Request for Additional Information
Holtec International
Docket No. 71-9261
HI-STAR 100 Transportation Package

By letter dated January 29, 2016, Holtec International (Holtec) submitted an amendment request for the Model No. HI-STAR 100 Transportation Package.

This request for additional information (RAI) identifies information needed by the U.S. Nuclear Regulatory Commission staff (the staff) in connection with its review of the HI-STAR 100 package application to confirm whether the applicant has demonstrated compliance with regulatory requirements.

The requested information is listed by chapter number and title in the package application. NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel," was used for this review.

Chapter 1 – General Information

1-1 Clarify the fuel acceptance criteria for the burnup and enrichment ranges of the fuel to be transported in the HI-STAR 100 package and resolve the discrepancies across the application.

The proposed Certificate of Compliance (CoC) indicates that the maximum enrichment of the fuel to be transported in the MPC-32 canister is 5.0 wt%. Figure C-4 of Holtec Report No. H-2156611 indicates that the burnup credit analysis requires the minimal burnup to be around 58 GWd/MTU for the 17x17B class PWR fuel with 5.0% (Holtec Report No. H-2156611, page C-64).

Table 1.2.33 of the application indicates that the maximum burnup is 45 GWd/MTU with enrichment ranges from 2.3 to 3.5 wt% U-235. Also, Table 5.2.23 indicates that the maximum burnup is 45 GWd/MTU.

There appears to be some discrepancies regarding the fuel qualification criteria. The applicant needs to clarify the burnup and enrichment ranges of the fuel to be transported in the HI-STAR 100 package and revise the application accordingly.

This information is needed to determine compliance with Title 10 of the *Code of Federal Regulations* (10 CFR) 71.35.

Licensing Drawings

1-2 Clarify the meaning of "equivalent" material for use in the HI-STAR 100 and HI-STAR 100 HB GTCC packages.

The lifting trunnion detail shown on sheet 3 of drawing 3913 of the HI-STAR 100 package indicates that an "equivalent" material can be used in lieu of those specified for both the trunnion end cap and trunnion end cap bolt. It is not clear how material equivalency will be determined.

Likewise for the HI-STAR 100 HB GTCC overpack, note E on sheet 1 of drawing 10315 states: "*the ASME and/or ASTM designation(s) of each material type specified herein is intended to fix its chemical and metallurgical attributes, not its raw material product form (viz. Plate or forging, seamless or welded tube, etc.). Alternate product forms having the same chemical designation and equal or better mechanical properties may be substituted by the manufacturer.*"

However, material properties can change with raw form, and it is unclear how mechanical properties, that are "equal" or "better", will be determined.

This information is needed to determine compliance with 10 CFR 71.31(c).

1-3 Clarify how subcomponents are classified.

According to the licensing drawings, Table 1.3.3 of the application describes component classification, per NUREG 6407. However, Table 1.3.3 now only indicates which components are important to safety or not. A footnote to Table 1.3.3 states that component classification is contained in written procedures. Section 1.3 states that subcomponent classification is documented "in a lower tier document". Written procedures and lower tier documents were not provided.

This information is needed to determine compliance with 10 CFR 71.33.

1-4 Clarify the changes made to drawing C1765 (sheet 6) of the HI-STAR 100 impact limiter.

Sheet 6 of drawing C1765 shows revised dimensions that describe impact limiter material. For instance, the section type 1 callout shows thicknesses and other quantities (T_1, T_2, and radii). Zone B is indicated in this callout and it is unclear what Zone B stands for. Callouts on this sheet previously had septums and other dimensional information. Clarify/justify what impact these changes have on the performance of the impact limiter with respect to normal conditions of transport (NCT) and hypothetical accident conditions (HAC).

This information is needed to determine compliance with 10 CFR 71.33(a)(5), 71.71, and 71.73.

1-5 Clarify how the dimensions of the MPC spacer ring will be varied to satisfy mass and center of gravity requirements of the package.

Drawing 10341 (sheet 1) of the licensing drawings indicates that the inner diameter of the spacer ring will be varied to satisfy mass and center of gravity requirements of the cask. Clarify how this criteria will be satisfied based on the dimensions of the spacer ring.

The same drawing indicates that the height of the spacer ring can be up 20 inches with no limitation on inner diameter dimensions. The "nominal" weight of the spacer ring is noted as 3,053 lb. which, if used in conjunction with the Diablo Canyon MPC-32 package (277,604 lb. per Table 2.III.2.1), would exceed the weight of the case that bounds it

(MPC-32). Describe the package's ability to satisfy performance requirements for both NCT and HAC, if this is the case.

This information is needed to determine compliance with 10 CFR 71.33(a)(5), 71.71, and 71.73.

1-6 Clarify the possible gap between the MPC spacer ring(s), the overpack, and the MPC canister.

Drawing 10341 (sheet 1) of the licensing drawings details the MPC spacer ring. However, its location relative to the overpack lid and MPC is not described. The staff is concerned that unintended interaction between components, during NCT and HAC conditions, may occur as a result of any gap.

This information is needed to determine compliance with 10 CFR 71.33(a)(5), 71.71, and 71.73.

1-7 Clarify the closure plate cutout dimension of the HI-STAR 100 overpack.

Drawing 3913 (sheet 2) of the licensing drawings details a 52 ¾" wide by 1/16" deep cutout in region D6 that previously had a ¼" tolerance which is now described as nominal. It is unclear where this cutout begins and ends in the plate since the dimension is not referenced directly to any feature of the closure plate.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

1-8 Justify the use of non-code compliant NDT examination for welds along the containment boundary of the HI-STAR 100 overpack.

Previously, drawing 3913 (sheet 2) of the licensing drawings depicted various components such as "gamma shells" welded to the containment boundary ("boundary welds") which complied with ASME standards. Now they are specified as non-code based (Detail A, Detail B, etc.).

These welds are to be examined and repaired in accordance with procedures which have not been identified. Justify/clarify these procedures and indicate how non-code welds and NDT inspection will meet or exceed previously approved procedures and methods.

This information is needed by the staff to determine compliance with the requirements of 10 CFR 71.31(b) and 71.31(c).

1-9 Clarify the stresses found at the MPC welds where grinding takes place.

Note 13 on sheet 1 of licensing drawing 3923 indicates that local grinding of the MPC shell may be as deep as 0.078" depending on the MPC in question over a specified area. Reference 2.6.5 (HI-2012787, supplement 62, page 62-1) adjusts stress in this area by scaling proportionally to the thickness of the shell in this area. Justify this approach for an abrupt change in the member geometry due to grinding such as a gouge and clarify how it would affect the packages performance with respect to NCT and HAC.

Note that calculated ASME Subsection NB allowable stresses in this area are very close to their limit for level D conditions for the 30 ft. side drop scenario under HAC.

This clarification is also needed by the staff for the GTCC waste container with respect to note 4 on sheet 1 of drawing 10316, and note 13 on sheet 1 of drawing 4459 for the Diablo Canyon enclosure vessel.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

1-10 Clarify the plug weld call out and set screw locations for the MPC enclosure vessel drawing.

Note 6 on sheet 3 of licensing drawing 3923 indicates that set screws in penetrations contained within the closure ring of the MPC vessel are optional and belong to a weld symbol show in Detail D. The weld symbol is ambiguous because it is unclear where it is located in the closure ring and it does not show a plug size or spacing. It is not clear what screw size or material specifications it will have.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

1-11 Clarify the torque load to be applied to the lift holes in the MPC enclosure vessel lid.

Note 8 on sheet 4 of licensing drawing 3923 specifies that a torque test may be used to qualify lift holes threads. It is unclear that amount of torque to be used nor where the written procedure describing it is.

This information is needed to determine compliance with 10 CFR 71.45.

1-12 Clarify member shapes and lengths on the licensing drawings.

Sheet 8 of drawing 3923 provides a limited number of nominal dimensions for spacer beams. Provide additional dimensions such as flange thicknesses, web thickness, maximum member length, etc. Indicate any gaps between fuel assemblies and MPC lid spacer beams.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

1-13 Clarify the location of the plugs and lid lift holes in the optional enclosure vessel lid.

A callout that is part of the “top” view of sheet 9, drawing 3923 indicates that the lid lift holes may no longer be centered on plugs. It is unclear where the plugs relative to the lid and lift holes are, since the details themselves seem to indicate that plugs and lift lid holes are concentric.

This information is needed to determine compliance with 10 CFR 71.45 and 71.33(a)(5).

1-14 Clarify the number of gusset plates used in impact limiter calculations.

Reference HI-2156708 (impact limiter design, page 15 of 209) appears to assume only one ring of gusset plates with respect to impact limiter calculations. However, there appears to be another ring of gussets according to drawing 10447 with different dimensions. Clarify the effect this has on the impact limiter calculations.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

1-15 Indicate on the drawings what welding process and weld filler material will be used at each of the welds specified on the plans.

Calculations in the application have assumed base material mechanical properties for welds. However, weld filler material and welding process have not been provided. Reference to the ASME codes alone is insufficient.

This information is needed to determine compliance with 10 CFR 71.31(c).

1-16 Clarify the weld information specified in the licensing drawings for the GTCC overpack assembly.

Note 2 on sheet 1 of drawing 10315 states: *"All weld sizes are minimums except as allowed by applicable codes and these drawings. Additional welds may be added by the fabricator as deemed necessary except where specified by holtec."*

Describe what codes will be used with non-minimum weld sizes and to what extent they will be increased. Clarify where additional welds will be made and what size they will have. Increased/extra welds can alter the load path of the package and affect its performance with respect to normal conditions of transport and hypothetical accident conditions. This is also needed for the GTCC waste container (note 7 on sheet 1 of drawing 10316).

This information is needed to determine compliance with 71.33(a)(5), 71.71, and 71.73.

1-17 Clarify where additional holes in the HI-STAR GTCC overpack will be and how they will be plugged.

Note 5 on sheet 1 of drawing 10315 states*: "Additional holes may be added by the fabricator for lifting and handling as necessary upon approval by the designer. Holes shall be plugged."*

The staff is concerned that randomly plugged holes can alter the performance of the package with respect to normal conditions of transport with respect to fatigue. Describe how holes will be plugged.

This information is needed to determine compliance with 10 CFR 71.33(a)(5), 10 CFR 71.71.

1-18 Specify the dimensions of the components that will be welded as an intermediate shell in the HI-STAR GTCC overpack.

Note 4 on sheet 1 of drawing 10315 states that: *"The intermediate shells may be made from more pieces, instead of two pieces as shown. For intermediate shell welding,* *fabricator to make final determination of the location and total number of Circumferential and longitudinal welds required."*

Clarify the size, location, and weld process that will be used to fabricate the intermediate shells. Random welds and their location could alter the packages performance under NCT with respect to fatigue.

This information is needed to determine compliance with 10 CFR 71.33(a)(5), and 71.71.

1-19 Clarify shell thicknesses for the HI-STAR GTCC overpack.

Flag note 1 on sheet 1 of drawing 10315 states: *"Outer layer shell thickness shall be determined based on tolerance stackup of all inner shells such that 8 1/2" minimum total thickness is maintained."*

The flag note that is called out in Section CB-CB of sheet 3 of drawing 10315 points to only one inner shell layer. The adjacent dimension describes a 8 3/8" nominal composite shell thickness for all 6 shells with a 8 1/2" minimum. The flag note appears to be in the wrong location, the minimum thickness of the composite shells is larger than the nominal dimension, and the total thickness of the composite shell appears to violate the notes. That is, if the interior shell (2 ½" thick) is added to the 5 intermediate shells (1 ¼" thick), a total of 8.75" is obtained. Dimensions should correspond to calculations used to support the packages performance with respect to NCT and HAC.

This information is needed to determine compliance with 10 CFR 71.33(a)(5), 71.71, and 71.73.

1-20 Clarify how thick the top and bottom lids are for the GTCC waste container (GWC).

Drawing 10316 depicts the split lid option for the GWC container. However, it is unclear how thick the top lid (bill of material item 17) and lower lid (bill of material item 18) are.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

1-21 Clarify the dimensions of the closure ring used for the GWC container.

The closure ring (item 20 of the bill of materials) shown in detail BV on sheet 1 of drawing 10316 attaches to both the top lid and shell top. However, it is unclear how wide or thick the closure ring is, or how far it protrudes beyond the edge of shell top. Nor is it clear how the 1/8" groove weld in this location will be made since the closure ring and shell top do not appear to be prepared (beveled) to receive this type of weld.

This information is needed to determine compliance with 10 CFR 71 and 71.33(a)(5).

1-22 Clarify the tolerances specified in the licensing drawings of the GTCC overpack assembly.

Note F on sheet 1 of drawing 10315 states partially: *"…hardware is fabricated in accordance to ensure with the fabrication drawings, which have tolerances appropriate to ensure component fit-up. Do not use worst case tolerance stack-up from this drawing* *to determine component fit-up. Dimensions indicated as "reference" are subject to tolerance stack-ups; dimensions indicated as "nominal" will vary in the manufactured hardware to the extent typical in applicable fabrication operations (such as rolling, plasma cutting and machining)…"*

It is unclear what the maximum and minimum values are for dimensions denoted as "nominal" based on the above description. Clarify the tolerances on components which are neither dimensioned as nominal, minimum, maximum or reference. For instance, the shells shown in Section CB-CB sheet 3 of drawing 10315 do not fall in any of the categories mentioned above as the drawing itself has no tolerance specified for such a case.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

1-23 Clarify the general note on tolerance stack-up in the licensing drawings for the Diablo Canyon enclosure vessel.

Note 2 on sheet 1 of drawing 4459 for the Diablo Canyon enclosure vessel states: *"dimensional tolerances on this drawing are provided to ensure that the equipment design is consistent with the supporting analyses. Hardware is fabricated in accordance with the design drawings, which may have more restrictive tolerances, to ensure component fit-up. Do not use worst-case tolerance stack-up from this drawing to determine component fit-up."*

Provide tolerances that do allow for a worst-case stack-up such that clearances and gaps can be properly evaluated. Each component should have a tolerance that is representative of the as-built condition of the component of interest in order to support any pertinent analysis.

Clarify how design drawings differ from licensing drawings, as it is not clear what restrictive tolerances imply.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

1-24 Clarify the weld with a backing symbol shown on Detail D on sheet 3 of drawing 4459 of the Diablo Canyon enclosure vessel.

A weld callout appears in Detail D of sheet 3 of drawing 4459 and points to the surface of the closure ring. It is unclear what kind of weld or size it is. The note associated with this weld (note 9) on sheet 6 of the drawings indicates that set screws may be used to seal penetrations for leak testing in addition to plug welds.

Provide dimensions that indicate the location and size of the plug weld(s) and indicate the size, type, and material properties of the stainless steel screws to be used in the closure ring.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

1-25 Clarify the spacer member sizes indicated in Section C-C of sheet 3 of drawing 4459 for the Diablo Canyon enclosure vessel.

Section C-C of sheet 3 of drawing 4459 depicts spacer beams under the MPC lid. However, it is unclear what the dimensions and spacing of the spacer beams are. Sheet 5 depicts what appears to be channels that are intended to be used for spacer beams, however it is unclear what material they are made of, and their relation to the spacer beams.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

1-26 Verify the cavity height of the Diablo Canyon MPC.

Section C-C of sheet 3 of drawing 4459 depicts a cavity height of 169 5/16" high. Taking into account the spacer beams that are 5" tall attached to the underside of the MPC lid, the cavity height available is only 164 5/16" high. Fuel assemblies may not fit in the cavity since Table 1.III.2 indicates that the maximum fuel assembly length specified is to be 166.9" or less. It is unclear if the specified maximum fuel assembly length includes a 2" provision for fuel growth as specified in the SAR or not.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

1-27 Clarify the location of the machined slots in the underside of the MPC lid as specified in note 7 on sheet 4 of drawing 3923.

Note 7 calls for slots to be machined in lift lug locations on the bottom MPC lid so that the lid may sit lower and flush with the MPC. Supplement 64 of reference HI-2012787 describes the slots as being in the bottom side of the "top closure plate". It is difficult to locate the slots based on the dimensions found only in note 7, especially since the MPC lid allows for the option of being "split". A dimensioned detail as part of the licensing drawings would clarify this note and support any calculations related to it.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

1-28 Clarify the trunnion detail shown in Section CG-CG on sheet 3 of drawing 10315.

The trunnions shown in Section CG-CG do not appear to match those shown in section CH-CH. They appear to be partially shrunk in section CG-CG relative to those shown in CH-CH.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

Chapter 2 – Structural Evaluation

2-1 Verify the weight used for deceleration calculations with respect to HAC drop tests for the HI-STAR HB GTCC package.

A value of 32.3g was determined to be the maximum deceleration experienced by the HI-STAR HB GTCC package for the 30 ft. drop test according to page 19 of 74 mentioned in reference HI-2114941. The maximum mass of the package was not used in the calculation, although the deceleration value is most likely still bound by the design deceleration used.

This information is needed to determine compliance with 10 CFR 71.73.

2-2 Clarify the fatigue analysis performed for the GTCC waste package.

While some supporting fatigue calculations have been provided due to canister loading, it is unclear how the structural performance of the package is with regards to fatigue, while the package is conveyed under NCT with respect to package vibration and not just for package loading and unloading operations.

This information is needed to determine compliance with 10 CFR 71.71.

2-3 Clarify how partially loaded MPCs for the HI-STAR 100 will perform during the drop tests outlined in normal conditions of transport and hypothetical accident conditions.

Section 1.2.3.10 of the application indicates that all partially loaded MPC's will be loaded to at least 50% of their capacity. While it is clear that the intent is to maintain the center of gravity of the system as described in Table 7.1.1 of the application, it is unclear how the package will behave for center of gravity over corner drop orientations and for other angles not examined for various content load patterns. The basket cells to be loaded should be clearly identified in operating procedures chapter of the SAR or licensing drawings by fuel type and MPC, and should correspond to analyzed conditions.

This information is needed to determine compliance with 10 CFR 71.33, 71.71, and 71.73.

2-4 Clarify or provide calculations used to describe the optional BWR lower fuel spacer shim assemblies.

It is unclear how the optional lower fuel spacer shim assemblies shown on sheet 8 of drawing 3923 will perform during drop tests specified for NCT and HAC. Clarify any gap(s) between the optional fuel spacer and fuel assemblies.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

2-5 Provide test data for modified Hexcell material.

Table 2.3.7 provides minimal aluminum honeycomb material properties and is referenced in impact limiter calculations (HI-2156708). Provide either calculations or graphs or catalog cuts, etc., of the modified Hexcell material showing stress-strain curves and its dependence on temperature, the testing conditions, and other mechanical properties of the material supporting the lock up parameter cited in HI-2156708.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

2-6 Clarify the safety factors reported for the closure plate lifting holes.

Section 2.5.1.2.1 of the application summarizes safety factors for the closure plate lifting bolts. Higher safety factors are reported than in the previous SAR for thread shear (1.31 vs. 5.31) and lifting bolt tension (1.67 vs. 3.31). Section 2.5.1.2.1 also states that a 45^{o} angle was conservatively taken into account for calculated safety factors as well as a 15% dynamic amplifier.

It is unclear how all these factors contribute to the final safety factors reported. Provide calculations for the lifting holes that clearly support the reported safety factors. Calculations should at a minimum include: combined tension and shear, bearing stress for components in contact that have an applied moment (lifting bars tensioned at 45^{o}), 15% dynamic amplification factor, and the scenario of a lifting bolt going slack while lifting.

This information is needed to determine compliance with 10 CFR 71.45.

2-7 Clarify how calculations for closure bolts have been revised since the last revision.

Updated safety factors for closure bolts for NCT are in Section 2.6.1.3.2.3 of the application. It appears that reference HI-2012786 (supplement 31b) could contain calculations related to the changes. However, supplement 31b does not appear not to have all change bars, and may have outdated references. For instance, maximum bolt preload (variable Q) is said to come from Table 7.1.1 of the application. However, Table 7.1.1 describes MPC fuel loading requirements which are not related to pre-bolt load. Similar findings were found for HAC conditions in Section 2.7.1.1 (see supplement 31c of reference HI-2012786).

Likewise, supporting calculation package HI-2012787 (page 5 of 998) indicates that supplement 35 has been revised (MPC lid lifting bolts), but it is unclear what has changed since change bars have not been indicated on the supplement.

This information is needed to determine compliance with 10 CFR 71.45, 71.71, and 71.73

2-8 Clarify the nomenclature used in the calculations and drawings with regards to components welded to the exterior of the HI-STAR 100 overpack.

It is unclear how components referred to in supplement 32 of reference HI-2012786 (MPC calculations) are called out in drawing 3913. Supplement 32 describes a 1/2" thick enclosure shell which appears to be described as an "enclosure shell panel" on sheet 6 of drawing 3913. The calculations describe an outer gamma shell which on sheet 2 of drawing 3913 is believed to be called an "outer layer", while sheet 8 describes it as the "5^{th} intermediate shell layer".

Similarly, it is unclear if the "toe plate" called out in supplement 32 refers to the "bottom plate" of sheet 2 or some other plate since the supplement itself has no figures. The enclosure shell return mentioned in supplement 32 does not appear to have a thickness pointed out in the licensing drawings.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

2-9 Clarify the calculations used to support the safety factors summarized in Section 2.7.3.3.1 of the application for the MPC.

Safety factors described in Section 2.7.3.3.1 with respect to HAC conditions for fire have changed since the last revision of the application with respect to the baseplate, top closure, and overpack bolts. It is unclear where the calculations that justify these changes are located.

This information is needed to determine compliance with 10 CFR 71.73.

2-10 Provide input files and references used to support the impact limiter calculations of Appendix 2C.

Provide:

a) "Analysis of HI-STAR 100 Transport Package Drop Accidents Supporting An Improved Impact Limiter Design," Holtec Report HI-2094448, Revision 2.
b) "Impact Limiter Test Report – Second Series," Holtec Proprietary Report HI-981891, Revision 3.
c) "Benchmarking of the LS-DYNA Impact Response Prediction Model for the HI-STAR Transport Package Using the AL-STAR Impact Limiter Test Data," Holtec Proprietary Report HI-2073743, Revision 1.
d) LS-DYNA input files used to support the conclusions of Appendix 2C with regards to impact limiters.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

2-11 Justify the safety factors presented in Section 2.I.5.3 of the application for the HI-STAR HB package.

Section 2.I.5.3 provides updated safety factors for lifting and tie down devices. However, it is unclear how these updated values were determined.

This information is needed to determine compliance with 10 CFR 71.45.

2-12 Clarify when damaged packaging fasteners will be replaced.

Section 8.2.3.4 indicates that damaged fasteners will be replaced. However, it is unclear from the drawings or the application what quantitative criteria will be invoked to induce fastener replacement.

This information is needed to determine compliance with 10 CFR 71.87(c).

2-13 Clarify the temperature assumed for impact limiter calculations used for the HI-STAR HB GTCC package and the HI-STAR 100 HB.

With respect to impact limiter material, clarify what temperature and material properties were assumed for both HI-STAR 100 HB and HI-STAR HB GTCC. While the weight of the HI-STAR HB GTCC package is less than the HI-STAR HB package, the package appears to be also thermally cooler. If the material yield strength is higher at these cooler temperatures, impact loads may be altered due to a stiffer impact limiter.

This information is needed to determine compliance with 10 CFR 71.71 and 10 CFR 71.73.

2-14 Verify the weight of the HI-STAR HB GWC container.

The GTCC package calculations (reference HI-2114941 page 8 of 74) state that the HI-STAR HB package and the HI-STAR HB GTCC package have the same over pack, and are bound by the same weight. However, with respect to the MPCs, the bottom plate is 2 ½" thick for the HB-MPC (sheet 2 of drawing 4102), vs. 4 ¾" thick for the GWC shown in detail CH of sheet 2 of drawing 10316. The GWC also contains an additional 1 ½" inner canister shell not found in the MPC-HB. Table 2.I.2.1 states that the MPC-HB weighs approximately 27,000 lb. (not including 32,000 lb of fuel) where the GWC empty weighs 26,000 according to Table 2.II.2.1. Given the additional inner canister and thicker bottom plate, the GWC waste container appears to weigh more.

This information is needed to determine compliance with 10 CFR 71.33(a)(2).

2-15 Provide calculations describing the performance of the shell top to closure ring weld area for the GWC container.

The closure ring (item 20 of the bill of materials) attaches to both the top lid and shell top and is part of the containment boundary for the GWC by way of a 1/8" groove weld shown in detail BV on sheet 1 of drawing 10316. Clarify how this weld will perform during NCT and HAC drop tests (end drop).

Note that the area surrounding the weld (shell top and closure ring) has an abrupt change in geometry where the shell top meets the closure ring and that stresses imparted by dunnage and contents on the top lid for an end drop scenario should be considered.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

2-16 Describe how the containment boundary of the GTCC waste package performs under NCT and HAC, and provide the corresponding analysis files.

The application states that the GTCC waste package is bound by the results of the HI-STAR 100 HB package which in turn is bound by the results of the HI-STAR 100 package. However, the primary containment boundary of the GTCC waste package is the canister (GWC) rather than the overpack, as is the case for the HI-STAR 100 and HI-STAR 100 HB.

It is not clear what the safety factors/margin of safety are for the GWC with respect to normal conditions of transportation or hypothetical accident conditions. While reference HI-2012787 indicates that there are at least two identically titled supplements (10 and 19) with ANSYS finite element results for MPCs (HI-STAR 100), they only contain ANSYS input files. Provide the digital input and output files that correspond to the aforementioned cases.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

2-17 Clarify the contents of partially loaded MPCs.

For MPCs that are partially loaded, it is unclear if mixed fuel types will be allowed into a MPC. If different fuel types are allowed, provide calculations which describe the effect it has on the center of gravity and criticality analysis of the package for NCT and HAC.

This information is needed to determine compliance with 10 CFR 71.33, 71.71, and 71.73

2-18 Clarify the calculations describing cover plate and basket welds.

It is unclear which MPCs are affected by revisions to supplement 41 (MPC cover plate weld) of reference HI-2012787 (MPC calculations). Corresponding licensing drawings detail “lid(s)” rather than a cover plate. Additionally, variables used in supporting the calculation are unclear, as the cover plate radius which is indicated as being on 2” on page 778 of 998 of reference HI-2012787 are referenced as coming from drawing 4838 which does not appear to be contained anywhere in the licensing drawings.

Supplement 41 also contains revised calculations used to determine basket fillet weld performance for drop tests cited in NCT and HAC conditions. These revised calculations do not appear to be mentioned in the application, and it is unclear what baskets are affected by these calculations.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

2-19 Verify the stress concentration factors used in calculating the effects of repair holes in the basket for the MPC 24 and MPC-68/68F/68FF.

Supplement 58 of reference HI-2012787 (MPC calculations) describes the effect that repair holes that are as large as 1 ¼” in the basket will have on the structural performance of the basket with regards to meeting drop test criteria and fatigue. Stress concentration factors have been determined by scaling the size of the repair hole to the width of the basket panel in which it resides. The result is a stress concentration factor of 1.172. The safety factor (inversely proportional to stress concentration factor) is reported to be 1.66 (side drop).

However, this approach is not conservative when compared to references which provide closed form solutions to this type of problem. The stress concentration factor determined by an alternate method appears to be 2 or higher. Holes which are smaller than 1 ¼” should also be examined as stress concentration factors vary with hole size in a non-monotonic way. Fatigue results should be based in part on the number of cycles the package is expected to see while conveyed during normal conditions of transportation and not just on loading operations.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

2-20 Describe the performance of the spacer beams attached to the lid of the Diablo Canyon MPC.

Spacer beams have been attached to the MPC lid of the enclosure vessel for Diablo Canyon to apparently help minimize any interaction between the contents and the enclosure vessel. It is unclear how the welds attaching the spacer beams (2 channels back to back welded on one leg) to the lid will behave under drop tests and vibratory conditions described under normal conditions of transport. The staff is concerned that the spacer beams may become loose and affect the packages performance for hypothetical accident conditions.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

Chapter 3 – Thermal Evaluation

3-1 Provide the calculation package where the HI-STAR HB and HI-STAR GWC-HB thermal analysis details are documented.

Supplement 3.I and 3.II of the application provides the thermal analysis results for these packages. However, details of the analysis are not provided in the application or calculation package HI-2156893. The staff needs these details to assess the adequacy of the results reported in the application.

This information is needed to determine compliance with 10 CFR 71.71.

3-2 Explain how cavity bulk temperatures are obtained for the HI-STAR DC MPC-32 package.

Table 3.III.2 of the application provides the calculated HI-STAR DC MPC-32 operating pressures. However, details on how the cavity bulk temperatures are obtained are not provided. The staff needs these details to evaluate the adequacy of the calculated pressures.

This information is needed to determine compliance with 10 CFR 71.71.

3-3 Provide calculation results for the HI-STAR HB, HI-STAR GWC-HB, and HI-STAR DC MPC-32 packages during loading operations (including time-to-boil and drying analysis).

Supplements 3.I, 3.II, and 3.III of the application provide the thermal evaluation during NCT. However, the application does not provide the thermal evaluation during loading operations. The staff needs to have this evaluation to assess the adequacy of short-term operations and resulting maximum temperatures.

This information is needed to determine compliance with 10 CFR 71.71.

3-4 Provide thermal analysis results and evaluations for the HI-STAR HB, HI-STAR WGC-HB, and HI-STAR DC MPC-32 during HAC (fire) conditions.

Supplements 3.I, 3.II, and 3.III of the application states that the generic HI-STAR 100 HAC (fire) results are bounding for these packages. However, the staff does not agree with this statement because the thermal capacity of these packages appears to be smaller than the generic HI-STAR 100 package which could result in larger temperatures and pressures during HAC (fire) conditions.

This information is needed to determine compliance with 10 CFR 71.73.

3-5 Provide maximum thermal stresses for the HI-STAR HB, HI-STAR WGC-HB, and HI-STAR DC MPC-32 packages.

Supplements 3.I, 3.II, and 3.III of the application states that the generic HI-STAR 100 HAC (fire) thermal results are bounding for these packages which would imply that thermal stresses are also bounding. However, based on RAI 3-4 above, this statement has not been demonstrated.

This information is needed to determine compliance with 10 CFR 71.73.

Chapter 4 – Containment Evaluation

4-1 Clarify in the application that the GWC-HB containment boundary is not affected by regulatory loads on a Type B package, including the NCT and HAC tests.

Section 4.II.1 indicates that the GWC-HB is the containment boundary. However, Chapter 2 of the application does not clearly show that the containment boundary's integrity is not affected by the NCT and HAC tests and that the leak rate would not be greater than the allowable leakage rate described in SAR Table 4.II.2.8.

This information is needed to determine compliance with 10 CFR 71.51 and 71.61.

4-2 Provide details of the O-rings (e.g., vendor data sheets) used to seal the GWC-HB and confirm (e.g., calculations, vendor data sheets) that seal groove dimensions are sized appropriately for the O-ring seal size.

Section 4.II.1 states that the vent and drain port cover plates are part of the containment boundary. In addition, Section 4.II.1.3.1 states that the vent port and drain ports are covered by port cover plates with "corresponding seals" and that seal and closure details are provided in the drawing package in Section 1.II.4. However, details of the seals and grooves were not found in DWG 10316.

This information is needed to determine compliance with 10 CFR 71.33.

4-3 Clarify whether the GWC-HB lid is removable or welded to the GWC-HB shell.

Section 4.II.1.4 states that the GWC-HB has a removable lid. However, it appears from DWG 10316 sheet 3 of 4 that the lid is welded to the GWC-HB shell. Provide details of sealing if the lid is removable.

This information is needed to determine compliance with 10 CFR 71.33.

4-4 Relate the source term conditions provided in the CoC and the analyses and discussions provided in Sections 4.II.2.4 and 4.II.2.5 of the application.

a) Section 4.II.2.4 and Section 4.II.2.5 provide discussion and calculations that attempt to show allowable leakage rates for given dispersible and non-dispersible source terms. However, there is no readily apparent connection between the discussion and the calculations with the proposed activity limits in CoC 5.(b)(1)(a)(3).

b) Provide the calculations that support the values provided in Table 4.II.2.3 through Table 4.II.2.9. The source term inputs and calculations that were used to generate the table information presented in Section 4.II were not provided and so a review could not be performed. For example, discuss the relation between the activities in Table 4.II.2.6 and the proposed activity limits in CoC 5.(b)(1)(a)(3).

c) Include, in Section 7 procedures, the need to ensure the dispersible and non-dispersible activity placed within a GWC-HB meets the allowable values defined in the CoC and Sections 4.II.2.4 and 4.II.2.5.

This information is needed to determine compliance with 10 CFR 71.33 and 71.51.

4-5 Explain the temperature and pressure parameters used to perform the release calculation so that a review can be performed.

Section 4.II.2.4, item 7, discusses temperature and pressure parameters that are estimated per NUREG/CR-6487. It was stated that these parameters are used in the release calculation. However, the mention or use of these parameters in NUREG/CR-6487 is not readily apparent.

This information is needed to determine compliance with 10 CFR 71.33.

4-6 Provide the calculations that result in the Table 4.II.2.6 effective A2 values so that a review can be performed.

Provide the radionuclides and calculations for determining the dispersible solid effective A2 values mentioned in Section 4.II.2.5.3 and confirm they are bounding. In addition, provide discussion/calculation for determining the different total effective A2 values for NCT and HAC in Table 4.II.2.6 for non-dispersible solids and dispersible solids.

This information is needed to determine compliance with 10 CFR 71.33.

4-7 Explain how the parameters described in Section 4.II.2.3 are appropriate and bounding as it relates to the dispersible and non-dispersible content in the GWC-HB.

a) Explain how the “estimated surface area of the expected waste”, “total surface area of the contaminated solids”, “activity surface density of the contaminated solids, and the “releasable activity” were determined and justify that they are bounding. [See pages 4.II-5, 4.II-6 and the S_{AS} and A_{SC} values in Table 4.II.2.3]

b) Verify that the NUREG/CR-6487 aerosol mass density is bounding for this application.

c) Show how the “specific activity of the dispersible solids was calculated using the total activity and weight of process waste” and show how it is bounding. In addition, show how the content mass, etc. described in Chapter 1 is used in that calculation.

d) Provide reference 4.II.2.1.

e) Page 4.II-6 states: “The activity density that results inside the HI-STAR HB GTCC containment vessel as a result of crud spallation from spent fuel rods is calculated using Equation 4-2”. According to the draft CoC, the HI-STAR HB GTCC package has non-fuel waste. Justify how the crud spallation from spent fuel rods is appropriate for this GTCC waste application.

f) Explain how the Cn and Cd values described in 4.II-6, 7, 8 and Table 4.II.2.5, 4.II.2.6 are related to the quantity of material noted in Section 5.(b) of the draft CoC.

g) Editorial: Section 4.II.2.3 has an incomplete sentence.

This information is needed to determine compliance with 10 CFR 71.33.

4-8 Confirm that the content for the Diablo Canyon MPC-32 is bounding.

Section 4.III.2.5.2 states that the inventory for the Diablo Canyon MPC-32 was assumed as the same as that described in Section 4.2.5.2 and Table 4.2.2.2. However, no statement was provided in Section 4.III to indicate that inventory was bounding for the Diablo Canyon MPC-32.

This information is needed to determine compliance with 10 CFR 71.33.

4-9 Clarify the statement in Section 4.III.2.5.3 "… exception of the fraction of rods that develop cladding breaches, which is explained in the previous section" and provide the fraction that is used in the calculation.

Table 4.2.4 provides the fraction of rods that develop cladding breaches. However, the above-mentioned statement indicates that the fraction described in the table is not used in the calculation. In addition, clarify the location of Table 4.2.2.2 mentioned in Section 4.III.2.5.2 of the application.

This information is needed to determine compliance with 10 CFR 71.33.

4-10 Explain the sealing mechanism of the Vent Port and Optional Vent/Drain connection, as denoted in DWG 3923, Sheet 2, Revision 31 and DWG 4459, Sheet 2, Revision14, and clarify whether the component acts as part of the containment boundary.

The drawing indicates a new sealing mechanism but there is no description of the viability for sealing or whether it is part of the containment boundary.

This information is needed to determine compliance with 10 CFR 71.33.

4-11 Confirm that content changes described in the revision do not affect previously supplied containment release estimates.

Tables 1.2.32, 1.2.33, and 1.2.38 include updated content. However, there was no discussion in their respective containment analyses that reflected the possibility that these changes would affect release estimates.

This information is needed to determine compliance with 10 CFR 71.33.

4-12 Clarify if the higher pressure affects the previously supplied containment release estimates.

Section 2.6.1.3.2.5 indicated that internal pressures have increased from 30 psi to 45 psi, but there was no indication that the pressure increase would have affected the containment release estimates. It is recognized that release is a function of vessel pressure (ANSI N14.5).

This information is needed to determine compliance with 10 CFR 71.33 and 71.51.

4-13 Clarify the activity that can be shipped in the HI-STAR 100 Version HB GTCC package so that a review can be performed.

Page 2.II-7 indicates that the package can transport 26,000 Ci of Co-60. However, the draft CoC (Section 5.(b)) indicates the activity is limited to 381 Ci of Co-60.

This information is needed to determine compliance with 10 CFR 71.33.

4-14 Provide discussion in the application that confirms the hydrogen concentration within the void space is less than 5 percent by volume.

a) Page 1.II-5 of the application indicates that the GWB's PWC maintains a hydrogen concentration of less than 5 percent by volume of the PWC void space, but there was no justification. In addition, specify the time period associated with the calculation.

b) Provide discussion in the application that clarifies the HI-STAR 100 package with Diablo Canyon MPC-32 maintains a hydrogen concentration of less than 5 percent volume prior to transportation and during the transportation period. In addition, specify the transportation period.

This information is needed to determine compliance with 10 CFR 71.33.

4-15 Clarify whether the test port plug, shown in Figure 4.1.2, is part of the containment boundary.

It is not clear from Figure 4.1.1 whether the test port plug seal is part of the containment boundary, considering that page 4.1-1 indicated that the containment system included "mechanical seals". A discussion proving the effectiveness of the test port plug seal is necessary to justify its capability to act as part of the containment boundary.

This information is needed to determine compliance with 10 CFR 71.33.

4-16 Clarify in the SAR that those approving the leakage test procedures and performing the leakage tests are qualified.

Sections 8.II.1.3.2.2 and 8.II.1.4 indicate that testing shall be performed per written and approved procedures. However, there was no mention in the SAR that those approving the procedures and performing the tests are qualified. For example, ANSI N14.5 provides information on the qualification and certification of personnel performing leakage rate tests. Likewise, an individual who has obtained certification as an ASNT nondestructive testing (NDT) Level III in leak testing has the qualification necessary to develop and approve written instruction for conducting leakage rate testing.

This information is needed to determine compliance with 10 CFR 71.33.

4-17 Provide the ITS safety classification of the GWC and HI-STAR 100 containment boundaries, including the seals.

Table 1.3.3 did not indicate the ITS safety classifications for containment boundary components, including the seals. In addition, the "MPC" portion of Table 1.3.3 and drawing 10316 (sheet 1 of 4) did not indicate safety classifications of the entire containment boundary.

This information is needed to determine compliance with 10 CFR 71.33.

4-18 Clarify in the SAR Section 4 tables that the GWC is leakage tested rather than the HI-STAR 100.

Tables 4.II.2.8 and 4.II.2.9 list the leakage rates for the HI-STAR HB GTCC package. As noted in Section 4.II.1, the GWC is the containment boundary that must meet leakage test criteria.

This information is needed to determine compliance with 10 CFR 71.33.

4-19 Clarify that the HI-STAR 100 GTCC HB and HI-STAR 100 Diablo Canyon MPC-32 content only includes "load and go" canisters.

Section 7.II.0 states "… the descriptions below include the steps required to transport the cask after a period of storage". This appears to indicate that content may include MPCs that have been in storage for a period of time. However, Section 8.II.1.3.2.2 seems to indicate that procedures are for "load and go". The storage period of the content should be provided for clarification. If the content includes MPCs beyond "load and go" storage periods, then detailed discussion must be provided on the condition of the canister and content that justify the application's calculations and conclusions remain valid.

This information is needed to determine compliance with 10 CFR 71.33 and 71.51.

Chapter 5 – Shielding Evaluation

5-1 Justify the waste densities used in Table 5.II.4.

Table 5.II.4 of the application states waste densities of 0.577 g/cm^3 for the Outer Region and 2.66 g/cm^3 for the Inner Region (Process Waste Container). Provide the information used to determine that the waste densities used yield the most conservative content for the dose calculations.

In addition, it is not clear what "Note 1" of Table 5.II.4 means, since it states the source covers both the outer and inner regions, but it is a note for only the outer region and there is a separate source strength identified for the inner region in the table.

This information is needed to determine compliance with 10 CFR 71.47 and 71.51.

5-2 Justify assuming a uniform source distribution for modeling in MCNP-4A.

As stated in Section 5.II.2, "Source Specification," the applicant's dose rates obtained by modeling with MCNP-4A assume a uniform distribution. There is no basis given in the application for this assumption, and non-uniformity could lead to non-conservative dose rates.

This information is needed to determine compliance with 10 CFR 71.47 and 71.51.

Chapter 6 – Criticality Evaluation

6-1 Provide drawings for the thorium rod canister, the loading pattern of the thorium rods in the thorium rod canister, and the loading pattern of the thorium rod canister(s) in the BWR basket and explain how the thorium rod canister(s) is held in the BWR fuel basket to support the assumptions used in the criticality safety analysis.

On page 3.4-28, the application describes the shape of the thorium rod canister. However, there was no drawing provided in the application to show the detailed structure of the canister, the required loading pattern of the thorium rods in the canister, the loading pattern of the thorium rod canisters in the BWR basket. Also, there is no explanation on how the thorium rod canister(s) is held in the BWR fuel basket under NCT and HAC conditions. Although the applicant provides a figure to show a sketch of the canister in Figure 1.2.11A, the figure does not include the dimensions in the x-y plane. In addition, from the figure, it appears that the thorium rod canister is much smaller than the normal opening of the basket cell for an 8x8 BWR fuel assembly. It is not clear how the thorium rod canister is loaded and held in the BWR fuel basket to support criticality safety. The applicant needs to provide drawing for the thorium rod canister, the loading pattern of the thorium rods in a thorium rod canister, and the loading pattern of the thorium rod canister in the BWR basket. The applicant also needs to explain how the thorium rod canister(s) is held in the BWR fuel basket to support the assumptions used in criticality safety analysis for the package under NCT and HAC conditions.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-2 Explain whether the thorium rod canister(s) will fill the entire BWR basket or will be loaded along with other BWR fuel assemblies in the BWR fuel basket and provide criticality safety analysis consistent with the loading configuration.

The applicant indicates that irradiated thorium rods will be loaded in thorium rod canister and the thorium rod canister(s) is loaded in the BWR fuel basket. Each thorium rod canister occupies one BWR fuel cell in the basket. However, it was not clear whether the thorium rod canister(s) will fill the entire basket or will be loaded along with other BWR fuel assemblies in BWR fuel basket. The application does not appear to include this important information. Although irradiated thorium rods were authorized in amendment 1 of the CoC in 2001, the staff noted that the approval was for storage only. Transportation packages are subject to much more impacts from external forces under NCT and HAC.

The staff also noted that, on page 6.4-11 of the application, the applicant states: "*The Thoria Rod Canister is similar to a DFC with an internal separator assembly containing 18 intact fuel rods. The configuration is illustrated in Figure 6.4.10. The* k_{eff} *value for an*

MPC-68F filled with Thoria Rod Canisters is calculated to be 0.1813." However, it was not clear what assumptions were used in the criticality safety analysis for this content to obtain this k_{eff} value. If the basket is filled with irradiated thorium rods, the criticality safety analysis should include the appropriate quantity of U-233 that is created during irradiation. If the thorium rods are loaded together with other BWR fuel assemblies, the criticality safety analysis should be performed consistent with the fuel loading. The applicant needs to explain whether the thorium rod canister(s) will be loaded alone or along with other BWR fuel assemblies in the BWR fuel basket and provide a criticality safety analysis consistent with the loading configuration and the assumptions used in calculating the k_{eff} value presented in page 6.4-11. The applicant also needs to demonstrate that the calculated k_{eff} value is correct for the content or provide criticality safety analysis for the package with the appropriate material composition.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-3 Provide the material compositions for the irradiated thorium rods for the criticality safety analysis model and revise the application accordingly.

On page 6.3-13, the application includes material composition and number densities for thorium rods. However, it appears that the material compositions are for unirradiated thorium rod. Since irradiation of thorium with neutron produces fissile material U-233, the material composition must include this new fissile material for criticality safety analysis. The applicant needs to provide the material compositions for the irradiated thorium rods for the criticality safety analysis model for the package containing irradiated thorium rods and revise the material composition presented in Table 6.2.42.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-4 Pertinent to determination of the fissile material in the irradiated thorium rods,

a. Provide the method used for computing the quantity of the fissile material in the irradiated thorium rods, or
b. Provide, if a computer code is used for this purpose:
    1. the name and version of the computer code and cross section library used for computing the material composition of the irradiated thorium rods,
    2. a code benchmark analysis for the computer code used for this purpose,
    3. all assumptions used with appropriate justifications, and
    4. a sample input file for the thorium rod irradiation model.

Because fissile material (namely U-233) is produced when thorium is irradiated in the reactor, it is important to determine the material composition of the irradiated thorium rods for criticality safety analysis of the package. However, this information appears to be missing in the criticality safety analysis. The applicant needs to provide the method used to compute the material composition of the irradiated thorium rods. If a computer code is used, the applicant needs to provide the name/version of the computer code, cross section library, and all assumptions used for this analysis. The applicant also should provide justifications for all assumptions. A code benchmark analysis is necessary to assure the accuracy and reliability of the calculated material composition. A sample input file for the thorium rod irradiation model will be helpful to the staff for understanding the model.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-5 Clarify if the k_{eff} value for the MPC-68 class package includes considerations of uncertainties of the input parameters and assumptions used in the criticality safety analysis model and justify that the calculated k_{eff} value is conservative.

In Table 6.1.2, on page 6.1-9 of the application, the applicant reports that the maximum k_{eff} for the MPC-68 class is 0.9459. However, it is not clear if this value includes uncertainties in the modeling parameters such as basket geometry, enrichment variations in the planar and axial directions, material compositions, and cross sections. Also, the application appears to not include information on the upper subcriticality limit to assist the staff to determine the safety margin of the reported k_{eff} value. The applicant needs to demonstrate that this k_{eff} value includes the uncertainties of the model input parameters and that the result is conservative.

The staff needs this information to determine compliance with 10 CFR 71.55 and 71.59.

6-6 Explain why the gaps between packages were modeled as air in the model for array of undamaged packages.

In Table 6.1.4, the applicant reports calculated k_{eff} values for array of undamaged BWR fuel packages. In the columns for internal and external moderation, it appears that the models assumed that the gaps between packages for array of packages with undamaged fuel were filled with air. This is inconsistent with the regulatory requirements of 10 CFR 71.55(b)(3). The applicant needs to explain the basis for this assumption.

This information is needed to determine compliance with 10 CFR 71.55(b)(3).

6-7 Explain why the reported k_{eff} values for packages with external reflectors are consistently lower than the ones without external reflectors.

In Table 6.1.4, the applicant provides the calculated k_{eff} values for all of the basket designs of the HI-STAR 100 package. From this table, it appears that the k_{eff} values for the packages without external reflector are larger than the ones with external reflector for all of the cases. Also, it appears that the differences are not within statistical error ranges. Based on the basic neutron transport theory, any reflector (except reflectors that are completely black to neutron) is better than void (air). It was not clear why the system exhibits such neutronic characteristics because these results are not consistent with the basic nuclear theory of fissile systems that an external reflector will always provide some reflector savings in neutron multiplication. The applicant needs to explain why the results exhibit such characteristics and are acceptable.

The staff needs this information to determine the package meets the regulatory requirements of 10 CFR 71.55(b)(3).

6-8 Revise Note 5 of Table 1.2.10 of the application to indicate that burnup credit is used for the package with MPC-32 only and the minimal burnup is determined by the equations in Table 1.2.34.

Note 5 for Table 1.2.10 indicates that the enrichment limits of 15x15 and 17x17 class fuel are given in Table 1.2.34. In fact, the values given in Table 1.2.34 are minimal burnup rather than enrichment limits. The applicant needs to revise Note 5 for Table 1.2.10 to clear indicate that burnup credit is used for the package with MPC-32 and the minimal burnup is determined by the equation in Table 1.2.34.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-9 Clarify the method used for burnup credit analysis.

On page C-5 of Holtec Report H-2156611, the applicant states: "*… due to the above change* [using ISG-8, Revision 3 method] *in burnup credit methodology from [1] [ISG-8, Revision 3], isotopic correction factors are no longer used*." However, on page 6.E.18 of the HI-STAR SAR Revision 16, the applicant states: "*Two different approaches are used to account for the differences between measured and calculated isotopic compositions. For the major actinide, i.e. all Uranium and Plutonium isotopes, a reactivity bias is determined that is applied in the design basis calculations to the results of the criticality calculations. For fission products and minor actinides, a conservative correction factor is developed individually for each isotope that is considered in the analysis. Np-237, Am-241 and Am-243 are considered minor actinides for the purpose of this evaluation*."

Also, on page 6.C-4 of the application, the applicant states that it took the recommended approach from ISG-8, revision 3, for fission products and minor actinides. From these various statements, it appears that there are some inconsistencies across the application (including the supplement materials) regarding the method used for burnup credit analysis. The applicant needs to clarify what method(s) has been used in the burnup credit analysis for the HI-STAR 100 package.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-10 Clarify if the burnup credit analysis method used in this amendment supersedes the one used in the previously approved HI-STAR package and whether these changes will impact the loading curves of the previously approved packages.

Page C-5 of Holtec Report H-2156611, the applicant states: "… *due to the above change* [using ISG-8, revision 3 method] *in burnup credit methodology from [1] [ISG-8, Rev. 3]*, *isotopic correction factors are no longer used. On page C-6, the applicant states: "The following loading curve calculations are performed with fuel class 15f, 17a, 17b, 17c and DCPP [Diablo Canyon Power Plant] specific fuel*." From these statements, it appears that this application is intended for all of these fuel classes because 15f is a 15x15 fuel assembly design as evidenced on page C-7 of the same document where the applicant states that 15x15 fuel class is a content approved before.

However, it is not clear from this statement if the current analysis results are applicable only to the currently requested contents or if they retrofit to all previously approved contents. The applicant needs to clarify the intent of this amendment application. If the intention of this new analyses with the new burnup credit analysis method is to supersede the method used in the previous application(s), the applicant needs to provide an assessment of the impact to the previously approved loading curves.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-11 Demonstrate the applicability of the recommendation of ISG-8, Revision 3 for treating the bias and uncertainty of the minor actinides and fission products as 1.5% of the worth of these isotopes for this package design.

The applicant used the recommendation of ISG-8, Revision 3 for treating the criticality safety analysis computer code benchmarking method for minor actinides and fission products. However, in order to be able to use this simplified approach, ISG-8, Revision 3 specifically points out that the applicant must demonstrate that the applicant's package design is sufficiently similar to the GBC-32 package with respect to the neutronic characteristics of the system. However, the application does not appear to include this information. The applicant needs to demonstrate that the HI-STAR 100 package is sufficiently similar to the neutronic characteristics of the GBC-32.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-12 Explain what method was used for depletion code benchmarking for minor actinides and fission products included in the burnup credit analysis and demonstrate that the approach used is conservative.

The applicant used the recommendation of ISG-8, Revision 3, for treating the bias and bias uncertainty associated with criticality safety analysis computer code for minor actinides and fission products, i.e., 1.5% of the reactivity worth of the fission products and minor actinides. However, the staff notes that this method is applicable only to criticality safety analysis code benchmarking.

Therefore, it is not clear how the bias and uncertainties associated with the depletion code, i.e., CASMO, were determined. The applicant needs to explain how the bias and uncertainties associated with the depletion analysis code CASMO were determined and demonstrate that the approach used is conservative.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-13 Provide details on the method used to generate surrogate data with justification for the reliability of the method and the generated data.

On page 6.C-5, the applicant indicates that it used surrogate data for code benchmarking. However, it was not clear how the surrogate data are generated. The applicant needs to provide details on how these surrogate data are generated, including the method and assumptions used. The applicant also needs to justify the applicability of the surrogate data to demonstrate that the surrogate data follow correct the statistical distribution.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-14 Clarify if the bias or the uncertainty, or both, has a few significant trends, and explain why the bias could be zero if there is a significant trend in these data and how this trend is accounted for in determining the maximum allowable k_{eff} for the package.

When discussing the criticality safety analysis computer code benchmark, on page 6.C-7 of the application, the applicant indicates that the results of benchmarking code calculation show a few significant trends with a bias of 0 and uncertainty of ±0.0111 for the full set of 562 experiments. The applicant needs to clarify which one, the bias or the uncertainty or both, has a few significant trends, and explain why the bias could be zero if there is a significant trend in these data. The applicant also needs to explain how this trend is accounted for in determining the maximum allowable k_{eff} for the package.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-15 Explain the technical basis for treating the bias as Bias = k_{eff} -1 and recalculate the bias if necessary.

On page 6.C-7 of the application, the applicant states: "*Note that in the tables of this appendix, the Bias is calculated as Bias =* k_{eff} *-1*." This equation appears to imply that the k_{eff} values of all selected critical experiments for this code benchmarking analysis are 1.0000. However, from the values provided in Table 6.C.7, it appears that very few of the reported k_{eff} values are 1.000.

The applicant needs to explain the technical basis for this treatment especially when the k_{eff} values of most of the critical experiments are not 1.0000. Therefore, the regression calculations for bias and bias uncertainties should be based on the actually reported values for these selected critical experiments rather than assuming them to be 1.0000. The applicant needs to provide justification for why it is acceptable to assume the average k_{eff} of the selected critical experiments as 1.0000 or recalculate the bias if necessary.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-16 Provide a justification for using fuel loading curve beyond its validated range.

Page 6.C-10 of the SAR states that the three enrichment points were selected for confirmation from two loading curves (15x15F Configuration B and 17x17B Configuration B). However, from the RCA data the applicant used for burnup credit analyses, it appears that the lowest enrichment was 2.45%. This is significantly higher than the lower end, 2.0% enrichment, of the loading curves. The applicant needs to provide a justification for why the burnup credit loading curves are valid for an enrichment that is much lower than the enrichment the burnup credit is valid for.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-17 Clarify if the Diablo Canyon fuel includes damaged fuel and provide a criticality safety analysis if damaged fuel is part of the intended content.

Appendix A of the application discusses the operating parameters of the Diablo Canyon nuclear reactors. However, it was not clear if the spent fuel from Diablo Canyon includes damaged fuel. The applicant needs to provide a criticality safety analysis if damaged fuel is part of the intended content.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-18 Explain how the additional reactivity margin was estimated and provide the list of isotopes and assumed cooling time used in estimation of the safety margin with a justification that the assumptions are conservative.

NUREG-1617 requires the staff to ensure that design-specific analyses provide an estimate of the additional reactivity margins available from fission product and actinide nuclides that are not included in the licensing safety basis (as described in Section 6.4.8.1). On page C-11 of the Holtec Report HI-2156611, the applicant states: "*One significant conservative assumption of the burnup credit methodology described here is crediting only recommended set of actinides and fission products, i.e. neglecting all additional fission products and actinides that are not endorsed by ISG-8. To estimate the safety margin that corresponds to just this single assumption, an additional calculation was performed crediting all isotopes from the CASMO5 depletion calculations for the 15x15F assembly class for Configuration A at 5 wt% enrichment and 50 GWD/MTU burnup. The comparison with the design basis calculation is listed in Table C.10. The results show that neglecting additional actinides and fission products results in a significant estimated safety margin of at least 0.016 delta-k*."

However, it is not clear how the additional reactivity margin was estimated and what isotopes were included in the model. In addition, it was not clear either what cooling time was used in estimating the additional reactivity margin because cooling time plays an important role in determining the quantities of these isotopes, particularly for short-lived isotopes. The applicant needs to explain how the additional reactivity margin was estimated and provide the list of isotopes and assumed cooling time used in estimation of the safety margin with justification that the assumptions are conservative. In addition, the applicant needs to justify why 50 GWd/MTU burnup is used in this estimate if the maximum burnup is 45 GWd/MTU.

This information is needed to determine compliance with 10 CFR 71.55 and 71.59.

6-19 Demonstrate that the HI-STAR 100 package with the MPC-32 basket in Configuration B meets the requirements of 10 CFR 71.55(b), (d), and (e), given that the package relies on 800 ppm soluble boron to assure criticality safety.

The applicant states on page 6.C-16 of the application: "*Following the approach outlined in the ISG-8 Rev. 3, misloading studies were performed specifically for the MPC-32 basket in HI-STAR 100. The studies conservatively consider the misloading of the single fresh fuel assembly with the initial enrichment of 5.0 wt% ^{235}U in one of the four central locations of the basket, which bounds both single severely underburned assembly misloads and misloads of multiple moderately underburned assemblies. The results of the calculations are presented in Table 6.C.17 and show that the soluble boron concentration of 800 ppm is sufficient to offset the reactivity increase due to potential misloading accident.*" The staff notes that this application is for a transportation package and the staff does not understand how soluble boron is made available in a condition flooded with fresh water per the requirement of 10 CFR 71.55(b), (d), and (e). The applicant needs to provide justification for availability of soluble boron for transportation package or revise the safety analysis to ensure the package meets the requirements of 10 CFR 71.55(b), (d), and (e).

This information is needed to determine compliance with 10 CFR 71.55(b), (d), and (e).

Chapter 7 – Operating Procedures

7-1 Pertinent to fuel qualification and verification, provide:

1. Operating procedures that require verification of burnup of each fuel assembly in addition to the fuel selection and verification procedures which focus mainly on the decay heat and source term for dry cask loading, and

2. Quality assurance for the burnup records for each fuel assembly.

The HI-STAR 100 package design with the MPC-32 basket takes burnup credit for criticality safety. An integral part of the burnup credit is fuel burnup verification. Potential uncertainties in fuel burnup calculation method and procedures should be considered and included in the determination of burnup records. However, there is no clear requirements in the Operating Procedures for the HI-STAR 100 package for fuel burnup verification. The applicant needs to provide specific requirements for fuel selection and verification as part of the operating procedures.

The staff understands that for storage systems, the fuel selection and verification parts have been defined as the licensee's responsibility for use of a storage cask design. However, because burnup verification is an integral part of fuel qualification for transportation packages taking burnup credit, the operating procedures for transportation packages taking burnup credit must include requirements for positive verification of fuel burnup records. The applicant needs to revise the operating procedures to clearly identify burnup verification is part of the fuel loading procedures.

This information is needed to determine compliance with 10 CFR 71.55, 71.59, and 71.89.

7-2 Provide details for acceptance criteria for the HI-STAR 100 to transport the MPCs that have been in storage or clarify that this amendment request does not seek authorization for transport of MPCs that have already been in storage.

Page 7.0-1 of the application states: "*The chapter also provides a description of the essential elements necessary to transfer a Holtec MPC from a dry storage system into the HI-STAR system for transportation*." On the same page, the SAR also states: "*Control of system operation shall be performed in accordance with the licensee's Quality Assurance (QA) program to ensure critical steps are not overlooked and that the MPC and overpack, as applicable, have been confirmed to meet all requirements of the Part 71 CoC before being released for shipment*."

However, it appears that there are no details on how to determine whether an MPC that has been in storage meets the requirements of 10 CFR Part 71. It is not clear either what the exact acceptance criteria are for this determination. The applicant needs to provide details for acceptance criteria for the HI-STAR 100 to transport the MPCs that have been in storage.

This information is needed to determine compliance with 10 CFR 71.55, 71.59, and 71.89.

7-3 Edit item 6 of Section 7.1.4 to indicate that the leak testing acceptance criteria are found in Section 8 of the application; acceptance criteria were not listed in Section 4.1.

The acceptance criteria in Section 8 should be referenced because it is incorporated in the CoC.

This information is needed to determine compliance with 10 CFR 71.33.

7-4 Clarify in the application that a periodic leakage would be performed.

a) Section 7.4 appears to state that the periodic leakage test, as defined by ANSI N14.5, would not be performed within a 12-month period. However, Section 8.1.4 states that a periodic leakage test would be performed per ANSI N14.5.

b) Based on the wording in Section 7.4, clarify whether a HI-STAR 100 package transport period would exceed one year.

This information is needed to determine compliance with 10 CFR 71.33.

Chapter 8 – Acceptance Tests and Maintenance Program

8-1 Clarify the miscellaneous tests outlined in Section 8.2.5 of the application.

Section 8.2.5 of the application describes miscellaneous tests for the HI-STAR 180D package when, most likely, the HI-STAR 100 was intended.

This information is needed to determine compliance with 10 CFR 71.33.

8-2 Clarify in the SAR that a maintenance leakage test is necessary if maintenance is performed on the containment boundary.

a) Table 8.II.3 indicates that a maintenance leakage rate test is not applicable. However, testing would be required to verify the integrity of the containment boundary if the boundary required repair.

b) Table 8.2.1 states that seals do not have to undergo a maintenance leakage rate test after replacement, however, this is not consistent with ANSI N14.5.

This information is needed to determine compliance with 10 CFR 71.33.

8-3 Clarify in Section 8.2.2 that a pre-shipment leakage test is performed prior to each shipment per ANSI N14.5.

The language in Section 8.2.2 appears to interchange the time periods associated with periodic leakage rate test and a pre-shipment leakage rate test. A pre-shipment leakage rate test can occur more than once during a year.

This information is needed to determine compliance with 10 CFR 71.33.

8-4 Justify the equivalency between a visual examination for water leakage and leakage testing.

Section 8.II.1.4 states that a “verification of a water-tight closure confirms the required leaktightness is met”, but there was no substantiation provided to ensure the leakage rate criteria would be satisfied.

This information is needed to determine compliance with 10 CFR 71.33.

8-5 Clarify the leakage rate acceptance criteria listed in Table 8.II.2 and provide the procedure for leakage testing the entire GWC enclosure vessel, per ANSI N14.5.

a) There were no discussions for determining the two leakage rate acceptance criteria listed in Table 8.II.2.

b) The procedure for testing the entire GWC enclosure vessel is not clearly discussed in SAR Section 7.

This information is needed to determine compliance with 10 CFR 71.33.