. L24321 in future correspondence related to this licensing action. If you have any questions, please contact me at (301) 492-3325.

Sincerely,

/RA/

John Goshen, P.E., Project Manager
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket No.: 72-1032

TAC No.: L24321

Ms. Tammy Morin,
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Distribution: SFST r/f **ADAMS: ML101200583**
File location: G:\SFST\HI-STORM FW\RAI 1\Ebfs01\nrc\NMSS\SFST\HI-STORM FW\RAI 1\First request for additional information.doc

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HOLTEC INTERNATIONAL

DOCKET NO. 72-1032

FIRST REQUEST FOR ADDITIONAL INFORMATION

RELATED TO THE HI-STORM FW MPC STORAGE SYSTEM APPLICATION

By letter dated September 18, 2009, Holtec International (Holtec) submitted a license application to the U. S. Nuclear Regulatory Commission (NRC) for the HI-STORM 100 Flood/Wind (FW) Multipurpose Canister (MPC) Storage System. The proposed application would license a new dry cask storage system under 10 CFR 72 Subpart L consisting of the HI-STORM FW overpack, the HI-STORM Variable Weight (VW) transfer cask, and two high capacity MPC models (MPC-37 and MPC-89). The NRC staff (staff) has reviewed your application and has determined that additional information is required to complete its detailed technical review.

1.0 GENERAL DESCRIPTION

1-1 Provide the type of appropriate safety evaluations required to use a solid neutron shield material in the HI-TRAC VW.

Page 1-43 of the Safety Analysis Report (SAR) states that in lieu of water, a solid neutron shield material such as Holtite-A or Holtite-B may be used at a host site after an appropriate safety evaluation. The thermal evaluation of the HI-TRAC VW should be based on all materials proposed for the design. For the same design heat load, a solid neutron shield material may result in higher cladding temperatures than predicted by using water liquid neutron shield.

This information is needed to verify compliance with 10 CFR 72.11 and 72.236.

1-2 Provide the technical basis for the pitch arrangement of the casks reported in Table 1.4.1. In addition, page 1-66 states that the pitch values may be varied by the user's specific needs. Does this imply that the pitch values reported in the table are not minimum values? What prevents a user from building an array with significantly smaller pitch values?

This information is needed to verify compliance with 10 CFR 72.11 and 72.236.

1-3 Provide a detailed list or table of Important-to-Safety (ITS) components which is subdivided in accordance with the three classification categories of NUREG/CR 6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety."

Storage canister components are presently classified as ITS/NITS per the licensing drawings. A detailed identification of each ITS component in accordance with the three category levels (A, B, and C) of NUREG/CR 6407 is needed to confirm the level of QA/QC documentation that is necessary for each ITS component.

This information is needed to verify compliance with 10 CFR 72.122(a).

2.0 PRINCIPAL DESIGN CRITERIA

2-1 Provide the operating restrictions to limit the maximum temperature excursion during short-term operations to 65°C (117°F) and the number of excursions to less than 10.

Per page 2-2 of the SAR, provide the operating restrictions to limit the maximum temperature excursion during short-term operations to 65°C (117°F) and the number of excursions to less than 10. This should be included in the appropriate SAR sections.

This information is needed to verify compliance with 10 CFR 72.11 and 72.236.

2-2 Clarify whether or not the non-fuel hardware specified in SAR section 2.1.8 contains any materials not previously reviewed and accepted for storage applications. Previously reviewed and accepted non-fuel hardware materials include: boron carbide, borosilicate glass, silver-indium-cadmium alloy, and thorium oxide.

Should different materials from the above list be included in the non-fuel hardware listed in SAR section 2.1.8, provide an assessment of potential chemical/galvanic reactions, as per SAR section 8.12.

This information is required to verify compliance with 10 CFR 72.120(d).

2.-3 Provide material property data and discussion which supports the fuel basket normal condition design temperature of 400°C (SAR table 2.3.3).

The Metamic HT Sourcebook material property data is limited to a maximum temperature of 350° C. Design temperatures which exceed the highest available temperature data are not acceptable to the staff.

This information is required for compliance with 10 CFR 72.124(b).

3.0 STRUCTURAL EVALUATION

3.1 Provide details of the fuel basket buckling analysis for design accident conditions.

SAR section 3.1.2.6 states that the Metamic HT fuel basket is not subject to buckling. However the SAR statements do not provide the mechanical properties of Metamic HT at 1000 degrees F (off-normal/design accident temperature) nor any buckling calculations. It is unclear, without supporting data or calculations, how the buckling performance statement is justified.

This information is required to verify compliance with 10 CFR 72.124(b).

3-2 SAR Section 12.2.1, page 12-11, Note 1: SA states:

"However, it is also a fact that at many sites a loaded HI-TRAC transfer cask is handled inside the Part 50 building, some of whom do not possess a single-failure-proof cask crane. At such plants, the licensee may use other means to mitigate a transfer cask drop event such as the use of an impact limiter."

There are no compensatory measures or guidelines provided in the proposed Technical Specifications (TS) or SAR. The staff finds this unacceptable. The TS will therefore require a single failure proof crane for this evolution.

This information is required to verify compliance with 10 CFR 72.236(l).

3-3 Evaluate the potential for crack propagation and growth for the MPC baskets under tipover conditions. Attachment D of the Metamic HT Sourcebook is based on results for conditions applicable only to the HI-STAR 180 and not the HI-STORM FW System.

This information is required to verify compliance with 10 CFR 72.236(l).

3-4 Clarify the definitions of φ and Ψ in SAR section 3.2. It is not clear from the paragraph how the parameters are defined or applied.

This information is required to verify compliance with 10 CFR 72.230(a).

3-5 Explicitly state whether the cask spacing will preclude impact between casks in the event of an earthquake, or whether the tipover is precluded by analysis. Otherwise, provide analyses that support that the casks are structurally adequate to withstand the impacts.

This information is required to comply with 72.236(l).

3-6 Explain how the ratio h/r governs the earthquake considerations versus the cylindrical cask used in NUREG/CR-6865 "Parametric Evaluation of Seismic Behavior of Freestanding Spent Fuel Dry Cask Storage Systems" without taking into account the total loaded weight into consideration.

This information is required to verify compliance with 72.236(l).

4.0 THERMAL EVALUATION

4-1 Revise all material thermal properties to ensure the tabulated data provided in the SAR adequately covers the entire range of predicted temperatures.

Some of the thermal properties provided in the SAR do not seem to cover the expected range of operating temperatures. For example, SAR Table 1.B.2 indicates that the Metamic-HT thermal conductivity and specific heat properties are for temperature ranges between 200°C and 350°C. Temperatures of the MPC basket reach higher temperatures (see for example Table 4.6.5, page 4-63).

This information is needed to verify compliance with 10 CFR 72.11 and 72.236.

4.2 Revise the effective thermal properties of the Pressurized Water Reactor (PWR) and Boiling Water Reactor (BWR) spent nuclear fuel.

Section 4.4 of the SAR includes effective thermal conductivity of both BWR and PWR design basis fuel for normal conditions of storage. Effective density and fuel capacity for these conditions are not provided in the SAR. Also, effective thermal properties of the design basis fuel for short-term operation are missing the SAR. Please provide this information.

This information is needed to verify compliance with 10 CFR 72.11 and 72.236.

4.3 Provide a detailed description of the Metamic-HT thermal model.

Page 4-18 of the SAR states the Metamic-HT fuel basket is modeled in the same manner as the model described in the HI-STAR 180 FSAR. The HI-STORM FW SAR lacks the necessary details to make a determination of the adequacy of the model.

This information is needed to verify compliance with 10 CFR 72.11 and 72.236.

4-4 Clarify if the flow resistance factors used in the porous media model described in Section 4.4.1.1 of the SAR are bounding for all MPC baskets and fuel assembly types.
Section 4.4.1.1 of the SAR states that calculated flow resistance factors described in Holtec Report HI-2043285, Revision 5 are bounding for all proposed contents. Holtec may need to recalculate flow resistance factors because the basket storage cell may have a different (possibly larger) flow area.

This information is needed to verify compliance with 10 CFR 72.11 and 72.236.

4-5 Perform a computational fluid dynamics (CFD) analysis on the heat transfer effects associated with the surrounding casks.

SAR page 1-66 states that the pitch dimension(s) of the cask array is a suggestion, not a minimum value. However, SAR page 4-23 calculates and compares the annular MPC area and lateral access area between casks and concludes that sufficient ventilation cooling is available. An analysis should be performed that conservatively takes into account the surrounding casks. This is especially true for a cask located in the center of the array as the overpack outer shell temperature would influence the heat transfer due to thermal radiation and convection heat transfer due to higher local ambient temperatures. A minimum array pitch must be specified to define the analysis of record.

This information is needed to verify compliance with 10 CFR 72.11 and 72.236.

4-6 Identify the procedures for ensuring the correct number of Burnable Poison Rod Assemblies (BPRA) in each MPC.

Per SAR pages 4-26 to 4-28, the MPC pressure analyses are based on a maximum allowable number of BPRA fuel assemblies and so means to ensure the correct loading should be included in the SAR.

This information is needed to verify compliance with 10 CFR 72.11 and 72.236.

4-7 Confirm the pressures listed in SAR Table 4.4.10 and Table 4.4.8.

The maximum pressure for MPC-37 is listed as 48 psig in Table 4.4.10 and Table 4.4.8 of the SAR. The maximum pressure for MPC-89 is listed as 50 psig in Table 4.4.10 and 47 psig in Table 4.4.8 of the SAR. Explain why is there the same MPC-37 pressure in Table 4.4.8 and Table 4.4.10 of the SAR but different MPC-89 pressures in Table 4.4.8 and Table 4.4.10 of the SAR?

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

4-8 Discuss the “operationally reliable” ALARA methods that are mentioned on page 4-40 of the SAR.

The “operationally reliable” ALARA methods mentioned on SAR page 4-40 should be discussed or clarified in section 4.5 of the SAR.

This information is needed to verify compliance with 10 CFR 72.11.

4-9 Clarify if CFD best practice guidelines (BPG) were applied to perform the thermal evaluation of HI-STORM FW storage system.

The thermal analysis methods described in Chapter 4 of the SAR do not include a discussion of the use of CFD BPG to perform the thermal evaluation of the HI-STORM FW spent fuel storage system. Per CFD BPG, the analyses results should include an estimate of the numerical uncertainty, grid convergence, and sensitivity of the performed CFD analyses. Holtec should provide an estimate of the numerical uncertainty and provide a response to the following questions:

a: Has a sensitivity analysis been performed concerning turbulence modeling, boundary conditions, grid independence and grid convergence?

b. Was grid convergence index (GCI) used to assess uncertainty of the predicted results? Holtec may consult to the following documents for further information on CFD BPG: (1) Best Practice Guidelines for the use of CFD in Nuclear Reactor Safety Applications, NEA/CSNI/R(2007)5, ADAMS accession number ML071581053. (2) Policy of Journal of Fluid Engineering of ASME about CFD analyses (http://journaltool.asme.org/Content/JFENumAccuracy.pdf).

This information is necessary to verify the requirements of 10 CFR 72.11 and 72.236.

4-10 Propose an adequate thermal acceptance test to validate the thermal analysis methods described in Chapter 4 of the SAR.

The proposed test should include experimental methods to measure the air flow through the annular gap between the MPC and the HI-STORM FW overpack. Also, due to the significant increase in the decay heat load of the system, as compared to previously approved storage systems of similar design, the proposed test should include experimental methods to perform some internal temperature measurements of the MPC. MPC Temperature measurements should include the location where the peak cladding temperature has been predicted in Chapter 4 of the SAR in addition to some other measurements of the MPC basket.

This information is needed to verify compliance with 10 CFR 72.11 and 72.236.

4-11 Perform sensitivity calculations to determine the adequate use of the k-ω turbulence model with the transitional option enabled.

Page 4-19 of the SAR states that the air flow in the HI-STORM FW/MPC annulus is simulated by the k-o turbulence model with the transitional option enabled. The SAR does not specify if adequate guidelines were followed to use a mesh which will resolve the viscosity-affected region. A mesh which will resolve the viscosity-affected region will place the first near-wall node at $y^+ \sim 1$.

This information is needed to verify compliance with 10 CFR 72.11 and 72.236.

5.0 SHIELDING EVALUATION

5-1 Provide additional information about the design criteria for the HI-STORM FW such as ALARA and occupational exposure criteria. Also, Holtec needs to provide the criteria such as objectives dose rates and the basis for these criteria.

The staff does not find that Holtec has provided enough information to describe the design basis criteria for the HI-STORM FW in term of ALARA and /or occupational exposure.

This information is necessary to verify compliance with 10 CFR 72.236.

5-2 Justify the use of Westinghouse (W) 17x17 and General Electric (GE) 10x10 as a design basis zircaloy clad fuel assemblies for the shielding analysis.

In Section 5-1 of the SAR, Holtec states that the design basis zircaloy clad fuel assemblies used for calculating the dose rates presented in the chapter are W 17x17 and the GE 10x10, for PWR and BWR fuel types, respectively. Provide this information and justify that it is applicable for all HI-STORM FW fuel contents.

This information is necessary to verify compliance with 10 CFR 72.236.

5-3 Provide additional information about the assumptions related to photons with energies in the range of 0.45 to 3.0 MeV.

In Section 5-2 of the SAR, Holtec stated that the bases were the previous analyses performed for the HI-STORM 100 system. Due to the magnitude of the gamma source at lower energies, photons with energies as low as 0.45 MeV must be included in the shielding analysis, but photons with energies below 0.45 MeV are too weak to penetrate the HI-STORM FW overpack or HI-TRAC VW. The effect of gamma radiation with energies above 3.0 MeV, on the other hand, was found to be insignificant. This is due to the fact that the source of gamma radiation in this range is extremely low. Provide this information and justify that it is applicable for all HI-STORM FW system.

This information is necessary to verify compliance with CFR 72.236.

5-4 Justify that the dose rates for both BPRAs and Thimble Plug Devices used from the HI-STORM 100 are applicable to HI-STORM FW.

In SAR Section 5.2.3.1, Holtec stated that the HI-STORM 100 presented dose rates for both BPRAs and TPDs. The results indicate that BPRAs are bounding, therefore all dose rates in the chapter will contain a BPRA in every PWR fuel location.

This information is necessary to verify compliance with CFR 72.236.

5-5 Provide additional information on alternate neutron shield materials for the HI-TRAC VW.

In SAR Section 5.3.2, Holtec states that the HI-TRAC VW transfer cask may be equipped with a water jacket to provide radial neutron shielding. Demineralized water (borated water) will be utilized in the water jacket. To ensure operability for low temperature conditions, ethylene glycol (25% in solution) may be added to reduce the freezing point for low temperature operations. Calculations were performed for the HI-STORM 100 system to determine the effect of the ethylene glycol on the shielding effectiveness of the radial neutron shield. Based on these calculations, it was concluded that the addition of ethylene glycol (25% in solution) does not reduce the shielding effectiveness of the radial neutron shield. The staff needs this information to determine if these calculations are applicable for this application.

This information is necessary to verify compliance with CFR 72.236.

6.0 Criticality Evaluation

6-1 For the HI-TRAC VW design, provide additional information demonstrating that flooding with unborated water cannot occur.

Since borated water is used for criticality control during loading and unloading operations, administrative controls and/or design features should be implemented to ensure that accidental flooding with unborated water cannot occur, or the criticality evaluation should consider accidental flooding with unborated water. The staff cannot locate any information about this consideration. Provide an analysis showing that the cask remain subcritical if there is accidental flooding with unborated water or state any administrative controls or design features that ensure that flooding with unborated water cannot occur.

This information is needed to verify compliance with 10 CFR 72.124(a).

6-2 Justify the fuel specification of the 9x9E and 9x9F fuel assemblies.

For the 9x9E and 9x9F Note 3 in Table 2.1.3 of the SAR says: *For the SPC 9x9-5 fuel assembly, each fuel rod must meet either the 9x9E or the 9x9F set of limits or clad O.D., clad I.D., and pellet diameter.* Provide additional information justifying that the criticality analysis was performed considering the most conservative set of fuel specifications.

This information is needed to verify compliance with 10 CFR 72.236(a) and (c).

6-3 Provide the following additional information regarding the description of the 10x10G fuel assembly:

a. Table 2.1.3 of the SAR states that the 10x10G will have “96/84” for "No. of Fuel Rod Locations." Other fuel types with this type of description indicate in the notes that the "/" designator indicates number of full length rods (versus part-length rods). Table 2.1-3 of the Proposed TS state that the "No. of Fuel Rod Locations" for the 10x10G is “96.” The staff is aware that this fuel type will have some partial length rods. In addition the staff is aware that the criticality analysis was performed with 96 full-length rods and that this was found to be conservative with respect to the inclusion of part-length rods. Although it would be acceptable by the staff to state in the TS that this fuel type will have 96 full-length rods, the staff believes that this does not adequately describe the assembly Holtec intends to represent by the 10x10G description. Therefore the staff will be changing the specification for “No. of Fuel Rod Locations” within the TS to state “96/84” and will additionally add a note similar to the other designs with part-length rods stating that this is to represent 96 total rods with 84 full length rods. Confirm that this change would adequately describe the fuel you wish to store under the 10x10G designation.

b. Table 6.1.2 of the SAR states that the "Maximum Allowable Planar-Average Enrichment" of the 10x10G is 4.6%. Table 2.1.3 of the SAR states that it is 4.8%. Clarify this value and correct the discrepancy.

This information is needed to verify compliance with 10 CFR 72.236(a).

6-4 Justify the fuel specification of the 8x8B and 8x8D fuel assemblies.

a. In Table 2.1.3, the 8x8B and 8x8D are specified with two separate values for “No. of fuel rod locations.” Justify that the most reactive value was used in the criticality analysis for these fuel types.
b. In Table 2.1.3, the 8x8B can have either 1 or 0 water rods. Justify that the most reactive value was used in the criticality analysis for this fuel type.

This information is needed to verify compliance with 10 CFR 72.236(a) and (c).

6-5 Clarify the title of Table 6.2.2 in the SAR.

The title of Table 6.2.2 in the SAR is *Reactivity Effect of Assembly Parameter Variations for BWR Fuel in the <u>MPC-68</u>*. State if this is a typographical error, and if so, correct the error. If not, explain why these calculations were not performed in the geometry of the MPC-89.

10 CFR 72.11(a) requires that the information provided by Holtec be complete and accurate in all material respects.

6-6 Correct the location of the acceptance testing for the neutron absorber material.

Section 6.1 (Page 6-3) and 6.3.2 (Page 6-19) of the SAR both state that the acceptance testing for the neutron absorber is located in Section 10.4.1 of the SAR. The staff did not find this information in Section 10.4.1 of the SAR. Correct this error.

10 CFR 71.11(a) requires that the information provided by Holtec be complete and accurate in all material respects.

6-7 Demonstrate that the fuel dimensional variations listed in Section 6.2.1 give the maximum reactivity for all fuel assembly types that are to be stored in the HI-STORM FW.

In Section 6.2.1 of the SAR you give the fuel dimensional variations that give the maximum reactivity for all fuel assembly types that are to be stored within the HI-STORM FW. The staff does not find that the SAR provides enough information to show that these characteristics would be bounding for all PWR and BWR assemblies proposed for storage in the HI-STORM FW. As stated in this section of the SAR, these parameters are based on analyses performed for the HI-STORM 100. There are a few assemblies that are new to the HI-STORM FW that were not previously approved contents for the HI-STORM 100. This includes the PWR 15x15I, 17x17C, 17x17E and BWR 10x10G. In addition, some assemblies that were previously approved for storage in the HI-STORM 100 have increased enrichment limits for the HI-STORM FW. It also appears as though the calculations may be based on the MPC-24 and MPC-68 designs of the HI-STORM 100. Therefore, the referenced analyses performed for the HI-STORM 100 may not be applicable for the HI-STORM FW and its contents. Provide additional information demonstrating that the generic limiting fuel specifications are applicable to the all of the fuel types and enrichment limits within the MPC-37 and MPC-89 of the HI-STORM FW.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-8 Justify the use of planar averaged enrichments rather than maximum or discrete radial enrichments.

a. Page 6-13 of the SAR states that *the results … in Table 6.2.2 … show that in all cases, the maximum keff calculated for the distributed enrichments is at or below that of the uniform enrichments*. However it appears as though in Table 6.2.2 of the SAR distributed enrichment case 2 gives higher reactivity than that of the reference case. Provide clarifying information on either the statement on Page 6-13 of the SAR or for the results reported in Table 6.2.2 of the SAR.
b. Appendix B of the HI-STORM 100 SAR states that the *calculations have been performed to confirm that the statement [the use of a uniform (planar-averaged) enrichment, as opposed to the distributed enrichments normally used in BWR fuel, produces conservative results] remains valid in the geometry of the MPC-68*. Provide information justifying that uniform (planar-averaged) enrichments produce conservative results within the geometry of the MPC-89.

This information is needed to verify compliance with 10 CFR 72.236(a) and (c).

6-9 Justify that the use of full density fuel is more conservative than annular pellets.

On Page 6-42 of the SAR, Section 6.4.9 states that there were studies performed for the HI-STORM 100 that demonstrate that the use of full density fuel is more conservative than annular pellets. The staff reviewed the HI-STORM 100 SAR and did not find enough information to determine that these studies are applicable to the HI-STORM FW and its contents. Justify that the studies performed for the HI-STORM 100 are applicable to the HI-STORM FW. Specifically include information such as what fuel types were used in this study, fuel enrichment, boron concentration and the geometry (i.e. infinite lattice, specific MPC and basket geometry, etc.).

This information is needed verify compliance with 10 CFR 72.236(a) and (c).

6-10 Provide additional information about non-fuel hardware definitions.

Table 2.1.1 on Page 2-16 of the SAR states that CEAs will be included with the non-fuel hardware contents. Provide a definition of a CEA. It is not listed in the definition of non-fuel hardware definition on Page xvi of the SAR.

10 CFR 72.11(a) requires that the information provided by Holtec be complete and accurate in all material respects.

6-11 Provide additional information about the calculation used to support the conclusion that pure water in the guide tubes for the PWR assemblies is a bounding assumption for assemblies without soluble boron.

Section 6.4.7 of the SAR states that for pure water the presence of the non-fuel hardware decreases reactivity because it is replacing moderator. Page 6-41 of the SAR states that *this conclusion is supported by the calculation listed in Section 6.2, which shows a significant reduction in reactivity as a result of voided guide tubes, i.e., the removal of the water from the guide tubes*. The staff did not find any discussion of this calculation mentioned in Section 6.2 of the SAR. Provide a more specific location of the referenced calculation and update the SAR providing a discussion and the results of this calculation.

10 CFR 72.11(a) requires that the information provided by Holtec be complete and accurate in all material respects.

6-12 Demonstrate that the calculations performed to support the inclusion of non-fuel hardware are conservative.

Table 6.4.5 of the SAR shows the results of a study used to demonstrate that assuming that the guide tubes are flooded with borated water would bound any configuration when the guide tubes are filled with non-fuel hardware by demonstrating that the flooded guide tubes bound the condition where the guide tubes are voided. State the assembly type and enrichment for which this calculation was performed and demonstrate that it is applicable for all HI-STORM FW contents that are to be loaded in the presence of borated water. Include information about the soluble boron concentrations used and justify that it bounds all maximum possible soluble boron concentrations including that of damaged fuel evaluations.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-13 Justify that the assumed location of guide tubes and water rods is conservative.

The location of guide tubes and water rods is not specified in Tables 2.1.2 and 2.1.3 of the SAR. Provide additional information demonstrating that the locations of guide tubes and water rods assumed in the criticality models are conservative as compared to the actual lattice geometry.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(a) and (c).

6-14 Provide additional information about the modeling of assemblies with a “water cross” design.

For fuel assemblies that employ a “water cross” design, the water cross geometry is not specified in Table 2.1.3 of the SAR. Provide additional information about the geometry used for the water cross in the criticality calculations. Justify that it gives conservative results compared to the actual lattice geometry. This applies to assemblies 8x8F, 9x9G, 10x10C and 10x10G.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(a) and (c).

6-15 Provide additional information on the modeling of damaged fuel for the 17X17D and 17x17E.

Page 6-39 of the SAR states that for the damaged fuel evaluations an active fuel length of 150 inches is used. Explain how this is bounding for the 17x17D and 17x17E assemblies which have an active fuel length of ≤170 inches.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-16 Justify that the bare fuel array analysis for damaged and moderately damaged fuel is conservative.

Section 6.4.4.1 (Page 6-40) of the SAR states that: *For the HI-STORM 100, additional evaluations for damaged fuel assemblies were performed to further show that the above approach using arrays of bare fuel rods are bounding. The evaluations considered conditions including*

- *Fuel assemblies that are undamaged except for various numbers of missing rods*
- *Variations in the diameter of the bare fuel rods in the arrays*
- *Consolidated fuel assemblies with cladded rods*
- *Enrichment variations in BWR assemblies*

The staff was unable to locate the stated evaluations in the HI-STORM 100 SAR. Provide this information. Justify that it is applicable for all of the HI-STORM FW fuel contents, moderately damaged fuel, MPC-89 and 37 basket geometry, design and applicable soluble boron requirements.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-17 Demonstrate that the 9x9E fuel is bounding for 10x10G damaged fuel evaluations.

When performing damaged fuel evaluations, Section 6.4.4.1 of the SAR (page 6-38) states that the 9x9E undamaged fuel was used to fill the cells that did not include Damaged Fuel Canisters and that this bounds the 10x10G fuel. Provide additional information demonstrating that this is conservative. Table 6.1.2 of the SAR shows that the 10x10G has higher reactivity than the 9x9E.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-18 State the cross section set used to perform the criticality analysis and benchmark calculations.

Section 6.5 of the SAR states *The benchmark calculations were performed with the same computer codes and cross-section data, described in Section 6.4, that were used to calculate the keff values for the cask.* Section 6.4 of the SAR does not specify the cross sections used in the analysis. State that the cross section set used in the analysis and in the benchmark calculations.

10 CFR 72.11(a) requires that the information provided by Holtec be complete and accurate in all material respects

6-19 State the soluble boron concentrations assumed in the damaged fuel evaluations and justify that they are conservative.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-20 State the fuel enrichment assumed for the intact fuel in the damaged fuel evaluations for the BWR fuel and justify that it is conservative.

Table 2.1.3 of the SAR states there are reduced enrichment limits for some damaged fuel assemblies. Table 6.1.5 of the SAR reflects these lower enrichment limits. However it is not clear to the staff what enrichment was used when modeling the intact fuel for these evaluations. Provide this information.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-21 Justify the UO_2 fuel density used in the criticality calculation is realistic or conservative for all fuel types.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-22 Provide additional information on how the structural material for the fuel assemblies was modeled.

The staff was unable to locate any information describing how the structural material was modeled in the criticality analysis. Justify that the modeling assumptions are conservative.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-23 Demonstrate that the results of the partial flooding calculations are representative of all fuel types and fuel conditions that would be loaded in the HI-STORM FW.

Table 6.4.2 of the SAR gives the results for the partial cask flooding evaluations. The results are presented for the 17x17B for the MPC-37 and the 10x10A for the MPC-89. It is not clear to the staff that the results of these two configurations would represent the behavior of all fuel types and fuel conditions (damaged and undamaged). In addition, per Tables 6.1.1 and 6.1.2 of the SAR, these fuel types are not the most reactive fuel types for the HI-STORM FW. Provide additional information demonstrating that these calculations are representative of all possible loadings in the HI-STORM FW.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-24 Demonstrate that the results of the pellet-to-clad gap flooding calculations are representative of all fuel types and fuel conditions that would be loaded in the HI-STORM FW.

Table 6.4.3 of the SAR gives the results of the evaluations performed to determine the most reactive flooding conditions of the pellet-to-clad gap. The results are presented for the 17x17B for the MPC-37 and the 10x10A for the MPC-89. It is not clear to the staff that the results of these two configurations would represent the behavior of all fuel types. In addition, per Tables 6.1.1 and 6.1.2 of the SAR, these fuel types are not the most reactive fuel types for the HI-STORM FW. Provide additional information demonstrating that these calculations are representative of all possible loadings in the HI-STORM FW.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-25 Justify the results of the preferential flooding calculations are applicable for all fuel loadings with DFCs.

The results of the preferential flooding calculations in Table 6.4.4 of the SAR do not state what fuel types were used in these calculations. Given the values of k-eff the staff can infer that these are for the 17x17B for the MPC-37 and the 10x10A for the MPC-89. Confirm if this is true. Justify that the results of these calculations would be applicable for all fuel loadings with DFCs and all boron concentrations.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-26 Justify that calculations used to determine the most reactive external moderator conditions are applicable for all fuel types and boron concentrations.

Table 6.4.1 of the SAR gives the results of the evaluations performed to determine the most reactive external moderator conditions. The results are presented for the 17x17B for the MPC-37 and the 10x10A for the MPC-89. It is not clear to the staff that the results of these two configurations would represent the behavior of all fuel types and boron concentrations. In addition, per Tables 6.1.1 and 6.1.2 of the SAR, these fuel types are not the most reactive fuel types for the HI-STORM FW. Provide additional information demonstrating that these calculations are representative of all possible fuel loadings and boron concentrations in the HI-STORM FW.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-27 Justify that the calculations used to determine the most reactive assembly positioning are applicable for all fuel types and boron concentrations.

Table 6.3.5 of the SAR gives the results of the evaluations performed to determine the most reactive assembly positioning within the basket. The results are presented for the 17x17B for the MPC-37 and the 10x10A for the MPC-89 and corresponding DFC evaluations. It is not clear to the staff that the results of these configurations would represent the behavior of all fuel types and boron concentrations. In addition, per Tables 6.1.1 and 6.1.2 of the SAR, these fuel types are not the most reactive fuel types for the HI-STORM FW. Provide additional information demonstrating that these calculations are representative of all possible fuel loadings and boron concentrations in the HI-STORM FW.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-28 Justify that the manufacturing tolerances for the basket assumed in the criticality analysis are conservative with respect to reactivity for all assemblies that are to be stored in the HI-STORM FW.

Section 6.3.1 (Page 6-18) of the SAR states: *the conservative dimensional assumptions listed in Table 6.3.3 were determined for the basket designs. Because the reactivity effect (positive or negative) of the manufacturing tolerances is not assembly dependent, these dimensional assumptions were employed for all criticality analyses.* The results of the analysis used to determine these tolerances are based on the 10x10A fuel for the MPC-89 and 17x17B fuel for the MPC-37. Per Tables 6.1.1 and 6.1.2 of the SAR, these fuel types are not the most reactive fuel types for the HI-STORM FW. The staff requires additional information justifying that the tolerances used are not assembly dependent.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-29 Provide the assemblies and conditions (boron concentration, etc.) used and justify that it is bounding for determining the bounding temperature effects using CASMO-4.

The results of the calculations used to determine the bounding temperature effects are presented in Table 6.3.1 of the SAR. This table does not state what assemblies were used to perform these calculations. Provide this information and justify that it is applicable for all HI-STORM FW fuel contents and conditions including all applicable boron concentration.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-30 Justify the separation in METAMIC in the basket panels used.

Section 6.3.1 of the SAR (Page 6-18) states that a 0.06” gap was assumed in the panels every 10”. Justify these values. The analysis results in Table 6.3.6 of the SAR are for the 10x10A fuel for the MPC-89 and 17x17B fuel for the MPC-37. Per Tables 6.1.1 and 6.1.2 of the SAR, these fuel types are not the most reactive fuel types for the HI-STORM FW. Justify the use of these assemblies in this calculation.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-31 Justify the use of the assemblies used to calculate the “representative” value of the overpack.
Holtec calculated “representative values” of k-eff for the storage cask (overpack) calculations and presented the results in Table 6.1.3 of the SAR. The staff notes that these may not be for the fuel that gives the maximum k-eff based on the results presented in Tables 6.1.1 and 6.1.2 of the SAR. Justify the use of these assemblies in this calculation.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-32 Justify the exclusion of the footnote information from the table describing the BWR contents in the proposed Technical Specifications.

Some of the information used to describe the fuel contents for the HI-STORM FW in the footnotes in Table 2.1.3 of the SAR are not listed in the proposed TS (Table 2.1-2). The staff intends to copy Table 2.1.3 in its entirety to be used for the Technical Specifications. Otherwise provide additional information justifying the exclusion of this information.

This information is needed to meet the requirements of 10 CFR 72.236(a)

6-33 Justify the statement that inclusion of neutron sources will not increase reactivity.

Start-up neutron source assemblies are stated as allowed contents in the HI-STORM FW. Section 6.4.8 of the SAR states that *“a neutron source of any strength will not increase reactivity, but only the neutron flux in a system, and no additional criticality analyses are required.”* Section 5.2.6 of the SAR gives the following examples of neutron sources: californium, americium-beryllium, plutonium-beryllium, polonium-beryllium, and antimony-beryllium. State the plutonium isotopes allowed and justify that they will not increase the reactivity by adding fissile material. Beryllium can also act as a moderator, justify that the inclusion of Beryllium will not increase reactivity.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

6-34 Provide additional information on alternate neutron shield materials for the HI-TRAC VW and their potential impact on the criticality analyses.

Section 1.2.1.4.2 of the SAR states that Holtite may be used in lieu of the water jacket for neutron shielding for the HI-TRAC VW transfer cask and that the water jacket may be fortified with ethylene glycol. Provide additional information discussing these other materials and what, if any, impact they will have on the criticality analyses.

The staff needs this information to determine that k-eff has been calculated with the maximum reactivity and to ensure that Holtec has met the requirements in 10 CFR 72.124(a) and 72.236(c).

7.0 CONFINEMENT EVALUATION

7-1 Clarify Note 1 on Table 3-1 in the TS (Appendix A) so that MPC pressure acceptance criteria is met *while the MPC is isolated from the vacuum pump*.

This clarification is included in Table 9.1.1 of the SAR but should be included in the TS.

This information is needed to verify compliance with 10 CFR 72.120(d) and 10 CFR 72.122(h).

7-2 Specify in the Technical Specifications that the leak rate through the Multi-Purpose Canister shop welds (shell seams and shell-to-base plate shop welds) shall be helium leak tested and found “leak-tight” in accordance with the requirements of ANSI N14.5 as part of the initial acceptance criteria.

This requirement is specified in Section 8.14.1 of the SAR but should be included in the TS.

This information is needed to verify compliance with 10 CFR 72.120(d).

7-3 Clarify that the helium leak testing of the vent and drain cover shall be leak tight in accordance ANSI N14.5 in Table 3-1 of the TS (Appendix A).

The specific requirements of ANSI N14.5 are described in Section 7.1.1 of the application, but should be also included in the TS.

This information is needed to verify compliance with 10 CFR 72.120(d) and 10 CFR 72.122(h).

7-4 Clarify or remove Note 25 on Sheet 3 of licensing drawing 6512.

Note 25 on Sheet 3 of licensing drawing 6512 would appear to permit the MPC lid to be fabricated out of dissimilar materials, austenitic stainless steel, and ferritic carbon steel. The latter of which is not included in the “Alloy X” grouping of stainless steels and was not included in the engineering design.

This information is needed to verify compliance with 10 CFR 72.120(A).

9.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

9-1 Explain the reason for not referring to the SAR section 4.5.5 unloading thermal analysis results in section 9 and section 12 of the SAR.

Per NUREG-1536, the thermal analysis associated with unloading operations should be referenced in section 9 and section 12 of the SAR. Explain the reason for not referring to the section 4.5.5 unloading thermal analysis results in section 9 and section 12 of the SAR.

This information is needed to determine compliance with 10 CFR 72.11 and 72.236.

10. RADIATION PROTECTION

10-1 Revise various incorrect SAR and TS references to the Metamic HT acceptance criteria of SAR section 10.1.6.3.

SAR sections 6.1 and 6.3.2 refer to these acceptance criteria being in SAR section 10.4 (which is leakage testing). The TS refer to these acceptance criteria being in SAR section 10.1.7.3 instead of 10.1.6.3.

12.0 TECHNICAL SPECIFICATIONS AND OPERATING CONTROLS AND LIMITS EVALUATION

12-1 Include a discussion of the off-normal malfunction of Forced Helium Dehydration (FHD) system event in SAR subsection 2.2.2.

SAR Page 12-1 states that the off-normal malfunction of FHD system event is discussed in FSAR subsection 2.2.2. However, this event is not listed in this subsection. For completeness and consistency of the information provided in the application, a discussion of this event should be included in SAR Section 2.2.2.

This information is needed to verify compliance with 10 CFR 72.11 and 72.236.

12-2 Provide proposed TS wording describing the requirements and acceptance criteria for the confinement (canister) shell helium leakage test described in SAR section 10.1.4 and SAR table 10.1.1.

Since the helium leakage test is the approved method used to demonstrate compliance with 10 CFR 72.104 and 72.106, its inclusion in the TS is necessary since it is a license condition.

This information is necessary to verify compliance with 10 CFR 72.104, 72.106, and 72.126.

13.0 MATERIALS EVALUATION

13-1 Clarify the coating qualification program used to qualify “equivalent” coatings (to be used on the HI-TRAC) which are not specifically recommended for immersion service by the coating manufacturer.

SAR section 8.7 and the SAR Chapter 8 appendices (Carboline data sheets) describe some coatings for use on the HI-TRAC that is not recommended for immersion service by Carboline but have been demonstrated as acceptable for use. SAR section 8.7 mentions several standard American Society of Testing Materials coating tests but does not specifically relate those tests to a qualification program for qualifying an equivalent coating from another manufacturer. Consequently, the substitution of “equivalent” coatings is not adequately supported for cases where the equivalent coating is not specified by the manufacturer for immersion service.

The staff understands that coatings are not classified as important to safety. However, historical experience with some unqualified coatings resulted in unanalyzed safety conditions when coating failure impeded loading operations.

This question does not concern the zinc-rich primers specified for use elsewhere.

This information is required to verify compliance with 10 CFR 72.120(d).