Request for Supplemental Information
Holtec International
Docket No. 71-9374
HI-STAR 80 Transportation Package

By letter dated August 23, 2016, Holtec International (Holtec) submitted an application for the Model No. HI-STAR 80 Package.

This request for supplemental information (RSI) identifies information needed by the U.S. Nuclear Regulatory Commission staff (the staff) in connection with its acceptance review of the Model No. HI-STAR 80 package application to confirm whether the applicant has submitted a complete application in 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 Provide the material compositions for all MOX fuel types to be shipped in the Model No. HI-STAR 80 package and provide safety analyses, as necessary, consistent with the MOX fuel type(s) to be shipped.

The application does not include information on the material composition of the pre-irradiated MOX fuel. Based on NUREG-1617, including Supplement 1 "Standard Review Plan for Transportation Packages for MOX Spent Nuclear Fuel," significant differences in material composition exist for different types of MOX fuel: larger gamma source and decay heat impact the safety evaluations of the package. Also, with an A_2 value of 1.0×10^{-3} TBq for most of the common plutonium isotopes, a relatively small increase in the plutonium-containing fines could have a significant influence on the overall containment criteria. The applicant needs to include the material compositions for all MOX fuel types to be shipped in the package and provide safety analyses, as necessary, consistent with the MOX fuel type(s) to be shipped.

This information is required to determine compliance with 10 CFR 71.43(g), 71.47(b), 71.51(a), 71.51(b), 71.51(c), 71.51(d), 71.55(b), 71.55(d), 71.55(e), 71.59(a), 71.59(b), and 71.59(c).

Chapter 2 – Structural and Materials Evaluation

Observations:

2-1 Provide information on the geometric shape and size of solid "chunks" of metals with activated elements, fissile metals, and plutonium. Provide information on whether the increased end-of-life rod internal pressures from Integral Fuel Burnable Absorber (IFBA)

PWR fuels were considered for their potential to result in increased radial hydride reorientation and their effect on the mechanical properties of the cladding.

The application includes various fuel/material classifications and describes contents with metals of activated elements, fissile metals and plutonium, all in solid form generally described as “chunks”. However, rubbles may be of a small “chunk” size and, for these small “chunks”, the applicant should address their potential pyrophoricity under normal conditions of transport (NCT) and hypothetical accident conditions (HAC).

The applicant explains that the drying process of high burnup fuel follows discussions made in ISG-11 Rev. 3 and the ASTM C1533 Guide. The staff has been analyzing potential hydrogen effects on high burnup cladding integrity, including the effects of radial hydride reorientation. The extent of reorientation is dependent on the peak cladding hoop stresses during drying operations, which will be higher in IFBA rods with poison materials that lead to helium generation. This application considers IFBA in the criticality analysis, but is unclear if these rods were considered for their potential to affect the mechanical properties of the cladding due to radial hydride reorientation.

This information is required to determine compliance with the requirements of 10 CFR 71.43(d) and 10 CFR 71.55(d).

2-2 Provide a plan, as part of the operating procedures, to ensure that channeled BWR spent nuclear fuel (SNF), selected for loading, is undamaged in accordance with the CoC conditions.

Crud-Induced Localized Corrosion (CILC) channeled BWR SNF has the potential for corrosion-induced damage to the cladding and, therefore, cladding integrity may be uncertain. If these assemblies are not dechanneled, visual inspection or ultrasonic testing of the cladding will not be viable. The user will likely need to rely on reactor operating records and/or SNF sipping methods to reasonably demonstrate that the cladding condition is within the bounds of the CoC conditions and not grossly-breached.

This information is required to determine compliance with the requirements of 10 CFR 71.43(d) and 10 CFR 71.55(d).

Chapter 3 – Thermal Evaluation

3-1 Explain the inconsistency of the temperatures between Table 3.1.1.B and Table 3.1.3 for the vent port seal and the spray cooling seal.

The applicant provided the maximum temperature of the vent port, drain port and spray cooling seals as a co-value of 139^{o}C in SAR Table 3.1.1.B, and the initial temperatures of the vent port, drain port and spray cooling seals as 126^{o}C, 139^{o}C and 125^{o}C, separately, in Table 3.1.3 of the application.

Given that the NCT temperatures are used as the initial conditions of the HAC fire analysis, the seal temperatures shown in Table 3.1.1.B and Table 3.1.3 should be consistent. Otherwise, the applicant needs to provide and clarify, in Table 3.1.1.B, the maximum component temperatures, separately, for the vent port, drain port, and spray cooling seals.

This information is required to determine compliance with 10 CFR 71.35 and 71.71 and 71.73.

3-2 Clarify the statements in Note (g) of Table 3.2 of the application.

The applicant stated in Note (g) of Table 3.2 that the aluminum shells and the ribs outside the cask cavity are assumed to melt under HAC. The applicant needs to clarify that:

(a) Both aluminum shells and the ribs are either not modeled in the HAC fire analysis or are modeled in the HAC fire analysis with different material properties before and after melting (as lead in Table 3.2.2),

(b) The assumption in Note (g) is either applicable only to a 30-minute fire or to both the 30-minute fire and the post-fire cooldown.

(c) The assumption for the thermal evaluation in the post-fire cooldown is conservative.

The applicant needs to explain and clarify the phenomena, described by Note (g), in the application.

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

3-3 Provide references for the statements in Note-5 and Note-6 of Table 3.2.12 of the application.

The applicant stated that the cask seal shall withstand a temperature at 250°C (482°F) for at least 70 hours (Note-5) and that the seal shall withstand a temperature at 320°C (608°F) for at least 1 hour, followed by a temperature at 200°C (392°F) for at least 70 hours.

The applicant needs to provide references to be able to verify such statements in Note-5 and Note-6.

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

3-4 Provide the NCT maximum component temperatures, as shown in Table 3.1.1.B, for the F-32B fuel basket loaded with 32 FAs, 28 FAs, and 24 FAs.

The applicant described the loading patterns for the F-32B fuel basket in Holtec Report No. HI-2156468. The loading patterns are categorized as 32 FAs (1.687 kW/FA), 28 FAs (1.928 kW/FA, and 24 FAs (2.35 kW/FA), all with the maximum permitted total heat load of 54 kW. The applicant provided the maximum fuel cladding temperatures in Table 3.3.4 and the temperature contours of F-32B basket loaded with 32 FAs, 28 FAs, and 24 FAs, respectively, in Figures 6.3, 6.4 and 6.5 of the Holtec Report HI-2156468 and determined the heat load pattern of 32 FAs as the bounding case for the F-32B fuel basket.

To justify the bounding scenario of F-32B loaded with 32 FAs for the thermal and containment review, the applicant needs to provide the maximum component

temperatures (with all containment seals included), as shown in Table 3.1.1.B, for the F-32B basket loaded with 32 FAs, 28 FAs, and 24 FAs, respectively.

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

Observations

3-5 Clarify the temperatures of package components during the fire.

In Table 3.1.3 of the application and Table 6.8 of the Holtec Report No: HI-2156468, the temperatures of the fuel cladding, fuel basket, inner closure lid, and inner seal and test plug seal at the outer closure lid are identical, at the end of a 30-minute fire, to their initial temperatures (with no increase). The applicant needs to explain such phenomena that show no increase of the temperatures on these components at the end of an HAC fire.

The applicant needs to explain these phenomena in the thermal chapter of the application or correct the typos in Table 3.1.3 and Table 6.8 of the Holtec Report No: HI-2156468.

This information is required by the staff to determine compliance with 10 CFR 71.73.

3-6 Perform NCT thermal evaluations with 12-hour insolation values.

The applicant adopted the 24-hour insolation for NCT thermal evaluations due to the large mass of metal and the size of the package. However, to determine the “maximum” temperatures of the package with insolation, the applicant needs to directly apply the constant 12-hour insolation values of 800, 200, and 400 W/m^2 for the NCT thermal evaluations, with the personnel barrier and the principal features described in Section 3.3.1.4 of the application.

The applicant needs to use the NCT results, based on a 12-hour insolation, as the initial conditions of the HAC thermal evaluations.

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

3-7 Revise the heat-up temperature (390^{o}C) to a lower value to ensure that the cask cavity can be backfilled with helium in time for cooldown.

The applicant stated, in Section 3.3.6.1 “Vacuum Drying,” that the time required for the fuel to heat-up from an initial temperature of 100^{o}C (212^{o}F) to 390^{o}C (734^{o}F) is determined. If drying completion criteria are not met, then the cask cavity must be backfilled with helium for cooldown before it reaches the temperature limit of 400^{o}C (752^{o}F) for high burnup fuel, as specified in ISG-11 Rev. 3.

To reduce the risk in determining the time required for the fuel to heat-up from 100^{o}C beyond 390^{o}C, the applicant needs to revise the heat-up temperature from 390^{o}C to a lower heat-up temperature to both increase the safety margin and ensure that the cask cavity can be backfilled with helium in time for the cooldown.

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

Chapter 4 – Containment Evaluation

4-1 Clarify the inconsistency in the components of the containment system.

The containment system components listed in Section 4.1 of the application, e.g., cover plate bots, leak test port, test port plug/seal, spray cooling cap, orifice helical, spray cooling thread insert, etc., are not consistent with the containment system components described in Section 4.1.1. The applicant needs to clarify this inconsistency to ensure that the entire containment boundary is exactly defined.

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

4-2 Clarify whether the entire containment boundary will be leakage-rate tested during the fabrication process and the maintenance of the package.

The applicant listed, in Table 8.1.2, all components needed for fabrication leakage rate test and maintenance leakage rate test. To ensure that none of the containment components will be missed in the test, the applicant needs to add statements in the containment chapter that the entire containment boundary, including base material, welds, seals, closures, valves, or other boundary elements, will be leakage-rate tested during the fabrication process, in accordance with ANSI N14.5.

This information is required to determine compliance with 10 CFR 71.51.

4-3 Provide calculations of the surface area of the typical thirteen PWR fuel assemblies.

The applicant stated, in Section 4.5.1 and Table 4.5.4 of the application, that a total surface area of 4.41×10^6 cm^2 of the contaminated solids is assumed and used in the calculations of the surface activity of the expected waste to determine the allowable leakage rates when loaded with NWFB-1 and this “assumed” area is greater than the surface area of thirteen typical PWR fuel assemblies. The applicant needs to provide the calculations of the surface area for review.

This information is required to determine compliance with 10 CFR 71.43(f) and 71.51.

Observations

4-4 Clarify the test procedures of the leakage rate tests written and approved by an ASNT certification Level III specialist/examiner.

The applicant stated in Section 8.1.4 that the leakage rate test on the package containment system shall be performed per written and approved procedures in accordance with the requirements of Chapter 7 and the requirements of ANSI N14.5, 1997. The applicant needs to clarify, and add the statements in the application, that an American Society for Nondestructive Testing (ASNT) certification Level III specialist/examiner is required for approval of the leak testing procedures.

This information is required to determine compliance with 10 CFR 71.51.

4-5 Clarify the criteria used for the pre-shipment leakage rate test for the containment system, particularly for the vent/drain port brushing/plug seals.

The applicant described the test methods for the pre-shipment leakage rate test, as shown in Table 8.1.2 and ANSI N14.5 Appendix A:

(1) the gas filled envelope method (A.5.4, nominal test sensitivity of 10^{-8} ref-cm^3/sec) is used for the HI-STAR package loaded with the fuel assemblies.
(2) the gas pressure drop method (A.5.1, nominal test sensitivity of 10^{-5} ref-cm^3/sec) or the gas pressure rise method (A.5.2, normal test sensitivity of 10^{-5} ref-cm^3/sec) is used for the package loaded with the non-fuel waste (NFW) contents,
(3) the alternative test method (no detected leakage, test sensitivity of at least 10^{-3} ref-cm^3/sec) for the package loaded with the fuel assemblies or the NFW contents, under the conditions that the gasket is prequalified and reusable.

The applicant needs to explain why the alternative test method, #3 above, is not applicable to the vent/drain port seals (Table 8.1.2) and if this indicates that the gaskets used at the vent port and the drain port are not allowed to be pre-qualified or reusable.

This information is required to determine compliance with 10 CFR 71.43(f) and 71.51.

Chapter 5 – Shielding Evaluation

5-1 Provide validation analyses for SAS2H and ORIGEN-S code for the purpose of source term calculations for UO_2 and MOX fuel with burnup up to 70 GWd/MTU.

The design basis fuel burnup for the HI-STAR 80 package is 70 GWd/MTU, for both UO_2 fuel and MOX fuel. The applicant calculated the source terms for the design basis fuels with the SAS2H computer code. On page 5.0-1 of the application, the applicant states: "The source terms for the design basis fuels were calculated with the SAS2H and ORIGEN-S sequences from the SCALE 5.1 systems." However, from the references provided in the application for these two codes, the NRC staff was unable to find the validation information for these two code versions for burnup up to 70 GWd/MTU for UO_2 and MOX fuels.

This information is required to determine compliance with 10 CFR 71.47(b), 71.51(a)(1) and 71.51(a)(2).

5-2 Provide a detailed description of the method used to model the non-fuel waste basket (NFWB) contents.

The staff did not find that there was enough information to determine that the NFWB model was sufficient for demonstrating regulatory dose rate limits are met. For the staff to be able to evaluate this content, the applicant needs to provide the following:

a) The applicant needs to include an explicit description of the allowable source. The description should describe either a list of the maximum activity of the allowable nuclides or break this down into allowable energy and particle per second per volume.

b) Since the applicant did not use a bounding point or line source model, justification for the assumed amount of self-shielding should be explicitly addressed. This needs to include justification for the material, density and geometry used in the evaluation.

The credited minimum amount of self-shielding material must be required by the CoC either directly or by reference.

c) The applicant needs to include a discussion of source distribution within the waste. The staff did not find this in the current application. The application has a specific activity limit, however it is not clear how the applicant prevents highly non-uniform sources from being shipped.

d) The applicant needs to discuss the modeling of the cartridge container and any other components associated with the NFWB content. The applicant needs to discuss which components are included in the shielding model and discuss if they are credited for either a shielding or shoring function, or both.

This information is required to determine compliance with 10 CFR 71.47(b), 71.51(a)(1) and 71.51(a)(2).

Chapter 6 – Criticality Evaluation

6-1 Provide information to demonstrate that fresh UO_2 fuel with an enrichment up to 5.0 wt% bounds MOX fuel with a large margin or provide criticality safety analyses for the MOX fuel package as necessary.

On page 6.2-4 of the application, the applicant states: "*It is well understood that fresh UO_2 fuel with an enrichment up to 5.0 wt% bounds MOX fuel with a large margin*." The applicant further references the "*Holtec International Report HI-951251, Safety Analysis Report HI-STAR 100 Cask System, USNRC Docket 71-9261, latest revision.*" However, the staff was unable to find this information in Revision 16 of this report. It is not clear either whether this assertion is valid for all types of MOX fuel or not. Based on NUREG-1617, there are significant differences in material composition for different types of MOX fuel and that will impact the criticality safety of the package. The applicant needs to provide information to demonstrate that fresh UO_2 fuel with an enrichment up to 5.0 wt% bounds MOX fuel with a large margin or provide criticality safety analyses for the MOX fuel package, as necessary.

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