Request for Additional Information
Holtec International, Inc.
Docket No. 71-9336
HI-STAR 60 Transportation Package

By letter dated November 21, 2008, Holtec International, Inc. (Holtec or applicant) submitted Revision No. 1 of the Model No. HI-STAR 60 package application and its responses to the request for additional information (RAI) dated September 3, 2008.

This second RAI identifies information needed by the U.S. Nuclear Regulatory Commission staff (the staff) in connection with its review of the package application. The requested information is listed by chapter number and title in the package application. NUREG-1617, “Standard Review Plan for Transportation Packages for Spent Nuclear Fuel,” was used for this review.

Each individual RAI describes information needed by the staff for it to complete its review of the Model No. HI-STAR 60 package application and to confirm whether the applicant has demonstrated compliance with regulatory requirements.

Chapter 2 – Structural Evaluation

2-1 Revise Table 2.7.2 or 2.7.3 in the package application (Holtec Report HI-2073710 pp. 2.7-21 to 2.7-22) to reflect correct G load values for the CG over corner evaluation.

In Table 2.7.2, for the CG over corner orientation, axial components are listed as approximately 10.7 to 10.9 Gs and the lateral components are listed as 33.4 and 34.0 Gs respectively. Conversely, the axial component is listed as 23.38 Gs and the lateral component is listed as 7.02 Gs in Table 2.7.3. It appears that one of the two tables has the numerical values reversed.

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

2-2 Provide an explanation illustrating why the peak accelerations of the Classical Dynamics Method do not show good agreement with the peak accelerations predicted by LS-DYNA for the full scale models. Provide overlay plots showing the deceleration time history comparison between the Classical Dynamics Method and the LS-DYNA approach for all drop orientations.

The data reported for the benchmark case for the HI-STAR 100, including the Classical Dynamics Method, the quarter scale LS-DYNA finite element model, and the LS-DYNA full scale model showed good agreement (within approximately 10%) with the measured peak decelerations of the quarter scale HI-STAR 100 package. Furthermore, when comparing the Classical Dynamics Method results with the LS-DYNA results for peak acceleration for both quarter scale and full scale, the values were nearly all within 10%, with the exception of two values which were within 15% and 18% respectively.

Enclosure

When a similar comparison is performed with the Classical Dynamics Method and the LS-DYNA approach for the HI-STAR 60 evaluation, the reported values differ by as much as 20% to 68% for four of five orientations. This indicates that there may not be a good agreement between the methodologies for the HI-STAR 60 and, lacking a third independent set of data, the staff cannot draw a conclusion with respect to a reasonable assurance of safety.

Given the apparent lack of agreement between the two methodologies for peak deceleration for the HI-STAR 60, staff requests the overlay plots showing deceleration time history to determine whether the generalized acceleration behavior shows a good agreement between the two methods or if the apparent lack of agreement is also demonstrated in the deceleration time history plots as well.

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

2-3 Justify the calculated Factor of Safety for the Lid Bolts for both the Average Service Stress and Maximum Service Stress at Extreme Fiber in Table 2.7.5.

The applicant calculated Factors of Safety (FS) of 1.27 (74.61 ksi / 95.075 ksi) and 1.22 (102.75 ksi / 125 ksi) for Average Service Stress and Maximum Service Stress at Extreme Fiber, respectively. A footnote points the reader to Figure 2.7.15 which shows a representative Stress Intensity plot for the lid bolts with a maximum Stress Intensity of 130.889 ksi which would result in a FS of 0.96 for Maximum Service Stress at Extreme Fiber and a potential for a FS less than one for Average Service Stress, depending on how the calculation is performed.

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

2-4 Justify the lack of consideration of fuel rod performance when subjected to a top down deceleration.

The applicant presented an evaluation of the fuel rod peak cladding strain when the fuel is subjected to a bottom down 30-foot drop, but neglected to consider the effects of the deceleration time history on a top down drop with the Fuel Impact Attenuators (FIAs) attached.

This information is necessary to determine compliance with 10 CFR 71.73

2-5 Justify the use of a peak cladding strain acceptance criteria of 1.7% plastic strain. Provide data or reference that justifies the use of this value as an acceptable failure criteria.

This information is necessary to determine compliance with 10 CFR 71.73

2-6 Justify the use of the Classical Dynamics Method to substantiate the input values for the cask-ground spring when evaluating the fuel performance characteristics.

The applicant used the Classical Dynamics Method to verify that the value used for the cask ground spring stiffness was appropriate for this analysis; however, the Classical

Dynamics approach appears to under-predict the results generated by the LS-DYNA analysis and subsequently the design basis peak G-loads.

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

2-7 Justify the classification of “restraint of free thermal expansion” as a primary stress.

The last paragraph of page 2.1-6 of the package application refers to restraint of free thermal expansion as a primary stress, while an unlabeled table on page 2-1.11 of the application, reproduced from ASME Code Figure NB-3222-1, lists expansion stresses as a secondary stress.

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

2-8 Provide the methodology used to obtain ‘Calculated Primary Stress Intensities’ listed in Table 2.5.3.

An evaluation of Figures 2.3.2, 2.5.3, and 2.5.4 referenced below Table 2.5.3 indicates that Stress Intensity values calculated are higher than those reported in Table 2.5.3 and furthermore, these values appear to be higher than the allowable stress intensity of 33 ksi. Staff requests an example of the methodology used to obtain the values presented in Table 2.5.3 and a demonstration that the values chosen from the ANSYS results are correct and conservative.

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

2-9 Provide examples which demonstrate how stress intensity information is extracted from FEA results and subsequently presented in summary tables contained within the package application.

The process for this operation is unclear to staff given that reported values in tables appear to contradict data presented in color fringe plots.

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

2-10 Clarify if the aluminum honeycomb impact material is intended to be specified as biaxial for all locations within the impact limiter.

The material properties used in the FEA model utilize the primary crush strength defined in two orthogonal directions; yet, Table 2.2.9 only refers to a single nominal crush strength and the licensing drawings do not indicate whether the aluminum honeycomb material is uniaxial, biaxial (cross core) or both.

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

2-11 Remove the statement "Compared with similar FE models such as the full scale HI-STAR 100 package model developed by NRC/PNNL investigators, the HI-STAR 60 LS-DYNA model is constructed with a much greater mesh density, which ensures numerical convergence for the analyzed impact events" contained on page 13 of 82 in Holtec Report HI-2073725.

This statement is not universally correct. Simply noting a higher global mesh density when comparing with a distinctly separate FE model, does not in fact ensure numerical convergence.

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

2-12 Provide a sensitivity study demonstrating that the lower bound crush strength will not significantly affect the G loads on drop orientations other than CGOC such that the results obtained are non-intuitive and conservative.

The lower bound crush strength of the aluminum honeycomb produced a higher G load in the CGOC orientation than the upper bound crush strength. This result is counterintuitive given that (1) the higher crush strength should produce a higher G load, and (2) the crush strength band for the upper bound and lower bound values is 200 psi, indicating that premature lockup should not be significant. Since this result is counterintuitive and non-conservative, the staff requests that the applicant rerun the remaining orientations with the lower bound honeycomb crush strength, to determine whether the non-conservative results can be generalized across all cases.

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

2.13 Justify the use of material rigid body decelerations when determining the peak deceleration for a given drop orientation.

Staff inspection of LS-DYNA models submitted by the applicant indicates that the methodology for using material rigid body decelerations may not capture all relevant peak decelerations for a given drop orientation. Staff utilized a methodology previously used by the applicant to determine a deceleration time history based on differentiated nodal velocities rather than direct acceleration values reported by the applicant. Staff found that, even with filtering, the previously used methodology produced higher peak decelerations than the methodology currently used to extract peak decelerations.

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

2.14 Justify the selective reporting of peak decelerations when reporting maximum values for a given drop orientation.

The applicant reported a peak G load, for the 30 foot side drop, of 55.10G's which was extracted via rigid body material deceleration. Staff subsequently plotted the deceleration time histories for the intermediate shells and the basket using the same methodology as the applicant and found that the intermediate shells exhibited a deceleration time history that was nearly identical to the containment shell. The basket, however, showed a deceleration time history in which the peak G loads were significantly higher than the maximum value reported for this orientation and subsequently used to develop maximum loads to be applied in the follow-on static analysis of the HI-STAR 60.

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

2.15 Specify a nationally recognized material code or manufacturing specification (e.g., American Society for Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PVC) Section IID) for the Fuel Impact Attenuators (FIA) springs listed in Table 2.2.10.

Tabulate the relevant mechanical and thermal properties of the material(s) from which the fuel impact attenuator is constructed over the temperature ranges that are expected to be seen under Normal Conditions of Transport and Hypothetical Accident Conditions.

The function of the FIA springs is important to maintaining the integrity of the cladding during a drop accident, and must have minimum guaranteed mechanical properties and a widely recognized industry code associated with its construction.

The staff notes that the proposed materials of construction for the FIA springs (e.g., 301 and 17-7 precipitation hardened stainless steels) have *significantly* different mechanical properties.

This information is needed to determine compliance with 10 CFR 71.31(c) and 10 CFR 71.33(a)(5)(iii).

2.16 Remove note 2 from Table 2.2.1 and Table 2.2.2 or provide adequate justification for the approximation in note 2, citing a widely recognized source (e.g., an American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PVC) case).

Elevated tensile strengths can only be approximated, not derived from the yield strength of a material by using a ratio of the two strengths at room temperature.

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

2.17 Specify the forging designation (e.g., F1, F12, etc.) of the SA336 steel referenced in Table 2.2.3.

The staff is unable to determine the material characteristics of the SA336 referenced in Table 2.2.3 without a complete American Society of Mechanical Engineers (ASME) designation.

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

2.18 Remove or clarify the note attached to Table 2.1.16.

This note permits the use of materials which do not meet the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PVC) for a wide number of components which are important to safety and depending on interpretation, appears to permit the substitution of non-code materials for materials meeting other industry specifications.

The staff *must* have a clear and unambiguous understanding of what materials are intended for use in the HI-STAR 60 package in order to render a regulatory decision. Of particular concern is the potential use of materials meeting unspecified “other standard industrial codes.”

This information is needed to determine compliance with 10 CFR 71.31(c) and 10 CFR 71.33(a)(5)(iii).

2.19 Clarify that the insulating material will have all of the critical characteristics listed in Table 2.2.9 at the maximum temperatures anticipated under normal operating conditions. If the presence of the insulating material affects the thermal analysis of the package during a hypothetical accident condition (HAC), specify that the insulating material will maintain the minimum thermal conductivity listed in Table 2.2.9 during the HAC.

The thermal conductivity of many insulating ceramics increases (marginally) with increasing temperature.

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

2.20 Clarify that the impact limiting material will have the crush strength listed in Table 2.2.9 at the maximum temperature anticipated under normal operating conditions.

Although the normal operating temperature of the impact limiters is not sufficient to affect the properties of aluminum, publicly available data from a manufacturer of epoxy-bonded aluminum honeycomb indicates that mildly elevated temperatures may affect the performance of a proposed honeycomb material.

Ref: “HexWeb™ Honeycomb Attributes and Properties,” Hexcel Inc., p. 27, 1999. http://www.hexcel.com/NR/rdonlyres/599A3453-316D-46D6-9AEE-C337D8B547CA/0/HexwebAttributesandProperties.pdf

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

2.21 Ensure that the acceptance criteria of the intermediate shells will be sufficient to provide shielding during a drop accident.

a) Specify on sheet 7 of Licensing Drawing 5238 that the SA 516 Grade 70 steel shall meet the testing requirements outlined in Table 2.1.13.

b) Justify that a Charpy impact energy of 10 ft-lbs for the gamma shield and related weld material will be sufficient to maintain shielding in the event of a drop accident. Alternatively, clarify in Table 2.1.13 that each sample of material tested for the gamma shield and related weld material will meet a minimum Charpy impact energy of 15 ft-lbs and a lateral expansion of 15 mils.

Subsection NF of the American Society for Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PVC) requires an average Charpy impact energy of 15 ft-lbs, but individual samples of material are permitted to have a Charpy impact energy as low as 10 ft-lbs. This latter value was not used in the structural analysis of the intermediate shell material in Holtec Report 2073716, “Structural Calculation Package for HI-STAR 60.”

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

2.22 Clarify in Table 2.1.16, what subsection and safety class of the American Society for Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PVC) is being applied to all of the materials which are important to safety, as listed in the Licensing Drawings. Ensure consistency between Table 2.1.16 and Table 2.1.18.

Table 2.1.16 does not appear to cover all of the components listed as important to safety in the Licensing Drawings, and the code of construction and safety class to design components listed in Table 2.1.16 is unclear. For example, Section II of the ASME B&PVC is not a code of construction, and does not have required testing for procured materials (e.g., Charpy impact testing).

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

2.23 Justify the lack of post-weld heat treatment (PWHT) for the “Cask Intermediate Shells” in Table 2.1.17 of the Safety Analysis Report (SAR).

The applicant is cautioned that any justification should include all potential materials which are authorized for the containment boundary (e.g., SA203-E, SA350-LF3) Section III, Division I, Subsection NB of the American Society for Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PVC) specifies PWHT for these welds, regardless of component size and thickness.

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

2.24 Justify the statement in Table 2.1.17, “Confirmatory radiographic examination after PWHT [post weld heat treatment] is not necessary because PWHT is not known to introduce new weld defects in nickel steels.”

Section III, Division I, Subsection NB of the American Society for Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PVC) specifies PWHT for welding ferritic steel. The applicant should provide a reference supporting this acceptation to the ASME Code.

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

2.25 Include additional, quantifiable data to the critical characteristics of the O-ring gasket in Table 2.2.8 of the package application.

a) Specify a temperature of retraction (T_{10}) for the elastomeric material.

This specification is to ensure the adequate performance of the seal at low temperature. Different providers of elastomeric material provide varying constraints on the operating limits of elastomers below T_{10}, the applicant should choose a conservative temperature limit below T_{10} (e.g., $5^{o}C$).

This specification is to ensure adequate performance of the seal at low temperatures. As a reference, the applicant should note that Parker Compound V0835-75, Viton GLT seals, which have a maximum T_{10} of -22°F (-30°C) performed poorly at -40°C.[1] The staff notes that Viton GLT has been replaced by a similar Parker Compound, VM835-75 with a maximum T_{10} of -24°F (-31°C). It is not expected that VM835-75 seals would perform adequately at -40°C.

b) Provide dimensional tolerances for the elastomeric material and the design-based percentage range of compression (also called “squeeze”) for the seal at ambient temperature. This value is not to be confused with the “compression set,” which is a measure of elastic degradation.

Note 9 on sheet 1 of Licensing Drawing 5238, which specifies tolerances, does not apply to the elastomeric material. The tolerances and percentage compression range for the seal should be provided to ensure adequate sealing.

c) Provide helium permeability of the chosen elastomeric seals as a function of operating temperature. In Chapter 7 of the application, provide a comprehensive leak test plan[2,3] considering the helium permeation, to demonstrate the compliance of allowable leakage rate analyzed in the containment analysis.

This specification is to ensure that the helium leak rate is measured accurately, and is not influenced by high permeability to helium.

d) Specify a range of hardness range (e.g., 70 to 80 Shore A Durometer) for the elastomeric seal at ambient temperature.

This specification is to ensure adequate sealing of the package.

e) Specify a minimum elongation (e.g., 100%) at ambient temperatures.

This specification is to ensure the seal is sufficiently elastic for the application.

This information is needed to determine compliance with 10 CFR 71.33(a)(5)(iii) and 71.51.

References:

1 Investigation into Replacement of Viton ‘O’-Rings. G. Holden and G. Hall. RAMTRANS, Vol. 13, No. 3-4, p. 233-242, 2002.

2 Proof-of-Principal Leakage Testing for the Model FL Containment Vessel, Part I – Containment Vessel Leakage Tests. Ronald S. Hafner. Lawrence Livermore National Laboratory. p. 1781-1787, PATRAM '98, Packaging and Transportation of Radioactive Materials Conf., Paris, France, May 10-15, 1998.

3 Proof-of-Principal Leakage Testing for the Model FL Containment Vessel, Part II – O-Ring Leakage Tests. Ronald S. Hafner. Lawrence Livermore National Laboratory. pp. 1788-1797, PATRAM '98, Packaging

and Transportation of Radioactive Materials Conf., Paris, France, May 10-15, 1998.

Chapter 3 - Thermal Evaluation

3.1 Explicitly state the alloys which are grouped together as “Alloy X” in Table 7.7 of Holtec Report, HI-2073740, “Thermal Analyses of the HI-STAR 60.”

Provide the thermal properties of the alloys at relevant temperatures, if not already listed in the application. It is unclear if “Alloy X” means stainless steel.

The staff is familiar with “Alloy X” from other Holtec applications, but the alloys which fall under the category of “Alloy X” are not stated in the HI-STAR 60 application.

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

3.2 Clarify if the NCT and HAC impact limiter temperature limits provided in Tables 3.1.2 and 3.1.4, respectively, are bulk temperature limits or maximum temperature limits.

Because Table 3.1.2 of the application includes bulk average and maximum impact limiter temperatures, it is not clear if the temperature limits that have been provided are bulk temperature limits or maximum temperature limits. All provided temperature limits should be maximum temperature limits.

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

3.3 Provide maximum temperatures for the impact limiters during HAC.

Table 3.1.4 of the application includes bulk temperatures for the impact limiters, but does not include maximum temperatures. Temperature provided for all components should be maximum temperatures.

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

3.4 Justify the time-to-boil calculation, specifically the mass contributing to the thermal inertia in Section 3.3.3 of the application.

In Section 3.3.3 of the application, it appears that the applicant is assuming all of the package mass will heat up and contribute to the thermal inertia in the time-to-boil calculation. The staff believes that (i) the fuel, water, basket, containment shell, and baseplate will heat up and contribute to the thermal inertia, and (ii) the assumption that all of the material outside of the containment shell would heat up and reach 100°C at the same time the water would begin to boil would be incorrect. The staff feels the time-to-boil thermal inertia should be adjusted accordingly.

This information is needed to confirm compliance with 10 CFR 71.43(f).

3.5 Revise the overall length of the thermal Fluent models and report any changes in maximum temperatures for all thermal Fluent models. Report any changes made to the model geometry to achieve the overall length provided in Section 1.2.1.3 of the application.

The overall length of the Fluent models is 0.21 m shorter than the overall length in Section 1.2.1.3 of the application and the Design Drawings. Thermal model dimensions should be consistent with the dimensions presented in the application and in the Design Drawings.

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

3.6 Revise, in the solar and post-fire Fluent models and in the application, the values used for the emissivity and absorptivity of polished stainless steel and report changes in temperature. Also, describe controls and procedures that will be in place to ensure the impact limiter surface will be maintained to compensate for changes in the package surface due to dirt, weathering, and handling during its lifetime.

Remove the footnote, on page 3.3-3 of the application, stating that: "In accordance with classical radiation principles absorptivity equal to the package emissivity is applied to the package surfaces." All package absorptivity values should be clearly identified in the application.

In the staff's reference for polished stainless steel radiative properties, absorptivity = 0.42 and emissivity = 0.11. The values presented in the application for polished stainless steel are less conservative than the staff's reference. The values in the application are also from a textbook reference which is in general not an acceptable source of materials property data. If the applicant plans to use radiative property values for polished stainless steel, it is necessary to describe controls and procedures that will be in place to ensure the impact limiter surface will be maintained to compensate for changes in the package surface due to dirt, weathering, and handling during its lifetime. All absorptivity values should be clearly presented in the application.

Reference: Kauder, L., "Spacecraft Thermal Control Coatings References," NASA Technical Procedure, NASA/TP-2005-212792, NASA/Goddard Space Flight Center, Greenbelt, MD, July 2005.

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

3.7 Revise the Fluent fire model absorptivity and emissivity values for polished stainless steel and report changes in temperature.

The absorptivity value used in the fire model to achieve the solar heat generation rate in the Fluent fire model does not meet regulation 71.73(4) which states, "the surface absorptivity coefficient must be either that value which the package may be expected to possess if exposed to the fire specified or 0.8, whichever is greater." The emissivity value used in the Fluent fire model is not consistent with Table 3.4.1 of the application.

This information is needed to confirm compliance with 10 CFR 71.73(4).

3.8 In the Holtec Report HI-2073740 "Thermal Analysis of the HI-STAR 60," clarify why the basket-to-cavity radial growth calculation does not include the thermal expansion of the basket supports as shown in Drawing 5217, Sheet 2, Rev. 4.

In order to account for the full basket-to-cavity radial growth to ensure the minimum cold gap is not exceeded, the staff believes the basket supports should be included in the basket-to-cavity radial growth calculation.

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

Chapter 5 – Shielding Evaluation

5.1 Clarify the response given to RAI 5-3 dated September 3, 2008.

RAI 5-3 was intended to ensure that there is no reconfiguration of the fuel rods after hypothetical accident conditions (HAC). The applicant responded by computing dose rates based on the assumption that the fuel is relocated so that the density and source term of the fuel increase by a factor of two. The applicant recalculated the dose rates and found them to be within the regulatory limits for HAC.

Staff did not find an already accepted precedent for the assessment of the fuel relocation so that density and source terms increase by a factor of two. The applicants needs to clarify the rationale for the assumption and the subsequent calculation as a “standard industry practice.”

This information is needed to confirm compliance with 10 CFR 71.51.

Chapter 8 – Acceptance Tests and Maintenance Program

8.1 Remove or clarify the statement “as applicable” from Section 8.1.3 of the application.

The containment boundary should be tested using a specified combination of helium leak test, pressure test, magnetic particle and dye penetrant tests as required by Section III, Subsection NB of the American Society for Mechanical Engineers Boiler (ASME) Boiler and Pressure Vessel Code (B&PVC) and 10 CFR.

This information is needed to satisfy the provisions of 10 CFR 71.33(a)(5)(iii).

8.2 Citing a controlling Quality Assurance document, specify that Metamic panels which do not meet the workmanship and finish criteria described in the second to last paragraph in Section 8.1.5.4.3 of the application will be rejected.

Although workmanship or finish criteria are listed in Section 8.1.5.4.3, the results and conditions for a Metamic panel failing to meet the minimum requirements of workmanship are unclear.

This information is needed to determine compliance with 10 CFR 71.33(a)(5)(iii) and 71.55(b).

8.3 Provide procedures in Section 8.1.7 of the application to perform thermal acceptance tests on the HI-STAR 60 package prior to shipment.

Although reasons were given in Section 8.1.7 of the application for not performing thermal acceptances tests, Section 8.1.7 of the application did not address fabrication anomalies in critical heat-removing components.

Due to the decay heat load of the spent fuel, the insulative properties of the neutron shield, as well as uncertainties in calculations and fabrication, it is necessary to establish thermal acceptance tests. The staff needs to ensure the heat transfer capability of the package has been achieved during the fabrication process prior to shipment.

The certificate of compliance (CoC) will include a condition for a thermal acceptance test to be performed on the first fabricated unit.

Section 8.1.7 of the application should include the method of testing, equipment used in the test, acceptance criteria, and the course of action if the acceptance criteria have not been met.

This information is needed to confirm compliance with 10 CFR 71.85(a) and 10 CFR 71.93(b).

8.4 Provide procedures in Section 8.2.4 of the application to perform thermal maintenance tests on the HI-STAR 60 package prior to shipment.

Although it was stated in Section 8.2.4 of the application that a thermal maintenance test would be performed for each package within 5 years prior to each shipment, no procedure for the test was provided. Section 8.2.4 of the application should include the method of testing, equipment used in the test, acceptance criteria, and the course of action if the acceptance criteria have not been met.

This information is needed to confirm compliance with 10 CFR 71.87(b) and 10 CFR 71.93(b).

8.5 Specify the surface finish (e.g., anodized, mill, bead blasted, etc.) of the Metamic panels in Section 8.1.5.4.1 and/or 8.1.5.4.2 of the application.

Section 4.2 of HOLTEC Report HI-2043215, “Sourcebook for Metamic Performance Assessment,” concludes with the statement that the results of corrosion testing, “emphasizes the need to clean the surfaces of the Metamic thoroughly to remove contaminants.”

This information is needed to determine compliance with 10 CFR 71.43(d) and 71.55(b).

8.6 Remove or clarify the statement, “Processing changes that will clearly lead to an improvement in the properties of the material may be incorporated into the production process…” from the last paragraph of Section 8.1.5.4.3, subsection “Qualification Testing Program” of the application.

The staff understands that the manufacturer of Metamic may, at certain times, make adjustments to the fabrication of Metamic in an effort to improve the product. From a regulatory perspective, however, this statement introduces ambiguity into the fabrication procedures which were introduced in the proceeding sections, which should be clarified.

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

8.7 Clarify the maximum open (interconnected) porosity of the Metamic panels in Section 8.1.5.4.1 and/or 8.1.5.4.2 of the application.

Justify or demonstrate that rapidly heating Metamic after submersion (as seen during cask drying) will not damage Metamic.

HOLTEC Report HI-2043215, "Sourcebook for Metamic Performance Assessment and the Acceptance Testing Criteria," provides the typical total porosity for Metamic. Corrosion and resistance to damage during rapid drying, is influenced primarily by porosity that is exposed to the environment.

This information is needed to determine compliance with 10 CFR 71.33(a)(5)(iii) and 71.55(b).

8.8 Justify why a change of supplier for Metamic would not require re-qualification of Metamic, similar to what is discussed in HOLTEC Report HI-2043215, "Sourcebook for Metamic Performance Assessment and the Acceptance Testing Criteria."

Alternatively, specify that Metamic will be manufactured by Holtec International Inc., or a wholly-owned subsidiary of Holtec.

The characteristics of Metamic are described in HOLTEC Report HI-2043215, "Sourcebook for Metamic Performance Assessment and the Acceptance Testing Criteria." Provided that the manufacturing process and manufacturer do not change, the properties of Metamic should also remain the same.

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

8.9 Clarify in Section 8.1.5.4.3 of the application that, if the wet chemistry analysis does not meet the minimum requirements for B_4C content, all panels from the mixed batch shall be rejected. If a coupon fails the neutron attenuation test, all panels from the mixed batch are rejected. The same consequence should apply to the results of wet chemistry analysis.

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

Others

O.1 Confirm that the term "or equivalent" on page A-1 of the proposed Certificate of Compliance (CoC), means the cladding composition will be identical to the composition of Zircaloy-4 (Zr-4) or will be within the compositional range specified in ASTM B 811-1997, "Standard Specification for Wrought Zirconium Alloy Seamless Tubes for Nuclear Reactor Fuel Cladding."

The term "or equivalent" as used on page A-1 of the proposed CoC should be clarified or removed.

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

O.2 Provide the following information in the proposed Certificate of Compliance (CoC):

a) The value of the minimum permissible areal density of ^{10}B of the Metamic panels (as given in Equation 1, referenced in Section 8.1.5.4.2 of the application).
b) The credited value of the areal density of ^{10}B in the Metamic used to perform the criticality analysis in Chapter 6 of the application, supplemented by Holtec Report, HI- 2073727, "Criticality Evaluation for the HI-STAR 60." (90% of the minimum permissible areal density of ^{10}B).

The minimum areal density of ^{10}B required for acceptance of the Metamic panels, and the credited areal density of ^{10}B should be explicitly stated and controlled to ensure the neutron absorbing behavior of the Metamic panels.

This information is needed to determine compliance with 10 CFR 71.33(a)(5)(iii) and 71.55(b).

O.3 Clarify Section 6(c) of the proposed CoC that all references to American Society for Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PVC) within the application refer to the 2004 ASME B&PVC.

The precise ASME B&PVC edition should be applied to the fabrication of NF and NG components, not just to the containment boundary, and should be referenced in the CoC.

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

O.4 Clarify where the statement, "All bolts are required to be ultra-sonically examined to "NB" acceptance standards to ensure the absence of internal voids" can be found in the application.

The applicant stated that this additional condition was added to the application in response to RAI 2-8, dated September 3, 2008, but the staff did not find this statement in the application, Revision No. 1.

This information is needed to determine compliance with 10 CFR 71.31(c) and 10 CFR 71.33(a)(5)(iii).

O.5 Clarify the welding codes used to produce the package.

Potential conflicts appear to exist between the welding codes cited for the construction of the package. The staff discussed this issue with the applicant via a teleconferencing call.[1]

This information is needed to determine compliance with 10 CFR 71.31(c) and 71.33(a)(5)(iii).

1. Ref: Conversation Record with Holtec International re: Proposed Language for Welding (Held on 2/19/09), ADAMS Accession No.: ML090550037

O.6 Clarify the type of standard (e.g., zirconium biboride, metal matrix composite, etc.) that is being used to calibrate the neutron attenuation beam.

The use of standards which are heterogeneous may not be appropriate as a neutron attenuation calibration standard.

This information is needed to determine compliance with 10 CFR 71.33(a)(5)(iii) and 71.55(b).

Licensing Drawings

D.1 Clarify if SA 105, which is listed in the Bill of Materials on Licensing Drawing 5238 sheet 7 is the material of construction for the steel trunnion plug, and provide the mechanical properties of SA 105 steel at relevant temperatures.

SA 105 and the mechanical properties of SA 105 are not mentioned in the body of the application.

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

D.2 Clarify or remove note 28 on Licensing Drawing 5238 sheet 1 for the HI-STAR 60 Package.

Note 28 states, “304 S/S materials, may be SA 240, SA 479, SA 336, or other applicable [American Society for Mechanical Engineers] ASME Code Material with equal or better mechanical properties.”

The specifications for SA 240, SA 479, and SA 336 cover a wide range of stainless steels, including austenitic, ferritic and martensitic steels. Although many of steels within these ASME classifications may have sufficient mechanical properties to meet the design requirements, the staff cannot make a regulatory finding in the absence of more specific materials being listed for the materials of construction of safety related components.

In addition, the term “other applicable ASME Code material with equal or better mechanical properties” is open to interpretation. It is unclear what mechanical properties are being referred to, and what materials are used for the basis of comparison.

The staff recognizes that the applicant referenced the use of ASME certified materials for safety-related components, and understands that flexibility in the manufacture of the HI-STAR 60 transportation package is advantageous. The applicant should, however, provide a more precise listing of the alternative materials of construction, and tabulated data for the mechanical properties of the alternative materials over the relevant range of temperatures.

The staff notes, however, that ductility and impact resistance of materials at low and ambient temperatures are not listed in Section IID of the ASME Boiler and Pressure Vessel Code (B&PVC). As such, the proposed substitution of austenitic stainless steel with other types of stainless steels (e.g., ferritic, martensitic, etc.) may be problematic from a regulatory standpoint. Additional issues arise when considering the welding characteristics and thermal properties of alternative but equivalent materials.

Finally, if alternative materials are permitted for safety related components, the applicant should specify in the Licensing Drawings that all components of a single type should be fabricated from one specific material (e.g., all basket support channels should be made of SA 240-304, but all basket support plates will be made of SA 336-F9).

This information is needed to determine compliance with 10 CFR 71.31(c) and 71.33(a)(5)(iii).

D.3 Remove the statement, "Except for containment boundary components, ASME, [American Society of Mechanical Engineers] materials may be substituted by ASTM [American Society for Testing and Materials] materials" from all Licensing Drawings.

Only ASTM materials which have identical or superior properties and levels of quality to their ASME counterparts can be used as substitutes for ASME materials designated for use in components which are important to safety. Such substitutions must be approved by the NRC staff.

The NRC staff is only evaluating a specific design with specific materials designations.

This statement was removed from Licensing Drawing 5238 in response to a request for additional information, but should also be removed from Licensing Drawing 5127 as well.

This information is needed to determine compliance with 10 CFR 71.31(c) and 10 CFR 71.33(a)(5)(iii).

D.4 Clarify the statements, "in the applicable code, as clarified in the SAR" in note 15 of Licensing Drawings 5238 and 5237, and "or other applicable code as delineated in the SAR," in note 9 on Licensing Drawings 5217, 5238, and 5237.

The staff is unsure what codes are being referred to by these notes. All alternatives to the American Society for Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PVC) should be referenced in Table 2.1.17 of the application.

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

D.5 Justify why space plate welds on the fuel basket are not made to according to Section III, Division I, Subsection NG of the American Society for Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PVC).

Even temporary attachments to the basket should be made according to Section III, Division I, Subsection NG of the ASME B&PVC. In addition, the space plates on the fuel basket appear to add support to the basket in the event of drop accident.

This information is needed to determine compliance with 10 CFR 71.31(c) and 10 CFR 71.33(a)(5)(iii).

EDITORIAL

E.1 Justify or remove all proprietary labeling on pages 3.3.3 – 3.3.5 of the application.

(1) *Page 3.3-3 to page 3.3-4, including the description of the 3D Cask Model and continuing through the bulleted list.* This information includes a general model description and principle features of the 3D thermal model. This information is general in content and does not include trade secret, confidential, privileged commercial, or financial information. It is requested that the noted proprietary information above be made public within the HI-STAR 60 package application.

(2) *Page 3.3-5, including the number of nodes and the nodal distribution of the 3D Cask Model.* This information should be justified as being proprietary or all proprietary information on page 3.3-5 should be made public within the HI-STAR 60 package application.

The staff notes that similar information on pages 3.3-3 through 3.3-6 in the HI-STAR 180 application is not labeled as proprietary.

E.2 The temperature in Table 2.2.4 is separated by commas, and should be replaced by decimals.

E.3 Correct the units for the neutron beam diameter used for attenuation measurements of the neutron absorbing material. In Section 8.1.5.4 of the application, the units for the neutron beam diameter used for attenuation measurements is in^2, which is an area, not a length.

E.4 Clarify that the test temperature for determining the lateral expansion of the bolting material during Charpy impact testing in Table 2.1.12 is -40^{o}F.

The test temperature for measuring the impact energy of the bolting material is listed in the note at the bottom of Table 2.1.12. The staff assumes that the lateral expansion will be determined from Charpy impact testing at the same temperature.

E.5 Clarify if the parameter, FB_4C, in Equation 1 from HI-2043215, referenced in Section 8 of the application, is the weight fraction or volume fraction of boron carbide in the aluminum matrix of the neutron absorbing material.

Since FB_4C is a unitless quantity, the staff is unsure if FB_4C referred to the weight fraction or volume fraction of boron carbide in the aluminum matrix of the neutron absorbing material.

The staff recognizes that the density of aluminum and boron carbide are “similar;” however they are not identical.

E.6 The applicant should consider including Equation 1 from HI-2043215 and the definitions for its parameters in the Package Application.

Including Equation 1 in the body of the application would help clarify the qualification and acceptance testing of Metamic.

E.7 Mention the use of an underwater camera to inspect the seal surface in 7.1.2.1 sub paragraph 4 of the application.

In response to RAI 7-3, the applicant stated that an underwater camera will be used to inspect the seal surface for damage and solid contamination, as part of the loading procedure. For the sake of clarity, the use of an underwater camera should also be included in 7.1.2.1 sub paragraph 4 of the application.

E.8 Specify that thermal neutrons are used for neutron attenuation testing of METAMIC. The staff has always understood that thermal neutrons are used to test the material.

E.9 Revise wording on pp. 2.6-8, “Lateral Gaps” second paragraph: “expect for fuel assemblies” should read “except for fuel assemblies”.

E.10 Revise Table 1 in Holtec Report 2084137R0 to reflect G loads consistent with the scale of the test data and prediction model used.

The data in the table is intended to represent a quarter scale test and a quarter scale prediction model, therefore the data reported in the table should not be scaled to imply that the test data and prediction model results are for a full scale package.

E.11 Revise Table 1 in Holtec Report HI-2073743 pp. 26 or Table 1 in Holtec Report HI-2084137R0 such that the reported measurements from the quarter scale test of the HI-STAR 100 are consistent. If a revision is not necessary, justify the discrepancy.

The measured values of Total Crush Depth and Impact Duration reported for the quarter scale test are not consistent between these two tables, yet the peak decelerations are consistent. The information provided in these tables either 1) needs correction, or 2) the applicant must provide a justification for the differences.

E.12 Remove all references to IP-1 fuel from Holtec Report HI-2073722 “HI-STAR 60 Shielding Evaluation”. Remove tables of dose rates using ICRP-74 conversion factors in the same document. Give a short explanation of the fractional standard deviations (fsd) which appear in Tables 5.1.1., 5.1.2, and 5.4.3 though 5.4.6.

E.13 Remove all references to Quinshan fuel in Holtec Report HI-2073728.

E.14 Provide references to support Table 1.2.5 of the application.