Response to NRC Request for Supplemental Information
Holtec International
Docket No. 71-9367
HI-STAR 180D Transportation Package

1- GENERAL INFORMATION

NRC RAI 1-1

1-1 Provide the American National Standard Institute (ANSI) N14.5-2014 definition of leaktight on Page G-4 of the application.

On Page G-4 of G-9 of the application, the definition of leaktight does not match the definition of leaktight in ANSI N14.5-2014.

This information is needed to determine compliance with Title 10 of the Code of Federal Regulations 10 CFR 71.51(a)(1) and (2).

Holtec Response to RAI 1-1:

The definition of "Leaktight", in the Glossary and Notation section of the HI-STAR 180D Transport SAR, has been revised to reflect the definition of Leaktight in ANSI N14.5-2014. Furthermore, for the purposes of completeness, a note has been appended to the definition of Leaktight to reflect the ANSI N14.5-2014 definitions of "Reference Cubic Centimeter per Second" and "Reference Air Leakage Rate". All proposed changes are reflected in Revision 4.A of the HI-STAR 180D Transport SAR provided with this response.

NRC RAI 1-2

1-2 Remove the following two paragraphs from Chapters 7 and 8, respectively, of the application.

"The text matter and data presented in this chapter in bold font (or as otherwise noted) are an integral part of the Certificate of Compliance (CoC) of the package and cannot be altered without NRC's approval through a license amendment. Moreover, essential elements and criteria in Section 7.0 through Section 7.3, essential elements and criteria in Appendix 7.A and the whole of Appendix 7.D have been identified as conditions of the CoC."

"The text matter and data presented in this chapter in bold font (or as otherwise noted) are an integral part of the Certificate of Compliance (CoC) of the package and cannot be altered without NRC's approval through a license amendment. Moreover, essential elements of the acceptance tests In Section 8.1 and of the maintenance program in Section 8.2 have been identified as conditions of the CoC."

The above two paragraphs are inconsistent with Condition 6 of the CoC that states,
"In addition to the requirements of Subpart G of 10 CFR Part 71:

(a) The package shall be prepared for shipment and operated in accordance with Chapter 7 of the application.

(b) The package shall meet the acceptance tests and be maintained in accordance with Chapter 8 of the application."

Therefore, based on Condition 6 of the CoC, any changes to Chapters 7 or 8 necessitate NRC's approval.

This information is needed to determine compliance with 10 CFR 71 Subpart G and Condition 6 of the CoC.

Holtec Response to RAI 1-2:

The statements noted by NRC staff to be removed from Chapters 7 and 8 have been removed. In addition, bold text associated with these statements is no longer used and other markings associated with these statements have been removed as well. All proposed changes are reflected in Revision 4.A of the HI-STAR 180D Transport SAR provided with this response.

2- STRUCTURAL EVALUATION

NRC RAI 2-1

2-1 Clarify the set pressure of the neutron shielding pressure relief devices in the licensing drawings.

Holtec Licensing Drawing 8545, "HI-STAR 180D Cask," contains Note 16 which states the maximum set pressure of the neutron shielding pressure relief devices is 35 psig. Note 16 describes that the set pressures of the devices will be lower if needed to avoid overstressing neutron shielding cover plates.

Note 16 of the drawing provides no indication of how the lower set pressures would be determined. Calculation 25 of Structural Calculation Package HI-2125252, Rev. 10 and Table 2.1.1 of the application show that several neutron shielding cavities would be overstressed if pressures where allowed to reach 35 psig. The drawing note should more specifically identify the set pressures for the neutron shielding pressure relief devices.

This information is needed to determine compliance with 10 CFR 71.51(a).

Holtec Response to RAI 2-1:

Pressure limits for cask cavities containing neutron shielding have been removed from Table 2.1.1 in the HI-STAR 180D Transport SAR. Flag Note 16 on Holtec Licensing Drawing 8545, "HI-STAR 180D Cask" has been updated to state clearly each neutron shielding location and the maximum allowable pressure relief setpoint. In addition, "Optional" notes have been removed where present from Item Balloons indicating neutron cavity pressure relief locations; Cavity pressure relief features are NITS but not

optional. All proposed changes are reflected in Revision 4.A of the HI-STAR 180D Transport SAR ad associated drawing package provided with this response.

NRC RAI 2-2

2-2 Regarding the impact limiter material properties:

- Revise Section 8.1.5.2 to identify the minimum critical properties of the impact limiter material, as defined in Table 2.2.10 of the application. Otherwise, provide the pertinent drawing (Drawing 8552 per Table 1.5.1 of the application), which identifies all the critical properties of the impact limiter, as defined in Table 2.2.10 of the application.

- Revise Section 8.1.5.2 of the application to identify the standardized method to be followed for characterizing the crush strength of the impact limiter material, and clarify that the minimum critical characteristics, as listed in Table 2.2.10 of the application, incorporate the uncertainties and errors associated with the standardized method.

- Provide reference 2.2.11 in justification of the minimum critical characteristics of the impact limiter material, as defined in Table 2.2.10 of the application.

The minimum critical properties of the impact limiter material are not identified in Chapter 8, which is identified as CoC condition 6(b). Per the application, critical characteristics of a material are those attributes that have been identified, in the associated material specification, as necessary to render the material's intended safety function.

The staff notes that the method for obtaining these minimum critical properties is not defined, and that the application is unclear on whether the uncertainties/errors of the characterization method are adequately accounted in the minimum critical properties of the impact limiter. The test results in reference 2.2.11 would serve to provide a basis for these properties and the associated uncertainties.

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

Holtec Response to RAI 2-2:

The critical characteristic of impact limiter crush material is its crush strength over the operating temperature range. It is noted in SAR Paragraph 8.1.5.2 that the impact limiter crush material crush strength ranges are specified in the drawing package. The temperature limit range has been added in SAR Table 3.2.10. SAR Table 2.2.10 has been updated for completeness.

The sample crush material tests (see reference [2.2.11] and additional data provided with this RAI response) are performed in accordance with ASTM D7336 ("Standard Test Method for Static Energy Absorption Properties of Honeycomb Sandwich Core Materials"). Similar standardized test methods shall be used for the procured crush materials for HI-STAR 180D impact limiters. This is clarified in SAR Paragraph 8.1.5.2.

As noted in Subparagraph 2.2.1.1.5 of SAR, the ranges of crush strengths provided in Drawing 8552 [**Withheld in Accordance with 10 CFR 2.390**] to account for uncertainties and

variations in critical properties with manufacturing, characterization methods and temperature. The supporting analyses performed in HI-2125251 and documented in Section 2.7 of SAR consider the maximum crush strength values to predict maximum decelerations and minimum crush strength values to predict maximum crush depth (see Table 2.7.3 of SAR). It is required (via Purchase Specification / Purchase Order) that the vendor supplying the crush material ensure that the specified ranges are satisfied while accounting for uncertainties and variations in critical properties with manufacturing, characterization methods and temperature. This is clarified in SAR Paragraph 8.1.5.2.

All proposed changes are reflected in Revision 4.A of the HI-STAR 180D Transport SAR provided with this response.

NRC RAI 2-3

2-3 Justify the applicability of the mechanical properties in Table G.1 of Holtec Report No. HI-2125251, Revision 8 (dated March 3, 2019) to the ASTM B29 lead grade/composition used in the transportation package

The finite element analyses of the package do not support that the assumed mechanical properties for the lead material are applicable to the specific lead grade used in the transportation package, as defined in Drawing 8545, Revision 7. These properties were obtained from a different reference than the one cited in Table 2.2.11 of the application.

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

Holtec Response to RAI 2-3:

It is acknowledged that the mechanical properties in Table G.1 of HI-2125251 are different from those provided in Table 2.2.11 for ASTM B29 Lead. The reason for not using the interpolated temperature dependent values from Table 2.2.11 is the unavailable data over a large temperature range (149°C to 316°C). In addition, the use of the mechanical properties listed in Table G.1 leads to conservative results for Lead slump. The yield strength and the elastic modulus per Table G.1 at 193°C are 190 psi and 1.82E6 psi, respectively, whereas the yield strength and elastic modulus from Table 2.2.11 of SAR at 193°C (linearly interpolated) are 285 psi and 1.80E6 psi. The elastic modulus is comparable whereas the yield strength value used in the analysis is significantly lower leading to more plastic deformation (slump) of Lead.

Therefore, the use of mechanical properties of Lead from the cited reference in Appendix G of HI-2125251 is conservative and results in greater deformations in Lead.

NRC RAI 2-4

2-4 Reconcile the property values for Holtite-B, as listed in Table 8.1.1 of the application, with those listed in the Holtite B Sourcebook.

The property values for Holtite B in Table 8.1.11 of the application (minimum bulk density, minimum hydrogen density) are different than those listed in Table 1.2 of the Holtite B Sourcebook (Document No. HI-2167314, Revision 5). As these are

requirements per CoC condition 6(b), it is important that the minimum values and associated tolerances be clearly defined.

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

Holtec Response to RAI 2-4:

The property values for Holtite-B in Table 8.1.11 of the application [3] are supported by the Sourcebook Tables 2.5 and 2.6 [1]. [

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Per Section 8.1.5.3 of the SAR document, each manufactured lot of Holtite-B neutron shield material is tested to verify the Boron Carbide content, Hydrogen density and Holtite-B material density meet the requirements in Table 8.1.11 of Reference 3.

References

[1] “Holtite-B Sourcebook”, Holtec Report HI-2167314, Revision 5.

[2] “Holtite-B Application Report for HI-STAR 180D”, Holtec Report HI-2177786, Revision 0.

[3] “Safety Analysis Report on the HI-STAR 180D Package”, Holtec Report HI-2125175, Revision 4

NRC RAI 2-5

2-5 Justify the removal of the visual inspection requirement for the representative friction stir weldment specimen from condition 6(b) in the revised CoC.

The requirement for visual inspection defined in the prior CoC, was removed without a justification.

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

Holtec Response to RAI 2-5:

CoC No. 9367 Revision 1 was previously issued to correctly restate the requirement already present in HI-STAR 180D Transport SAR Revision 3, Paragraph 8.1.5.4. The NRC Staff may refer to the NRC's SER for CoC Revision 1 for details of the event. This LAR (LAR 9367-2) corrects the typographical error in the application as reflected in HI-STAR 180D Transport SAR Revision 4 Paragraph 8.1.5.4 (i.e. the reference to ASME Code has been corrected to be NG 5362). Therefore, while the requirement no longer appears in Condition 6(b) of the CoC, it has, in effect, not been deleted from the proposed CoC. Instead, the requirement is now correctly stated in SAR Paragraph 8.1.5.4 which is part of the CoC and as was originally intended in Revision 3 of the SAR.

NRC RAI 2-6

2-6 Clarify the intent of the reflooding action described in Section 2.6.1.3.5 of the application, "Re-flood Event."

Section 2.6.1.3.5 was revised to discuss and reference analyses to demonstrate the integrity of fuel rod cladding inside the HI-STAR 180D cask during a reflood event. The discussion and referenced analyses do not specifically refer to the packaging unloading operations discussed in Section 7.2 of the application. Therefore, it is unclear as to whether reflooding during loading operations is considered in the application.

The information is needed to determine compliance with 10 CFR 71 .33(b)(3).

Holtec Response to RAI 2-6:

Per Table 1.4.1 of SAR, cask reflood is an unloading operation and is not considered to occur prior to cask transport. Cask reflood analysis is also not required for licensing of transportation packages per NUREG-1617, Regulatory Guide 7.9, ISG-11, ISG-19 and ISG-8. This is performed as a defense-in-depth analysis to support the multi-layered approach for safe transport of high burnup fuel as described in Chapter 1 of SAR and summarized in SAR Table 1.4.1.

NRC RAI 2-7

2-7 If a reflooding action may occur prior to transport (in response to RAI 2-6), justify that reflooding will not result in adverse changes to undamaged fuel contents

The consequences of reflooding to fuel material exposed to water and steam does not appear to be addressed in the application. More specifically, the application should address the potential interaction of water and steam with fuel material through non-gross ruptures in undamaged fuel (i.e., hairline cracks and pinholes).

The staff further notes that the application does not address potential changes to the cladding mechanical properties as a result of reflooding. Therefore, if reflooding of the contents may occur prior to transport, the impacts to the assumed chemical and physical form of the contents should be addressed.

The information is needed to determine compliance with 10 CFR 71.33(b)(3).

Holtec Response to RAI 2-7:

As explained in the response to RAI 2-6, cask reflood is an unloading operation and is not considered to occur prior to cask transport. Cask reflood analysis is performed as a defense-in-depth analysis to support the multi-layered approach for safe transport of high burnup fuel as described in Chapter 1 of SAR and summarized in SAR Table 1.4.1.

NRC RAI 2-8

2-8 If a reflooding action may occur prior to transport (in response to RAI 2-6), regarding the stress analyses of fuel rod cladding during cask cavity reflooding operations (Document HI-2146017, Revision 2, dated August 21, 2018):

- Provide a basis for the assumed rod internal pressure and the applicability to the allowable fuel contents of the transportation package.
- Provide a basis for the assumed mechanical properties of the cladding, and its applicability to the alloys and maximum average burnup in the allowable contents of the package.
- Describe experimental evidence or testing conducted in support of the stress analyses of the fuel rod cladding during reflooding operations.

The application includes a stress analysis of fuel rod cladding during cask cavity reflooding operations (Document HI-2146017, Revision 2, dated August 21, 2018). The basis for the assumed rod internal pressure is not provided in the analyses, nor a justification on whether the assumed pressure applies only to standard rods or also to integral fuel burnable absorber rods.

Further, the analyses do not provide a basis for the assumed mechanical properties of the cladding, and its applicability to the alloys and maximum average burnup in the allowable fuel contents (i.e., maximum assembly average burnup up to 55 GWd/MTU).

In addition, the analyses do not appear to be benchmarked or validated by any experimental data. Therefore, the conclusion that the classic shell theory solution or a

finite element analyses are adequate approaches for assessing fuel rod stresses does not appear to be validated.

The information is needed to determine compliance with 10 CFR 71.33(b)(3).

Holtec Response to RAI 2-8:

As explained in the response to RAI 2-6, cask reflood is an unloading operation and is not considered to occur prior to cask transport. Cask reflood analysis is performed as a defense-in-depth analysis to support the multi-layered approach for safe transport of high burnup fuel described in Chapter 1 of SAR and summarized in Table 1.4.1.

The fuel rod internal pressure of 2,100 psi used in the analysis is a conservative upper bound value based on Reference 1 below, and it also exceeds the design basis value in SAR Table 2.11.3. In addition, per Figure 2-1 of Reference 2 below, the maximum End-of-Life (EOL) rod internal pressure at 25°C is less than 5.0 MPa (725 psi) for burnups as high as 68 GWD/TU. Per the ideal gas law, the equivalent pressure at 400°C (conservatively bounding temperature per SAR Chapter 3) is only 11.3 MPa (1640 psi). The analyzed pressure is bounding for standard rods and also for rods with integral burnable absorbers (IBAs) per Reference 3. Rods with integral fuel burnable absorbers (IFBAs) are not considered in this application.

The mechanical properties of Zircaloy fuel cladding at high burnup, as it pertains to the HI-STAR 180D transport package, are discussed and presented in Section 2.11 of the SAR. In particular, Section 2.11 of the SAR states:

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Withheld in Accordance with 10 CFR 2.390

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The stress analysis of the fuel rod cladding during a cask cavity reflooding (unloading operation) in HI-2146017 uses the same minimum cladding thickness as considered in SAR Section 2.11 (see SAR Table 2.11.3), which accounts for material thinning due to in-reactor oxidation at high burnup. Meanwhile, the yield strength of the Zircaloy cladding material used in HI-2146017 is conservatively input as 50,500 psi at 400°C, which is roughly 35% less than the above value from SAR Section 2.11 (which is also at 400°C). The elastic modulus (1.040×10^7 psi) used in HI-2146017 is slightly greater than the above value from SAR Section 2.11. The combination of a significantly lower yield strength and a slightly higher elastic modulus means that the fuel rod model analyzed in HI-2146017 is even more conservative than the one presented in SAR Section 2.11, since it has a lower strain energy density at the material yield point (i.e., it is more prone to inelastic strains).

In spite of these conservatisms, and the other conservatisms mentioned in Sections 5.2, 5.3 and 5.5 of Calculation 5 of HI-2146017, the calculated stresses in the fuel rod cladding due to the cask cavity reflooding remain completely elastic with no permanent deformation (i.e., no inelastic strain). Therefore, the fuel rods will not breach as a result of a cask cavity reflood event.

Lastly, it is acknowledged that the analyses performed in Calculation 5 of HI-2146017 are not validated or benchmarked by experimental data. However, based on the abundance of conservatism associated with the analysis model, the good agreement between the results from two independent numerical solutions, and the substantial safety margin against yielding of the material, Holtec does not believe that an experimental validation is required. It is further noted that the same finite element analysis methodology was used previously by Holtec to perform fuel rod quenching analyses in USNRC Docket Nos. 72-1014 and 72-1032 for the HI-STORM 100 and HI-STORM FW Systems, respectively.

Reference 1: PVP2004-2804, Spent Nuclear Fuel Structural Response When Subjected to an End Impact Accident, PVP-Vol 483, Transportation, Storage and Disposal of Radioactive Materials-2004

Reference 2: Electric Power Research Institute, Spent Fuel Transportation Applications - Assessment of Cladding Performance, A Synthesis Report, December 2007

Reference 3: NUREG/CR-6760, “Study of the Effect of Integral Burnable Absorbers for PWR Burnup Credit” Oak Ridge National Laboratory, U.S. NRC, March 2002

NRC RAI 2-9

2-9 Provide justification for classifying the Friction Stir Welds (FSW) along the length of the exterior corners of HI-STAR 180D fuel baskets as full penetration corner welds.

Appendix 17B, the fuel basket weld calculation, of Holtec Report No. HI-2125252, “Calculation Package for the HI-STAR 180D Transportation Cask System,” analyzes FSWs that are designated Important-to-Safety. This calculation uses a weld quality factor taken from Table NG-3352-1 of the ASME Boiler & Pressure Vessel Code, Section III, Subsection NG. As stated in the calculation, this weld quality factor is associated with Type III full penetration welded joints. However, these FSWs are not full penetration welds. As noted by the applicant in the report, “Summary of Proposed Changes HI-STAR 180D Transport LAR 9367-2, Revision 0,” and Licensing Drawing 8553, these FSWs have a weld size less than the basket panel fitness. Further justification is needed for classifying the welds as full penetration welds and the use of the associated weld quality factor.

This information is needed to satisfy the requirements of 10 CFR 71.31.

Holtec Response to RAI 2-9:

The fuel basket weld evaluation in Appendix 17B of HI-2125252 has been revised to reduce the weld quality factor from 0.5 (for full penetration welds with visual examination) to 0.35 (for single groove welds with visual examination) per Table NG-3352-1 of the ASME Boiler & Pressure Vessel Code, Section III, Subsection NG, 2007. It is noted that the calculation is conservatively performed: a) as a static analysis using a bounding peak deceleration from drop analysis; b) using the minimum strength of weld material as 80% of the base material MGV; c) using the minimum weld penetration depth of 12.7 mm; and d) using a conservatively bounding temperature for basket corner welds.

3- THERMAL EVALUATION

NRC RAI 3-1

3-1 Clarify that the application's changes in the proposed gaps were incorporated in the thermal normal conditions of transport and hypothetical accident conditions models and that the component temperatures reported in Chapter 3 and thermal calculation HI-2125241 reflect the updated gaps.

The Statement of Changes in the application mention that gaps and differential thermal expansions were revised (DI06, DI15, PC-9). Gap dimensions can impact thermal results, but it was not clear whether the reported results in Chapter 3 and calculation package reflect the gap changes. If the newly proposed gaps were not incorporated in the thermal models, then updated results should be provided for the review.

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

Holtec Response to RAI 3-1:

HI-STAR 180D thermal model does not include gaps in Holtite pockets since they have no significant impact on the computed temperatures and pressure. Heat is transferred primarily through the metal around the Holtite regions. For example, heat transferred through the Holtite pockets in the cask MSC is approximately 7% of the total cask heat. Therefore, any gaps in the Holtite regions will have a second order effect on the calculated temperatures and pressure values. Considering that the margins to temperature limits are more than 50^{o}F, there will be no change in the safety conclusions. This clarification was presented in Item 16, Section 2.0 of Holtec report HI-2125241 Rev. 5.

NRC RAI 3-2

3-2 Discuss the impact of the Holtite-B decomposition by-products on the package's thermal performance.

Clarify that the decomposition by-products of Holtite-B (mentioned in DI-11 of Summary of Changes) does not impact package performance, including generation of flammable decomposition by-products during NCT and HAC and the potential for additional thermal input due to combustion during the thermal hypothetical accident condition.

This information is needed to determine compliance with 10 CFR 71.43(d).

Holtec Response to RAI 3-2:

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Withheld in Accordance with 10 CFR 2.390

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NRC RAI 3-3

3-3 Provide the decay heat axial profiles (chart or table) for the actual decay heat profile (current amendment) and the profile based on the linear-dependent burn-up.

DI13 mentions a change in the decay heat axial profile in HI-2125241 Revision 5 thermal calculation but there was little description provided in Section 7.8.2, "Relationship between the burn up profile and the distribution of the decay heat".
This is relevant considering that item 11 (bottom of page in Chapter 3) states " ... the overall package heat transfer through the top end of the package is a fraction of that heat transfer through the entire package."

This information is needed to determine compliance with 10 CFR 71.33 and 71.43(f).

Holtec Response to RAI 3-3:

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Withheld in Accordance with 10 CFR 2.390

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NRC RAI 3-4

3-4 Clarify that the gap associated with the attachment of the finned enhanced surface was considered in the thermal model presented in Appendix F of the thermal calculation HI-2125241.

The results from Appendix F indicate that the fins result in a reduced surface temperature, compared to a bare surface. However, it was not clear that the gap that formed with the attachment of the finned surface was considered.

If not modeled, the size of a gap should be incorporated in the thermal models because this would impact the results.

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

Holtec Response to RAI 3-4:

The fins on the cask external surface are machined directly from the cask MSC. Holtec drawing 8545, presented in section 1.5 of the SAR, also shows the finned surface is integral to the cask MSC, i.e. it is a contiguous metal structure. Therefore, there is no gap between the fins and the cask MSC. For the HI-STAR 180D dual-purpose cask, the fins are designed to enhance heat transfer from the cask in vertical orientation, which is the orientation during long-term storage. When the cask is in horizontal orientation during transport, the effect of fins on the heat transfer from the cask is negligible. This is confirmed by the evaluations presented in Appendix F of HI-2125241 Rev. 5. The finned surface temperature is slightly lower than the bare surface since the heat transfer by natural convection is better, albeit slightly, as compared to the bare surface.

NRC RAI 3-5

3-5 Clarify that the enhanced Holtite-B with a new composition does not result in changes to the thermal-related package performance, including density, specific heat, thermal conductivity, maximum and minimum allowable temperatures, and thermal/radiolytic decomposition (e.g., flammable gap generation).

Changes in material composition often result in property changes and corresponding performance changes, but there was no justification to demonstrate there would be no changes. This is especially relevant considering the Holtite-B temperature during normal conditions of transport is slightly below its allowable temperature.

This information is needed to determine compliance with 10 CFR 71.33 and 71.43(d).

Holtec Response to RAI 3-5:

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Withheld in Accordance with 10 CFR 2.390

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NRC RAI 3-6

3-6 Clarify how the thermal models used to calculate Time-to-Boil time limits would be demonstrated to be the same or consistent with the models used in the safety analyses.

Page 7.0-2 of the application mentions that FLUENT 3D models "consistent" with the application may be used to determine Time-to-Boil time limits. However, no criteria were presented to demonstrate that models utilized are the same or consistent with the models used in the safety analyses. One criterion of the demonstration would be to benchmark the model with the results presented in Table 3.3.6.

This information is needed to determine compliance with 10 CFR 71.35 and 71.43(d).

Holtec Response to RAI 3-6:

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Withheld in Accordance with 10 CFR 2.390

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4- CONTAINMENT EVALUATION

NRC RAI 4-1

4-1 Provide justification for the temperature limits for the Technetics seal design with a silver jacket material and update Chapter 3 of the application to reflect any changes in seal temperature limits. In addition, clarify if there are any chemical, galvanic, or other reactions due to the Technetics seal jacket material change.

Proposed change DI 11 refers to a seal design featuring a silver jacket material, instead of aluminum, for the HI-STAR 180D Technetics seals. For the staff to evaluate this type of change, a justification is necessary for the staff to verify any change in seal temperature limit.

Material compatibility is necessary to ensure there are no significant chemical, galvanic, or other reactions among the packaging components, or between the packaging components and the packaging contents.

This information is needed to determine compliance with 10 CFR 71.43(d), 71.51(a)(1) and (2).

Holtec Response to RAI 4-1:

Table 3.2.12 of the HI-STAR 180D Transport SAR has been revised to identify the temperature limits and durability of the seals for various lengths of time as would be required for temperatures attained during normal, off-normal, and accident conditions that may occur during transport options. The proposed changes are reflected in Revision 4A of the HI-STAR 180D Transport SAR provided with this response. These temperature limits are defined by the seal manufacturers based on tests and analysis of the various seal designs. The most limiting conditions of time and temperature are utilized in the Table. Technetics Group Letter to Savit Sinha of Holtec dated September 5th, 2019 lays out the temperature limits and is included as an attachment to the RAI response. The seal temperature limits listed in the revised Table 3.2.12 are well in excess of the seal temperatures calculated for normal, off-normal, and accident conditions given in Tables 3.1.1 and 3.1.3.

With respect to material compatibility, a change from aluminum to silver jacketed material results in a material combination that is less likely to corrode. Aluminum has a lower electrode potential than both silver and stainless steel and would be more likely to corrode due to a galvanic reaction. Silver and the stainless-steel surfaces that it is in contact with have electrode potentials that are very close such that galvanic corrosion is not a concern. Silver is also less likely to corrode than aluminum in the spent fuel pool and atmospheric environments. The seals that form the containment boundary are not subject to significant amounts of corrosive materials as the inner surface is in contact with inert helium and the outer surface is in contact with a closed environment that is protected from atmospheric products by the outer seal used to facilitate the leakage test. Therefore, there are no materials concerns with substituting silver jacketed seals for aluminum jacketed seals.

5- SHIELDING EVALUATION

NRC RAI 5-1

5-1 Clarify the lead slump assumptions in the dose rate evaluation.

On page 5.1-3 of the application, the applicant states: “To model the lead slump as a result of the hypothetical accident conditions, the lead in the bottom lead shield is reduced in the radial direction by 6.35 cm, and in axial direction by 2 mm. These are conservative values since in reality no lead would be removed from the base plate.”

The applicant needs to include details on where the slump was applied to in the calculation of the external dose rate (side, top and bottom) and justify these assumptions are appropriate. For example, for a drop on the cask’s side, a reduction in the radial thickness of the radial shield on one side is conceivable and the reduction of lead shield would increase HAC dose rates in the radial direction. Therefore, this physical phenomenon should be applied to one side as it creates a streaming path at the bottom and dose rates are evaluated near this streaming path.

From the application, it appears that the applicant has chosen to reduce the radial thickness of the bottom plate, equally on either side. However, the staff does not have enough information to determine how this was done nor if it is conservative.

This information is needed to determine compliance with 10 CFR 71.51(a)(2).

Holtec Response to RAI 5-1:

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Withheld in Accordance with 10 CFR 2.390

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The discussion of the lead slump modeling is moved from Section 5.1 to Section 5.3. The discussion of the sensitivity study calculation is provided in Section 5.4 of the SAR, and more detail and results are provided in reference [5.4.6] (HI-2125175) of the SAR.

Figure 5-1 [**Withheld in Accordance with 10 CFR 2.390**]

Figure 5-2 [**Withheld in Accordance with 10 CFR 2.390**]

7- OPERATING PROCEDURES

NRC RAI 7-1

7-1 Clarify step 7.1.2.2.3 of the application to include torque requirements provided in Table 7.1.1 of the application.

Step 7.1.2.2.3 of the application describes that the containment boundary outer closure lid access port plug is fitted with a new seal and closed; however, it does not describe that torque requirements are provided in Table 7.1.1 of the application. See step 7.1.3.1.e of the application for comparison.

This information is needed to determine compliance with 10 CFR 71.43(c), 71.51(a)(1) and (2).

Holtec Response to RAI 7-1:

Step 7.1.2.2.3 of the HI-STAR 180D Transport SAR has been revised to include the torque requirement in Table 7.1.1. The proposed change is reflected in Revision 4.A of the HI-STAR 180D Transport SAR provided with this response.

8- ACCEPTANCE TESTS AND MAINTENANCE

NRC RAI 8-1

8-1 Clarify Sections 8.1.4 and 8.2.2 of the application to specify an American Society for Nondestructive Testing (ASNT) nondestructive testing (NDT) Level III in leak testing.

An ASNT NDT Level III specifically in leak testing, should write and approve the detailed leakage rate testing procedures for each package.

This information is needed to determine compliance with 10 CFR 71.51(a)(1) and (2).

Holtec Response to RAI 8-1:

Section 8.1.4 and Section 8.2.2 of the HI-STAR 180D Transport SAR have been revised to clearly state that “Leakage rate testing procedures shall be approved by an American Society for Nondestructive Testing (ASNT) Level III specialist in leak testing for the nondestructive method(s) of leak testing for which the procedures are written”. In addition, the edition of SNT-TC-1A in reference [8.1.2] has been revised from “December 1992” to “2006 (or subsequent revisions)”. The proposed changes are reflected in Revision 4.A of the HI-STAR 180D Transport SAR provided with this response.

NRC RAI 8-2

8-2 Provide justification for, or alternatively revise the factor of 1.86 in Note 1 of Table 8.1.1 of the application.

Based on Section B.15.13, "Example 13," of ANSI N14.5-2014, for 1.0×10^{-7} ref-cm^3/s, air, the equivalent helium leakage rate at the same reference conditions is 1.85×10^{-7} atm-cm^3/s, helium, rather than 1.86×10^{-7} atm-cm^3/s, helium.

This information is needed to determine compliance with 10 CFR 71.51(a)(1) and (2).

Holtec Response to RAI 8-2:

Note 1 of Table 8.1.1 of the HI-STAR 180D Transport SAR has been revised to reflect the correct conversion factor of 1.85 consistent with ANSI N14.5-2014. The proposed change is reflected in Revision 4.A of the HI-STAR 180D Transport SAR provided with this response.

OTHER ENHANCEMENTS:

Holtec XPC-1

Proposed Change and Justification:
The fuel basket maximum width dimensions as shown on fuel basket licensing drawing 8553R7 (Sht 2, Zone B8, and Sht 4, Zone B8) have been increased from the values presented in 8553R6 (Sht 2, Zone B8, and Sht 4, Zone B8) [**Withheld in Accordance with 10 CFR 2.390**]. The proposed change does not impact the Transport SAR, the safety case for the HI-STAR 180 Package, supporting calculation packages, or other supporting documents.

Safety Evaluation Justifications:
Structural: [**Withheld in Accordance with 10 CFR 2.390**]
Thermal: [**Withheld in Accordance with 10 CFR 2.390**]
Criticality: [**Withheld in Accordance with 10 CFR 2.390**]
Shielding: [**Withheld in Accordance with 10 CFR 2.390**]

Reasons for Proposed Change:
[**Withheld in Accordance with 10 CFR 2.390**]

Licensing Drawings: The revised basket width dimensions are specified in Licensing drawing 8553 Revision 7.

SAR Supporting Documents: None affected.

Holtec XPC-2

Proposed Change and Justification:
SAR Paragraph 8.1.5.3 has been revised to remove the statement requiring samples of Holtite to be maintained. As required by SAR Paragraph 8.1.5.3, all lots undergo testing to confirm that it meets the critical characteristics during manufacture. The testing and recording of test results are carried out in accordance with our QA program and test results for each manufactured lot if neutron shield material shall become part of the final quality documentation package.

Degradation of the material may result from long-term exposure to high temperatures or exposure to high fluence radiation, but not from just the passage of time. Any samples maintained for future reference will not reflect actual components conditions in a loaded cask, so that these samples would not be a valid proxy for material used in the cask. The materials in the cask are subject to confirmatory testing as part of the periodic shielding effectiveness test that is currently required in the SAR.

[

Withheld in Accordance with 10 CFR 2.390

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The proposed changes are reflected in Revision 4.A of the HI-STAR 180D Transport SAR provided with this response.

Reasons for Proposed Change: Maintenance of samples for each lot would require storage space and administrative oversight with no technical value to be gained.

Licensing Drawings: None affected.

SAR Supporting Documents: None affected.

ADDITIONAL MINOR CLARIFICATIONS TO THE APPLICATION:

1) SAR Table 8.1.4 “Tier System for Metamic-HT Production Coupon Testing” revised to enhance the explanation of the tier system and the use of the table. No technical changes have been made.
2) SAR Table 8.1.9 “Fracture Toughness Test Criteria: Containment System” revised Note 1 to allow the use of subsequent editions of ASTM E208-87a. Certain vendors can no longer certify to the 87a edition. NRC periodic reviews of Reg Guides 7.11 and 7.12 as recent as 2016 concluded that the 2006 and 2012 editions of ASTM E208-87a do not affect the implementation of these Reg Guides. Due to the well-established nature of ASTM E208, it is foreseen that future revisions of ASTM E208 will not have material impact on these Reg Guides or ultimately a safety impact on the HI-STAR 180D package.
3) SAR Table 8.1.11 “Properties of Holtite-B for Shielding Function” and Note 1 of Table 2.2.13 “Holtite-B Properties” have been revised with clarifications with respect to Copper Content. No commitments have changed.

The above additional minor clarifications are reflected in Revision 4.A of the HI-STAR 180D Transport SAR.