NON-PROPRIETARY INFORMATION

Response to Request for Additional Information
Holtec International
Docket No. 71-9325
HI-STAR 180 Transportation Package – LAR 9325-1

Chapter 1 – General Information

Licensing Drawings

1-1 Clarify on licensing drawing 4845, sheet 2, Rev. 8, or in Appendix 4.A of the application which is incorporated by reference into the Certificate of Compliance (CoC), the following related to seal core materials, seal jacket materials, microfinish range, and seal option 1 and 2.

The spring-energized core material, seal jacket material, and microfinish range play a specific role for containment. Licensing drawing 4845, sheet 2, Rev. 8, note 41, includes multiple spring-energized core materials, as well as multiple seal outer jacket / plating materials, and note 15 includes a microfinish range.

a) Specify if some of the seal core materials are only associated with seal option 1 or seal option 2.
b) Specify if some of the seal jacket materials are only associated with seal option 1 or seal option 2.
c) Specify if a portion of the microfinish range is only associated with seal option 1 or seal option 2.
d) Specify if some of the seal core materials are only associated with a portion of the microfinish range.
e) Specify if some of the seal jacket materials are only associated with a portion of the microfinish range.
f) Specify if some of the seal core materials are only associated with some of the seal jacket materials.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33, 71.51(a)(1) and (2).

Holtec Response to RAI 1-1:

The range of material options and surface finishes mentioned in the licensing drawing were intended to define the menu of options that were permitted for the application. Materials identified on the drawing were those that were compatible with the seal environment (spent fuel pool water, atmospheric chemicals) and seal service temperatures. The surface finishes listed bound the range of finishes recommended by seal suppliers contacted during development of the cask and seal design. In order to better define the specific seals currently specified for the application, the material and finish requirements have been added to the tables in Appendix 4A of the SAR provided in Enclosure 3 to Holtec Letter 1553036-NRC.

1-2 Clarify detail B and optional detail B on drawing 4847, sheet 4, Revision 6, and drawing 4848, sheet 4.

Per discussions with the applicant, the staff requests a clarification of the drawings with respect to the use of friction stir welding (FSW) for detail B. Currently, the drawing indicates that a conventional welding process is specified for this configuration rather than FSW. If the applicant intends on using FSW for this configuration, it must be properly specified on the licensing drawings.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33.

Holtec Response to RAI 1-2:

Detail B in the two licensing drawings is hereby updated to identify that only FSW will be used for the corner welds on the basket. The proposed change to these licensing drawings is provided in Enclosure 5 to Holtec letter 1553036-NRC.

Chapter 2 – Structural Evaluation

2-1 Demonstrate that the use of structural corner welds (previously characterized as non-structural welds) utilized on the basket does not alter the structural performance under normal conditions of transport and hypothetical accident conditions with respect to deformation acceptance criteria.

Corner welds on the basket assembly were previously characterized as construction welds as opposed to structural welds. Furthermore, a new welding process is identified in this amendment request. Due to these changes, staff does not have reasonable assurance that the finite element analysis of the basket is sufficiently robust to demonstrate that the basket can meet stated deformation performance requirements.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.71 and 71.73.

Holtec Response to RAI 2-1:

We regret the confusion created by the (loosely phrased) initial characterization of all peripheral welds in our meeting with the Staff as non-structural. In fact, the external corner welds that serve to provide dimensional fixity to the basket are structural and ITS welds. This confusion, fortunately, did not propagate into the licensing drawings, which correctly identify the corner welds as structural and other welds as "non-structural" (see notes 12 and 17 on Holtec licensing drawing 4847 rev. 6 and 4848 rev. 6). Similar notes appear on the previous revisions of these two drawings (rev. 5), which have been reviewed and approved by the Staff as part of the original license (Revision 0 of the CoC (Revision 3 to the HI-STAR 180 SAR)).

(PROPRIETARY INFORMATION WITHHELD)

In summary, we submit that the finite element analysis of the basket is sufficiently robust to demonstrate with confidence that the basket can meet stated deformation performance requirements.

2-2 Explain in more detail the proposed change (B5) relative to the brittle fracture acceptance criteria.

The applicant states, without any detailed explanation or justification, that the fracture initiation criteria, as presented in NUREG/CR-3826, is to be used.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33(a)(5)(iii) and 71.39.

Holtec Response to RAI 2-2:

Proposed change B5 changed the brittle fracture acceptance criteria for the HI-STAR 180 cask from the fracture arrest method detailed in Regulatory Guide 7.12 to the facture initiation method detailed in NUREG/CR-3826 for containment vessel (CV) components with a wall thickness greater than 4 (four) inches. Furthermore, the proposed change expanded the testing requirements to include cask qualification for lowest service temperature (LST) options of -20°F and -40°F for all CV components.

The original proposed change B5 is hereby modified to clarify that the facture initiation criterion, as presented in NUREG/CR-3826, is to be used when either the LST or the CV wall thickness of the cask component falls outside the technical basis of Regulatory Guide 7.12. That is, the fracture initiation criterion applies for 1) cask qualification to -40°F (LST) and CV wall thicknesses greater than 4 (four) inches and 2) cask qualification to -20°F (LST) when the CV wall thickness is greater than 12 inches. The proposed change to SAR Section 2.1 (Paragraph 2.1.2.2 and Table 2.1.10) is hereby provided in Enclosure 3 to Holtec Letter 1553036-NRC.

(PROPRIETARY INFORMATION WITHHELD)

SAR Table 2.1.10 is hereby modified to identify that 1) casks qualified for an LST of -20°F will use the fracture arrest criteria recommended by RG 7.12, for CV component wall thicknesses up to 12 inches, 2) casks qualified for an LST of -20°F with CV component wall thickness greater than 12 inches will use the fracture initiation criteria recommended by NUREG/CR-3826 and 3) casks qualified for an LST of -40°F will use the fracture initiation criteria recommended by NUREG/CR-3826 for CV component wall thicknesses greater than 4 inches.

2-3 Explain further why yield strength and ultimate strength properties are being reduced and whether or not the fuel basket support shims are an important to safety (ITS) component.

The applicant does not provide any justification on the reduction of the strength properties of the fuel basket shims.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33(a)(5)(iii) and 71.39.

Holtec Response to RAI 2-3:

The Basket Shims are classified as Important-to-Safety. Their yield and ultimate strength properties were previously taken from the handbook "Properties of Aluminum Alloys" (Reference [2.2.7] in SAR). We subsequently discovered that the minimum strength properties cited in the ASTM standard B221M are slightly lower. As the ASTM values are binding on the material suppliers (when purchased to the ASTM specifications, as we would), it was necessary to re-state the physical properties to accord with the ASTM data and to re-assess their safety compliance under the revised strength properties.

2-4 Explain the difference between "useful spring-back" and "total spring-back," and the meaning of "fix," as used in the justification for change.

The application states that "useful spring-back" is now used instead of "total spring-back" to clarify the required seal performance and that the information presented in Appendix 4.A, as well as in the drawings, together "fix" the seal joint design.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33(a)(5)(iii).

Holtec Response to RAI 2-4:

The difference between "useful spring-back" and "total spring-back" is illustrated below in Figure 2-4.1 below. Total spring-back (which is measured from point C to point A in Figure 2-4.1) refers to the elastic recovery of the seal when the load on the seal is reduced to zero (i.e., complete decompression of seal). Useful spring-back (which is measured from point C to point B in Figure 2.4-1) is established by the seal manufacturer, and it indicates the amount of spring-back that the seal can sustain without compromising its performance (i.e., measured leakage rate remains below leakage rate limit). Useful spring-back typically corresponds to the elastic recovery of the seal when the compression load on the seal reduces to 20% to 30% of its maximum seating load.

The word "fix" was used in the Summary of Proposed Changes (SOPC) to connote that the seal joint design is not variable. That is to say the licensing drawings, together with the information in Appendix 4.A, fully define the seal joint design. In particular, Appendix 4.A defines the specific seal manufacturers and part numbers that are to be used with the HI-STAR 180 cask.

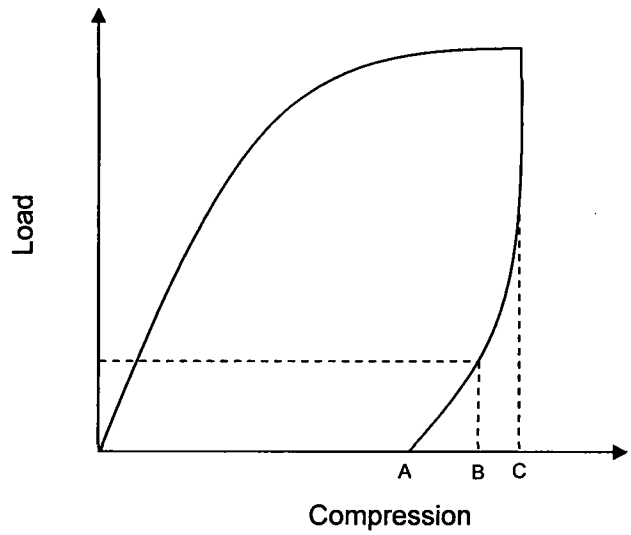

Figure 2-4.1: Typical Loading/Unloading Curve for Metallic Seals

2-5 Explain what specification of Nickel Alloy is used and why there is a need for weld overlay of the cask sealing surfaces.

The application mentions, in Change C1, that there is an option for Nickel Alloy for weld overlay of cask sealing surfaces.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33(a)(5)(iii).

Holtec Response to RAI 2-5:

The proposed change to add the option of Nickel Alloy for weld overlay of cask sealing surfaces is hereby withdrawn. The Nickel Alloy option has been removed from licensing drawing 4845 and from SAR Subsections 2.2.2 and 4.1.3. The proposed change to the licensing drawing is provided in Enclosure 5 to Holtec letter 1553036-NRC. The proposed change to the SAR is provided in Enclosure 3 to Holtec letter 1553036-NRC.

The groove region of the gasket bearing surface for spent fuel transportation casks has been historically overlayed with stainless steel or with an exotic nickel alloy (e.g., Inconel) to protect the gasket seating surfaces. Weld overlay of the cask sealing surfaces is incorporated in the design to ensure improved corrosion and wear resistance. Stainless steel weld overlay of cask sealing surfaces in Holtec's metal casks has performed satisfactorily in the NRC approved HI-STAR-100 (Docket No. 71-9261 and 72-1008) and HI-STAR HB (Docket No. 71-9261) currently in active service. To our knowledge, there is no industry report on mal-performance of stainless steel fortified gasket seating surfaces in dry storage & transport service.

2-6 Provide weld test results to support the weld strength requirements and to demonstrate that the minimum weld strength requirements are met.

Note 17 of drawings 4847 and 4848 specifies that the weld strength of the basket corner welds shall be greater than 60% of the minimum tensile strength of the Metamic-HT panel material. The applicant also states in page 2.3-3 of the application that "Actual weld qualification test results showed weld strengths significantly higher than the minimum required."

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33(a)(5)(iii).

Holtec Response to RAI 2-6:

The Table 2-6.1 below provides summary results data on the tensile tests of weld coupons extracted from our procedure qualification record (PQR) database along with the corresponding MGVs required of the base metal.

(PROPRIETARY INFORMATION WITHHELD)

The above PQR data speaks to the superior weld integrity realized by the FSW process in comparison to the MIG process on which the initial qualification of the Metamic HT welding was based.

2-7 Provide justifications for deviating from American Society of Mechanical Engineers (ASME) code requirements and explain the rationale for using radiographic testing in lieu of bend testing for weld soundness.

The applicant states in HSP 630 "Requirements for Welding of Metamic-HT," Section 6.1.2, that "Radiographic Testing shall be used for weld soundness in lieu of bend testing." ASME Boiler & Pressure Vessel Code Section IX requires bend testing to assess the soundness of the weld.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33(a)(5)(iii).

Holtec Response to RAI 2-7:

The principal rationale for substituting "bend test" with full radiography lies in the fact that Metamic-HT, a metal matrix composite reinforced with nano-dispersoids, is not intended to be used in component shapes that are subject to sharp bends or large strains in the manufacturing process. As can be observed from the basket design provided in the licensing drawing package, the structural parts are all in the shape of flat panels and there are no bent shapes. We recognize the importance of the bend test for the ASME code materials which, being essentially focused on metals and metal alloys specifies the bend test to cover the widespread use of curvilinear shapes subject to large strains in pressure vessels and weldments. We reasoned that for Metamic-HT welds, it is more appropriate to demand and insure a complete

absence of internal flaws and discontinuities through a rigorous volumetric examination than to subject it to a (bend) test that is irrelevant to its structural function.

2-8 Provide inspection acceptance criteria for FSW weld joints and the standards used as a basis for such acceptance criteria.

Note 9 of the drawing requires visual examination. Additional non-destructive evaluation (NDE) inspections are noted where required. Acceptance criteria are governed by ASME Code Section V, as clarified in Chapter 8 of the application.

Paragraph 2.2.1.1.4 of the application states that all NDE specifications will comply with Section V of the ASME Code which establishes the NDE inspection content format, inspection qualification requirement (ASNT-TC-1A), and the inspection results minimum documentation.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33(a)(5)(iii).

Holtec Response to RAI 2-8:

ASME Sec. V references the techniques and methods to conduct VT, but the acceptance criteria are not stated in this section. Rather ASME Sec. V paragraph T-980.1 states that one will follow the applicable code; which, in our case is Holtec Standard Procedure, HSP-638 (latest revision provided in Enclosure 7 to Holtec Letter 1553036-NRC).

As for inspection qualification requirements, Holtec follows its Quality Control Procedure, QCP 9.1, which references and follows ASNT-TC-1A. Inspection results are documented in HSP-638 using a form, or similar to, Exhibit 9.1.

Chapter 4 – Containment Evaluation

4-1 Provide the following information relevant to the two seal options shown in Appendix 4.A, "Confinement Boundary Seal Data," of the application which is incorporated by reference into the CoC. The following should be addressed relevant to Appendix 4.A of the application.

a) Appendix 4.A of the application should indicate both the dimensions and tolerances, not nominal dimensions, of the containment boundary seals and grooves to ensure compression / springback of the seals. Nominal values do not ensure compression / springback of the seals in order to provide a leaktight seal.

b) Appendix 4.A should indicate the value for the seal seating load, not the nominal value. The seating load values for the inner lid and outer lid seas were arrived at by American Seal and Engineering to provide the needed recovery during a transient event. A nominal value does not ensure the needed recovery during a transient event.

c) Confirm that the seating load values and units in Appendix 4.A are in agreement. It appears that in Attachment C.A to HI-2063563 (ML073100307) which was

provided for the Rev. 0 CoC, the seating load values are given in units of mass or mass/length. It appears that the values in Appendix 4.A are in units of force or force/length.

d) In Appendix 4.A, Table 4.A-3, "Inner Port Cover Seal," clarify the units and values for the inner seal seating load and the outer seal seating load. For example, 42 N is equal to 9.5 pounds-force, not 9.5 kip. Also, 165 N is equal to 37.1 pounds-force, not 942 kips. Although unlikely, consider that there is the unit of force known as the kilogram-force or kilopond (kp) when ensuring the numerical values are correct for the units given.

e) In Appendix 4.A, Table 4.A-4, "Outer Lid Access Port Plug Seal," clarify the seal part/drawing number 050333. Previous tables in Appendix 4.A included two values for American Seal and Engineering seal part/drawing numbers and the part/drawing number, 050333, appears to be for the "Inner Port Cover Seal."

f) In Appendix 4.A, Table 4.A-4, "Outer Lid Access Port Plug Seal," provide the seal seating load.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33, 71.51(a)(1) and (2).

Holtec Response to RAI 4-1:

a) Limits on seal diameter and groove depth are provided in the tables found in Appendix 4.A. The minimum and maximum dimensions are given for both values based upon the recommendation of the seal suppliers. This allows for proper evaluation on the compression of the seal and insures proper sealing. Nominal values are given for the seal and groove overall diameter to provide perspective for the size of the seals and to allow for estimation of the total seating load required to compress the seals for evaluation of the bolted joint. These values may vary slightly from the nominal value due to manufacturing tolerances and changes to the vendor manufacturing standards.

b) The seating load is provided by the manufacturer as a nominal value. The final value is a function of the actual yield strength for the material used for the seal components as well as seal and groove geometry. The actual seating load for a specific seal will vary due to the fact that material yield strength tends to vary between batches. The expected tolerance on the value listed is +/-10%. Testing by the seal manufacturer using the specific heats/lots of materials to be used in the actual seal ensures that the seating load is within specification.

c) The vendor information provided in HI-2063563 Revision 1 includes the seating load in both force/length and mass/length. The force/length values were given for the English units of measure. They were incorrectly converted by the seal supplier to mass/length when they converted to metric units. The proper units for a spring load are force/length. The seal proposal provided by American Seal has undergone a revision after the version that was included in Attachment C.A of Holtec Report HI-2063563 Rev. 1. The latest revision of the proposal is provided in Enclosure 9 to Holtec Letter 1553036-NRC.

d) The units for the metric values should be kN, rather than N. The value of 9.5 kips is correct. The values for the Technetics seals appear to have been corrupted. They have been corrected in the table.

e) The seal drawing number for the Outer Lid Access Port Plug Seal was mistakenly entered using the Outer Lid Access Port Cover Plate Seal number which is the same as the Inner

Port Cover Outer Seal. The correct part number for the plug seal is 050334. The table has been corrected.

f) The seal seating load for the Access Port plug seal is included in the revised table.

4-2 Provide the sealing proposal for the American Seal & Engineering seal option 1 if it is different from what was provided for the Rev. 0 CoC. Provide the sealing proposal for the Technetics seal option 2.

Licensing drawing 4845, sheet 2, Rev. 8, note 15, includes a microfinish range, and note 41 includes a new spring-energized core material, as well as a new seal outer jacket / plating material. It therefore appears that the American Seal & Engineering seal option 1 may have changed from what was provided for the Rev. 0 CoC, in Attachment C.A to HI-2063563 (ML073100307). In addition, the Technetics seal option 2 is new to this application and the sealing proposal has not been provided. The basis for the seal design should be provided.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33 and 71.51.

Holtec Response to RAI 4-2:

Seal proposals from American Seal & Engineering and Technetics are provided in Enclosure 9 to Holtec Letter 1553036-NRC.

4-3 Provide confirmation that the seal option 1 and 2 containment boundary groove designs will not plastically deform during hypothetical accident conditions.

Based on the change to the seal / groove design, the application did not address that the containment boundary groove designs will not plastically deform during hypothetical accident conditions based on the structural analysis.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33 and 71.51(a)(2).

Holtec Response to RAI 4-3:

We confirm that the plastic deformation of the groove under any operational mode, including the accident scenarios, is precluded by virtue of the configuration of the sealing geometry. The joint detail employed in HI-STAR 180 (and all other Holtec metal casks) utilizes the so-called "controlled compression joint", which limits the pressure under the seal surface from exceeding a pre-determined limit and protects the gasket from being crushed. The mechanics of sealing action in the controlled compression joint is explained in Holtec Position Paper DS-337 provided in Enclosure 6 to Holtec letter 1553036-NRC.

Under accident conditions, the bolt tensile stress may increase above the "seating condition" (an ASME Code term) value. However, the additional equilibrating force on the flange surface is

developed on the "land" (explained more fully in the above Position Paper) thus protecting the seals from over-stress.

(PROPRIETARY INFORMATION WITHHELD)

4-4 Provide the basis for Table 2.2.12, "Containment Boundary Bolted Joint Data," Item No. 5 containment boundary seal minimum "Useful" spring back definition and value, such as from manufacturer data sheets and structural analysis.

The value that was previously approved as the minimum spring back at complete decompression was equal to 0.030 inches and was necessary in order to ensure sealing capability during a transient event. The value is now described as the minimum "Useful" spring back to maintain leaktightness with a value of 0.010 inches.

It is not clear what prompted the change in definition / value and how the new definition / value will maintain a leaktight seal considering numerically, a minimum value of 0.010 inches is less than a minimum value of 0.030 inches.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33, 71.51(a)(1) and (2).

Holtec Response to RAI 4-4:

Please see the response to RAI 2-4 for the difference between "useful" spring-back and "total" spring-back. "Useful" spring-back is the more appropriate (and conservative) measure for evaluating whether the leaktight seal is maintained following a hypothetical accident condition. "Useful" spring-back corresponds to the minimum compression load on the seal that must be maintained in order to ensure its sealing capability. The minimum "useful" spring-back specified in Table 2.2.12 of the SAR is a lower bound value for the seal options listed in SAR Appendix 4.A. Using the total spring-back to evaluate the seal performance is non-conservative because the compression load on the seal, by definition, diminishes to zero at that point, causing a loss of sealing capability.

With regard to the structural analysis, the seals are modeled explicitly in LS-DYNA using linear elastic solid elements, as shown in Figure 4-4.1 provided below. By monitoring the change in compressive load on the seal under accident loading conditions, the spring-back of the seal is obtained from the LS-DYNA solution. The maximum predicted spring-back from the LS-DYNA solution is then compared with the minimum "useful" spring-back established in Table 2.2.12 of the SAR to assess the seal performance. In all cases, the maximum predicted spring-back in the wake of the accident event is less than the minimum "useful" spring-back of 0.010 inches, indicating that the leaktight seals are maintained.

(PROPRIETARY INFORMATION WITHHELD)

4-5 Provide adequate justification for both the Technetics and American Seal & Engineering seal and groove designs such that the ANSI N14.5 leaktight criterion is achieved.

The staff is aware that a Technetics seal / groove design did not meet the leaktight criterion during leakage rate testing on a scale model of the HI-STAR 180 in October 2012. A Technetics seal / groove design has been submitted for this amendment and the lessons learned from the scale model testing may be appropriate to consider for the Technetics, as well as for the American Seal & Engineering seal / groove design.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33 and 71.51(a)(1).

Holtec Response to RAI 4-5:

The seal suppliers have conducted in-house testing to demonstrate that the full scale seals will meet the leakage rate criteria specified in the application with significant margin.

(PROPRIETARY INFORMATION WITHHELD)

The lessons learned during the scale model testing have been collected and will be used to develop seal installation procedures to ensure that the seals installed in the field will meet the leakage rate criteria. These include guidance for proper handling, maintaining clean sealing surfaces, pre-installation inspections of the seals, use of proper supports to maintain the seal in position during lid installation, and pre-use inspections of the lid and flange sealing surfaces. The full size cask will also benefit from the increased seal cross section which will help to make the seal easier to handle. Every cask that is delivered to the end user will be tested in the factory to ensure that the leakage criteria will be met.

4-6 Address if the option of an aluminum jacket has any impact on the seal temperature limits presented in Table 3.2.12 of the application, "HI-STAR 180 Component Temperature Limits."

Table 3.2.12, note 1, states, "...the temperature limits tabulated herein bound the manufacturers recommended limits for the limiting material (stainless steel)." It was not clear if the jacket material also should be considered, including the addition of an aluminium jacket, for the limiting material.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33, 71.51(a)(1) and (2).

Holtec Response to RAI 4-6:

Technetics has confirmed that the seals provided with aluminum jackets are suitable for use at temperatures up to 700 F. The aluminum outer jacket on the seal is designed to be relatively soft such that it can flow into the surface profile of the flange and groove surfaces and effectively form a barrier to helium flow. At higher temperatures, the aluminum will further soften such that sealing will be improved. The structural performance of the seal is provided by the Nimonic 90 inner spring and the stainless steel inner jacket. The temperature limits specified for the seal are well below the annealing temperature for aluminum such that the aluminum will not be subject to any failure due to metal melting. To eliminate the confusion caused by the prior reference to the 700 °F being for stainless steel material, the reference to stainless steel is

hereby removed from note 1 of Table 3.2.12 of the SAR (The proposed change is provided in Enclosure 3 to Holtec Letter 1553036-NRC).

Chapter 5 – Shielding Evaluation

5-1 Demonstrate that the dose rates, calculated using MCNP, are conservative and have adequate safety margins with respect to the regulatory limits.

Tables 5.1.3 and 5.1.4 of the application show that the maximum dose rate at two meters from the point 5 of Figure 5.1.1 for the F-32 basket, and from points 2 and 5 from the F-37 basket, are 0.0861, 0.0882, and 0.0873 mSv/hr, respectively. Adding two standard deviations, these dose rates exceed the regulatory limit of 10 CFR 71.47.

The margin for safety also is very small for most of the other dose rates in the tables mentioned above. This is without considering the uncertainties in source terms calculations using SAS2H.

The applicant needs to demonstrate with code benchmarked results that the accumulated errors in the dose rates, including errors and uncertainties in source terms and dose rate calculations using the MCNP code, will not exceed regulatory limits.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.47 and 71.51.

Holtec Response to RAI 5-1:

NRC staff has advised us that Holtec correctly determined dose rates and uncertainties, and that there are adequate safety margins to the regulatory limits when uncertainties are included. Chapter 5 of the SAR is hereby updated to clarify the use and presentation of the uncertainties (R values) in the dose calculations (The propose change is provided in Enclosure 3 to Holtec Letter 1553036-NRC).

Chapter 8 – Acceptance Tests and Maintenance Program

8-1 Describe the Heat Affected Zone (HAZ) as a result of the Friction Stir Welding (FSW) process used for joining the Metamic-HT material in terms of mechanical properties, residual stress and microstructure.

Chapter 8 of the application discusses welding of Metamic-HT using the FSW process and corresponding HAZ. The temperatures are lower than those in the Thermo-mechanically Affected Zone (TMAZ), but may still have a significant effect if the microstructure is thermally unstable.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33(a)(5)(iii) and 71.39.

Holtec Response to RAI 8-1:

Phenomenologically, the FSW process does not produce a heat affected zone (HAZ) in the classical sense of conventional welding processes, where the material undergoes phase transformation solid→liquid→solid (rapid solidification) causing severe changes to microstructure. In FSW, the material temperature (about 400 deg. F) is too low to produce melting, re-crystallization or modification of grain boundaries. The material participating in the joining action remains in a solid, but plasticized, state while the penetrant tool's rotating action homogenizes the stirred zone obliterating the interface plane between the mating parts. As a result, the welded zone has no internal seams and substantially resembles the base material's microstructure. Although some residual stresses in the junction region are inevitable, they are low because no cooling of a molten puddle (as occurs in conventional welding) is involved.

Finally, higher temperature tensile testing has shown that the mechanical properties of the weld behave similar to the base material, indicating that the weld zone's microstructure is thermally stable. Table 8-1.1 below provides summary results of the higher temperature tensile tests. Table 8-1.1 is supported by the ITLS test report provided in Enclosure 8 of Holtec Letter 1553036-NRC.

(PROPRIETARY INFORMATION WITHHELD)

8-2 Describe all aspects from discovery to final NDE of how weld repair of defects will be performed on joints welded using the FSW process, both in-production and in-service.

Chapter 8, Section 8.1.2, of the application removes reference to the ASME code and American Welding Society (AWS) for the examination and repair of Metamic-HT basket welds. FSW is associated with a number of unique defects and may require repair.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33(a)(5)(iii) and 71.39.

Holtec Response to RAI 8-2:

The FSW process fortunately lends to weld repair in a straightforward manner. The weld mass containing the defect is re-plasticized using the rotary tool removing the internal discontinuity as the weld mass coalesces upon the tool's withdrawal. Except for the disappearance of the defect, the repaired weld is visually indistinguishable from the weld prior to the repair.

During the FSW development program, samples with existing defects, as described in HSP-638 (See Enclosure 7 of Holtec Letter 1553036-NRC), were successfully re-welded/repaired. Even welds with deliberately introduced discontinuities were successfully welded and determined to be sound upon NDE. In particular, PQR # 1308 contains weld repair using a second pass, i.e., a repair weld that corrects surface defects as described in HSP 638. PQR # 1318 and 1319 was performed on weld joints with intentionally incorporated gaps.

8-3 Describe why coupon testing for lot pass/rejection has been revised from meeting any of the seven properties to only the failed Minimum Guaranteed Value (MGV) property of an ITS component and whether this follows ASME code and/or American Society of Testing Materials (ASTM).

Chapter 8, Table 8.1.4, of the application revises notes regarding coupon testing for lot pass/rejection.

This information is needed for the staff to determine if the package design meets the regulatory requirements of 10 CFR 71.33(a)(5)(iii) and 71.39.

Holtec Response to RAI 8-3:

Testing that has been completed on material to verify that the lot meets the stated MGV requirements has been brought into closer alignment with industry practice, ASME code, ACI, etc. Specifically, that the failure on one property does not negate all other test results, thus only the failed property is re-tested to verify if the original result obtained is a false-negative or true-negative.

The previous testing protocol in the SAR dates back to the early days of the Metamic HT program in the mid- 2000s when it was necessary to gather large volumes of properties data. As the program has matured into the routine production phase, it has become necessary to adopt established practice from the ASME and other proven codes to enable the production to be carried out without undue testing induced delays. Thus, by basing the testing requirements of production lots on the practice established through many decades of use in the national codes and standards provides the confidence that the manufactured materials will meet the applicable criteria necessary for an ITS component.

END of RESPONSES