Request for Supplemental Information for HI-STAR 330 Transportation Cask
Certificate of Compliance No. 9397
Docket No. 71-9397
Revision 0

This request for supplemental information (RSI) identifies information needed by the staff in connection with its acceptance review of the Holtec International (the applicant) Model No. HI-STAR 330 transportation package.

Chapter 2: Structural Review

St-1: Provide center-of-gravity information for the Model No. HI-STAR 330 package for all potential package configurations.

Table 1.1.1 in the safety analysis report (SAR), HI-2210970, Revision 0, provides overall dimensions of the HI-STAR 330 transportation package, and SAR table 7.1.1 provides the weights for two package configurations and the maximum content weights. Drawing 12482, "HI-STAR 330 Type B/C Waste Transport Cask," Revision 5, indicates the center-of-gravity location of the empty containment cask outfitted with dose blocker plates. However, component weights and package center-of-gravity information have not been provided. This information is needed to confirm the bounding structural analyses for various transportation package configurations.

This information is required to satisfy the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) 71.31(a)(1), 71.31(a)(2), 71.33(a)(5), and 71.35(a).

Holtec Response: The following changes are made to Holtec drawing 12482:

1) The CG on drawing 12482 (Sheet 3, Zone B2) is rounded to 54" (for simplification) and Flag Note 12 is added: THE CENTER-OF-GRAVITY (CG) SHOWN IS THE APPROXIMATE VALUE FOR A LOADED CASK WITH ALL IMPACT LIMITERS INSTALLED. THE CG DOES NOT VARY SIGNIFICANTLY WITH WASTE PACKAGE TYPE. THE WEIGHT OF THE WASTE CONTENTS IS ASSUMED TO BE APPROXIMATELY EVENLY DISTRIBUTED WITH EACH LINER TANK.

It should be noted that the models used in the structural evaluations that rely upon the CG location (for example, CG over corner drop evaluations) determine the CG based on the model configuration, so they are not dependent upon the CG indicated on the drawing. The CG used in the analysis slightly differ from the drawing due to the content location within the liner tank cassette and the liner tank. The CG in the models is derived based on the actual content location and is aligned with the drop orientation.

St-2: Provide the following information in HI-2240470, Revision 0, of "Dimensional Limit Summary Report for the HI-STAR 330 Transport Cask":

a) lengths of the Closure Lid Bolt and Impact Absorber Strongback Attachment Bolt to table A-1

b) bolt length, thread specification, and minimum thread engagement length of Liner Tank Bolts to table A-2.

The information requested for the bolts is not indicated on the corresponding licensing drawings in the SAR and is needed in order to verify that the structural evaluations performed for them are accurate. The revision in the note for the Liner Tank Bolts is to provide alignment between the design documents and HI-2240470. Update and submit the documents as necessary.

This information is required to satisfy the requirements of 10 CFR 71.33(a)(5).

Holtec Response: The following changes are made to Holtec report HI-2240470 and Holtec drawing 12596:

1) The Closure Lid Bolt length **[Withheld per 10 CFR 2.390]** is added to Table A-1 of HI-2240470.

2) The Impact Absorber Strongback Attachment Bolt length **[Withheld per 10 CFR 2.390]** is added to Table A-1 of HI-2240470.

3) The Liner Tank Bolt length will vary with the liner tank configuration, as a longer bolt is needed for the thicker lid of the DL types. The Liner Tank bolts are addressed in the structural analysis (HI-2210998) for tensile and shear loading, which are not related to the bolt length. Therefore, no additional changes are needed to the drawings or reports.

4) Drawing 12596 (Sheet 2, Zone A8): In the parts list, the description for the Liner Tank Bolt is changed to **[Withheld per 10 CFR 2.390]** to bring the drawing into agreement with the thread specification assumption in the structural calculation package (HI-2210998). As this fully defines the necessary bolt characteristics, the redundant citing of the bolt size and specification is removed from Table A-2 of HI-2240470.

5) The minimum thread engagement length of the Liner Tank Bolts is **[Withheld per 10 CFR 2.390]**, as specified in Flag Note 6 of Drawing 12596. No additional changes are needed to the drawings or reports.

Observations

The following questions are the staff's Observations in connection with its acceptance review of the applicant Model No. HI-STAR 330 transportation package.

<u>Chapter 2: Structural Review:</u>

Obs-St-1: Clarify which version(s) of the finite element program, LS-DYNA, are being employed to support in this application.

The following versions of the LS-DYNA finite element program were noted throughout the application documents:

a) Version R10.1.0 dated 2018 cited in the report HI-2210251, Revision 1, "Benchmarking of Material Stress-Strain Curves in LS-DYNA,"
b) Version 971 dated 2006 cited as SAR Reference 2.6.1, and
c) Version 971 with no date cited in the report HI-2240059, Revision 0, "Drop Analysis of the HI-STAR 330 Transport Package."

Staff is concerned that the use of multiple versions of the program for structural analyses may produce inconsistent results. Update and submit the documents as necessary.

This information is required to satisfy the requirements of 10 CFR 71.41(a).

Holtec Response: It shall be noted that the LS-Dyna code versions used in support of this licensing effort are all validated under Holtec QA program. The program validation considered same dynamic problems solved using different versions of LS-Dyna 971 executable. The key results generated from different software versions have shown results that are in close agreement (~2%) as documented in LS-Dyna QA validation.

The QA validation therefore ensures that the results between different validated versions of the LS-Dyna code will yield consistent results.

a) The report HI-2210251, which considers material benchmarking, was initially developed for HI-STAR ATB-1T several years back and it uses Version R10.1.0 dated 2018. The benchmarking of the new crushable material, to be used for HI-STAR 330 cask, is documented in the revision to this report.

b) The SAR is updated to list the LS-Dyna versions used in this licensing effort.

c) The calculation package is revised to list the LS-Dyna version used for the drop analysis.

Obs-St-2: Clarify how a secondary impact from the package contents during a package drop is either addressed or mitigated for the existing drop analyses.

Subsection 1.2.2 of the SAR states that "segments are not stabilized in the liner tank cassette (LTC) and will move if the Liner Tank is upset." This statement raises concerns with staff that the package contents may be free to change locations during a free drop, which could cause a secondary impact to the containment and/or liner tank. This secondary impact effect would be amplified if the package was partially full with the contents free to shift to the various sides of the package during package drop events of different orientations.

This information is required to satisfy the requirements of 10 CFR 71.41(a), 71.71(c)(7), and 71.73(c)(1).

Holtec Response: Additional sensitivity analysis is performed to investigate the effect of discrete bodies (individual masses) as against a single block in the revised calculation HI-2240059 which addresses any secondary impacts from the contents.

Obs-St-3: Justify or reconcile the following apparent inconsistencies in the structural evaluations of HI-2210998, Revision 0, "Structural Calculation Package of HI-STAR 330 Transport Cask":

1. Calculation 2 - Structural Qualification of HI-STAR Baseplate, page 2-2: The value of an American Society of Mechanical Engineers (ASME) Level A allowable stress, defined as Sm_{as}, is determined to be 96,900 psi, however, the **[Withheld per 10 CFR 2.390]**.

   Holtec Response: This is corrected in the revised report to **[Withheld per 10 CFR 2.390]**.

2. Calculation 2 - Structural Qualification of HI-STAR Baseplate, section 2A.2 of appendix 2A: Compares Containment Baseplate weld stresses resulting from an ASME Level A event to allowable stresses taken from ASME subsection NF, table NF-3324.5(a)-1, however, the applicant has stated that the containment would be designed per ASME subsection NB.

   Holtec Response: It is correctly noted that the HS-330 containment must meet the stress limits from ASME Subsection NB. Since ASME subsection NB doesn't provide weld stress reduction factor directly, the stress allowable for weld is used from Subsection NF for convenience.

3. Calculation 4 - Liner Tank and Liner Tank Cassette Evaluation, page 4-2: The Liner Tank Cassette bounding temperature (for Normal Conditions of Transport (NCT)) is stated as **[Withheld per 10 CFR 2.390]**, however, SAR table 3.1.1 reports a temperature of **[Withheld per 10 CFR 2.390]** for the Liner Tank Cassette side plates.

   Holtec Response: It is correctly noted that the maximum service temp. of the LTC side plates is noted as **[Withheld per 10 CFR 2.390]** and that of the top and side plates is **[Withheld per 10 CFR 2.390]**. However, the average/bulk temperature of the LTC in its entirety is expected to be less than **[Withheld per 10 CFR 2.390]**. Nonetheless, the calculation is revised to consider the maximum temperatures from the Table 3.1.1 of the SAR.

4. Calculation 4 - Liner Tank and Liner Tank Cassette Evaluation, pages 4-11 and 4-13: The Liner Tank weld and bolt stresses resulting from NCT events are compared to Level D allowable stresses taken from ASME subsection NF, which are normally employed for hypothetical accident conditions (HAC). Also, include the citation to the specific section of the code that is the source of the allowable stress equations in the calculation.

   Holtec Response: As noted in Subsection 2.1.2.2 of the SAR, the liner tank and the components of the LTC serve only shielding function. In order for the liner tank and LTC components to perform their intended safety function during the critical drop loadings, it is necessary to demonstrate that there is no gross failure or separation of these components (see SAR Subsection 2.1.2.2 (iii)). For structural stability of key components of the liner tank and LTC as noted in the SAR, the ASME Level D stress limits are conservatively used to demonstrate their continued safety function. For others, the gross failure or buckling is used in order to ensure its safety function. The citation for specific allowable stress limit or acceptance limit will be added to the calculation.

5. Calculation 4 - Liner Tank and Liner Tank Cassette Evaluation, page 4-12: **[Withheld per 10 CFR 2.390]** fillet weld is being evaluated for structural adequacy. The weld throat size is defined to be **[Withheld per 10 CFR 2.390]**; however, this dimension appears to be the weld leg size.

   Holtec Response: The calculation is revised with the correct weld throat and area.

6. Calculation 8 - Fire Accident Pressure, page 8-2: Confirm the values chosen as inputs for pressure and temperature as they do not appear to match those published for the containment wall plates in SAR tables 3.1.3 and 3.1.2, respectively. Also, advise where the verification that Level D stress limits per ASME subsection NB are met by the containment structure for this HAC event is documented.

   Holtec Response: The supplement 8 of calculation HI-2210998 is revised to address this comment. Specific references are added to the supplement.

7. Calculation 9 - Closure Lid Bolts Preload and Containment Fatigue Evaluation, page 9-2: The net tensile area defined for the **[Withheld per 10 CFR 2.390]** Containment Lid Closure Bolt employed in the calculation appears to be low, as compared to values published in commercially available handbooks. This bolt area affects the determination of the required torque value.

Holtec Response: The net tensile area of the bolt in Calculation is updated from Mark's Handbook.

Obs-St-4: Verify the material properties appearing in SAR table 8.1.5, "Critical Material Characteristics for Non-Containment Waste Package Components," for the Liner Tank Cassette Corner Tubes, which list American Society for Testing and Materials (ASTM) A513 or A519 Grade 1026 SRA as the "Pre-Evaluated Material."

A review of the ASTM A513 and A519 standards indicate minimum Yield and ultimate material properties lower than those included in SAR table 8.1.5. It appears to staff that if the higher material property values are required for the design application, a different material may need to be specified.

This information is required to satisfy the requirements of 10 CFR 71.41(a).

Holtec Response: Holtec agrees that neither ASTM A513 nor ASTM A519 specify minimum material strength properties that meet or exceed those listed in SAR Table 8.1.5 for the Liner Tank Cassette Corner Tubes. However, these values are achievable with proper heat treatment of the material, and this heat-treated condition is readily available for manufacturing the Corner Tubes. Holtec's procurement process includes requirements for meeting and documenting these minimum strength values. To clarify this in the SAR, the following note (Note 7) is added to "Pre-Evaluated Material(s)" column in Table 8.1.5 for the Corner Tubes:

"The pre-evaluated material types for the cassette corner tubes are suitable for achieving the minimum required yield and ultimate material strengths. The purchase specification for these components shall include requirements for verification of these strength values through testing, in addition to meeting all other requirements of the ASTM specifications."

Obs-St-5: Justify the use of the following material properties in calculation 4 of HI-2210998, which evaluates the Liner Tank and Liner Tank Cassette structural design, versus the minimum values provided in flag notes of licensing drawing 12596, Revision 0, "Liner Tanks and Cassettes":

1. Page 4-2: A material for the Liner Tank and Liner Tank Cassette is chosen with the following properties at **[Withheld per 10 CFR 2.390]** (vs. flag note minimum properties at room temperature of **[Withheld per 10 CFR 2.390]**.
2. Page 4-13: A material for the Liner Tank Top Plate Bolts is chosen with the following properties at **[Withheld per 10 CFR 2.390]** (vs. flag note minimum properties (no temperature specified) of **[Withheld per 10 CFR 2.390]**.

3. Page 4-19: Material for the Liner Tank Cassette Corner Tubes is chosen with the following properties at **[Withheld per 10 CFR 2.390]** (vs. flag note minimum properties at room temperature of **[Withheld per 10 CFR 2.390]**.

It appears to staff that employing larger material strength values in the structural adequacy evaluations than those minimum values specified for the materials is a non-conservative design approach. Additionally, specifying the minimum material strength properties at room temperature (or not specifying the temperature associated with the properties) when the component assessment will be performed at an elevated temperature may amplify design non-conservatisms.

This information is required to satisfy the requirements of 10 CFR 71.41(a).

Holtec Response: The material properties listed for the Liner Tank components have been reviewed to fully align them with those used in Calculation 4 of HI-2210998, so that the design approach is not non-conservative. For consistency with Table 8.1.5 of the SAR, all material properties in the structural report are evaluated at a minimum temperature of **[Withheld per 10 CFR 2.390]**, which conservatively bounds all components temperatures. In addition, material properties specified in the Flag Notes of drawing 12596 are moved to Table 8.1.5 so that all structural properties can be found in a single location with additional notation for clarification. Specific changes are:

1) Flag Note 1 of drawing 12596 is changed to: SEE CHAPTER 8 OF SAR FOR CRITICAL CHARACTERISTICS OF MATERIALS FOR LINER TANKS (INCLUDING ADDITIONAL "MDL" PLATES ON SHEET 4, IF USED) AND CASSETTE TOP AND BOTTOM PLATES.

2) For consistency, the minimum yield and ultimate strengths for the liner tank materials listed in Table 8.1.5 are adjusted to match the ASME Section II minimums at **[Withheld per 10 CFR 2.390]** for the pre-evaluated material, which is SA-516 Grade 70. These values are used in Calculation 4 of HI-2210998, and the description on Page 4-2 of the material properties used for the Liner Tank and Liner Tank Cassette is changed accordingly.

3) Flag Note 6 of drawing 12596 is changed to: SEE CHAPTER 8 OF SAR FOR CRITICAL CHARACTERISTICS OF LINER TANK BOLT MATERIAL. THE NOMINAL THREAD ENGAGEMENT OF EACH BOLT SHALL BE ONE INCH OR GREATER.

4) A row is added to Table 8.1.5 for the liner tank bolts. A pre-evaluated material (SA-564 Grade 630 H1150) is included for the bolts, with corresponding ASME Section II minimum values at **[Withheld per 10 CFR 2.390]**. These values are used in Calculation 4 of HI-2210998, and the description on Page 4-13 of the material properties used for the Liner Tank Bolts is changed accordingly.

5) Flag Note 4 of drawing 12596 is changed to: SEE CHAPTER 8 OF SAR FOR CRITICAL CHARACTERISTICS OF THE CORNER TUBE MATERIAL. The minimum values listed in Table 8.1.5 at **[Withheld per 10 CFR 2.390]** are used in Calculation 4 of HI-2210998, and the description on Page 4-19 of the material properties used for the Corner Tubes is changed accordingly.

6) Also note: For consistency with the properties of stainless steel material used throughout Table 8.1.5, the minimum yield strength for the impact limiter strongback assembly and attachments is adjusted slightly.

In the course of reviewing Calculation 4 of HI-2210998, it was noted that material requirements for the OPTIONAL HELICAL INSERTS shown on drawing 12596 (Sheet 2, Zone D5) were not specified. To correct this, additional note 5 is added to drawing 12596: HELICAL THREAD INSERTS, IF USED, SHALL HAVE YIELD AND ULTIMATE STRENGTH PROPERTIES EQUAL TO OR GREATER THAN THE BASE MATERIAL.

Obs-St-6: Justify or reconcile the following apparent inconsistencies between the licensing drawing 12482, “HI-STAR 330 Type B/C Waste Transport Cask,” Revision 5 and the SAR content:

1. SAR sections 1.2.1.2 and 1.2.1.9 indicate that a unique nameplate will be placed on each HI-STAR 330 package that provides at least its maximum gross transport weight. However, the planned location of the nameplate on the package and what information it will include is not indicated on drawing 12482. The following items are recommended for inclusion on the nameplate per NUREG/CR 5502, “Engineering Drawings for 10 CFR Part 71 Package Approvals”: model number, serial number, gross weight and package identification number.

2. SAR section 2.3 indicates that the containment cask material is SA-517/A514, whereas drawing 12482 lists **[Withheld per 10 CFR 2.390]**.

3. SAR section 2.3 indicates that the dose blocker structure material is austenitic steel type 304, whereas drawing 12482 lists **[Withheld per 10 CFR 2.390]**.

4. SAR table 8.1.4 indicates the Material for the Containment Closure Lid to be SA-203 Grade E, however, drawing 12482 lists **[Withheld per 10 CFR 2.390]** as an alternative.

5. SAR table 8.1.4 indicates the Material for the Containment Closure Lid Bolts to be SA-564 Type 630 H1100, however, drawing 12482 lists the material to be **[Withheld per 10 CFR 2.390]**. Additionally, SAR table 8.1.4 indicates the Closure Lid Bolt diameter to be **[Withheld per 10 CFR 2.390]**, while the bolt diameter is omitted from drawing 12482.

Accurate material specifications are required to inform the technical analyses submitted in the application for this transportation package.

This information is required to satisfy the requirements of 10 CFR 71.85(c) and 10 CFR 71.33(a)(5).

Holtec Response: The following numbered responses correspond to Observations 1 through 5 of Obs-St-6.

1) Drawing 12482 is revised to add the location and information to be included on the cask’s nameplate.

2) The erroneous reference to **[Withheld per 10 CFR 2.390]** is removed from the first paragraph of Section 2.3 of the SAR. Reference to the specific material type is not necessary for the discussion in this Section of the SAR.

3) The erroneous reference to **[Withheld per 10 CFR 2.390]** is removed from the first paragraph of Section 2.3 of the SAR. Reference to the specific material type is not necessary for the discussion in this Section of the SAR. Note also that an erroneous statement of “as well as the closure lid outer plate” is also removed from this Section.

There is no separate dose blocker plate attached to the closure lid. Shielding is entirely provided by the thickness of the closure lid itself.

4) A note (Note 4) is added to the Closure Lid in Table 8.1.4, stating **[Withheld per 10 CFR 2.390]** may be used as an alternative material for the cask closure lid.”

5) The material for the Closure Lid Bolts in Table 8.1.4 is corrected to **[Withheld per 10 CFR 2.390]**. Note that the **[Withheld per 10 CFR 2.390]** thread designation in drawing 12482 (Sheet 3, Zone C6 implies that the bolt material diameter listed in Table 8.1.4 is approximately **[Withheld per 10 CFR 2.390]**, and the drawing and Table are therefore in agreement.

Obs-St-7: Provide the procurement, design, fabrication, welding, non-destructive examination and testing codes applicable for the important-to-safety (ITS) items of the liner tanks and liner tank cassettes on licensing drawing 12596, “Liner Tanks and Cassettes,” which is part of SAR section 1.3. Section 1.4 of the SAR indicates that this information is provided on the drawings provided in section 1.3 but is not apparent.

Per NUREG/CR-5502, it is recommended that the design, procurement, fabrication, welding, non-destructive examination and testing codes applicable for the ITS items be indicated on the drawings. Provide this information for the ITS items of the liner tanks and liner tanks cassettes, on the drawing or in the SAR, commensurate to that which is provided in SAR table 8.1.2.

This information is required to satisfy the requirements of 10 CFR 71.31(c).

Holtec Response: Table 8.1.2 is revised with the following information added

Component ID	Material Procurement	Component Design Acceptance Criteria	Stress and Deformation Analysis Criteria	Welding (Fabrication and Qualification)	Inspection	Testing
Liner Tanks	ASTM or ASME Code Section II	**[Withheld per 10 CFR 2.390]**	Not Applicable	ASME Code Section IX and Chapter 8 of this SAR	ASME Code Section V	Not Applicable
Liner Tank Cassettes	ASTM or ASME Code Section II	**[Withheld per 10 CFR 2.390]**	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Tertiary Container	ASTM or ASME Code Section II	**[Withheld per 10 CFR 2.390]**	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Obs-St-8: Provide the basis of the values of the true stress-strain flow curves for the upper- and lower-bound aluminum impact limiter materials, as presented in Appendix A of calculation report HI-2240059, Revision 0, “Drop Analysis of the HI-STAR 330 Transport Package,” which are employed in the LS-DYNA HAC event analyses. Also advise and document the temperature at which these values are being reported. Explain inconsistencies between SAR tables 2.2.5 and 8.1.5 and other submitted and referenced documents, as noted below.

The aluminum **[Withheld per 10 CFR 2.390]** impact limiter flow curves presented in Appendix A of report HI-2240059 indicate that the input parameters are taken from ASME BPVC Section II, Parts A and D, cited as reference A.2. The values for material yield strength, ultimate strength, and modulus of elasticity presented for the lower- and upper-bound do not consistently match those presented in the SAR table 2.2.5, “Mechanical Properties of Aluminum (Impact Absorbers),” which also cites ASME BPVC Section II, Parts A and D as its source for the properties presented; however the specific aluminum material for which the values are being reported is not identified.

Staff notes that ASME Section II Part A does not contain material specifications for aluminum, but ASME Section II Part B does. For ASTM B209 5083 specifically, elongation values (engineering strain/failure strains) are reported to be **[Withheld per 10 CFR 2.390]**, for plates that are between 2 inches and 8 inches thick, respectively. The true **[Withheld per 10 CFR 2.390]** by the applicant was determined based on an uncited area reduction value “q” in report HI-2240059, for both upper- and lower-bound aluminum material values. Moreover, SAR table 2.2.5 values for aluminum would not fit within the specifications of SAR table 8.1.5, as the maximum yield strength is **[Withheld per 10 CFR 2.390]** which the reported value **[Withheld per 10 CFR 2.390]** from table 2.2.5 would exceed. In addition, the minimum yield strength of aluminum used in LS-DYNA drop simulations is reported to be **[Withheld per 10 CFR 2.390]** which does not fall within the range of parameters in table 8.1.5. The licensing drawings indicate that impact limiters may be made of plates that are as thick as **[Withheld per 10 CFR 2.390]**, which is a value that is outside the bounds of the specification in ASME Section II Part B, thus material properties are unspecified for plates that exceed 8 inches in thickness.

Additionally, report HI-2210251, Revision 1, “Benchmarking of Material Stress-Strain Curves in LS-DYNA,” was updated and submitted to include material testing results of aluminum alloy ASTM B221 5083 (Ellcast 5), noted by the applicant as being intended for use in the HI-STAR 330 cask impact limiters; the values for material yield strength, ultimate strength, and modulus of elasticity intended for LS-DYNA input in Appendix A do not consistently match those presented in this report.

Furthermore, the value for reduction in area, defined as “q”, cited in HI-2240059 is much larger than that presented in the material testing results of HI-2210251. As this value is employed to determine the fracture strain of the material, employing a larger value in the model would make the material more ductile than the actual, resulting in nonconservative outputs.

The staff notes that SAR table 8.1.5 lists ASTM B209 5083 as the “pre-evaluated material” for the aluminum impact absorbers and provides minimum and maximum values for material yield and ultimate strengths as well as a minimum area reduction percentage value, all of which match those employed in HI-2240059. Staff also notes that in Note 4 of the table, the material properties correspond to a room temperature, while Note 5 indicates that the minimum area reduction percentage value is based on the testing results of HI-2210251, which does not appear to be the case.

Finally, it appears that the values of the lower-bound true stress-strain flow curves presented in Appendix A of HI-2240059 were not correctly translated into the LS-DYNA model.

As accurate aluminum material impact absorber properties are critical to the package’s evaluation for all drop tests, the applicant is asked to:

a) verify the exact aluminum material being employed for the impact absorbers (e.g., ASTM B209 5083, B221 5083, or other),
b) advise at what temperature the impact absorbers are being evaluated,
c) provide the exact citations for each material input value employed in for the impact absorber flow curves in HI-2240059,
d) provide a justification for a minimum area reduction percentage requirement that is much larger than the results of those from the testing program in HI-2210251, and,
e) update all documentation, including SAR tables 2.2.5, 8.1.5, report HI-2240059, and LS-DYNA models and analyses, as appropriate.

This information is required to satisfy the requirements of 10 CFR 71.41(a).

Holtec Response:

a) The impact absorbers are made of aluminum alloy and the minimum properties are listed in Table 8.1.5 of the SAR.

b) The material properties for Aluminum impact absorbers are considered at ambient temperature.

c) All citations are updated in revised Appendix A of HI-2240059.

d) Justification and citations are added in revised report HI-2240059.

e) SAR/Drop analysis report tables are verified and updated to avoid any discrepancies.

Obs-St-9: Explain the method employed in determining the area reduction value for several materials included in Appendix A of report HI-2240059, where their associated true stress-strain flow curves are incorporated in the LS-DYNA dynamic analysis models.

For several materials, a value for “S_{yr}” is defined by the applicant, however this variable is not identified. This variable is then employed in a subsequent calculation for area reduction, “q”, as a ratio to the material yield stress, multiplied by an unidentified fraction. The applicant is asked to provide a definition and references for the "S_{yr}" variable as well as the equation for determination of "q". This information is required for the following materials in Appendix A:

- **[Withheld per 10 CFR 2.390]**, Containment Plates
- **[Withheld per 10 CFR 2.390]**, Dose Blocker Plates
- **[Withheld per 10 CFR 2.390]**, Trunnions

For the **[Withheld per 10 CFR 2.390]** material for Closure Lid Bolts, a value for reduction in area, "q", is defined by the applicant, providing the ASME BPVC Section II as a reference. However, the exact citation within Section II must be provided, as this value is critical to properly model the seal area dynamic behavior.

This information is required to satisfy the requirements of 10 CFR 71.41(a).

Holtec Response: For **[Withheld per 10 CFR 2.390]** (Containment Plates) and **[Withheld per 10 CFR 2.390]** (Dose Blocker Plates) per ASME Section II, Part A, SA-20/SA-20M (S15, page 97), the minimum acceptable limit for reduction of area is **[Withheld per 10 CFR 2.390]**. For (**[Withheld per 10 CFR 2.390]**, Trunnions), per ASME Section II, Part D, SA-479/SA-479M Table 2 of (page no. 1084), the reduction of area is **[Withheld per 10 CFR 2.390]**.

For the Closure Lid Bolt material **[Withheld per 10 CFR 2.390]** the percentage area reduction is taken from Table 2 of (page no. 1084) on page ASME Section II, Part D.

Respective details are added to Appendix A of the report HI-2240059.

Obs-St-10: Justify the application of the strain rate curves provided in ASME BPVC Section I Appendix EE for stainless steel to all ITS package materials other than the aluminum impact absorbers in the LS-DYNA dynamic event analyses.

Section 5.3 of calculation report HI-2240059 indicates that the ASME BPVC Appendix EE strain rate amplification is applied for all materials in the LS-DYNA model, except for the aluminum impact absorber material. The strain rate factors presented in Table EE-1250-1 of the appendix for various temperature and strain rates are clearly labeled as being applicable to type **[Withheld per 10 CFR 2.390]** stainless steel materials. As the HI-STAR 330 does not employ this material for any of the ITS components of its package, use of these strain rates for all non-impact absorber components in the dynamic evaluations does not appear to be appropriate.

This information is required to satisfy the requirements of 10 CFR 71.41(a).

Holtec Response: The calculation HI-2240059 is revised to address strain rate curves used for distinct material groups in this safety analysis.

Obs-St-11: Provide an explanation as to why the following HAC event cases are not included in the scope of dynamic evaluations for the HI-STAR 330 package, as well as responses to the trunnion-related questions:

- 30-foot free drop with optional bottom trunnions installed

- Puncture with bar that strikes either the side or bottom trunnion, which drives the trunnion directly into the containment boundary, whichever produces the more severe results

One of these HAC events was requested to be evaluated for the HI-STAR ATB 1T package, and appears to be a challenge to the HI-STAR 330 package as well. Likewise, the new optional bottom surface trunnions present another opportunity to directly challenge the containment boundary.

Additionally, the exact dimensions of the trunnion and its interface with the dose blocker and containment plates is not clearly communicated on drawing 12482, Sh. 3 of 6, Detail 3E-3E, which shows the side trunnion:

a. There are two different diameters of the solid trunnion shaft depicted in this Detail, with **[Withheld per 10 CFR 2.390]** being the smaller one, inserted within the dose blocker plate. However, the dimensional report, HI-2240470, lists the maximum diameter trunnion diameter as **[Withheld per 10 CFR 2.390]**.

b. The only shown attachment of the trunnion to the package is the all-around fillet weld between the trunnion circumference and the dose blocker plate. This connection is not translated properly into the LS-DYNA model, where tied contacts between the trunnion and surrounding dose blocker plates essentially "fuse" both parts together as a full penetration weld would between the parts. Also, the structural evaluation for this fillet weld does not appear to be included in calculation #1 of report HI-2210998.

c. It is not clear whether the trunnion end/retainer plate, categorized as NITS, is relied upon for keeping the lifting sling on the trunnion during lifting operations and/or resisting lateral loads from the tie-down strut during tie-down conditions. Provide justification for its apparent lack of material information and/or structural evaluation.

This information is required to satisfy the requirements of 10 CFR 71.41(a).

Holtec Response:

In the 30ft drop scenario, the drop analysis documented in HI-2240059 has demonstrated that the aluminum impact absorbers (aka crushable attachments) do not crush to a depth sufficient for the trunnions or tie-down bars to become engaged with the drop surface, in all potential drop orientations. This differs from the HI-STAR ATB1T design, where less material was available for crushable attachments and the lifting trunnions required a collapsible design. As shown in drawing 12482 (Sheet 3, Zones A1 and C8), the protrusion length of the trunnion and tie-down bars is limited to **[Withheld per 10 CFR 2.390]** to ensure direct impact engagement is not possible. Additional evaluation of the 30-foot free drop with optional bottom trunnions installed is therefore unnecessary.

In the scenario of a puncture bar striking either a trunnion or tie-down bar, the intent of the design is to provide an increased diameter of the protruding section of the trunnion/tie-down bar so that it cannot be driven directly into the containment boundary. Instead, impact forces are resisted by the material of the larger diameter, protruding section of the trunnion which would be primarily loaded in shear. This prevents the trunnion from driving directly into the containment boundary.

For both these cases, Holtec agrees that additional dimensional constraints of the trunnion/tie-down bars and their interface with the dose blocker and containment plates should be added to the licensing basis documents. The following discussions directly address the comments (a,b,c) above.

a. Table A-1 of HI-2240470 lists the minimum diameter of the trunnions and tie-down bars (the small end inserted into the dose blocker plate) as **[Withheld per 10 CFR 2.390]**. This is intended to establish the minimum diameter used in the cask lifting or cask tie-down analysis (see HI-2210998). A larger diameter, protruding section of the bars is depicted in drawing 12482 (Sheet 3, Zones A1 and C8), which is limited to a maximum protrusion length of **[Withheld per 10 CFR 2.390]**. The diameter of the protruding section, however, is not specified. To address this, these changes to Table A-1 of HI-2240470 are made:

I. A maximum diameter of **[Withheld per 10 CFR 2.390]** is added to Table A-1 for the Lifting Trunnion Diameter. The description of the dimension is changed to clarify that it applies to both the lifting trunnions and tie-down bars, and discussion is added to describe the purpose of the dimensional limit.

II. A Table row is added to specify dimensional limits of **[Withheld per 10 CFR 2.390]** minimum and **[Withheld per 10 CFR 2.390]** maximum on the protruding diameter of the trunnions and tie-down bars. This includes a discussion of the reasoning behind the specified limits.

III. The Table row for the Lifting Trunnion Protrusion Length is edited to show that the dimensional limit on the length also applies to the Tie-Down Bars.

b. The evaluation of the trunnion-to-cask fillet weld provided in Appendix D of HI-2240059 concludes that the weld will not fail under the hypothetical drop event, so that it remains in place and no direct puncture event through the trunnion hole into the containment boundary is possible. Its representation in the LS-DYNA model is therefore not relevant, as the trunnion does not participate in the impact (as discussed above). It must be noted, however, that the changes to the dimensional limits discussed above do affect the HI-2240059, Appendix D evaluation. Specifically, both the minimum weld length and the maximum possible trunnion/tie-down bar mass are affected. These changes are reflected in Revision 1 of HI-2240059.

c. The inclusion of the trunnion end plate in drawing 12482 (Sheet 3, Zone C8) is intended only to acknowledge that a retention feature for the engagement of lifting equipment, such as slings, is good practice for lifting safety. It does not imply that there are any quantifiable lateral loads on the end plate that require evaluation. Therefore, justification for its material properties, dimensional limits, or structural capacity are not required.

Obs-St-12: Explain why, in the LS-DYNA model, the material properties for the seal area seating flange weld overlay are input as "elastic" when they are exceeding the material yield strength as a result of a HAC drop event. Also, identify where material properties for the weld overlay cited in SAR table 8.1.5 were obtained.

During a review of the resulting stresses from the LS-DYNA Bottom End Drop of the HI-STAR 330 package analysis, several locations within the grooved areas of the seal bottom flanges were observed to have stress magnitudes exceeding that of the material yield strength. This was observed in both the inner (ITS) and outer (NITS) seal grooves. When the assigned material properties were verified, it was discovered that the materials for the "ER 360" listed in SAR table 8.1.5 weld overlay were input as ELASTIC. Identify where the material properties for the "AWS ER360" weld overlay presented in SAR table 8.1.5 were obtained.

This information is required to satisfy the requirements of 10 CFR 71.41(a).

Holtec Response: The seal seating surfaces (seal weld overlay surfaces on the closure lid and the containment top flange) are simulated using elastic material model. This is a reasonable representation given that the PRIMARY STRESSES in the containment (inner) seal seating surfaces are below the material yield strength. This is confirmed by the analysis results which indicate that the primary stress on these surfaces is less than the weld overlay material yield strength **[Withheld per 10 CFR 2.390]**. Moreover, any local stresses noted outside the containment sealing region exceeding the material yield limit is overestimated given that the induced stress in the material follows the linear elastic relationship in this region attributed to elastic material representation in LS-Dyna model. Nonetheless, a sensitivity analysis is performed in revised calculation HI-2240059 to demonstrate that the non-linear material effect is minimal in weld overlay region.

Chapter 7: Materials Review:

OBS-M-1: Specifications (e.g., ASME SA 516 Grade 70, ASTM B209 Alloy 6061-T651) for package components that are designed and constructed in accordance with a code or standard and/or components that provide a structural, thermal, shielding, or containment function. The staff observed that drawing 12482, identifies materials as “Steel” and “Aluminum” but material specifications and grades are not identified.

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

Holtec Response: Note that materials listed as “STEEL” or “ALUMINUM” in the part list of drawing 12482 also reference Flag Note 5 of the drawing, which states that the critical characteristics of the materials for these components are included in Chapter 8 of the SAR (specifically, Table 8.1.5). Table 8.1.5 includes acceptable material specifications, such as ASME SA-516 Grade 70 for the dose blocker components. The SAR and drawings are organized in this way to provide better definition of the key attributes required for the non-containment component materials and better explain their function. This method also provides more flexibility in the substitution of material types that may become necessary due to material availability or other factors.

Obs-M-2: Explain the basis for excluding the impact absorbers from the baseline drop simulations which use true stress-strain relationships developed using minimum material properties. In SAR section 2.6.1, “Description of the Finite Element Model”, the staff observed that the applicant used LS-DYNA drop simulations to assess the behavior of the package dynamic response including a safety determination of the closure lid join connections. This benchmark study included physical testing of multiple tensile test specimens for separate material used in the HI-STAR 330 package followed by LS-DYNA simulations using identical input conditions, including specimen geometry, boundary conditions and material inputs, but did not include the impact absorbers.

This information is requested by the staff to demonstrate compliance with 10 CFR 71.31(c).

Holtec Response: The revised benchmark analysis considers the representative material to be used as impact absorbers for the HS-330 package. Furthermore, the drop analysis considers range of material properties specified in Table 8.1.5 of the SAR for the safety demonstration.

Obs-M-3: Clarify the ASME Boiler & Pressure Vessel (BPV) code edition used for the package design and construction. In SAR chapter 3 References, it mentions ASME BPV Code section II, Part D, 2023 Edition being used, but 2023 is not referenced elsewhere in the application.

This information is requested by the staff to demonstrate compliance with 10 CFR 71.31(c)

Holtec Response: The reference to the 2023 edition of the code in Chapter 3 is corrected to refer to the 2013 Edition.

Obs-M-4: In SAR Drawing No. 12482, Sheet 1 of 6, Note 5 states, “Unless otherwise specified, cask surfaces may be painted or coated with evaluated and pre-qualified preservatives (or equivalent products with acceptable critical characteristics) for corrosion prevention purposes.” Although four surface treatments/coatings appear to be described in SAR section 2.2.4, the applicant should clarify whether the coating is relied on to prevent loss of material that could affect a safety function such as shielding or structural performance.

This information is requested by the staff to demonstrate compliance with 10 CFR 71.31(c) and 10 CFR 71.43(d).

Holtec Response: The corrosion preventive coatings referred to in drawing 12482 and SAR section 2.2.4 are <u>required</u> on corrosion-susceptible materials to prevent the degradation of the cask materials. However, the primary mechanism for detecting and preventing loss of material that could affect safety functions such as shielding or structural integrity are the visual inspections specified in Table 8.2.1 of the SAR. As discussed in Section 8.2 of the SAR, touch-up of corrosion preventive coatings is required if damaged.

Obs-M-5: Identify the material(s) for the Weld Metal for NB Welds in SAR table 8.1.4, “Fracture Toughness Test Criteria: Containment System.” The applicant identified the line item for weld metal for NB Welds but no material(s) were specified in the table.

This information is requested by the staff to demonstrate compliance with 10 CFR 71.31(c)

Holtec Response: A weld material specification has been added to Table 8.1.4.

Obs-M-6: In SAR table 8.1.3, “ASME Code Requirements and Alternatives for the HI-STAR 330 package”, for the alternative concerning NB-4243, the applicant stated, “the structural acceptability of this weld join for all normal and accident conditions has been demonstrated by analysis,”

The staff requests the applicant to clarify if there were considerations for stress reduction factors due to the alternative NDE chosen (PT), the procedure for the weld material deposited, how acceptable fracture toughness is ensured, and how is hydrogen cracking minimized for the weld materials.

For the code alternative in SAR table 8.1.3, provide the following information:

1. Identify whether weld stress reduction factors and fatigue reduction factors are applied to the welds examined by progressive penetrant testing (PT).

2. Describe how the progressive PT will be conducted with respect to the weld material deposited.

3. Explain how the progressive PT examinations consider the fracture toughness of the weld.

4. Describe is ensured controls to detect and minimize hydrogen cracking of the weld materials.

This information is requested by the staff to demonstrate compliance with 10 CFR 71.31(c).

Holtec Response:

The following responses correspond, numerically, to the numbered observations:

1. The weld quality factor corresponding to progressive PT, per NG-3352-1, is appropriately reflected while calculating the allowable stress limit.

2. Progressive PT will be performed at each weld layer as specified in Table 8.1.3, with acceptance criterial per NB-5352.

3. Consideration of both the base material and weld material is an important factor in the proposed progressive PT examination method. Both materials were selected for their low-temperature fracture toughness, and the formation of brittle microstructures in either the weld filler metal or the HAZ of the SA-203 plates is not expected.

4. Both the ER80S-Ni1 weld wire and the SA-203 grade E are ductile materials with low hydrogen diffusibility, so there is a very low likelihood of metal hydrogen cracking. RT examination is therefore not considered necessary for detecting this type of cracking, and progressive PT is considered sufficient.

__**Editorial:**__

Obs-E-1: Clarify HI-STAR 330 only accepts HI-STAR waste package types B and C as specified in table 1.2.1 and 7.1.2. For example, the first paragraph of section 1.2.1.4 concludes: "The attenuation of gamma radiation occurs through three sequential metal masses in the body of the HI-STAR package for waste package Types A through D." In addition, section 1.2.1.1.b states that "four waste packages (Types A, B, C, and D) are analyzed for HI-STAR 330 package."

Holtec Response: The HI-STAR 330 only accepts HI-STAR waste package types B and C as specified in Tables 1.2.1 and 7.1.2. To correct this error, the following changes are made to the SAR:

The third sentence in Subsection 1.2.1.1(b) is changed to: Two waste package types are analyzed (Types B & C).

The final sentence is the first paragraph of Subsection 1.2.1.4 is changed to: The attenuation of gamma radiation occurs through three sequential metal masses in the body of the HI-STAR package.

Additional OBSERVATIONS

Chapter 2: Structural Review

St-1. Describe the resulting condition of the package for several Hypothetical Accident Condition (HAC) drop scenarios not described in the application and justify that these are bounded by those already included in the application:

a. The scenario where the package has been dropped 30 feet per a HAC event in the center-of-gravity over corner (CGOC) orientation (or ~1-15 degrees from orientation), causing maximum damage to the connections of the impact absorber plates where these absorber plates could potentially separate from the impact limiter assembly and damage the assembly overall, followed by the same CGOC drop orientation where the puncture bar is in direct alignment with the damaged region of the corner.

The applicant indicated in Safety Analysis Report (SAR) Section 2.7.2 that this drop scenario was not evaluated because the impact limiter absorber plates would remain in place after the 30-foot drop. However, it is unclear to staff whether the absorber plates will remain in place after the 30-foot HAC drop, as the modeling assumptions made in LS-DYNA connecting the absorber plates to the strongback assembly (Item 606) do not match the details on the drawing 12482. Specifically, **[Withheld per 10 CFR 2.390]** fillet welds (welds 4-1, 5- 1) attach bracket assemblies (Item 604) to Item 606, and **[Withheld per 10 CFR 2.390]** fillet or groove weld (weld 4-2) attaches bracket side plates (not numbered on the licensing drawings) that allow impact absorber plates connections to the side plates via bolting (Items 605 and 609). However, the bolts (Items 605 and 609), and unidentified side plates, are not modeled in LS-DYNA, nor are the welds. Instead, the bracket assembly (Item 604) is essentially “fused” entirely to the strongback (Item 606) and impact absorber plates (Items 601-603) via TIED_SURFACE_TO_SURFACE contacts. This effectively treats these parts as one monolithic part, rather than individual parts that are much more susceptible to damage from a CGOC drop. Furthermore, the **[Withheld per 10 CFR 2.390]** groove weld (weld 4-3) for the seam of the **[Withheld per 10 CFR 2.390]** thick strongback plate (Item 606) is modeled as a full- depth weld, which is more robust than the actual weld provided.

[Withheld per 10 CFR 2.390]

Staff is concerned that, if modeled more accurately, the impact absorber assembly could separate from the package, leaving the remaining part of the package susceptible to the CGOC puncture drop, as the HI-STAR ATB-1T package was, which then leaves the package vulnerable to the subsequent HAC fire as well as causing dosing paths. Staff has noted that material erosion of the lid and lid bolts was shown for the CGOC top drop in the screen shot below (note that part of impact limiter in the region has been removed for clarity):

[Withheld per 10 CFR 2.390]

b. As mentioned in Observation St-11 of NRC letter sent to Holtec on August 1, 2025 (ML25178C763), the scenario where the package is dropped 30 feet per a HAC event in the bottom end down configuration (or slap-down configuration), followed by the drop where the puncture bar is in direct alignment with any optional tie-down bar (Item 13) located on the bottom side of the package is of particular concern for the HI-STAR 330 package since the Side View on drawing 12482, sheet 3, indicates that the number, dimensions, and locations of the optional tie-down bars varies. Since the number and dimensions of the tie-down bars are not yet specified, staff is concerned that the presence of multiple tie-down bars may weaken the underside of the package. Regardless of the quantity, the tie-down bars make the containment boundary plate (Item 1) behind them susceptible to damage from any 30-foot HAC drop, and very vulnerable to the subsequent HAC puncture drop, during which the tie-down bar and/or puncture bar could be driven into the containment boundary.

This information is required to satisfy the requirements of 10 CFR 71.41(a), 10 CFR 71.71, and 71.73.

Holtec Response:

St-1 a)

- The impact absorbers are designed such that they will remain sandwiched between the package and the rigid target.
- Any oblique package orientation (wherein the package c.g. is offset from the initial impact location), the package will rotate and the primary impact point shifts to the adjacent impact absorbers. Consequently, the adjacent impact absorber will essentially crush and sandwich between the package and the target.
- HI-STAR ATB-1T simulations determined that the 1-m puncture drop following the 30-ft

drop has only a local second order effect on the package overall safety performance. In other words, the damage to the HS-330 cask is dominated by the HAC 30 ft drop which possesses substantial impact energy **[Withheld per 10 CFR 2.390]** as compared to the 1m puncture drop **[Withheld per 10 CFR 2.390]**.

- The modeling simplification wherein the impact absorber is tied to the package ensures the damage to the package is concentrated and the entirety of the impact energy is absorbed by limited number of impact absorbers which potentially maximizes the local damage to the cask.

The damage depicted in the image above is likely overpredicted due to the use of element erosion. In the current simulation setup, solid elements are eroded once the effective plastic strain at single element integration point exceeds the failure strain limit. Furthermore, the element erosion mechanism in LS-DYNA treats tensile and compressive strains equivalently, without distinguishing between failure modes.

In the context of this drop case, the eroded region is primarily under compressive loading. Therefore, the material erosion or separation from these components is unrealistic. Instead, it is more likely to undergo localized crushing or plastic deformation while still remaining connected to the cask. As such, the erosion observed in the simulation may not represent actual physical failure, and the extent of material removal in the model is considered overly conservative.

The following updates are made in the revised FEA model:

1) The material model for cask components is updated to **[Withheld per 10 CFR 2.390]** to accurately capture the failure using triaxiality.

2) The above-mentioned welds Weld 4-1 and Weld 4-2 are explicitly modeled using strain failure criteria to represent welded connection instead of tied connection between Cask/Strong back outer protective cover and impact absorber attachment brackets.

3) The connection between impact absorber and impact absorber attachment brackets is replaced from tied connection to a representative bolted connection.

The revised analysis demonstrates that the erosion of the dose blocker plates is minimal using triaxiality and updating the material model to **[Withheld per 10 CFR 2.390]** for all crushing components in the load path.

Additional drop orientation is considered wherein the corner impact absorbers and its attachments to the cask are challenged the most resulting in detachment of the corner impact absorber attachments.

Nonetheless, the revised analysis with aforementioned changes appropriately simulates the bolted and welded connections between the impact absorbers and the cask. The results demonstrate that even in the event of bolt or weld failure, the package safety is maintained.

The size of the tiedowns and their attachment to the cask is same as that of the trunnions. Additional information regarding direct impact on the cask trunnions (or tie bars) is further explained in another RSI. Additional puncture drop simulations are performed to maximize the damage to the cask.

ST-1 b)

- The size of the tiedown bars and its connections to the cask is identical to the of a cask trunnion. The trunnions and the tiedown bars are designed to survive the HAC 30 ft. drops and remain connected to the cask. This is documented in Appendix D of the calculation package.

- The 1m puncture drop following HAC 30 ft. if postulated to impact tiedown bars, this scenario is less detrimental to the package than the direct impact to the package baseplate or side walls. The design of trunnions and the tiedown bars is engineered such that any axial or lateral load on the trunnions and the tiedown bars will be transmitted directly to the cask dose blocker (side/end) plates and the containment boundary will not realize significant loading from postulated drops of the package.

Additionally, the revised analysis, considering the trunnion weld connection, demonstrates that the **[Withheld per 10 CFR 2.390]** weld (Weld 3-9) connecting the trunnions (and cask tiedowns) to the cask remains adequate and the trunnion (and tiedowns) will remain attached to the cask subsequent to the critical HAC drop events (including the puncture drops).

St-2. Describe the condition of the package post HAC 30-foot drop (bottom end orientation) followed by the puncture bar test (cumulative damage) where the puncture bar is oriented to strike the underside of the Top Impact Limiter/Strongback Assembly.

Specifically, describe the condition of the package post 30-foot HAC drop (bottom end orientation) followed by one of the two possible puncture bar drop tests where the puncture bar can strike the underside of the Top Impact Limiter/Strongback Assembly (Item 600), possibly damaging it severely or removing it altogether leaving the cask susceptible to the HAC fire.

[Withheld per 10 CFR 2.390]

[Withheld per 10 CFR 2.390]

Staff noted that modeling the bolts (Item 608) “elastic” in LS-DYNA, thus they cannot fail, is unrealistic. It is not clear how the internal protective cover of Top Impact Limiter/Strongback Assembly will retain the impact limiter when it is anything but **[Withheld per 10 CFR 2.390]** or have material properties other than steel as it currently is considered not important-to-safety (NITS), and thus for all practical purposes could be any material and have any dimensions (see other RAIs for these issues).

This information is required to satisfy the requirements of 10 CFR Part 71.73.

Holtec Response:

Additional puncture simulations are carried out in the revised calculation, as follows:

1. Puncture drop onto the strongback plate edge as presented in following figure.

[Withheld per 10 CFR 2.390]

2. Puncture drop onto the side of the strongback bracket (which will try to lift the strongback assembly).

[Withheld per 10 CFR 2.390]

3. Puncture drop onto the corner strongback bracket.

[Withheld per 10 CFR 2.390]

4) Puncture on trunnion.

[Withheld per 10 CFR 2.390]

The response from these additional analyses demonstrates that the cask strongback assembly, which serves as the enclosure for the insulation board, remains connected to the cask subsequent to the severe puncture drops noted above. Additionally, it is also demonstrated that the trunnion weld (Weld 3-9) can sustain the puncture event, and trunnion will not detach from the cask.

Additional 30-ft HAC followed by puncture drops are also analyzed in the revised calculation addressing the strongback connections.

St-3. Justify why modeling the following package connections more robustly in the LS-DYNA analysis model than they are connected in reality is a conservative approach for determination of the package or connection structural acceptability for a given HAC scenario:

> Trunnions: Side trunnion (Item 12) is shown as being connected to the side Dose Blocker plate (Item 9), with a **[Withheld per 10 CFR 2.390]** all-around weld. However, in the LS-DYNA model, a tied contact has been used to essentially fuse the trunnion (Item 12) to the side dose blocker plate.

Staff is concerned that the more robust connections represented between these parts in the LS-DYNA models do not accurately reflect the actual connection and may overestimate the load transfer mechanism between the parts, producing nonconservative results.

This information is required to satisfy the requirements of 10 CFR 71.71 and 71.73.

Holtec Response:

The main purpose of modeling trunnions was to add weight and measure decelerations or forces in trunnion which is an input for the dose blocker plate to trunnion weld evaluation in Appendix D.

The tied contact between trunnion and does blocker plate doesn't affect the overall validity of the trunnion connection as trunnion doesn't appear in direct load path during impact events.

During the HAC 30-ft drop, the trunnions and the tied-down bars are shown not to impact the rigid target since the impact absorbers do not bottom out. Any impact loads during head on puncture bar impact on the trunnions will be transmitted through the exterior body of the cask since trunnion is oversized and it butts against the outer DSB plates.

In the revised analysis, the tied contact previously defined between the trunnion and the cask has been removed, and the welds (Weld 3-9 between trunnion and cask dose blocker plates) have been explicitly modeled to accurately represent the as-built condition.

St-4. Justify the omission of triaxiality effects consideration for package materials that experience material erosion for the CGOC Top Drop, as well as any other HAC events where material erosion occurs.

Holtec report, HI-2240059, “Drop Analysis of the HI-STAR 330 Transport Package,” indicates that triaxiality was considered for aluminum crushable attachments, lid shims, and closure lid spacer which experience significant damage/material erosion but not other parts such as Item 604 (impact absorber attachment bracket set), Item 6 (closure lid), Item 7 (Lid Bolts), and Steel Internal Protective Liner (NITS). However, the CGOC Top drops shows significant damage to these parts, in the form of material erosion, for shielding and containment parts such as the dose blocker and lid, and gross failure (impact limiter Item 601, Item 606, and Part Steel Internal Protective Cover).

[Withheld per 10 CFR 2.390]

Note: Not all parts shown, “exploded view” used for viewability”

It is unclear how containment boundary components fair with triaxiality effects for drops like the 30-foot CGOC drop, with cumulative damage considerations in this region such as the puncture bar.

This information is required to satisfy the requirements of 10 CFR Part 71.73.

Holtec Response:

In the revised analysis, all the aforementioned components have been modeled incorporating the effect of triaxiality **[Withheld per 10 CFR 2.390]**. The updated results demonstrate that there are no safety concerns.

St-5. Clarify how stress values for closure lid bolts, primary seal seating regions, and containment boundary plates were derived.

Holtec report HI-2240059, “Drop Analysis of the HI-STAR 330 Transport Package,” tabulates stresses (induced stress) with respect to ASME primary membrane stress intensities and primary bending stress intensities, etc., for various containment boundary components such as the seal region, flange, wall plates, and closure bolts. While raw stress output as that displayed in Figure 13.3-26 in the report can be confirmed when examining LS-DYNA output files, it is unclear what procedure the applicant employed to determine the various primary stress values in table 9-1 used for calculating safety factors. These values directly affect safety factors displayed in the same table and table 2.7.1 of the SAR, which support release and dose assessments for various Normal Conditions of Transportation (NCT) and HAC drops. Clarify the methodology used to calculate these values from raw LS-DYNA output and update HI-2240059 and the SAR as necessary.

This information is required to satisfy the requirements of 10 CFR Part 71.71and 71.73.

Holtec Response:

Below is the methodology utilized for deriving the stress values (Primary or primary membrane plus bending).

[Withheld per 10 CFR 2.390]

St-6. Justify how the following package components that are directly in the impact load path for various NCT and HAC drops are classified as NITS and/or are not detailed fully (materials/dimensions) in the SAR, licensing drawings, and/or the LS-DYNA model:

a. Shim Strips (no item number, NITS, LS-DYNA part number 1029) and impact limiter bracket side plates (no part number, not modeled in LS-DYNA) that are bolted with Items 605 and 609 to Item 604, ITS [important to safety]): These parts experience stresses higher than **[Withheld per 10 CFR 2.390]** (Von Mises, CGOC Top drop*) but dimensions and material properties are not specified on the licensing drawings for them. These parts transfer forces directly from the impact limiters to containment boundary parts.

b. Steel Internal Protective Cover (no item number, NITS, Part 1030 in LS-DYNA): This part experiences stresses higher than **[Withheld per 10 CFR 2.390]** (Von Mises, CGOC Bottom drop*) but dimensions and material properties are not specified on the licensing drawings. This part's structural integrity is needed to retain the impact limiter to the package after the HAC drop.

c. Closure Lid Shims (no item number, NITS, Part 1034 in LS-DYNA): This part experiences stresses higher than **[Withheld per 10 CFR 2.390]** (Von Mises, CGOC Bottom drop*) but dimensions and material properties are not specified on the licensing drawings. These shims transfer forces directly into the lid bolts and surrounding containment boundary parts and help to prevent movement of the lid. In addition, SAR table 2.1.2B note 3 states that the lid bolts are not subject to shear. However, the 30-foot HAC short side drop indicates the bolts experience **[Withheld per 10 CFR 2.390]** of rigid body acceleration (as does the lid), and shear stresses (TYZ) reach **[Withheld per 10 CFR 2.390]**, and inelastic strain values of **[Withheld per 10 CFR 2.390]** for the 30-foot HAC long side drop. In addition, this item is defined as being "aluminum" in Holtec report HI-2240059 which does not reflect the NITS designation for this part which permits it to be virtually any material.

d. Closure Lid Bolt Washers (no item number, NITS, Part 1011 in LS-DYNA): This part experiences stresses higher than **[Withheld per 10 CFR 2.390]** (Von Mises, Top End Drop*) but dimensions and material properties are not specified on the licensing drawings. Washers distribute bolt forces into the closure lid.

e. j Strongback bolts (Item 608, ITS, Part 1033 in LS-DYNA). This part was observed to have axial forces as high as **[Withheld per 10 CFR 2.390]** and shear forces of **[Withheld per 10 CFR 2.390]** (Von Mises, Top End Drop*) and, although not fully dimensioned on the licensing drawings, appear to be longer on the drawings/actuality (**[Withheld per 10 CFR 2.390]** minimum, but is unspecified) than as modeled in LS-DYNA (**[Withheld per 10 CFR 2.390]** long). In addition, these bolts are modeled as being "elastic" in LS-DYNA simulations, thus they will never fail under any drop condition but are critical in retaining impact limiters during/after HAC drop events.

**Note that drops cited are just examples; stresses could be higher for other drop events*.

Staff is concerned that these parts with vague or unknown dimensions or material properties are modeled in a nonconservative manner in LS-DYNA drop simulations. Since some of these parts are NITS, and have minimal or no material designations or dimensional information, it is unclear how the package performs for NCT and HAC drops when their material properties are varied widely (since virtually any material could be permitted), or when these parts are removed from the analysis, or have their dimensions modified. These parts could impart higher forces and fail neighboring parts by redirecting forces, as the use of "softer" material properties could. Currently, these parts are modeled with one set of dimensions and material characteristics in LS-DYNA which are either described poorly or not at all in the SAR or licensing drawings.

This information is required to satisfy the requirements of 10 CFR 71.71 and 71.73.

Holtec Response:

The following responses correlate to the lettered list provided in the comment.

a. Holtec agrees that the shim strips should be considered ITS-C, as their size and location contributes to the load distribution from the impact absorber brackets to the cask. Table 8.1.5 of the SAR is updated to include the shim strip material as part of the strongback assembly, and Table A-1 of the ITS Categorization Report (HI-2220203) is updated to specify them as ITS-C. Drawing 12482 is updated to reflect this change and add relevant dimensions. The bracket side plates are considered part of the bracket assembly, so are subject to the material requirements of the assembly. The LS-Dyna model is updated to capture the necessary structural details, and the calculation is revised accordingly.

b. The internal protective cover is a thin steel material that plays a minor role in the structural response of the cask. Holtec will change this part to ITS-C since it is included in the structural model and covers a large portion of the cask. The nominal material thickness is added to drawing 12482. The LS-Dyna model is updated to capture the necessary structural details, and the calculation is revised accordingly. The only structural criterion for this protective cover is to ensure that it remains connected to the cask and protect the insulation board from detaching from the cask during the hypothetical drop events. For that reason, this component is evaluated for the maximum plastic strain which must be less than the material failure strain.

c. Holtec agrees that the closure lid shims should be considered ITS-C, as their size and location play a significant role in limiting lateral movement of the closure lid. Table 8.1.5 of the SAR is updated to include the shim strip material, and Table A-1 of the ITS Categorization Report (HI-2220203) is updated to specify them as ITS-C. Drawing 12482 is updated to reflect this change and add relevant dimensions. The shims provide cushioning effect to the closure lid during side impact events

d. Closure lid washers are typically considered NITS items, as their effect on distributing loads is minor compared to the thickness of the lid and, as they are thin material loaded in compression, variations in their material strength properties have little effect upon the overall structural response of lid closure bolts. Their primary function is operational, to provide a bearing surface for the head of the bolt during bolt torquing. To clarify this, drawing 12482 is revised to add **[Withheld per 10 CFR 2.390]** to the description of the washers. The closure lid washers are NITS components because they are steel members only loaded in compression. Any compression loading transferred from the lid bolt washers to the lid will further compress the land region of the controlled compression joint thereby lid sealing is further enhanced. The LS-Dyna model accurately captures in the lid compression during the critical drop scenarios.

e. The strong back bolts are not modeled in detail as during top end drop the shearing due to spring back plate won't be critical as there won't be much relative motion between the plates and the cask. Similar statement is valid for short and long side drop event. There will be slight clearance between bolts and the hole on spring back plate. During bottom end drop event, the strongback assembly on top may bounce back to impose shear loads in the bolts, however, the shear capacity of the bolts is **[Withheld per 10 CFR 2.390]** which is **[Withheld per 10 CFR 2.390]** times more than the weight of the top strong back assembly. (note: Allowable shear strength is considered **[Withheld per 10 CFR 2.390]** the ultimate strength) The higher forces are observed in the strong back bolts (beam output) are due to simplified modeling (rigid connections at the end of the beam). In revised analysis, the strongback bolts are explicitly modeled and results demonstrate that the strongback assembly remains attached to the cask after drop events.

St-7. Justify the gap size included in the LS-DYNA model between the Liner Tank and containment boundary during HAC drop analyses.

Per Sheet 2 of Drawing 12596, the liner tank has a minimum height of **[Withheld per 10 CFR 2.390]**, however, the height is modeled as **[Withheld per 10 CFR 2.390]** in LS-DYNA. The modeled gap between the Liner Tank and containment boundary in LS-DYNA is **[Withheld per 10 CFR 2.390]** for HAC drop simulations. However, a gap of approximately **[Withheld per 10 CFR 2.390]** could form between the two, if the applicant's NCT gap calculation methodology is applied to HAC drops, which is physically possible if the liner tank height is taken to be its minimum height of **[Withheld per 10 CFR 2.390]** rather than the **[Withheld per 10 CFR 2.390]**, as currently modeled. Since larger gaps between components within the package cause higher impact forces (and 'g' forces) in all package components, staff is concerned that maximum impact forces the containment boundary have not been accounted for in all HAC drop simulations when minimum liner tank dimensions are used. Update the SAR, pertinent calculations, and licensing drawings as necessary.

This information is required to satisfy the requirements of 10 CFR 71.71 and 71.73.

Holtec Response:

The design intent is to limit the axial clearance between the top of the liner tank and the spacers on the underside of the closure lid to **[Withheld per 10 CFR 2.390]** (as modeled in LS-DYNA) or less, by adjusting either the thickness of the spacers or adding a steel plate underneath the liner tank. Note that a minimum thickness of **[Withheld per 10 CFR 2.390]** is required for the closure lid spacers (see Sheet 2, Zone B2 of drawing 12482) as the spacers participate in the top end drop scenario by absorbing some energy. Thicker spacers are allowable. This approach limits the g-forces in the components during drop analyses, regardless of the relative heights of the liner tanks to the cask cavity. This is clarified on drawing 12482 by making the following changes:

1) Flag Note 7 is changed to: THE CAVITY HEIGHT IS MEASURED TO THE UNDERSIDE OF THE CLOSURE LID SPACERS. CLEARANCE BETWEEN THE LINER TANK AND CLOSURE LID SPACERS SHALL BE **[Withheld per 10 CFR 2.390]** OR LESS. TO ACHIEVE THE REQUIRED CLEARANCE, THE HEIGHT OF CLOSURE LID SPACERS MAY BE INCREASED AND/OR STEEL SHIM PLATE (NITS) MAY BE PLACED AT THE BASE OF THE CASK.

2) The REMARKS column (Sheet 2) for ITEM 14 (CLOSURE LID SPACER) is changed to: SEE FLAG NOTES 5 & 7.

3) The cavity height specified in the SIDE VIEW of the cask (Sheet 3, Zone B2) is changed to reference FLAG NOTE 7, with a nominal reference dimension included for information.

St-8. Clarify the adequacy of Liner Tank lid bolts and the dimensions of the lid/flange area in the closure region of the Linker Tank lid.

According to the applicant, the Liner Tank lid (Item 4, Sheet 2 of Drawing 12596) must not separate from the rest of the liner tank during NCT drop conditions. However, it appears that the liner tank bolts (Item 5, Sheet 2 of Drawing 12596) are not specifically modeled for shear and tension loads and experience as much as 190 g during the NCT Bottom End (Bed Cassette) drop scenario according to the applicant's NCT drop simulations. The applicant in part states that these bolts are not subject to shear loads due to the "lip" in the lid itself which would bear the brunt of all shear loads, however, the lip detail and associated dimensions that are intended to preclude shear forces in these bolts in Detail 2C on Drawing 12596, sheet 2 of 4, have not been detailed.

This information is required to satisfy the requirements of 10 CFR 71.71.

Holtec Response:

- The shear in bolts is evaluated for thread stripping due to tensile load from the drop/ rebound. The bolt shank pure shear is not credible due to the geometric features and the allowances of the closure lid bolt holes (**[Withheld per 10 CFR 2.390]** hole for bolt clearance on sheet#2 of drawing 12596-R2) and containment top forging (**[Withheld per 10 CFR 2.390]** relief as shown in sheet#3 of drawing 12482 -R6). This implies that before the bolt shank incurs any shear, the top plate of the liner tank will be in contact with the containment top forging. Hence, the bolt shank will not be subjected to any shear loads.
- The bounce back of the lid during bottom end drop is critical for tensile loading on bolts. The bolts are evaluated for the bottom end drop in Calculation 4 of HI-2210998. The critical deceleration of the lid during bounce back is considered (**[Withheld per 10 CFR 2.390]**).
- The necessary gap details are specified in drawings 12482-R6 and 12596-R2.

St-9 Identify and clarify the purpose of the box-like part (Part 1022 in LS-DYNA) that is located inside the Liner Tank and envelopes the Liner Tank Cassette.

Part 1022, a rectangular shaped box, without a top or bottom, is approximately **[Withheld per 10 CFR 2.390]** thick (treated as steel in LS-DYNA), surrounds the Liner Tank Cassette in LS-DYNA simulations. This item is not depicted anywhere in the licensing drawings, therefore the purpose it serves in the LS-DYNA models is currently unclear. Regardless, this part affects the performance of the Liner Tank and Liner Tank Cassette via direct contact, as well as the overall behavior of the package. Therefore, clarify Part 1022's function in the LS-DYNA models, as well as defining its material properties, dimensions, and importance to safety on the licensing drawings.

This information is required to satisfy the requirements of 10 CFR 71.71 and 71.73.

Holtec Response:

- The components 1016,1017,1018,1019,1020 and 1022 together represent the simplified cassette.
- From the components presented above, except 1022, other cassette components are modeled rigid. With this modeling technique, the rigid components transfer load to part 1022 and are further transferred to Liner tank components.
- In general, the distinct components (contents) of the cassette will tend to move incoherently (not in unison), resulting in lesser net inertial load. Above modeled technique conservatively overestimates the inertial loads on to the liner tank. This is further investigated and evaluated in Appendix F of the drop analysis report.
- The details about load transfer from cassette to liner tank in different orientation are discussed in Assumption 2 of HI-2240059.

St-10. Clarify the interaction between package components in LS-DYNA NCT and HAC drop simulations which have multiple contacts assigned to them.

The applicant's LS-DYNA NCT and HAC drop scenario models assign multiple contact definitions to the same part. Multiple contact definitions assigned to the same part is poor modeling practice as unknown and nonconservative results due to numerical instabilities can occur according to LS-DYNA resources and staff experience. Multiple parts have more than one contact definition. For instance, LS-DYNA Part 1006 (dose blocker side plate) is assigned to 4 different contact types which may or may not erode or transmit impact forces between parts. Clarify the behavior of each part that has multiple contacts for NCT and HAC drop simulations and update the SAR and pertinent calculations as necessary.

This information is required to satisfy the requirements of 10 CFR 71.71 and 10 CFR Part 71.73.

Holtec Response:

The contacts between different components are essentially defined using *CONTACT_AUTOMATIC_SURFACE_TO_SURFACE algorithm. There are some parts which appear in multiple contact definitions. In the end it is ensured that all parts which are expected to come in contact or interface with adjacent components are appropriately reflected during the dynamic loading event which involves erosion and significant movement between parts. Furthermore, it is verified from contact energies as well as global energies that the contacts are working fine by transferring the loads accurately and there are no instabilities observed. It is, therefore, confirmed that any redundant contact definition will not affect the cask response and the safety results.

ST-11. Identify where the following package components are evaluated for structural adequacy during the postulated HI-STAR 330 package loading events:

a. Impact Absorber bracket plate assembly and welds (**[Withheld per 10 CFR 2.390]** all-around fillet) to
strongback.
b. Impact Absorber attachment plates and (**[Withheld per 10 CFR 2.390]** fillet or groove) welds to brackets, **[Withheld per 10 CFR 2.390]** dia. attachment bolts.
c. Strongback Bolts.
d. Strongback seam weld (**[Withheld per 10 CFR 2.390]** groove) for **[Withheld per 10 CFR 2.390]** thick outer covering plate.
e. Dose Blocker side plate corner weld (**[Withheld per 10 CFR 2.390]** groove) (in Det. 3D).
f. Dose Blocker to Cont. Flange outer edge (**[Withheld per 10 CFR 2.390]** bevel groove), shown in blown-up of Side View.
g. Dose Blocker side-to-bottom plate weld (**[Withheld per 10 CFR 2.390]** fillet or groove) (in Det. 3B).
h. Any other welds evaluations not currently documented in calculation packages.

This information is required to satisfy the requirements of 10 CFR 71.31(c), 71.71, and 71.73.

Holtec Response:

Below are the changes in the revised analysis.

a) The bracket plate assembly and welds to strongback are explicitly modeled.

b) Impact Absorber attachment plates and (**[Withheld per 10 CFR 2.390]** fillet or groove) welds to brackets, **[Withheld per 10 CFR 2.390]** dia. attachment bolts are modeled.

c) Strongback bolts are explicitly modeled in analysis.

d) The strongback seam weld **[Withheld per 10 CFR 2.390]** groove) for the **[Withheld per 10 CFR 2.390]** thick outer covering plate is not explicitly modeled, as this weld is considered sufficiently strong. The weld size, being **[Withheld per 10 CFR 2.390]** of the covering plate thickness, provides adequate strength to justify this assumption.

e) Dose Blocker side plate corner weld (**[Withheld per 10 CFR 2.390]** groove) (in Det. 3D) is explicitly modeled.

f) Dose Blocker to Cont. Flange outer edge (**[Withheld per 10 CFR 2.390]** bevel groove), is explicitly modeled.

g) Dose Blocker side-to-bottom plate weld (**[Withheld per 10 CFR 2.390]** fillet or groove) is explicitly modeled.

h) All critical welds are covered in the revised drop analysis.

St-12. Explain why in SAR section 2.1.2.1.2, Normal Conditions of Transport Loads, the Heat and Cold conditions required to be evaluated by 10 CFR 71.71(c)(1) and (c)(2) are not mentioned as being considered as part of NCT loading combinations and advise whether these conditions are addressed and documented for the HI-STAR 330 package.

This information is required to satisfy the requirements of 10 CFR 71.71.

Holtec Response: The discussion pertaining to the hot and cold conditions of transport is added to section 2.1.2.1.2 in line with HI-STAR ATB-1T Package SAR. Furthermore, the cold and hot loading conditions of the package are discussed in Chapter 2.

St-13. Identify where the structural evaluation of the following items for lifting and handling loads are documented, as indicated in SAR table 2.1.1, "Structural Loading Events and Associated Acceptance Criteria for HI-STAR 330," Line item number 3 and 4, "Loading Case A: Closure Lid Lift Points" and "Loading Case A: Closure Lid Plate".

The structural evaluation of these package components does not appear to be included in the HI-2210998, Revision 0, "Structural Calculation Package for HI-STAR 330 Transport Cask."

This information is required to satisfy the requirements of 10 CFR 71.45(a).

Holtec Response: The evaluations of the "Loading Case A: Closure Lid Lift Points" and "Loading Case A: Closure Lid Plate" is added to the Holtec Calculation Package HI-2210998 and the summary is included in the SAR.

St-14. HI-2210998, Revision 0, "Structural Calculation Package for HI-STAR 330 Transport Package," Calculation #2, "Structural Qualification of HI-STAR 330 Baseplate":

a. p. 2-1: Scope states that the structural analysis of the inner containment shell closure lid and top forging is performed during cask lifting in this calculation but it does not appear to be.
b. p. 2-3: Section 8 reports a maximum combined stress of **[Withheld per 10 CFR 2.390]** for baseplate in Figure 2.2, however maximum stress for the entire structure occurs in Figure 2.3 for the wall, of **[Withheld per 10 CFR 2.390]**.

Holtec Response:

a. Calculation #2 "Structural Qualification of HI-STAR 330 Baseplate" does not show the stress results for the inner containment shell closure lid and top forging during the cask lifting as their magnitude was very small as compared to the stresses induced in the inner baseplate and the containment shell. However, Calculation #2 is updated to include the stress plots for the inner containment shell closure lid and the top forging. Since the induced stresses in these components are miniscule, safety factors for these components are not estimated.
b. Holtec agrees with the observation. The maximum stress of **[Withheld per 10 CFR**

2.390] will be used to quantify the safety factors for the entire structure.

St-15. SAR, HI-2210970, Rev. 0: Provide drawings and associated documentation for Tertiary containers.

SAR section 1.2.2 indicates that Tertiary containers may be employed as needed to increase shielding of transported package contents, and states that these containers are ITS components designed to meet ASME Boiler and Pressure Vessel Code (BPVC) Section III Subsection NF requirements. SAR table 7.1.2 indicates that these containers are only employed for the Type B Waste packages, while SAR table 7.1.3 indicates that two container configurations are available. Provide licensing drawings, complete with typically expected content, as well as documentation of the structural evaluation of these Tertiary containers for required loadings against the ASME Subsection NF acceptance criteria.

This information is required to satisfy the requirements of 10 CFR 71.71 and 71.73.

Holtec Response: Licensing drawing 18092 is provided for the Tertiary Containers. The analysis is documented in the revised calculation package HI-2240059, and the safety evaluation is documented in the revised SAR.

St-16. SAR, HI-2210970, Rev. 0: The following information is requested to be provided or revised on drawing 12482, “HI-STAR 330 Type B/C Waste Transport Cask,” Revision 0, in SAR section 1.3 in order that the function of the overall package and/or the individual component may be properly assessed:

a. Sh. 1: Justify note 6 which allows unlimited additions of NITS components and welds to the package.
b. Sh. 1: Justify flag note 6 which sets no maximum dimensional limit on the size of the impact absorber profiles which are presented on sh. 6 of the drawing.
c. Sh. 2: Resolve the discrepancy between the ITS Components Bill of Material showing a quantity of **[Withheld per 10 CFR 2.390]** for Item 13 (tie-down bar), and the note under Side View on sh. 3 that states “quantity…may vary.”
d. Sh. 3: Provide location and details of inner and outer seal grooves.
e. Sh. 3: Explain why no surface finish/flatness requirements are indicated for the Cask Body and Cask Lid Sealing Surface areas (Welds 3-3 and 3-4) shown in the enlarged area of the Side View.
f. Sh. 3: Provide the exact dimensions and structural evaluation of Item 13, Optional Tie-Down Bar: i) its interface with the Dose Blocker Bottom Plate (Item 8) is not clearly communicated in the Side View, which shows two different diameters of the solid trunnion shaft depicted in this view, with **[Withheld per 10 CFR 2.390]** being the smaller one, inserted within the Dose Blocker Plate (however, the dimensional report, HI-2240470, lists the maximum diameter as **[Withheld per 10 CFR 2.390]**), ii) the only shown attachment of the Tie-Down Bar to the package is the all-around seal weld between the bar circumference and the Dose Blocker Plate, the structural evaluation of which does not appear to be included in calculation #1 of report HI-2210998 for impact or tie-down loading.
g. Sh. 3: Provide details and locations for the NITS Scuppers indicated on the Side View.
h. Sh. 3: Justify the anchorage of an unspecified number of NITS Optional Attachment Bolts (fabrication aid) with unspecified locations into the containment boundary per ASME BPVC Subsection NB requirements.
i. Sh. 4: Provide the overall length, width, and depth dimensions of the Strongback Assembly, Item 606.

j. Sh. 4: Provide the vertical locations of the Strongback Bolts, Item 608.
k. Sh. 4 & 5: Provide the material and dimensional information and ITS category for the perpendicular side plates (no Item number) that connect the absorber plates (Items 601 603) to the Attachment Bracket Sets (Item 604).
l. Sh. 4 & 5: Provide the spacing and locations of Impact Absorber Attachment Bolts and Nuts (Items 605 and 609).
m. Sh. 4 & 5: Correct the duplicate Item 602 used for both the Top and Bottom Side Impact Absorbers: Item 602 on sh. 4 is **[Withheld per 10 CFR 2.390]** thick, while item 602 on sh. 5 is **[Withheld per 10 CFR 2.390]** thick.

This information is required to satisfy the requirements of 10 CFR 71.45, 71.71, and 71.73.

Holtec Response:

The following responses correlate to the lettered list provided in the comment.

a) The intention of Note 6 is to allow the addition of minor NITS parts or welds (such as seal welds intended only to prevent crevices between adjacent parts) to the cask that may be desirable for operations. It is understood that an evaluation must be performed to characterize all cask components as either ITS or NITS, with the distinction that the characteristics (configuration, materials, etc.) of ITS components will have an impact on the safety functions of the cask while NITS components will not. Like all other components, the addition of any NITS components is documented in the ITS Categorization Report (HI-2220203) which includes some justification for their classification. Holtec believes this approach effectively assures compliance with the safety evaluation of the cask while providing some minor flexibility in the cask's fabrication details, which may be desired, for example, to reduce the time for loading operations or simply provide more convenience for the operators.

b) The intention of Flag Note 6 is to provide a simple inspection mechanism for the oddly shaped impact absorbers that ensures the as-built profiles adequately represent those used in the structural analysis. Specifically, the intent is to place a calibrated inspection plate of the profile form shown in the licensing drawing on each impact absorber and verify that the impact absorber size exceeds the plate size at all locations. This is considered to be more effective than performing individual inspections of radii and linear offsets from axes and center points that could actually skew the final profile in unanticipated ways unless tolerances are held very tightly. As implied by the question, however, it is understood that significant variation in the maximum size of the impact limits would also lead to configurations that differ markedly from the analysis models. Therefore, Flag Note 6 is modified to state: TO ENSURE THE MINIMUM REQUIRED MATERIAL FOR IMPACT ENERGY ABSORPTION IS PRESENT, THE FABRICATED ABSORBER PLATE PROFILE SHALL BE EQUAL TO OR EXCEED THE PROFILE SHOWN. A CALIBRATED TEMPLATE MAY BE USED FOR THIS MEASUREMENT. TO ENSURE CONFORMITY IN THE OVERALL SIZE OF EACH IMPACT ABSORBER, THE ABSORBER MATERIAL PROFILE SHALL NOT EXCEED THE TEMPLATE BY MORE THAN **[Withheld per 10 CFR 2.390]** AT ANY LOCATION.

c) The intent of the note by the **[Withheld per 10 CFR 2.390]** MAX dimension on the optional tie-down bars is to allow tie-down bars to be included on the cask in any location necessary for any operations that require securing the cask in place. The presence of tie-down bars does not affect the cask's shielding performance, and the limitation on their protrusion length ensures that they are not engaged in any drop onto a flat surface, as the impact limiter crush will not allow it. Four tie-down bars are shown in the drawing as a likely example of the numbers that are anticipated to be used. However, to allow the use of additional tie-down bars, the quantity of tie-down bars (Item 13) in the BOM is changed to "AS REQ-D".

d) A DETAIL view of the cask seal dimensions and locations is added to licensing drawing 12482.

e) The surface finish requirement for the o-ring sealing surfaces (cask groove and lid seating surface) is added to the DETAIL view in licensing drawing 12482.

f) The response provided for Obs-St-11 answers this question. The trunnions and tie-down bars are similar in design, and both are discussed in the response to Obs-St-11.

g) The purpose of the eight scuppers on the corners of the cask is to allow any water that could possibly accumulate in the gap between the lid and cask flange to drain. They are a precautionary feature, as the top impact limiter strongback protects the region from rainwater during shipment and there are no wet operations performed during cask loading. The limitations for the size of the scuppers in Table A-1 of HI-2240470 are provided to establish a bounding size for localized shielding reduction. Structurally, the location of the scuppers has minimal impact on the cask. The horizontal distance from the edge of the cask to the scuppers is added to drawing 12482.

h) With respect to ASME BPVC Section NB, the applicable requirement specified in the SAR is compliance with the Level A stress intensity limits for normal conditions and Level D stress intensity limits for accident conditions. Because the cask is not a pressure vessel, stress intensity at the bolted regions where material is removed is not increased during normal operations. Reinforcement at the bolted regions, as required for local penetrations of pressurized vessels per Section NB, is not necessary. For accident conditions (that is, cask drop scenarios), stress generated in the bolted regions is considered secondary and not subject to the Level D limits. However, Holtec recognizes that "unspecified" limits on the bolt number, size and location could create an interpretation of the drawing that would allow significant removal of material that would affect the cask's overall structural response to accident conditions. Therefore, the note on the view in drawing 12184 that shows the typical attachment bolt is changed to: TYPICAL OPTIONAL ATTACHMENT BOLT (NITS) TO AID IN POSITIONING OF COMPONENTS DURING FABRICATION. BOLTS MAY BE INSTALLED IN MULTIPLE LOCATIONS, AND LEFT IN PLACE WITH STEEL PLUGS (NITS) INSTALLED AND SEAL WELDED TO PREVENT RADIATION STREAMING. MAXIMUM BOLT SIZE SHALL BE **[Withheld per 10 CFR 2.390]**, WITH A MINIMUM OF **[Withheld per 10 CFR 2.390]** OF SPACING BETWEEN BOLTS.

i) Height, width and length of the impact limiter strongback are added to drawing 12482.

j) Add nominal dimension in the SIDE VIEW OF TOP IMPACT ABSORBER, showing the vertical locations of the strongback bolts in relation to its top surface.

k) The side plates are part of the bracket set (Item 604 of drawing 12482), so are fabricated from a minimum **[Withheld per 10 CFR 2.390]** thick stock plate. Thicker stock plate sizes are allowable if needed for manufacturing or operational reasons. The material requirements for the bracket sets are listed in Table 8.1.5. For consistency between the drawing and SAR, the nomenclature in the SAR is changed to "Impact Absorber Attachment Bracket Sets". The bracket sets are ITS, as they are listed in the "ITS COMPONENTS" table on the drawing. Their specific safety category is ITS-C, as listed in Table A-1 of the ITS Categorization Report (HI-2220203). For consistency between the drawing and HI-2220203, the nomenclature in the Table A-1 of the report is changed to "Impact Absorber Attachment Bracket Sets".

l) The bolt pattern for all the Impact Absorber Attachment Bolts is identical for all attachment brackets. Their locations have been added to Sheet 6 of drawing 12482. Note that the location of several of the bolts has been adjusted slightly in Revision 6 of drawing 12482, to allow a chamfer to be added to the bracket as discussed in another section of these responses.

m) For licensing purposes, the drawing generically refers to the side impact absorbers as Item 602 since the profile shown on Sheet 6 of the drawing and the material specified in

Table 8.1.5 of the SAR are the same. The different thicknesses of the plate are shown on Sheets 4 and 5 of the drawing, and a Note at the profile dimensions shown on Sheet 6 provides further explanation. Holtec believes that no additional changes to the drawing 12482 are needed to fully define that parts' dimensions.

St-17. SAR, HI-2210970, Rev. 0, The following information is requested to be provided or revised on Drawing 12596, "Liner Tanks and Cassettes," Revision 1, in SAR section 1.3 in order that the function of the overall package and/or the individual component may be properly assessed:

a. Sh. 2: Provide the typical weld detail for the Liner Tank long side plate (Item 2) to short side plate (Item 3) joint, if one is intended.
b. Sh. 2, Detail 2C: Per Calculation 4 of HI-2210998, the Top Cover protrusion into the Liner Tank cavity protects the lid bolts from all shear loads by bearing on the side wall. Therefore, provide much more detail on the Top Cover (Item 4) protrusion, including dimensions and proximity to the side plates. Also provide dimensions for the vertical gap between the bottom of the Cover surface and top of the side wall. Indicate whether the seal shown resides in a groove in the top of the side wall plate, including its location, depth and width dimensions, as applicable.
c. Sh. 4, for Liner Tank T-150MDL Configuration: Justify the use of a **[Withheld per 10 CFR 2.390]** fillet weld for joining a minimum **[Withheld per 10 CFR 2.390]** to maximum **[Withheld per 10 CFR 2.390]** thick plate.

This information is required to satisfy the requirements of 10 CFR 71.71 and 71.73.

Holtec Response:

The following responses correlate to the lettered list provided in the comment.

a. Additional Note 2 in licensing drawing 12596 states that the drawing only specifies safety-related welds necessary to retain the component's structural configuration. The welds between the side walls are therefore not shown. However, Holtec does recognize that the welds between the side plates do provide a sealing function for retention of the loaded waste. Therefore, Additional Note 2 is revised as follows: ONLY SAFETY-RELATED WELDS, NECESSARY TO RETAIN THE LINER TANK OR CASSETTE CONFIGURATION, ARE SHOWN. ADDITIONAL SEAL WELDS ARE APPLIED AT ALL OTHER JOINTS (FOR EXAMPLE, SIDE-WALL TO SIDE-WALL JOINTS) TO RETAIN THE LINER TANK CONTENTS. MINIMUM SEAL WELD SIZE (FILLET OR GROOVE) IS **[Withheld per 10 CFR 2.390]**.
b. The Liner Tank closure lid bolts are not subjected to shear loading when the transport package is subjected to side drop conditions. This is due to the geometric configuration of the closure system. Specifically, the bolt hole and bolt clearance is greater than the relief gap between the containment vessel sidewall and the containment top flange. As a result, when a side drop occurs, the closure lid contacts the containment top flange before any contact or engagement occurs between the bolt shank and the hole wall. Therefore, no analysis is warranted for the Liner Tank top closure bolts when the transport package is subject to side drop loadings. The seal between top of the side wall and bottom of top cover surface is not important to safety (NITS). The only requirement from structural standpoint is that the bolts do not incur gross failure. Therefore, the Liner Tank seal function is not critical for the cask safety demonstration.
c. Calculation #4 is updated to include the weld validation for bounding loading and its updated to **[Withheld per 10 CFR 2.390]**.

St-18. SAR, HI-2210970, Rev. 0: Justify the omission of several potentially bounding ASME Code Level D stress intensity limits indicated in SAR tables 2.1.2A and 2.1.2B for Section III Class I Pressure Vessels and Bolts, respectively, as noted below. Also justify a reference to Subsection NF-3324.6 in note 3 of table 2.1.2B when it seems Subsection NB should apply since the table is applicable to containment bolts:

a. Table 2.1.2.A, Primary Membrane limit shown is true for high-nickel alloy in ASME table 2A, otherwise, for ferritic steels, the limit is only **[Withheld per 10 CFR 2.390]**.

b. Table 2.1.2.A, [Local] Membrane plus Primary Bending limit shown is one limit, but other is based on a collapse load limited by yield stress.

c. Table 2.1.2.A, Primary Membrane plus Primary Bending limit shown is one limit, but other is based on a collapse load limited by yield stress.

d. Table 2.1.2.B, Average Service Stress limit, per F-1335.1 is the smaller of Sy or **[Withheld per 10 CFR 2.390]**. Unless Su is greater than **[Withheld per 10 CFR 2.390]** at operating temperature, the limit is Su.

This information is required to satisfy the requirements of 10 CFR 71.31(c).

Holtec Response:

a. It is correctly noted that the primary membrane limit for the ferritic steels as **[Withheld per 10 CFR 2.390]** and min. of **[Withheld per 10 CFR 2.390]** and **[Withheld per 10 CFR 2.390]** for austenitic steel. Table 2.1.2A is updated to distinguish this limit by material.
b. The collapse load limit specified in terms of material yield is applicable for static (or equivalent static) loads. Given that the drop analysis considers dynamic loading wherein the non-linear effects are appropriately considered, the collapse load criteria is not applicable for this loading scenario.
c. The Same response utilized for point “b” is applicable here.
d. The limit set on Average Service Stress for Level D loading is based on elastic stress evaluation; however, the overriding acceptability of the joint design is performance based on an assured absence of leakage. The same limits for the bolt average service stress were used for HI-STAR ATB-1T (Docket #9375), HI-STAR 180 (Docket #9325) and HI-STAR 180D (Docket #9367).

St-19. Justify the specification of the closure lid bolting material as SA-564/SA-705 Gr 630 H1025 as it is not an acceptable material per American Society of Mechanical Engineers (ASME) BPVC Section III, Division 1, Subsection NB, which is cited as the reference Code for the design and construction of the HI-STAR 330 containment cask in SAR section 2.1.1.1 and per the table on sheet 1 of drawing 12482, “HI-STAR 330 Type B/C Waste Transport Cask.”

Throughout the SAR and supporting calculations, citations of alternate design material parameters are made due to this containment bolting material not appearing in the required Code tables, e.g., SAR tables 2.1.7 and 2.2.2 and calculation 7, “Differential Thermal Growth of the Closure Lid and Bolt During Fire” in report HI-2210998. Provide justification for the use of this containment bolting material and the alternate design material properties and stress allowables. Note that for SAR table 2.1.7, article NB-3232.2 directs that the allowable stress intensity be drawn from Table 4 of ASME Section II, Part D, Subpart 1.

This information is required to satisfy the requirements of 10 CFR 71.31(c).

Holtec Response: Since HI-STAR 330 package is not a pressure vessel, it need not necessarily follow all the ASME rules meant for the boiler and pressure vessels. However, the package qualification uses the stress limits from ASME Section III, Subsection NB per the recommendations from Reg. Guide 7.6.

Moreover, this is a proven bolting material and has been used in prior transport applications HI-STAR 180 (Docket #9325) and HI-STAR 180D (Docket #9367).

St-20. In the SAR section 2.1.2, Design Criteria, table labeled "Conformance with Reg. Guide 7.6 Provisions on the Structural Requirements for HI-STAR 330 Containment Boundary," justify the entries regarding considerations of fatigue, where it is stated that there are no significant cyclic loads on the HI-STAR 330 package, therefore no fatigue curves are utilized. Similar statements appear in SAR section 2.6.5, Fatigue Considerations. Also, consider comments noted below to SAR table 2.6.5, "Results for Fatigue Assessment."

Over the 40- or 50-year package life, the package will experience a considerable number of stress cycles under normal conditions of transport. This cumulative stress shall be evaluated. Furthermore, staff notes that a fatigue evaluation of the containment side plates were performed under normal conditions of transport and documented in calculation report HI-2210998, supplement/calculation #9. The resulting number of cycles limit for the associated stress is presented in SAR table 2.6.5. However, since there is no indication as to what the expected number of cycles the package will experience included in the table, it is unknown whether the package adheres to this limit.

SAR table 2.6.5 "Number of Cycles" column is assumedly intended to indicate the quantitative limit associated with the computed stress. If so, it is recommended that the "greater than" (>) symbol either be deleted or changed to a "less than" (<) symbol for the Containment Wall Plates and Closure Flange Internal Threads Entries.

This information is required to satisfy the requirements of 10 CFR 71.71.

Holtec Response: As there are no significant cyclic loads on the HI-STAR Package, fatigue is not critical for this package. However, the minimum number of cycles required are estimated in Calculation #9 of HI-2210998 for the closure lid bolts and the containment flange threads. The minimum number of bolting cycles are specified in Table 8.1.5 of the SAR. The "greater than" (>) symbol is changed to a "less than" (<) symbol for the Containment Wall Plates and Closure Flange Internal Threads Entries.

St.21. SAR, HI-2210970, Rev. 0: Review and update entries in SAR table 2.2.3, "Mechanical Properties of Trunnion Material," as follows:

a. Include identification of trunnion material in header of table as "SA-479 S21800" to agree with SAR table 8.1.5 and Calc #1 of report HI-2210998.
b. Note 2 states that Su is not found in table U, however, staff located an entry on p. 521, line 36, where Su at 100 °F is **[Withheld per 10 CFR 2.390]**; correct Su values at all temperatures and delete note 2.

This information is required to satisfy the requirements of 10 CFR 71.31(c).

Holtec Response:

a. The table header is identified with “SA-479 S21800” to agree with Table 8.1.5 and Calc #1 of report HI-2210998.
b. Note 2 of Table 2.2.3 is updated to cite Table U of ASME code. The note also mentions that limiting values from Table 8.1.5 are used.

St-22. SAR, HI-2210970, Rev. 0, Review and update SAR table 2.2.4, “Mechanical Properties Dose Blocker Structure,” where it seems SA-516 Gr 70 is a Group 2 steel. Therefore, values of “α”, should be from Group 2 in ASME table TE-1, necessitating a revision of the column entries and note 3.

This information is required to satisfy the requirements of 10 CFR 71.31(c).

Holtec Response: SA-516 Gr 70 is a carbon steel material. Per Table TE-1, the carbon steel is a Group 1 material. Hence no change is warranted.

St-23. SAR, HI-2210970, Rev. 0: In SAR table 8.1.5, explain why, for the Lifting Trunnions and Tie-Down Bar entries, the yield and ultimate strength values listed do not agree with those published in the ASME table 2A for SA-470 S21800 at 200 °F, of **[Withheld per 10 CFR 2.390]** and **[Withheld per 10 CFR 2.390]**, respectively.

The values tabulated are lower than those employed in the structural evaluations, which may result in an inadequate as-built design.

This information is required to satisfy the requirements of 10 CFR 71.71 and 71.73.

Holtec Response: The material strength properties for the Lifting Trunnions and the Tie-Down Bar entries in Table 8.1.5 now mention the minimum guaranteed properties as **[Withheld per 10 CFR 2.390]** for yield and **[Withheld per 10 CFR 2.390]** for ultimate strength. The same strength properties are used in the calculations to be consistent with Table 2.2.3 and Table 8.1.5, which results in conservative estimate of the safety margins.

St-24. SAR, HI-2210970, Rev. 0: Indicate where the compliance with RG 7.6 guidance for extreme total stress intensity is documented for the HI-STAR 330 package.

Entry number 7 of the SAR section 2.1.2 table titled “Conformance with Reg. Guide 7.6 Provisions on the structural requirements for HI-STAR 330 Containment Boundary,” indicates that the guidance for the extreme total stress intensity range has been complied with but does not indicate specifically where this compliance is documented in the SAR or elsewhere.

This information is required to satisfy the requirements of 10 CFR 71.71 and 71.73.

Holtec Response: Per Regulatory Guide 7.6, the extreme total stress intensity range between the initial state, the fabrication state, normal service conditions and the accidental conditions need to be considered for fatigue analysis. This case is now addressed in Section 2.6.5 of the SAR.

St-25. SAR, HI-2210970, Rev. 0: Identify the correct expected service life of the HI-STAR 330 package.

SAR section 1.1 indicates a package service life of 40 years while Section 2.2.3 indicates that the package will be in use for 50 years. The correct information is required to assess package acceptability for several age-related characteristics of the package.

This information is required to satisfy the requirements of 10 CFR 71.33.

Holtec Response: The service life of the package is updated to 40 years in Section 2.2.3 to be consistent with Section 1.1.

St-26. SAR, HI-2210970, Rev. 0: Justify the examination procedures and statements made in SAR section 8.2.3(iii) regarding the Cask Lid Closure and Liner Tank Bolts.

The application states that the Cask Closure Lid Bolts are to be examined per ASME Section III Subsection NF-2582. However, since these bolts are part of containment, greater than **[Withheld per 10 CFR 2.390]** in diameter, and stainless steel, it seems they should be examined per Subsection NB-2582 and NB-2585.

The application states that the Liner Tank Bolts are to be examined to ensure that the licensing drawings, i.e., 12596, are met, otherwise, replacement is required. However, no bolt examination requirements could be found on the drawings.

The application states that bolting of the Liner Tank Top Cover is expected to be a one-time event, which does not seem to be a correct statement. It is also stated that frequent installation of the Liner Tank Top Cover is not anticipated, thus no fatigue analysis is required for the Liner Tank Bolts or internal threads. Staff would anticipate, however, that the Liner Tank Top Cover and its Bolts would be installed as frequently as the Containment Closure Lid and its Bolts, which are being replaced due to fatigue considerations per the maintenance schedule in SAR table 8.2.1. Please clarify this apparent discrepancy.

This information is required to satisfy the requirements of 10 CFR 71.31(c).

Holtec Response: Holtec agrees that the cask closure lid bolts shall be examined per ASME NB-2582 and NB-2585. Subsection 8.2.3 of Chapter 8 has been revised to reflect this.

The liner tank bolts are not designed or examined per ASME pressure vessel standards, and are therefore only examined to ensure the necessary thread size and thread engagement specified on drawing 12596 are achieved. As the liner tanks are disposable along with the waste contents, it is a true statement that bolt installation should be a one-time event. At best, bolts may be removed and installed only a very limited number of times, should loading operations require multiple openings of the liner tanks for unforeseen reasons. Fatigue due to repeated installation is therefore not a structural concern.

St-27. HI-2210998, Revision 0, “Structural Calculation Package for HI-STAR 330 Transport Package,” Calculation #1, “Lifting Trunnion Stress Analysis”:

a. p. 1-1 and 1-5: States that the trunnion evaluation for 3 times the lifted load versus the yield strength is not warranted, however, this is a requirement of 10 CFR 71.45(a).
b. p. 1-2: The “Su_t” value for trunnion at 200 °F is stated as **[Withheld per 10 CFR 2.390]**, which currently conflicts with the lower values shown in SAR tables 2.2.3 and 8.1.5.
c. p. 1-4 and 1-7: The length of trunnion inserted into dose blocker plate, “Lt_h,” is defined as **[Withheld per 10 CFR 2.390]** but is actually **[Withheld per 10 CFR 2.390]**, per the Dimensional Summary Document, HI-2240470.

Holtec Response:

a. The statement that "the trunnion evaluation for 3 times the lifted load versus the yield strength is not warranted" will be updated to "additionally, the trunnion is also evaluated for 3 times the lifted load versus the yield strength" on p. 1-1 and 1-5.

b. The "Su_t" value for trunnion at 200 °F will be updated per the updated values presented in SAR Tables 2.2.3 and 8.1.5.

c. Holtec agrees with the comment raised. The length of trunnion inserted into the dose blocker plate "Lt_h" ranges from **[Withheld per 10 CFR 2.390]** to **[Withheld per 10 CFR 2.390]** per the Dimensional Summary Document, HI-2240470. However, Minimum calculated length of insertion is lower (**[Withheld per 10 CFR 2.390]**) and bounding for the calculation.

St-28. HI-2210998, Revision 0, "Structural Calculation Package for HI-STAR 330 Transport Package," Calculation #4, "Liner Tank and Liner Tank Cassette Evaluation":

a. p. 4-2: The bounding temperature of Liner Tank Cassette plates for NCT is stated to be **[Withheld per 10 CFR 2.390]**, however, table 8.2 of the Thermal calculation, HI-2240063, indicates a temperature of **[Withheld per 10 CFR 2.390]**.
b. p. 4-3: Plate length and width dimensions employed are not maximum dimensions.
c. p. 4-5: The calculated allowable bucking stress is a large number determined via the theoretical realm, which should be disregarded, and limited by the material compressive stress limit.
d. P. 4-6: The reported tank deceleration of **[Withheld per 10 CFR 2.390]** appears to be lower than the maximum that appears on the referenced graph.
e. p. 4-6: The Case 2 check appears to be enveloped by Case 1, where a conservative load is employed to evaluate a conservative Section of wall for buckling and compression for a lower deceleration value. If it is determined that Case 2 is required, justify the methods for loading determination and buckling resistance determination as conservative.
f. p. 4-12: Section 6.1 examines the strength of the bottom plate liner tank weld for the NCT side drop condition, where shear forces would predominate the response, based on a **[Withheld per 10 CFR 2.390]** acceleration. However, all welds resist a combination of tensile, compressive, and shear forces. Therefore, the acceleration that this weld must resist is at least **[Withheld per 10 CFR 2.390]**, which is experienced by the bottom plate of the liner tank according to rigid body acceleration results for the NCT Bottom End case (BED Cassette).
g. p. 4-13, 4-16: Section 6.2 evaluates the top plate bolts, referring to Figure 8.9.4 of Drop Calculation, HI-2240059, which does not appear to exist. It is stated that the top plate bolts are analyzed for a deceleration value of **[Withheld per 10 CFR 2.390]** and **[Withheld per 10 CFR 2.390]** for Dunnage tanks. A deceleration of **[Withheld per 10 CFR 2.390]** from Bott End NCT (BED-Cassette Scenario) appears to be the correct acceleration for the analysis, but it is not clear what is meant by "dunnage tanks."
h. p. 4-13, 4-14, 4-17 to 4-19: Explain why although it is stated that the lid bolts will not have any shear transmitted to them due to the lid geometry having a shear ledge, 1) the bolts and this lid ledge are not explicitly included in the LS-DYNA model and 2) the calculation goes on to determine shear loading on the bolts and inserts.
i. p. 4-14: For the Nitronic thread insert material, provide specific ASME Code references for allowable stresses and check material values versus those in SAR table 2.2.3, which has RAI comments.
j. p. 4-22: for the unbraced length determination for the pipe, a citation is made to "flag note 7" on dwg. 12596, however no such note appears to exist.

k. p. 4-22: it is stated that the safety factor determined is valid for the T-100, T-150 versions of the Liner Tank Cassette "which has the wall support beams as an ITS component." Confirm the validity of this note, as the ITS designation of the wall support beams cannot be found on the dwg. 12596 or in table A-2 of the ITS designation report HI-2220203.

p. 4-22: it is stated that the T-150DL and T150MDL versions of the Liner Tank Cassette "does not have corner tubes (item 7)". Confirm the validity of this note, as dwg. 12596 does not appear to show these two versions of the Liner Tank Cassette (LTC).

Holtec Response: The latest revision of the report HI-2210998 will be updated with the following updates:

a) The bounding temperature of Liner Tank Cassette plate for NCT will be updated to **[Withheld per 10 CFR 2.390]** as per HI-2240063.

b) Per DWG 12482, bounding cavity dimensions are employed for the plate length and width.

c) Additional evaluation for compressive loading on the side plate is added to the latest revision.

d) This was a typo in Figure reference. However, the deceleration value is updated as per latest bounding results and referenced appropriately.

e) Yes, Case 1 envelopes Case 2. Case 2 evaluation is removed.

f) Acceleration load of **[Withheld per 10 CFR 2.390]** will be applied as per the latest revised drop simulation. This acceleration load of **[Withheld per 10 CFR 2.390]** is used from NCT Bottom End Drop case.

g) Reference Figure 8.9.4 name is corrected in latest revision.

   -The deceleration value of **[Withheld per 10 CFR 2.390]** was wrongly used as it is for the bottom plate (This will be corrected in the report HI-2240059), however, the deceleration value for top lid is **[Withheld per 10 CFR 2.390]** (g load acting in a way which separates the plate from cask and loading the lid bolts in tension).

   Dunnage tanks are the Direct Loading Tank variants of Liner Tanks which do not use cassettes. However, the verbiage "Dunnage will be removed from latest revision of the report.

h) 1. The bolts are evaluated separately from the bounding acceleration load in calculation package. The Lid ledge was not modeled for simplification purposes. 2. The shear in bolts is evaluated for thread stripping due to tensile load from the drop/ rebound. The bolt shank pure shear is not credible due to the geometric features and the allowances of the closure lid bolt holes and containment top forging.

i) Thread insert is omitted from the latest revision, as the calculation without the thread insert is more critical due to higher load acting on lesser shear areas of plate hole and the insert material is stronger than the plate.

j) It was an unnecessary flag note citation; it has been removed in the latest revision. This free length of pipe is subjected to buckling load.

k) The statement related to wall support beam is removed. It is not referenced in 12596 or in Table A-2.

For T-150DL and T150MDL versions, there is no Liner Tank Cassette. The corner tubes are part of Liner Tank Cassette. This description can be found in DWG 12596- Additional Note 1.

St-29. HI-2210998, Revision 0, "Structural Calculation Package for HI-STAR 330 Transport Package," Calculation #5, "Strength Evaluation of Cask Tie-Down Devices":

a. Since the center-of-gravity of the package is above the bottom frame, some portion of the overturning loads caused by lateral and longitudinal accelerations would be expected to be transferred to the Trunnions.
b. Identify where lower (optional) tie-down devices (item 13 on drawing 12482, "HI-STAR 330 Type B/C Waste Transport Package") are checked for structural adequacy, for what loading, and how they interface with the lower transport frame.

Holtec Response:

a) Holtec is in agreement with the comment raised. It will be negligible because the bottom frame's **[Withheld per 10 CFR 2.390]** angular cut will resist overturning at the Liner Tank Bottom plate line. However, the overturning axis will shift to the lines marked in below image where Center of gravity height will be measured from this virtual overturning line plane.

[Withheld per 10 CFR 2.390]

b) The lower (optional) tie-down devices (item 13 from [1]) are provided to tie down the cask in case of a different bottom support frame, if any. However, current HI-STAR 330 transport package will not be using any other bottom support frame. Therefore, evaluation of lower (optional) tie down devices is not warranted. This is fully justified in calculation#5 of the latest revision.

St-30. HI-2210998, Revision 0, "Structural Calculation Package for HI-STAR 330 Transport Package," Calculation #6, "Frequency of Loaded Cask":

a. Section 6.1: Verify that lowest frequency has been determined, as it appears that the other support direction may produce a lower value.
b. Section 6.2, Material properties of Poisson's ratio and density for stainless are being utilized although the containment material is not stainless steel.

Holtec Response:

a. The frequency calculation in Section 6.1 is updated to consider the vertical cavity height, instead of the longer cavity width to estimate the lowest frequency.
b. The material properties for the containment material (SA-203-E with composition 2 ½ Ni) are: Poisson's ratio = **[Withheld per 10 CFR 2.390]** and density = **[Withheld per 10 CFR 2.390]**. The value of density will be updated in the latest revision.

St-31. HI-2210998, Revision 0, "Structural Calculation Package for HI-STAR 330 Transport Package," Calculation #7, "Differential Thermal Growth of the Closure Lid and Bolt During Fire":

a. p. 7-1 and 7-2: The objective of the calculation is stated to determine the maximum differential growth at the closure lid seat to verify that it does not exceed the seal useful springback of **[Withheld per 10 CFR 2.390]**, however, this value does not appear to be determined in this calculation. It is also stated that the closure lid temperature is assumed to be at a conservative temperature corresponding to NCT for the calculation, but this also does not appear to be the case.

b. p. 7-1: The temperatures of the closure lid and bolt are defined as being “bulk” temperatures for NCT, however, they are both ”local” temperature results from the HAC fire event.

c. P. 7-1: The length of the bolt and thickness of lid that should be considered for the determination of differential thermal expansion is from below the bolt head to the bottom of the lid, not the entire lid, flange and bolt length.

d. P. 7-2: The bolt is initially in tension from preload. The bolt lengthening from thermal would decrease bolt tension, while the lid expanding upward would increase tension on the bolt.

e. P. 7-2: The allowable tensile stress on the bolt for service level D conditions, per ASME Appendix F, F-1335.1 (and SAR table 2.1.2B) is the smaller of Sy or **[Withheld per 10 CFR 2.390]**, unless Su is greater than **[Withheld per 10 CFR 2.390]** at operating temperature, then the limit is Su.

Holtec Response:

a. The differential thermal growth (Δδ estimated on p. 7-2) is the maximum opening of the seal that can occur. A statement will be added that “The differential thermal growth estimated herein is less than the useful springback of **[Withheld per 10 CFR 2.390]**”. The closure lid temperature is taken for the fire accident as a local temperature. This will be updated in the calculation.
b. The term “bulk” will be replaced by “local” temperature for the fire accident case for both, the bolt and the lid. This will be updated in the calculation.
c. The length of the bolt and thickness of lid will be updated to consider it from below the bolt head to the bottom of the lid to determine the differential thermal expansion.
d. Holtec agrees with the comment. Thus, the resultant difference in thermal expansion is observed more than the spring-back.
e. The allowable tensile stress on the bolt for service level D conditions is updated per ASME Appendix F, F-1335.1 in the latest revision of the report.

St-32. HI-2210998, Revision 0, “Structural Calculation Package for HI-STAR 330 Transport Package,” Calculation #9, “Closure Lid Bolts Preload and Containment Fatigue Evaluation”:

a. p. 9-1: Material properties of density for stainless steel are being utilized although the containment material is not stainless steel.
b. p. 9-2: Explain how the width and length of rectangular gasket slot on closure lid measurements were determined; source of **[Withheld per 10 CFR 2.390]** is not cited.
c. p. 9-4: Explain why the Young’s modulus of the bolt at **[Withheld per 10 CFR 2.390]** was chosen when other bolt properties employed in the calculation correspond to **[Withheld per 10 CFR 2.390]**.
d. p. 9-4: The Average service stress allowable is **[Withheld per 10 CFR 2.390]**, however the Maximum is **[Withheld per 10 CFR 2.390]**. ASME Figure I-9.4 is still used, but curve

for Maximum nominal stress of **[Withheld per 10 CFR 2.390]** is employed, so cycle limit reduces to **[Withheld per 10 CFR 2.390]**.

This information is required to satisfy the requirements of 10 CFR 71.31(c), 71.33, 71.45, 71.71 and 71.73.

Holtec Response:

a) The density of the containment material (SA-203-E with composition 2 ½ Ni) is updated in the latest revision.

b) The seal length calculation approach is revised, and it is measured from the cavity dimensions of the cask.

c) The temperature **[Withheld per 10 CFR 2.390]** mentioned on p. 9-4 is a typo. The Young's modulus for the bolting material at **[Withheld per 10 CFR 2.390]** is **[Withheld per 10 CFR 2.390]** which is correctly used in the evaluation of the effective stress amplitude. The typo **[Withheld per 10 CFR 2.390]** is corrected to **[Withheld per 10 CFR 2.390]** in the latest revision.

d) Agree. The Maximum allowable service stress for the bolts is **[Withheld per 10 CFR 2.390]**. For a stress amplitude of **[Withheld per 10 CFR 2.390]**, the cycle limit can be conservatively estimated to **[Withheld per 10 CFR 2.390]** cycles (although it can be seen from the curve that the value exceeds **[Withheld per 10 CFR 2.390]** cycles). This is updated in the calculation.

[Withheld per 10 CFR 2.390]

St-33. HI-2210998, Revision 0, "Structural Calculation Package for HI-STAR 330 Transport Package," Calculation #3, "HI-STAR 330 Cask Analysis for External Pressure and Compression Test": p. 3-5, 3-7, and 3-9, the majority of stress result values presented in table 9.1 do not appear to match the stress maxima presented in Figures 11.4 and 11.7, e.g., Fig 11.4 wall plate maximum stress is **[Withheld per 10 CFR 2.390]** ksi.

Holtec Response:

- The stress values reported in Table 9.1 are taken from the contour plots (intermediate stress levels from the contour legend), representing the Primary Membrane plus Primary Bending stress induced in the respective components. The maxima stress state (which may include secondary and/or peak stress) is omitted when the induced primary membrane plus primary bending in the components is considered. However, a note will be added in Table 9.1 to explain this criterion.

St-34. Justify the use of the 2013 edition of the ASME Boiler and Pressure Vessel Code (BPVC) for the design, procurement, fabrication, examination, and testing of the HI-STAR 330 transportation package, rather than a more contemporary edition, given that the initial application is being submitted in 2025.

Section NCA-1140 of the ASME BPVC (in both 2013 and 2023 editions) indicates that the item being designed shall employ a code edition dated no earlier than 3 years prior to the date that the application is docketed with the regulatory authority. This statement, with some exceptions, is written specifically for nuclear power plants, however, ASME Section III, Division 1 has traditionally been employed for nuclear transportation package design. Confirm how the use of 2013 edition provides a commensurate level of safety when compared to the more contemporary edition for design items such as stress-strain curves, fatigue curves, inspection techniques and requirements, code-approved materials, acceptance testing, etc., as necessary. Provide the technical and commercial rationale for choosing to employ an ASME BPVC edition that is outdated by a dozen years at the time of a new transportation package design application submittal.

This information is required to satisfy the requirements of 10 CFR 71.31(c).

Holtec Response:
Per Regulatory Guide 7.6, ASME Boiler and Pressure Vessel Code (BPVC), Section III was developed for reactor components, not fuel casks, and many of the Code's requirements may not be applicable to fuel cask design. As the HI-STAR 330 is a non-fuel waste cask, use of ASME Boiler and Pressure Vessel Code (BPVC), 2013 is justified. Moreover, since the HI-STAR 330 is not necessarily a pressure vessel or a reactor component, every aspect of the ASME code is not applicable to its design.

St-35. Provide responses to the following questions on items pertaining to HI-2220203, Revision 0, "HI-STAR 330 Cask ITS Categorization Report":

a. Table A-1: Explain why NITS "scuppers" shown on the licensing dwg. 12482 in the SAR are not included in this table.

b. Table A-1: Better explain/specify which item "Impact Absorber Attachment Bolt Washers" refers to. The licensing dwg. 12482 blow-up of Section 4A-4A indicates both a "steel strongback washer" and a "strongback bolt spacer"; perhaps it is one in these two. If so, it seems the other item is not included in the list of this document

c. Table A-2: A line entry for "set screw" indicates it is for Liner Tank shielding, but none could be located on the licensing dwg. 12596.

This information is required to satisfy the requirements of 10 CFR 71.33.

Holtec Response:

The following responses correlate to the lettered list provided in the comment.

a. The scuppers were mistakenly missed in Table A-1 of HI-2220203. They have been added.

b. The line item in Table A-1 refers to the "STEEL STRONGBACK WASHER" on Sheet 4 of drawing 12482. For consistency, this items in both drawing 12482 and HI-2220203 are changed to state "STRONGBACK ATTACHMENT BOLT WASHER". The part labeled STRONGBACK BOLT SPACER is added to HI-2220203.

c. The term "SET SCREW" in Table A-2 is referring to shielding plugs that are used to fill shop handling holes in the liner tanks as discussed in Flag Note 2 of drawing 12596. These are often filled by inserting a threaded set screw or other similar part. To provide more clarity, the line item in HI-2220203 is changed to "Plugs for Shop Handling Holes (for example, Set Screws)".

St-36. EDITORIAL

1. Remnants from HI-STAR ATB 1T that require correction:
   a. "cask lid locking system" (in SAR 2.1.2.2(i)e).
   b. "cask…is a stainless steel…weldment…" (in SAR 2.3 and throughout).
   c. Dose blocker structure "closure lid outer plate" (in SAR 2.3).
   d. Remove reference to BFA Tank terminology, as it is not used or defined in the SAR (in HI-2220203, revision 0, "HI-STAR 330 Cask ITS Categorization Report" and Calculation #6 of HI-2210998).

2. Reference 1.1.1 (IAEA SSR-6) does not appear to be cited in this SAR.

3. SAR section 1.2.1.6 refers to Figure 1.3.1, however, Figure 1.2.3 appears to be the correct figure number.

4. SAR table 2.1.1, "Structural Loading Events and Associated Acceptance Criteria for HI-STAR 330," for Lifting Trunnions, and SAR section 2.1.2.1.1 states that the Trunnions are designed for a Factor of Safety of 5 against ultimate strength considering a redundant load path, but Calc #1 of report HI-2210998 stated that it uses a Factor of Safety of 10 considering a redundant load path.

5. Figure 2.3.6 cited in SAR sections 2.1.2.2(v), 2.2.1.6, and 2.6.1 does not appear to exist.

6. Update Reference 2.1.9 (NUREG-1617),cited in SAR section 2.1.4, to current SRP (NUREG-2216).

7. SAR table 2.2.1, "Mechanical Properties of Containment Components":
   a. Remove **[Withheld per 10 CFR 2.390]**, for first Temperature entry as this does not appear in ASME;
   b. If table is intended to display properties for both SA-350 and SA-203 materials (last 2 columns seem to apply to SA-203 material) then label columns more specifically.
   c. Note 4 indicates Group C was used when it appears that Group B was used.

8. Entries 2, 4 and 6 of table in SAR section 2.1.2 refer to SAR table 2.1.1, but it appears that SAR table 2.1.2A is the correct reference.

9. Table 2.2.4 cited in SAR section 2.2.1.6 does not appear to be applicable.

10. SAR section 2.5.1.1 states that trunnion material is identified on drawings however it is not.

11. SAR table 2.5.1 third table entry mentions trunnion "hollow" shaft, which does not exist for the HI-STAR 330 cask.

12. Appendix 2B cited in SAR section 2.6 does not appear to exist.

13. SAR section 2.7.1 refers to Figures 2.7.4 and 2.7.5 for CGOC top and bottom end drops,

however, it appears that only Figure 2.7.5 exists for the top end drop.

14. Title of SAR Reference 2.6.7 requires revision from “HI-STAR 330” to “HI-STAR ATB 1T”.

15. Revision of SAR Reference 2.6.8 should be changed from “0” to “1”.

16. SAR Reference 2.7.1 may not be cited since it is not yet published and is not permitted to be circulated outside the ASME committee.

17. The statement in SAR section 2.1.2.2.iv), “The top and bottom plates of the LTC are also credited for shielding under HAC,“ does not align with that made in SAR section 5.3.1.1.2, where it is stated that “the cassette top and bottom plates are not credited (not present) in the MCNP accident model as shown in Figure 5.3.3.”

18. HI-2240470, revision 0, “Dimensional Limit Summary Report for the HI-STAR 330 Transport Cask,” table A-2 for Liner Tank Bolt: revise current note that bolts only carry shear loads in structural analysis, as they are also checked for tension loading in Calculation 4 of HI-2210998, “Structural Calculation Package for HI-STAR 330 Transport Package,” Revision 0.

Holtec Response:

1.a. Removed the “cask lid locking system” through the chapter.
1.b. Replaced stainless steel with carbon steel wherever applicable.
1.c. Deleted “closure lid outer plate” in section 2.3.
1.d. Replaced “BFA tank” with “Liner Tank’ in Calculation#6 of HI-2210988. HI-2220203 has been updated to make this change.

2. Reference is removed from the SAR.
3. Reference to figure number in SAR section 1.2.1.6 is corrected to Figure 1.2.3.
4. Updated Table 2.1.1 and Section 2.1.2.1 to mention that a safety factor of 10 against ultimate strength is considered.
5. Corrected to refer Figure 2.3.3 in sections 2.1.2.2(v), 2.2.1.6, and 2.6.1.
6. Updated reference [2.1.9] to NUREG-2216 in Section 2.1.2.2 and Section 2.1.4.

7.a. Removed the row with **[Withheld per 10 CFR 2.390]** in Table 2.2.1.
7.b. Added additional row to explicitly mention the material for their respective properties in the column.
7.c. Note 4 is corrected to mention Group B instead of Group C.

8. Corrected entries 2, 4 and 6 in table in SAR Section 2.1.2 to correctly refer Table 2.1.2A.
9. Table 2.2.5 is now correctly referred to in Section 2.2.1.6.
10. Section 2.5.1.1 is updated to state that the trunnion materials are identified in Table 8.1.5.
11. The third entry in Table 2.5.1 is updated to “Bearing Stress in Dose Blocker Side Plate”.
12. Reference of Appendix 2B has been removed from Section 2.6.
13. Corrected to cite only Figure 2.7.5 for the Top CGOC drop in Section 2.7.1.
14. SAR Reference 2.6.7 is changed from “HI-STAR 330” to “HI-STAR ATB 1T”.
15. SAR Reference 2.6.8 is changed from “0” to “1”.
16. SAR reference [2.7.1] is removed.

17. Statement in Section 2.1.2.2 iv) is corrected to “The top and bottom plates of the LTC are not credited for shielding under HAC”.
18. Report HI-2240470 to be updated to mention that tension loading is also checked.

Chapter 2.2/3.2 Materials Review:

M-1: In table SAR 8.1.4, “Fracture Toughness Test Criteria: Containment System for Weld Metal” it states in note 3 that TNDT has been specified in accordance with recognized guidelines, but the applicant does not specify which guidelines. Additionally, the Maximum Drop Weight Test Temperature is stated as TNDT but does not elaborate on the acceptance criteria.

This information is requested by the staff to demonstrate compliance with 10 CFR 71.31(c).

Holtec Response: In Note 3, the “recognized guidelines” is referring to the Regulatory Guides discussed in Table 8.1.3.

As described in Note 2 of SAR Table 8.1.4, T_{NDT} is determined in accordance with the applicable Regulatory Guide, so is not subject to any additional testing or associated acceptance criteria.

M-2: Closure Lid in SAR table 3.2.7 lists the closure lid as SA-203/SA350 as noted in the Drawing, the staff requests the applicant to clarify this inconsistency in table 8.1.4 where the closure lid is listed as SA-203 Gr E only.

This information is requested by the staff to demonstrate compliance with 10 CFR 71.31(c).

Holtec Response: Note 4 is added to Table 8.1.4 of the SAR to allow SA-350 LF3 material to be used as an alternative lid material to SA-203 Grade E.

Chapter 3: Thermal Review:

TH-1. Clarify in the SAR the reason for the large difference between the calculated decay heat and the specified maximum permissible heat load.

SAR table 1.2.1 listed **[Withheld per 10 CFR 2.390]** and **[Withheld per 10 CFR 2.390]** calculated decay heats for the content placed within the package. However, table 7.1.2 stated that the maximum permissible heat load was **[Withheld per 10 CFR 2.390]**. Recognizing that containment release calculations and shielding calculations are based on the content’s activity, it was not clear if those analyses were based on content with a decay heat of **[Withheld per 10 CFR 2.390]** or **[Withheld per 10 CFR 2.390]**. If based on **[Withheld per 10 CFR 2.390]**, then the appropriateness of a **[Withheld per 10 CFR 2.390]** permissible heat load was not addressed.

This information is needed to determine compliance with 10 CFR 71.35.

Holtec Response: The decay heat load in Table 1.2.1 is calculated based on the maximum allowable content activity. The package is qualified for the specified maximum permissible heat load in Chapter 7.1.2, as thermal evaluations in Chapter 3 adopt a conservatively higher heat load. This is the reason for the large difference between the two values.

All the thermal evaluations are based on **[Withheld per 10 CFR 2.390]** heat load, and therefore, envelope both the maximum permissible heat load and the calculated waste package heat loads. A statement will be added in Chapter 3 to clarify the conservatism in reference to Table 1.2.1.

TH-2. Clarify in the SAR that vacuum drying conditions are sufficient to prevent the generation of hydrogen gases due to reactions (e.g., radiolysis) during transport.

SAR section 3.3.11 stated that all water would be removed from the Liner Tank after undergoing a vacuum drying process. However, whereas SAR section 3.3.11 and SAR table 7.1.1 stated that the vacuum drying pressure would be based on the water vapor pressure at the package temperature, the footnote at the end of SAR section 2.2.4 specified a 10 torr pressure. [Staff notes that **[Withheld per 10 CFR 2.390]** is different from the **[Withheld per 10 CFR 2.390]** vacuum drying condition discussed in NUREG-2215.] The differences in SAR section 2.2.4 and table 7.1.1 should be clarified and there should be discussion in the SAR that demonstrates the vacuum drying conditions would be sufficient to prevent the formation of hydrogen from water reactions (e.g., radiolysis).

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

Holtec Response: The NUREG-2215 provides a guidance of **[Withheld per 10 CFR 2.390]** pressure based on allowable gases that could react directly with the cladding or by reacting with exposed UO_2 fuel. Since the waste contents allowable in the HI-STAR 330 cask contain neither of these, the reactivity of the gases with the cask contents is not of concern. Rather, as noted by the reviewer, the concern would be one of explosivity of hydrogen that results from the radiolysis of the unremoved water.

Based on a saturation pressure of **[Withheld per 10 CFR 2.390]** corresponding to **[Withheld per 10 CFR 2.390]** water temperature (which is highly conservative), the maximum amount of water vapor that could still be in the cask cavity is about **[Withheld per 10 CFR 2.390]**. The maximum amount of molecular hydrogen that could result from the radiolysis of this water is also, therefore, **[Withheld per 10 CFR 2.390]**. Post drying, the amount of air at 1atm pressure and **[Withheld per 10 CFR 2.390]** is about **[Withheld per 10 CFR 2.390]**. Therefore, the percentage of hydrogen in the mixture will be less than 3%. This is an extremely conservative value as it assumes that all the water undergoes radiolysis. Since the lower flammability limit of hydrogen in air is about 4%, there is no concern of water reactions generating sufficient hydrogen to be of concern.

As specified in Chapter 7 of the SAR and reiterated in Chapter 3, the vacuum drying pressure shall be less than or equal to the saturation pressure of water at the package temperature. The **[Withheld per 10 CFR 2.390]** discussed in Note 3 of Section 2.2.4 is not a specification – it is a first order approximation based on the saturation pressure of water at the package temperature during the vacuum drying operation. This note has been removed to eliminate any confusion.

Chapter 4 Containment Review:

Co-1. Provide in the SAR the O-ring groove design dimensions and surface roughness details for the inner and outer O-rings that are used for containment and to test the containment boundary.

Although SAR table 2.2.6 listed nominal O-ring groove depth and width dimensions, additional groove details are needed to specify a design and to ensure sealing performance during NCT and HAC (e.g., including designed for internal and external pressures). For example, drawing 12482 appears to indicate a dovetail groove design, but complete dimension details were not provided. In addition, O-ring seal performance is dependent on surface roughness of the groove as well as the lid and flange contact area with the O-ring.

This information is needed to determine compliance with 10 CFR 71.35.

Holtec Response: Details of the O-ring groove type and surface finish requirements are added to drawing 12482.

Co-2. Clarify in the SAR that the size and material associated with the metal chips demonstrate that they are not pyrophoric and that small size particles do not contribute to the release calculations, such as acting as additional aerosolized content similar to the loose contamination discussed in SAR section 4.4.1. [Note: A particle size fraction was not provided, thus indicating the possibility of particles less than 100 micrometers, 50 micrometers, etc.]

a) SAR section 4.4.1 stated that the metallic content may include metal chips that can be below 200 micrometers. There was no discussion explaining that the small particles were not pyrophoric and, therefore, would not result in adverse effects during NCT and HAC.

b) Although SAR section 4.4.1 indicated some particles can be less than 200 micrometers (and therefore are potentially dispersible), there was no detailed discussion whether these particles would contribute to the releasable contaminated activity and the corresponding release calculation in SAR section 4.4.

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

Holtec Response:

Co-2.a) SAR section 4.4.1 has been revised to add discussion that the metallic debris is not pyrophoric based on the size of the metallic particles. As such, there would be no adverse effects during NCT and HAC. If average particle diameter particle size exceeds 100 micrometers the pyrophoric hazard of metal powders is greatly reduced or eliminated [3-4]. In addition, the reference shows that stainless steel powders do not ignite i.e. stainless steel metal filings are not pyrophoric.

Reference: Explosibility of Metal Powders, Murray Jacobson et. al., Report of Investigation 6516, 1964, Bureau of Mines.

Co-2.b) The presence of metallic debris smaller than 200 μm at levels below 0.001 wt% does not significantly affect the releasable contaminated activity or the corresponding release calculation. This conclusion is based on the representative acceptance standard leakage rate for Type B Packages dispersible solids specified in NUREG-CR-6487

Chapter 8: Acceptance and Maintenance program Review:

AM-1. Specify the safety categories designated with the ITS package components listed in the drawings.

Specifically, drawing 12482 is an example detailing the containment baseplate, containment side walls, containment end walls, containment top flange, closure lid, elastomeric lid inner seal gasket, and closure lid bolts as important-to-safety components, but a safety category (e.g., A, B, C) associated with these components was not described. The safety category for a component is an important designation as the corresponding quality assurance of the component reflects the degree of its safety significance.

This information is needed to determine compliance with 10 CFR 71.35 and 71.37 (e.g., 71.101, 71.107).

Holtec Response: The specific safety categories for ITS components, along with notes discussing the reasoning behind the categorization assignments, are provided in the ITS Categorization Report (HI-2220203).