UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

February 4, 2019

Mr. Royston Ngwayah
Holtec International
1 Holtec Blvd
Camden, NJ 08104

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR THE REVIEW OF THE MODEL NO. HI-STAR 100MB PACKAGE

Dear Mr. Ngwayah:

By letter dated February 16, 2018, you submitted an application for the Certificate of Compliance No. 9378 for the Model No. HI-STAR 100 MB. Your application was accepted for review on June 1, 2018, when staff received your responses to our request for supplemental information dated May 11, 2018.

The staff has determined that further information is needed to complete its technical review. The information requested is listed in the enclosure to this letter. We request you provide this information by March 15, 2019.

Please reference Docket No. 71-9378 and EPID-L-2018-NEW-0000 in future correspondence related to this licensing action. If you have any questions regarding this matter, please contact me at 301-415-7505.

Sincerely,

/RA/

Pierre Saverot, Project Manager
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9378
EPID - L-2018-NEW-0000

Enclosure:
Request for Additional Information

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR THE REVIEW OF THE MODEL NO. HI-STAR 100MB PACKAGE, DOCUMENT
DATE: February 4, 2019

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Request for Additional Information
HOLTEC INTERNATIONAL
Docket No. 71-9378
Model No. HI-STAR 100MB Package

By letter dated February 16, 2018, Holtec International submitted an application for the Certificate of Compliance No. 9378 for the Model No. HI-STAR 100 MB transportation package.

The U.S. Nuclear Regulatory Commission (NRC) staff (the staff) issued a request for supplemental information dated May 11, 2018, for which responses were received on June 1, 2018.

This request for additional information (RAI) identifies information needed by the staff in connection with its review of the application.

Each individual RAI describes information needed by the staff to complete its review of the application and to determine whether the applicant has demonstrated compliance with the regulatory requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 71.

CHAPTER 1 GENERAL INFORMATION

1-1 Clarify the references in the application regarding the MPC Enclosure Vessel Drawing No. 3923.

Drawing No. 3923 Notes 4 and 11 contain unclear references to the “SAR (Transportation)” and “FSAR (Storage)” regarding component safety classifications and ASME Code alternatives.

The staff notes that Section 1.3 of the application states that the MPC enclosure vessel drawings are the same as those used in the HI-STAR 100 drawing package; however, Drawing No. 3923 should clearly specify the sources of the referenced information, including revision numbers.

This information is required by the staff to demonstrate compliance with 10 CFR 71.31(c) and 71.33(a).

1-2 Clarify the allowable contents of the HI-STAR 100MB package.

Sections 1.2.2 and 4.2 of the application state that the package may contain “canisterized damaged fuel and fuel debris”. However, Table 7.7.1 and Section 6.1.1 of the application state that the MPC-32M, as well as the F-32M and F-24M baskets, are designed only for undamaged fuel assemblies. The staff also notes that the proposed CoC references Table 7.7.1 for allowable contents, and that the drawings do not include a damaged fuel container.

This information is required by the staff to demonstrate compliance with 10 CFR 71.33(b).

Chapter 2 STRUCTURAL AND MATERIALS REVIEW

2-1 Provide the materials standards and required mechanical properties for important-to-safety aluminum and stainless steel basket shims and stainless steel corner brackets.

Table 2.1.15 states that yield strength is a critical characteristic of the fuel basket supports (shims) for their function of positioning and cushioning of the fuel basket. However, the staff notes that the important-to-safety stainless steel solid shim in Drawing 11070 (HI-STAR 100MB Cask), the aluminum shims in Drawing 11084 (MPC-32M Basket), and the stainless steel corner bracket in Drawing 11084 (MPC-32M Basket) do not have any requirement for the material standard or mechanical properties. It is not clear how the material procurement will be controlled to ensure that critical yield strength properties are achieved.

This information is required by the staff to demonstrate compliance with 10 CFR 71.31(c) and 71.35(a).

2-2 Clarify the mechanical properties or the heat treatment condition of the stainless steel used in the lifting trunnions.

Table 2.2.3 provides the mechanical properties of ASME Code SA-705 and SA-564 Grade 630 age-hardening stainless steel used in the lifting trunnions. Table 2.2.3 and the drawing in Section 1.3 specify the heat treatment condition of the alloys as H1025. However, the staff notes that the cited mechanical properties in the application are consistent with the properties for heat treatment condition H1100 (per Table Y-1 of ASME Code Section II, Part D).

This information is required by the staff to demonstrate compliance with 10 CFR 71.33 and 71.35(a).

2-3 Clarify the fracture toughness test criteria for ferritic steels at a lowest service temperature (LST) of -29°C (-20°F) and provide justification for not performing the drop weight fracture toughness test for the containment welds.

Section 2.1.3.1 states that, for components between 4 and 12 inches of thickness and a LST of -29°C (20°F), the fracture arrest criteria of Regulatory Guide 7.12 are used to define the fracture toughness test temperature. However, Table 8.1.5 shows that the fracture initiation criteria are used to define the test temperature for the containment top flange and inner closure lid at a LST of -29°C (20°F).

Also, Table 8.1.5 of the application states that the drop weight test for containment welds is not required. It is unclear to the staff whether the absence of this test is considered to be in conformance to the ASME Code, or if it is being proposed as a Code alternative. If it is being proposed as a Code alternative, justification should be provided.

This information is required by the staff to demonstrate compliance with 10 CFR 71.33(a)(5), 71.51(a), 71.71, and 71.73(b).

2-4 Clarify the statement regarding the susceptibility of closure lid bolts to brittle fracture.

Section 2.1.3 of the application references NUREG/CR-1815, indicating that "bolts are generally not considered susceptible to brittle fracture". The application further states that the toughness testing of the closure lid bolts provides "additional assurance" of bolt performance.

The staff does not consider this interpretation of NUREG-1815 to be correct. NUREG/CR-1815 refers to certain cases where bolts may not be "fracture critical," meaning that, if bolts were to fail, the closure lid would still perform its design function.

Absent an analysis that demonstrates that failure of lids bolts would not affect the function of the closure lid, the staff considers bolt impact toughness testing and other mechanical tests to provide the primary assurance of the performance of the bolted connection (consistent with the ASME Code Subsection NB requirements to which the containment system is designed).

In addition, NUREG/CR-6007 provides guidance for performing stress analysis of closure bolts for shipping casks containing nuclear fuels. Section 6.2 of NUREG/CR-6007 notes that the recommended analysis method requires confirmation of bolt ductile behavior by meeting the ASME toughness testing criteria for bolts.

This information is required by the staff to demonstrate compliance with 10 CFR 71.33(a)(5), 71.51(a), 71.71, and 71.73(b).

2-5 Provide the basis for finding the calculated cumulative creep strain in the aluminum basket shims to be acceptable.

Section 2.2.1.2.3 provides an analysis of the cumulative creep strain of the aluminum basket shims and concludes that the strain does not have any adverse effect on the fuel basket geometry. However, no basis is provided for that conclusion. It is not clear to the staff what degree of strain the shims may experience before intended functions are impacted.

This information is required by the staff to demonstrate compliance with 10 CFR 71.35.

2-6 Clarify missing or incorrect information regarding the thermal properties of materials.

The application appears to have either missing or incorrect information, regarding:

- The title of Table 3.2.4 states that it provides the thermal conductivity of extruded basket shims and solid shims material. However, only data for the extruded basket shims is provided.
- Note 3 of Table 2.2.2a states that sources for thermal expansion coefficient for the SA-193 Grade B7 alloy steel bolting includes Tables TE-1 and TE-4 of the ASME B&PV Code Section II Part D. The staff notes that Table TE-4 is associated with nickel alloys.

This information is required by the staff to demonstrate compliance with 10 CFR 71.33(a)(5) and 71.35(a).

2-7 Provide missing information that is cross-referenced in the application.

The application appears to be missing information to which the application cross-references:

- Section 2.2.1.1.6 states that the drawings in Section 1.3 provide the materials specifications for the closure lid seals. The drawings are missing that information.
- HI-STAR 100MB cask drawing No. 11070: Note 14 states that critical characteristics of the Holtite shielding materials are defined in Table 2.2.13. The staff notes that this table addresses Holtite-B only; the critical characteristics of Holtite-A are found in Table 2.2.14.

This information is required by the staff to demonstrate compliance with 10 CFR 71.31(c) and 71.33(a)(5).

2-8 Justify that the age-hardened stainless steel lid closure bolts will not be subject to overstress due to differences in thermal expansion with the closure lid.

The HI-STAR 100MB cask drawing specifies ASME SA-564 Type 630 and SA-705 Type 630 age-hardened stainless steels as potential materials for the lid closure bolts. The staff notes that the Type 630 materials have a lower coefficient of thermal expansion compared to that of the lid material (ASME SA-350 Grade LF3 alloy steel).

For example, at a temperature of 200°F, Table 2.2.2b states that the thermal expansion coefficient of the Type 630 bolting material is 6.3×10^{-6} in/in per degree F, while Table 2.2.1 states the coefficient of the lid material is 6.7×10^{-6} in/in per degree F. It is unclear if, upon installation of the lids and bolts, a greater lid expansion, upon heat-up, could overstress the bolts.

This information is required by the staff to demonstrate compliance with 10 CFR 71.51(a)(1).

2-9 Provide additional justifications for the conservative arguments made for the puncture simulation scenarios.

In Section 2.7.3, "Puncture", the applicant states that for both puncture scenarios (sidewall and top-end) the results obtained from the HI-STAR 190 package analysis conservatively bound the HI-STAR 100MB because the "geometric configuration of the HI-STAR 100MB cask over pack is similar to the HI-STAR 190 package".

For the horizontal drop puncture scenario, the applicant provided, in addition to the HI-STAR 190 results, an additional calculation using the Nelms' equation to demonstrate compliance.

For the top end drop puncture scenario, the applicant stated that "… the 1-m top end drop accident is acceptable for the HI-STAR 100MB package, since the puncture resistance of the HI-STAR 100MB outer lid is almost identical to that of HI-STAR 190 in terms of lid material, thickness, total number of bolts. The heavier weight and larger lid diameter of the HI-STAR 190 package are more than enough to offset the effect of a slightly (4.3%) smaller lid thickness for HI-STAR 100MB." It is not clear to the staff how the usage of the Nelms' equation in the horizontal drop puncture scenario and the statement from the last sentence in the excerpt above, for the top end drop scenario, provide conservative arguments for both cases.

Provide additional justification as to why (i) the conclusion reached above with the methods used is in fact conservative and (ii) no additional puncture tests need to be performed for the HI-STAR 100MB.

Provide a side by side comparison in table format of the pertinent material characteristics (thicknesses, material strengths, dimension, etc.,) necessary for the puncture analysis of the HI-STAR 190 and 100MB packages.

This information is required by the staff to determine compliance with 10 CFR 71.71(c)(10) and 71.73(c)(3).

Chapter 3 THERMAL REVIEW

3-1 Provide the maximum NCT and HAC temperatures of the inner seal in the (i) closure lid, (ii) vent port, (iii) drain port and, (iv) test plug seal at the test port in Table S.6.2 of Report HI-2188066 for the HI-STAR 100 MB package containing the MPC-32M.

The applicant has only provided the maximum NCT and HAC temperatures for the closure lid seal in Table S.6.2 of Report HI-2188066 and did not justify that the seal temperatures of the package, predicted from the computer model, are both consistent with the package heat removal path under NCT and HAC and below their corresponding NCT and HAC limits for containment performance.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73(c)(4).

3-2 Provide the maximum HAC fuel cladding and component temperatures of the HI-STAR 100 MB package with the MPC-32M to justify the HAC bounding correlation between the packages containing the F-32M fuel basket and the MPC-32M.

The applicant provided the maximum NCT and HAC fuel cladding and component temperatures in Tables 3.1.1 and 3.1.3, respectively, for the HI-STAR 100 MB package with the F-32M basket, and the maximum NCT fuel cladding and component temperatures, in Table S.6.2 of Report HI-2188066, for the HI-STAR 100 MB package with the MPC-32M.

Even if the HI-STAR 100 MB package containing the MPC-32M is bounded under NCT by the package with the F-32M basket, the bounding correlation may not exist under HAC because the heat flow path and direction, and the parameters used in the NCT thermal model, can be different from those used in the HAC thermal model.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.73(c)(4).

3-3 Provide the thermal expansion of the MPC-32M under HAC to justify the bounding correlation, under HAC, of the thermal expansion between the HI-STAR 100 MB packages containing the MPC-32M and the F-32M.

The applicant provided the NCT thermal expansion of the fuel and the fuel basket for both the F-32M and MPC-32M in Table S.6.9 of Report HI-2188066 and the HAC thermal expansion of the fuel and the fuel basket only for the F-32M basket in Table S.6.10 of Report HI-2188066.

Even if the temperature rise for the package with the MPC-32M is expected to be similar to that calculated for the package with the F-32M basket, the bounding correlation of the thermal expansion under NCT may be different from that under HAC because the heat flow path, direction, and the thermal phenomena under NCT could be different from those under HAC.

Therefore, the applicant should provide the HAC thermal expansion of the MPC-32M, especially when there is a “negative” differential expansion of the fuel axially at the hottest fuel location for the package with the F-32M basket.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.73(c)(4).

3-4 Clarify the thermal conductivities of Holtite-A and Holtite-B used in the thermal analyses of NCT, HAC 30-minute fire, and HAC post-fire cooldown, in Table 3.2.2 and Table 3.2.12.

The applicant presented thermal conductivities of 0.25 W/m-K for Holtite-B and 0.4 w/m-°K for Holtite-A in Table 3.2.2, but stated in Note #2 of Table 3.2.12 that “During fire, no reduction in Holtite-B heat conduction effectiveness is assumed. During post-fire cooldown, conductivity of air is assumed.” It’s not clear to the staff what are the thermal conductivities of Holtite-A and Holtite-B used for thermal analyses of NCT, HAC 30-minute fire and its post-fire cooldown.

The applicant should clarify (a) the thermal conductivities of Holtite-A used in the thermal analyses of NCT, HAC fire and HAC post-fire cooldown and (b) the thermal conductivities of Holtite-B used in the thermal analyses of NCT, HAC fire, and HAC post-fire cooldown.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.71 and 71.73(c)(4).

3-5 Verify that the number of 120% of the maximum per cell decay heat is appropriate for the regionalized loading pattern permitted to store the hot fuel in the packages with either the F-32M basket or the MPC-32M canister.

The applicant stated in Note #2 of Table 7.7.5 that the hot fuel heat load is limited to 120% of the maximum per cell decay heat, under loading tabulated in Table 7.7.5, but did not justify that this number of 120% of the maximum per cell decay heat is appropriate for the regionalized loading patterns permitted in the packages with either the F-32M basket or the MPC-32M canister.

The applicant should also justify that the maximum NCT and HAC fuel cladding and component temperatures, as well as the NCT and HAC thermal expansions for the fuel and the fuel basket, are still below their corresponding NCT and HAC limits.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73(c)(4).

Chapter 4 CONTAINMENT REVIEW

4-1 Define clearly the containment boundaries, in Section 4.1 and 4.1.4, to be consistent with the containment boundary shown in Figure 4.1.2 for a single lid cask.

The HI-STAR 100MB includes options for a single lid cask when used with the MPC-32M and a dual lid cask when used with a bare basket, i.e., F-32M or F-24M. Sections 4.1 and 4.1.4 specify that the containment system of the single lid cask consists of the containment shell, containment top flange, containment bottom flange, vent port and drain port cover plates, port cover bolts, outer closure lid with closure bolts, and their respective elastomeric seals (inner seals) and welds.

The staff reviewed the containment boundary shown in Figure 4.1.1 for the dual lid cask and the containment boundary shown in Figure 4.1.2 for the single lid cask and finds inconsistencies in the containment boundary.

In particular, the containment components of the vent and drain port cover plates are not marked in Figure 4.1.2; the test port cover (and its test plug seal), marked in Figure 4.1.2, is not identified as the containment boundary.

This information is required by the staff to determine compliance with 10 CFR 71.33.

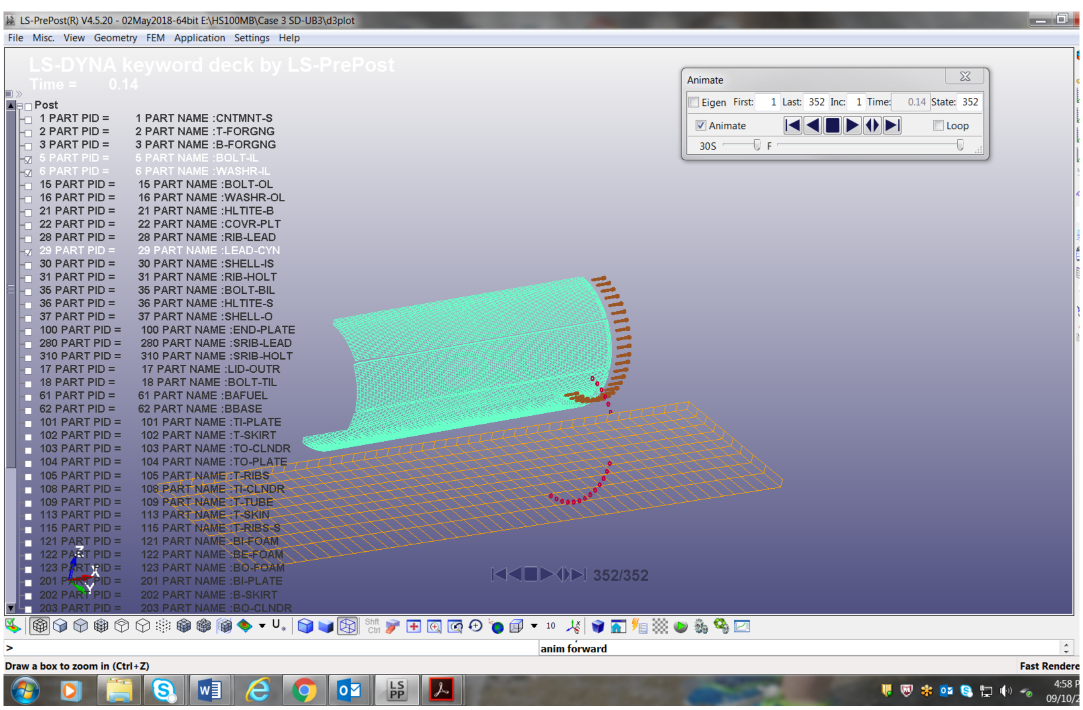
4-2 Clarify the observed behaviors of the inner lid washers in the LS-DYNA drop simulations.

The LS-DYNA results of Case 3 SD-UB3 (portrayed below), show that, at some point during the drop simulation, the inner lid washers (LS-DYNA 6 Part PID = 6 Part Name Washr-IL) seem to move separately from the bolts. It is not clear to the staff if this situation is realistic, and if containment can be maintained. The following needs to be addressed:

a. Clarify if the observed behavior is in fact expected and, if so, describe how the containment boundary is maintained with the absence of the washers.

b. If the observed behavior is not expected, revise the model for this and all simulated drop scenarios, as appropriate.

This information is required by the staff to demonstrate compliance with 10 CFR 71.71(c)(7) and 71.73(c)



4-3 Justify that the inner lid seals of the HI-STAR 100 MB package with the F-32M basket will perform their containment function without any material degradation when experiencing temperatures exceeding the NCT or HAC limits for a period of time.

As shown in Table 3.1.1 of the application, the maximum NCT temperature of the inner lid seals is 121°C, which exceeds the NCT limit of 120°C, as shown in Table 2.2.11. The maximum HAC temperature of the inner lid seals is 208°C, which exceeds the limit of 170°C for a period of time not greater than 20 hours.

The applicant should provide adequate information to justify that the inner lid seals of the HI-STAR 100 MB package with the F-32M basket will perform their containment function without material degradation when experiencing those temperatures.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73(c)(4).

4-4 Provide the maximum NCT and HAC temperatures of the inner seal in (i) the inner closure lid, (ii) the inner closure lid vent port, (iii) the inner closure drain port, and (iv) the outer closure lid and test plug seal at the test port in Tables 3.1.1 and 3.1.3 for the package with the F-32M fuel basket.

The applicant has only provided the maximum NCT and HAC temperatures for the inner lid seal but did not justify that the seal temperatures of the package with the F-32M fuel basket, predicted from the computer model, are consistent with the package heat removal path under NCT and HAC conditions and are below their corresponding NCT and HAC limits for containment performance. The applicant should provide the maximum NCT and HAC temperatures of the inner seal in the inner closure lid, in the inner closure lid vent port, in the inner closure drain port, in the outer closure lid and test plug seal at the test port.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73(c)(4).

Chapter 5 SHIELDING REVIEW

5-1 Provide a justification to explain the shielding impacts of the extra 1 cm height modeled in HI-STORM 100 MB XL analyses.

The HI-STORM 100 MB XL is modeled as being 1 cm taller than the design specifications for the package. The applicant stated that this difference between the heights modeled in MCNP and that of the drawings is small and has a negligible impact on external dose rates; however, the staff finds there is insufficient information to verify this conclusion.

Staff is unable to determine if this difference is a result of an increase in thickness of a single shielding component or an aggregated effect of smaller approximations over the length of the package. The applicant's analysis relied on a conservative reduction of shielding materials, e.g., due to manufacturing tolerances, to demonstrate bounding analyses. Yet, the extra height may represent a non-conservative contradiction to the applicant's modeling simplifications. Without knowing the specific nature of this

extension, it is not possible for staff to determine that the applicant's analyses remain conservative and bounding.

This information is required by the staff to determine compliance with 10 CFR 71.51(a)(2)

5-2 Provide the basis for allowing the cladding temperature of moderate burnup fuel to exceed 400°C during short-term drying operations.

Table 3.3.8 shows that the cladding temperature for moderate burnup fuel reaches 436°C (817°F) during vacuum drying with the F-32M bare fuel basket configuration. The footnote of the table states that the temperatures comply with ISG-11, Revision 3. Also, Table 7.1.7 states that the cladding temperature limit for moderate burnup fuel is 570°C (1058°F) under drying operations.

ISG-11, Revision 3 states that, for low burnup fuel, a cladding temperature exceeding 400°C (752°F) may be used if the applicant can show that the cladding hoop stress is equal to or less than 90MPa (13,053 psi). The application does not contain an analysis of the cladding hoop stress, and thus it is unclear if the potential for hydride reorientation may exist and, if so, whether the fuel cladding can fulfill its safety functions during transportation.

This information is required by the staff to demonstrate compliance with 10 CFR 71.51 and 71.55.

CHAPTER 6 CRITICALITY REVIEW

6-1 Justify that the parametric studies performed for the HI-STAR 190 are applicable to the HI-STAR 100MB package or provide separate analyses.

On page 6.0-2 of the application, in the discussion of the reactivity impact of various parameters such as the geometries of the fuel rod, assembly design, and fuel basket design, the applicant concludes that there is no need to perform parametric studies for the HI-STAR 100MB. The studies performed for the HI-STAR 190 are applicable to the HI-STAR 100MB because: "*PWR fuel is always undermoderated. Any variations that cause an increase in the amount of water without decreasing the amount of fuel will increase reactivity.*"

The staff notes that, for the HI-STAR 190 results, these studies appeared to be based on fresh fuel at the maximum enrichment (5% U-235). While this conclusion is true for fresh fuel, it may not be the case for a spent fuel package that takes burnup credit. Based on the staff's own calculations, the fissile material present in a Westinghouse 17x17 fuel assembly with an initial enrichment of 5 w.t.% U-235 and 60 GWd/MTU burnup is roughly 1.6×10^4 grams of fissile materials (U-235+Pu-239+Pu-241) per metric ton of uranium (MTU). This is roughly equivalent to a 1.6% U-235 enrichment, neglecting the slight difference between U-235 and Pu-239/Pu-241 for their contributions to reactivity. With consideration of the presence of fission products and other absorber actinides in the spent fuel, the spent fuel package flooded with fresh water could become over-moderated. As such, the applicant's parametric studies for the HI-STAR 190 may not be applicable to the HI-STAR 100MB package that takes burnup credit.

This information is required by the staff to determine compliance with 10 CFR 71.55(b), 71.55(d), 71.55(e), and 71.59.

6-2 Demonstrate that the studies on the impact of basket tolerances on the system's reactivity for the HI-STAR 190 package are applicable to the HI-STAR 100MB package design.

On page 6.0-2 of the application, the applicant states: "*Studies regarding the basket tolerances and deflections have historically shown to be reliant solely upon basket structure (flux trap vs. no flux trap). Decreasing the cell ID for each basket cell reduces the distance between fuel assemblies; however, increasing the cell ID for each basket cell increases moderation for those fuel assemblies. In the case where flux traps are not present in the basket structure, reducing the distance between fuel assemblies increases reactivity of the system much more than the reduction in reactivity due to decreased moderation. In the case where flux traps are present in the basket structure, increasing the amount of water within a cell increases the reactivity of the system much more than the reduction of reactivity due to increased distance between fuel assemblies. Therefore, this study, performed for MPC-37 of the HI-STAR 190 SAR, is not necessary to repeat and its results apply to the MPC-32M and F-32M fuel packages*."

However, the staff notes that the HI-STAR 100MB and the HI-STAR 190 packages have different fuel basket configurations and sizes: the MPC-37 basket in the HI-STAR 190, with 37 PWR fuel assemblies, is much larger than the MPC-32M and F-32M fuel baskets and hence has a much smaller geometric buckling. Consequently, the neutron flux and neutron importance distributions will be different.

Because neutronic sensitivities highly depend on the neutron flux and neutron importance, the sensitivity studies performed for the HI-STAR 190 may not be directly applicable. The staff needs this information to determine if the results and conclusion are directly applicable to the HI-STAR 100MB package design that takes burnup credit.

This information is required by the staff to determine compliance with 10 CFR 71.55(b), 71.55(d), 71.55(e), and 71.59.

6-3 Provide the bounding fuel assembly (FA) design used in the criticality safety analyses for an array of packages under normal conditions of transport and hypothetical accident conditions.

In Tables 6.1.1 and 6.1.2, the applicant identified the bounding k_{eff} values for the package containing the MPC-32M canister, the F-32M, or the F-24M basket. Table 6.1.1 indicates that the package containing the 16x16 FA design in the MPC-32M canister or the F-32M basket has the maximum k_{eff} and Table 6.1.2 indicates that the package containing the 17x17A FA design in the F-24M basket gives the highest k_{eff}.

In Table 6.1.3 of the SAR, the applicant provides a summary of the criticality safety analyses for a single package, as well as, an array of packages that contain the MPC-32M canister or F-32M or F-24 basket to demonstrate compliance with the regulatory requirements of 10 CFR 71.55 and 71.59. However, the staff notes that the FA class 15x15B is used in these analyses. This is not the bounding FA as identified in Table 6.1.1 and 6.1.2 of the application.

This information is required by the staff to determine compliance with 10 CFR 71.55(b), 71.55(d), 71.55(e), and 71.59.

6-4 Justify that the various sensitivity studies performed for the HI-STAR 190 are applicable to the criticality safety of the HI-STAR 100MB package containing the MPC-32M canister, F-32M basket, or the F-24M basket.

The applicant provides studies on various factors, such as moderator density, partial flooding, preferential flooding, and eccentric positioning of the FAs for the HI-STAR 190 and claims that these studies are applicable to the HI-STAR 100MB package. From the data presented in the tables of the HI-STAR 190 application (Table 6.3.7, 6.3.12(a), 6.3.12(b), etc.), it appears that these studies are based on a single burnup, enrichment, and cooling time combination.

However, the equations provided in Table 7.7.3(a) (i.e., the loading curve) of the HI-STAR 100MB application indicate that the required minimum burnup is a function of the enrichment and the enrichment can vary from 2.25% to 5.0% with a cooling time of 3 years. The applicant provides no specific justification for the applicability of these studies to the HI-STAR 100MB package.

Without a clear justification, the staff cannot determine the applicability of the various sensitivity studies performed for the HI-STAR 190 to the criticality safety analyses of the HI-STAR 100MB package containing the MPC-32M canister, F-32M basket, or the F-24M basket. The staff is particularly concerned with the applicability of these studies to the F-24M basket, because the package containing the F-24M basket does not take burnup credit.

This information is required by the staff to determine compliance with 10 CFR 71.55(b), 71.55(d), 71.55(e), and 71.59.

6-5 Demonstrate that the loading curve developed for the HI-STAR 190 package containing the MPC-37 canister is appropriate for the HI-STAR 100MB package containing either the MPC-32M canister or F-32M basket.

On page 6.B-1 of the application, the applicant states: "*The same loading curve developed for MPC-37 of HI-STAR 190 is used for the MPC-32M and F-32M fuel packages. As discussed in Subsection 6.0.1, the results of benchmark evaluations for MPC-37 of HI-STAR 190 are applied to HI-STAR 100MB, i.e. the total bias and bias uncertainty determined for fresh (MPC-89) and spent fuel (MPC-37) in Table 6.B.14 have been used for F-24M and MPC-32M/F-32M, respectively. This is acceptable due to the similarities between the HI-STAR 100MB and HI-STAR 190 characteristics, such as considered materials, fuel assembly and fuel basket geometry, etc. (see Subsection 6.0.1) and evaluation methodologies, including the same codes for depletion and criticality calculations*."

The staff notes that the design and contents of the two packages are significantly different. The HI-STAR 190 package contains 37 PWR fuel assemblies whereas the HI-STAR 100MB contains only 32 PWR fuel assemblies. As such, the fuel basket sizes are significantly different, resulting in significantly different geometric buckling (the geometric buckling of the MPC-37 is 0.000715574, the geometric buckling of MPC-32 is 0.000832485 assuming a typical 144 inches active fuel length) that impact the system's reactivity. Consequently, the same fuel assembly will have a different reactivity worth and the loading curves may be significantly different between these two packages.

This information is required by the staff to determine compliance with 10 CFR 71.55(b), 71.55(d), 71.55(e), and 71.59.

6-6 Demonstrate that the total bias and bias uncertainty determined for fresh (MPC-89) and spent fuel (MPC-37) in Table 6.B.14 can be used for F-24M and MPC-32M/F-32M.

On page 6.B-1 of the application, the applicant concludes that the results of benchmark evaluations for MPC-37 of HI-STAR 190 are applied to the HI-STAR 100MB, i.e. the total bias and bias uncertainty determined for fresh (MPC-89) and spent fuel (MPC-37) in Table 6.B.14 have been used for F-24M and MPC-32M/F-32M, respectively. The applicant further determines that the bias and bias uncertainty are acceptable due to the similarities between the HI-STAR 100MB and HI-STAR 190 characteristics.

The staff notes that the design and contents of the two packages are significantly different in three aspects: (1) the capacity of the HI-STAR 190 is 37 PWR assemblies and the capacity of the HI-STAR 100MB with MPC-32M or F-32M basket is 32 PWR assemblies; (2) both the MPC-89 and F-24M assume fresh fuel but the MPC-89 is a BWR basket whereas the F-24M is a PWR basket; and (3) the F-24M includes flux traps while the MPC-89 does not.

With such significant differences in these two package designs, it is not clear why the total bias and bias uncertainty determined for the MPC-89 basket (fresh fuel) can be used for the F-24M and the total bias and bias uncertainty determined for the MPC-37 (spent fuel) can be used for the MPC-32M or F-32M basket.

This information is required by the staff to determine compliance with 10 CFR 71.55(b), 71.55(d), 71.55(e), and 71.59.

6-7 Demonstrate that the Interim Staff Guidance 8 (ISG-8) Revision 3 (ISG-8, Rev. 3), applicability conditions for treating the bias and bias uncertainty of the minor actinides and fission products (MAFP) is applicable to the HI-STAR 100MB package design.

On page 6.0-2 of the application, the applicant concludes that the results of benchmark evaluations for the MPC-37 of HI-STAR 190 are applied to all HI-STAR 100MB fuel packages. The results of the burnup credit analysis and verification of assembly burnup evaluated for MPC-37 of HI-STAR 190 are directly applied to the MPC-32M and F-32M fuel packages. The staff notes that the burnup credit analyses for the HI-STAR 190 used the recommendation of ISG-8, Rev. 3. The ISG sets the conditions for using the recommendation as:

- “uses the SCALE code system with the ENDF/B-V, ENDF/B-VI, or ENDF/B-VII cross section libraries,
- can justify that its design is similar to the hypothetical GBC-32 system design used as the basis for the NUREG/CR-7109 criticality validation, and
- demonstrates that the credited minor actinide and fission product worth is no greater than 0.1 in k_{eff}.”

In addition, the applicant performed some analyses to compare the similarities between the GBC-32 cask and the HI-STAR 100MB cask containing the MPC-32M canister and the F-32M basket. The applicant concludes that overall the evaluations show that the HI-STAR 100MB is sufficiently similar to the GBC-32 cask to justify the applicability of the method (Appendix 6.C, “6.C.1 Comparison of GBC-32 and MPC-32M, F-32M Fuel Baskets”).

The staff reviewed the applicant’s comparison of the cask design and the neutronic characteristics between the GBC-32 and the HI-STAR 100 MB and notes:

1. The applicant used the CASMO code in its spent fuel material composition analyses and the CASMO code is not capable of tracking the ingrowth of Gd-155

as a fission product. Therefore, the use of the CASMO code does not meet the condition for using the recommendation of ISG-8, Revision 3.

2. The basket designs of the HI-STAR 100 MB and the GBC-32, including the basket and fuel cell geometric dimensions, poison plates, are significantly different.

3. The fuel types to be loaded are different. GBC-32 contains only 17x17 fuel assembly whereas the MPC-32M/F-32M is designed to load both 17x17, 14x14, 15x15 and 16x16 fuel assemblies and many subtypes of these assemblies.

4. The active fuel region length of the fuel assemblies in the MCP-32M/F-32M is 6 inches longer than that of the GBC-32 fuel assembly (150 vs 144 inches). Consequently, MPC-32M/F-32M contains more fuel.

5. The 16x16 fuel class contains Er_2O_3 burnable poison in the fuel pellet. The applicant did not perform any study on the bias and bias uncertainty of the criticality safety analysis code associated with the fuel poisoned with Er_2O_3.

Based on the above comparisons, it appears that the fuels and basket designs of the MPC-32M canister or the F-32M bare basket are significantly different from that of the GBC-32 cask.

The staff needs specific justifications for the applicability of the recommendation from ISG-8, Rev. 3 on the bias and bias uncertainty for the criticality code benchmarking for MAFPs is appropriate.

This information is required by the staff to determine compliance with 10 CFR 71.55(b), 71.55(d), 71.55(e), and 71.59.

6-8 Demonstrate that the results of the misload analyses performed for the HI-STAR 190 are applicable to the HI-STAR 100MB package.

On page 6.E-1 of Appendix E of the application, the applicant asserts that the results of the misload analysis for the HI-STAR 190 is used for the HI-STAR 100MB. The applicant concludes that the same loading curve developed for the MPC-37 of the HI-STAR 190 is used for the MPC-32M and F-32M fuel packages and the results of the misloading condition in MPC-37 will have a similar result for a misloading condition in the MPC-32M or F-32M because of the baskets nearly identical geometry and materials.

The staff, however, notes that the two packages have significant differences in fuel basket geometry and total fuel load. The HI-STAR 190 fuel basket is loaded with 37 PWR fuel assemblies while the HI-STAR 100MB can hold only 32 PWR fuel assemblies. Thus, a misload of the fuel assembly in these two packages will have different reactivity insertions because the neutron leakage and neutron importance distribution in these two packages are different.

The applicant is requested to demonstrate that the misload analyses performed for the HI-STAR 190 package bound the reactivity insertion in the HI-STAR 100MB package.

This information is required by the staff to determine compliance with 10 CFR 71.55(b), 71.55(d), and 71.55(e).

CHAPTER 7 OPERATING PROCEDURES

7-1 Mark Note #2 in Tables S.6.7 and S.6.8 of Report HI-2188066 for the HAC maximum pressures of the packages containing either the F-32M basket or the MPC-32M.

Note #2 in Tables S.6.7 and S.6.8 of Report HI-2188066 states that the HI-STAR 100MB helium backfill pressure limits are specified in Chapter 7 of Reference [3] for an HAC maximum pressure for the packages with the F-32M fuel basket and the MPC-32M. However, this statement is not correct and Note #2 is not marked in Tables S.6.7 and S.6.8.

This information is required by the staff to determine compliance with 10 CFR 71.73(c)(4).

7-2 Revise the dryness criteria of the forced helium dehydration (FHD) in Table 7.1.6.

The current dryness criteria of the FHD in Table 7.1.6 are not consistent with those mentioned in Note #3 of Table 7.1.5. Staff suggests to adopt, as FHD dryness criteria, "≤ -5°C (22.9°F)" for the gas dew point and ≤ -6.1°C (21°F) for the gas temperature" in Table 7.1.6.

This information is required by the staff to determine compliance with 10 CFR 71.81.

7-3 Explain why a leakage test to the cask cavity is not required for the single lid cask loaded with an MPC containing moderate burnup fuel (MBF).

Section 7.1.4 specifies that, if the MPC contains high burnup fuel (HBF), then the cask cavity is leak tested to the required acceptance criteria in Chapter 8. Given that staff requires to have the leakage rate testing to the entire containment boundary of a transportation package, the applicant shall justify why the leakage rate testing to the cask cavity is not required for the single lid cask loaded with an MPC containing MBF.

This information is required by the staff to determine compliance with 10 CFR 71.51(a)(1) and 71.51(a)(2).

7-4 Provide consistency between the statements in Sections 7.1.4 and 7.1.5 for periodic leakage rate tests on the overpack's containment boundary.

The applicant stated in Section 7.1.5 that a periodic leakage test of the overpack's containment boundary (cask cavity) shall be performed unless such test has been performed less than a year before. This statement requires the periodic leakage rate test on the cask cavity, not only for the MPC containing high burnup fuel, but also for the MPC containing moderate burnup fuel.

Given that a periodic leakage rate test on the overpack's containment boundary could also cover the leakage rate test on the cask cavity, the statement in Section 7.1.5 could conflict with the statement that "the cask cavity is leak tested to the required acceptance criteria if MPC contains HBF" in Section 7.1.4.

This information is required by the staff to determine compliance with 10 CFR 71.51(a)(1) and 71.51(a)(2).

7-5 Provide conditions and criteria for the installation of the new seals on the closure lid inter-seal test port plug, closure lid port cover, and cover plate inter-seal test port plug for the preparation of the MPC for transport.

The applicant stated in item #1b of Section 7.1.5 that, if necessary, the closure lid inter-seal test port plug, closure lid port cover, cover plate inter-seal test port plug are installed with new seals. The applicant should clarify the conditions and the criteria for installing new seals, as important to safety components, in a procedure for the users to follow in preparation of the package for transport.

This information is required by the staff to determine compliance with 10 CFR 71.81, 71.87(a), and 71.87(c).

7-6 Provide acceptance criteria under item #7 of Section 7.1.6, "Loading the MPC with Spent Fuel," for (a) combustible gas monitoring and (b) purging the space below the MPC lid to ensure there is no combustible mixture present in the welding area.

The applicant stated in item #7 of Section 7.1.6: "Perform combustible gas monitoring and purge the space under MPC lid with an inert gas to ensure that there is no combustible mixture present in the welding area" for loading of MPC with spent fuel.

The applicant should provide criteria, under item #7 of Section 7.1.6, for monitoring of the combustion gas and purging the space below the MPC lid. The acceptance criteria could include, but not limited to, inert gas purity level, gas pressure, limit of combustion gas concentration, etc.

This information is required by the staff to determine compliance with 10 CFR 71.43(d).

7-7 Provide acceptance criteria in Section 7.2.3, "Removal of Contents from MPC," for (a) combustible gas monitoring and (b) venting or purging the space below the MPC lid during the MPC lid cutting operations to ensure there is no combustible mixture present.

The applicant stated at item #5 of Section 7.2.3: "Appropriate monitoring for combustible gas shall be performed prior to, and during MPC lid welding operations. The space below the MPC lid shall be vented/exhausted or purged with inert gas prior to, and during MPC lid cutting operations to provide additional assurance that flammable gas concentrations will not develop in the space." The applicant did not provide acceptance criteria for monitoring of the combustible gas and venting/purging the space below the MPC lid. The acceptance criteria could include, but are not limited to, inert gas purity level, limit of combustion gas concentrations, etc.

This information is required by the staff to determine compliance with 10 CFR 71.43(d).

7-8 Define the conditions to allow an alternate torque onto the outer closure lid access port plug for the dual lid cask (bare basket fuel package).

The applicant tabulated torque requirements for the dual lid cask (bare basket fuel configuration) in Table 7.1.3 and recommended a torque of "Snug Tight" to the outer

closure lid access port plug with the additional comment that "alternative torque may be permitted with Holtec approval." The applicant did not define and did not justify the conditions allowing an alternate torque to the outer closure lid access port plug.

This information is required by the staff to determine compliance with 10 CFR 71.87(a).

7-9 Provide acceptance criteria on gas sampling for removal of contents from the dual lid cask (bare basket configuration) to assess the conditions of the fuel cladding and determine the special actions needed to vent the cask cavity.

The applicant stated, in Section 7.2.4 "Removal of Contents from Bare Basket Cask," that gas sampling is performed to assess the condition of the fuel cladding and the user's Radiation Control organization may require special actions to vent the cask cavity. The applicant did not provide the acceptance criteria in Section 7.2.4 for these conditions or actions.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.81.

CHAPTER 8 MAINTENANCE PROCEDURES

8-1 Revise Table 8.1.2 to list separately the containment components of the single lid cask and those of the dual lid cask leak-tested at the fabrication facility.

The applicant summarized the helium leakage rate tests in Table 8.1.2 for the HI-STAR 100MB and MPC containment systems. The applicant listed the tested components without identifying the containment components of the single lid cask or of the dual lid cask.

The applicant should revise Table 8.1.2 to list the containment components of the single lid and dual lid casks, separately, leak-tested at the fabrication facility.

(a) Information in the revised Table 8.1.2 should include, but not limited to, test location (shop or field), components tested, type of leakage test, allowable leakage rate, and

(b) Tested components listed in the revised Table 8.1.2 should be consistent with the containment components specified in Sections 4.1 and 4.1.4 for the single lid cask and with the containment components specified in Sections 4.1 and 4.1.5 for the dual lid cask.

This information is required by the staff to determine compliance with 10 CFR 71.33, 71.51(a)(1) and 71.51(a)(2).

8-2 Clarify the containment components of the single lid and dual lid casks tested for pre-shipment, maintenance, and periodic leakage rate tests.

In Table 8.1.2, the applicant listed both the HI-STAR 100MB Cask and the MPC system as being tested for both the pre-shipment leakage rate test and the periodic leakage rate test, but listed the HI-STAR 100MB Cask only for the maintenance leakage rate test.

To ensure that the required containment components are being tested for pre-shipment, maintenance, and periodic testing of the containment integrity, the applicant should clarify whether

a) the pre-shipment leakage rate test on the HI-STAR 100MB is required only for the single lid cask and the pre-shipment leakage rate test on both the HI-STAR 100MB and MPC are required for the dual lid cask?

b) the periodic leakage rate test on the HI-STAR 100MB is required only for the single lid cask and the periodic leakage rate test on both the HI-STAR 100MB and MPC is required for the dual lid cask?

c) the maintenance leakage rate test on the HI-STAR 100MB is required for both the single lid and dual lid casks and there is no maintenance leakage rate test required for the "empty" MPC in the single lid cask configuration.

The applicant should clarify items (a), (b) and (c) above, and may revise Table 8.1.2 to summarize each type of leakage rate tests separately for the single lid and dual lid cask configurations.

This information is required by the staff to determine compliance with 10 CFR 71.51(a)(1) and 71.51(a)(2).

8-3 Provide the nondestructive examination requirements of the welds in the fuel basket drawings.

Section 8.1.2 states: "[b]asket welds shall be examined and repaired in accordance with NDE specified in the drawing package and with written and approved procedures…." The staff notes that the drawings for the MPC-32M, and the F-32M, and F-24M baskets, do not include NDE requirements.

This information is required by the staff to demonstrate compliance with 10 CFR 71.33.

8-4 Justify that the proposed approach for eddy current testing of MPCs will adequately sample MPCs considered to be most susceptible to aging degradation.

Table 8.1.6 provides the approach for selecting MPCs for eddy current testing prior to transportation. The proposed sampling approach tests a percentage of MPCs containing high burnup fuel and stored for greater than 5 years under 10 CFR Part 72. However, the staff notes that there are no guidelines for the selection of the specific MPCs to test at an ISFSI, and thus it is unclear to the staff whether MPCs that may be most susceptible to degradation will be adequately sampled.

This information is required by the staff to demonstrate compliance with 10 CFR 71.87.