SAFETY EVALUATION REPORT
Docket No. 71-9325
Model No. HI-STAR 180 Package
Certificate of Compliance No. 9325
Revision No. 1

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SUMMARY

By application dated May 31, 2013, Holtec International (Holtec) submitted an amendment request for the Model No. HI-STAR 180 as a Type B (U)F-96 package. On September 18, 2013, Holtec responded to a first request for additional information (RAI) letter dated August 29, 2013. On January 7, 2014, Holtec responded to a second RAI letter dated December 19, 2013. On April 21, 2014, Holtec submitted Revision No. 6 of the package application which supersedes in its entirety the application dated May 31, 2013.

The Model No. HI-STAR 180 package is designed to hold undamaged Uranium Oxide (UO_2) and Mixed Oxide (MOX) irradiated fuel assemblies in a thermally conductive fuel basket. Metamic-HT, a composite of nano-particles of aluminum oxide and boron carbide particles dispersed in the metal matrix of pure aluminum metal, is the principal constituent material of the fuel basket. The package has two closure lids, with each lid individually designated as a containment boundary component. The inner and outer lids each feature two concentric annular metallic seals, thus providing a total of four independent barriers against leakage. The outer diameter of the package is approximately 2700 mm without the impact limiters. The length of the package is approximately 4429 mm without the impact limiters and 7240 mm with the impact limiters. The maximum gross weight of the loaded package is 140 Metric Tons.

The amendment request updated the information available for the qualification of Metamic-HT as fuel basket material, modified some of its minimum guaranteed values, its sampling plan, and other aspects of this material. The amendment request also introduced a new welding process (friction stir welding), changed the design and function of the fuel impact attenuator, the strength properties of the fuel basket support shims, and the minimum Holtite pocket thickness for shielding evaluations. Finally, the applicant requested the approval of a metallic seal design with well defined critical parameters.

NRC staff reviewed the application using the guidance in "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel," NUREG-1617. The analyses performed by the applicant demonstrate that the package provides adequate thermal protection, containment, shielding, and criticality control under normal and accident conditions.

Based on the statements and representations in the application, and the conditions listed in the certificate of compliance, the staff concludes that the package meets the requirements of 10 CFR Part 71.

References

Holtec International application “Safety Analysis Report on the HI-STAR 180 Package,” Holtec Report No. HI-2073681,” Revision No. 6, dated April 21, 2014.

1.0 GENERAL INFORMATION

The Model No. HI-STAR 180 package is a Type B (U)F-96 package designed for the transport of undamaged commercial UO_2 and MOX fuel assemblies over a plant's entire life cycle.

1.1 Packaging

The Model No. HI-STAR 180 package consists of a monolithic cylinder configured from several short annular shield cylinders, each holding the Holtite-B neutron shielding material, which are stacked on top of each other to provide full-length gamma and neutron shielding. The containment boundary is formed by a cryogenic steel inner shell welded at the bottom to a nickel steel baseplate (containment baseplate) and, at the top, to a machined nickel steel forging (containment closure flange). The packaging closure system includes two independent closure lids, each equipped with two concentric annular metallic seals. Each lid is bolted independently to the containment closure flange.

The intrinsic design of the packaging was not modified by this amendment request, although the function of the fuel impact attenuator, the strength properties of the fuel basket support shims, and the minimum Holtite pocket thickness for shielding evaluations were changed.

1.2 Materials

The amendment request updated the information available for the qualification of the Metamic-HT, modified some of its minimum guaranteed values to facilitate production scale fabrication of the material, its sampling plan, and other aspects of this material. The amendment request also introduced a new welding process, i.e., friction stir welding, for Metamic-HT.

Material and manufacturing control processes are carried out using written procedures to ensure that all critical characteristics are met. In particular, a sampling plan is an integral part of the Metamic-HT manufacturing manual and provides a reasonable assurance that the minimum guaranteed values are met in the production lots.

Staff reviewed the revised Metamic-HT Qualification Sourcebook and found that the new proposed values meet the service requirements of the components of the package. The Metamic-HT Qualification Sourcebook provides information on weld coupon testing of Metamic-HT weldment though friction stir welding (FSW). The Metamic-HT manufacturing manual contains the necessary procedures for Metamic-HT welding requirements and visual inspection.

Staff disagreed with the applicant on the concept of "equivalent materials," as "fully developed and having gained NRC acceptance in the HI-STORM FW SAR,", because the flexibility for evaluation of changes contained in 10 CFR 72.48 is not included in the 10 CFR Part 71 regulatory frameworks. Therefore, this statement could lead to an incorrect conclusion that something other than a material specified in the licensing drawings could be used. Any packaging component which does not comply with the licensing drawings referenced in the certificate of compliance (CoC) is not acceptable for shipment.

1.3 Criticality Safety Index

The Criticality Safety Index (CSI) for the HI-STAR 180 package is zero, as an unlimited number of packages will remain subcritical under the procedures specified in 10 CFR 71.59(a).

1.4 Drawings

The packaging is constructed and assembled in accordance with the following Drawing Nos.:

HI-STAR 180 Cask:	Drawing 4845, Sheets 1-6, Rev. 11
HI-STAR 180 F-37 Fuel Basket:	Drawing 4847, Sheets 1-4, Rev. 7
HI-STAR 180 F-32 Fuel Basket	Drawing 4848, Sheets 1-4, Rev. 7
HI-STAR 180 Impact Limiters:	Drawing 5062, Sheets 1-5, Rev. 6

Drawings were revised to incorporate a complete description of the new seal requirements, reflect basket weldment options suitable for the FSW process, clarify basket support (shim) requirements, allow a minimum open volume to accommodate the thermal expansion of the Holtite neutron shield with a new width of 70 mm for the Holtite pocket width, and allow a lower range for the width of the full height panel of the basket from 204 mm to 115 mm.

1.5 Evaluation Findings

A general description of the Model No. HI-STAR 180 package is presented in Chapter 1 of the package application, with special attention to design and operating characteristics and principal safety considerations. Drawings for structures, systems and components important to safety are included in Section 1.3 of the application. The staff concludes that the information presented in this section of the application provides an adequate basis for the evaluation of the Model No. HI-STAR 180 package against 10 CFR Part 71 requirements for each technical discipline.

2.0 STRUCTURAL REVIEW

The objective of the structural review is to verify that the structural performance of the package meets the requirements of 10 CFR Part 71, including performance under the tests and conditions for both normal conditions of transport (NCT) and hypothetical accident conditions (HAC).

2.1 Structural Design

The Model No. HI-STAR 180 package is comprised of a steel containment system with a Metamic-HT basket, cast monolithic external shield cylinders and steel and aluminum impact limiters. The cylindrical steel shell containment system is welded to a bottom steel baseplate and a top steel forging machined to receive two independent steel lids with a total of four independent metallic seals. This dual lid arrangement, where each lid is bolted independently to the containment closure flange and each closure lid employs two seals, forms the basis for allowing moderator exclusion when evaluating the safety of this package.

The proposed changes pertaining to the evaluation of the structural performance of the package are as follows:

(1) Redesign of the fuel impact attenuator(s) to correspond with a revised design function,

(2) Utilization of FSW for the identified important to safety (ITS) external corner structural welds on the Metamic-HT basket, and

(3) Revision of material properties of fuel basket shims.

The primary change to the fuel impact attenuator (FIA) design follows the change in functional performance requirements of the device. Previously, this device acted as a secondary internal impact limiter to mitigate additional damage that may occur with a hard secondary impact following initial deformation of the external impact limiters. The current device, located in the bottom of the package cavity, is now classified as an active-passive device that is designed to limit the gap prior to impact rather than mitigate the impact itself. Functionally, this achieves a similar result in the damage imparted on the fuel assemblies but, practically, the design and therefore the structural evaluation is simplified.

With respect to a top end drop, the FIA contains a spring (Spring 1) that has sufficient stiffness to translate the fuel assembly while shifting to a lid-down configuration, thereby closing any residual gap that may be present and reducing any additional damage from a secondary impact to both the closure lid and the fuel assemblies. The second component of the FIA is designated a spring (Spring 2) but functionally acts as a rigid spacer. During a bottom down-end drop, the fuel assembly rests on Spring 2, as Spring 1 is not designed to be rigid enough to support the fuel assembly dead load in this configuration. During freefall, however, it is possible for the spring to unload causing the fuel assembly to contact the closure lid thereby allowing the maximum internal gap to be present. Because of this potential condition, the applicant evaluated the bottom end drop with a bounding 20 mm gap (ignoring the FIA) and demonstrated that the structural integrity of the package or contents would not be compromised including the condition that Spring 2 would not be susceptible to yielding or gross buckling. The applicant did report that the maximum clearance gap was reduced from 20 mm to 18 mm; however, this change does not alter any conclusions with respect to the structural analysis.

The evaluation and justification for the change in the design and function of the FIA are currently satisfactory to the NRC staff such that no requests for additional information were necessary at this time.

However, the NRC staff's current technical position on the effects of secondary internal impacts is under review and, as such, the staff is not requiring such devices to account for physical gaps that may adversely affect fuel assembly performance or closure lid bolt performance during a drop event. Should the staff's technical position change, there may be a need to revisit this evaluation in the future for completeness or to satisfy additional safety concerns not yet identified.

The second proposed change to allow the use of FSW, in general, does not change the safety basis already evaluated by staff with respect to basket performance. Since the basket corners already have a welded joint specified in the initial licensing review, the primary consideration is that of the weld process and qualification, rather than structural performance of the weld itself. It was evident from the observations of the NRC staff that the methods employed to structurally qualify the weld joint were sufficiently robust to demonstrate comparable structural performance.

Furthermore, the NRC staff has determined that questions surrounding the welding process and qualification are not sufficient to warrant a safety concern with respect to structural performance at this time. This is primarily due to the loading conditions and the fully supported boundary conditions (via shims) of the peripheral basket panels. The current configuration of the welded joint will not be developed to its full capacity leaving sufficient margin to account for any differences in welding procedures, should they arise in the future. It should be noted that these conclusions only apply to the ITS basket corner welds and shim arrangement defined by this amendment request.

The third change relevant to structural performance was a revision to the yield strength and ultimate strength properties of the fuel basket support shims. Revising these values downward had no appreciable effect on safety given that adequate margin was maintained and no material yielding occurred.

2.2 Materials

The Model No. HI-STAR 180 package incorporates the use of Metamic-HT for the fuel basket structure. The remaining materials used in the fabrication of the HI-STAR 180 package have been used in previously staff-reviewed transportation and storage system designs. There are no changes to the various other materials used to fabricate the HI-STAR 180 package, therefore evaluation is primarily provided for the HI-STAR 180 fuel basket material and structure, Metamic-HT. The HI-STAR 180 package fuel basket structure is similar to the HI-STORM 100U VVM approved in CoC No. 72-1014.

Metamic-HT is a Holtec proprietary aluminum-based material intended for dual purpose use in the HI-STAR 180 fuel basket structure. Metamic-HT is designed to be both a neutron poison for criticality control and a load-bearing structural material. Metamic-HT is a powder metallurgy material composed of aluminum combined with aluminum oxide and boron carbide. Holtec uses the terminology metal matrix composite (MMC) to generically describe the Metamic-HT. The aluminum oxide is a finely dispersed second-phase particle that provides enhanced room temperature and elevated temperature (creep) strength. The boron carbide is the neutron poison used for criticality control.

The staff finds the composition and properties of Metamic-HT to be unique; however the applicants test program was comprehensive in scope and supported the wide variety of property data for characterizing Metamic-HT. Using the guidance of ASME Code, Section II, Appendix 5, Holtec determined mechanical properties at various temperatures. Material properties are discussed in Section X.X of the application. The staff reviewed all materials selected and determined that they are acceptable and provide reasonable assurance for safety of the package based on specifications, temperature dependent mechanical properties, including yield strength, tensile strength, allowable strength, modulus of elasticity, and coefficient of thermal expansion conforming to ASME Code requirements. The applicant concluded that Metamic-HT has more than adequate corrosion resistance for the intended service. Metamic-HT was tested for compatibility with borated water, as would be typical for cask loading and unloading conditions. Aluminum alloys are very slightly corroded by borated water and Metamic-HT performed similar to other aluminum-based materials in immersion tests.

The staff finds that Metamic-HT is not susceptible to chemical and/or galvanic reactions under normal conditions based on the above discussion, its dry, inert environment during transportation, isolated contact with surrounding internal packaging materials and is in accordance with 10 CFR 71.43(d). The staff also finds the material specification EN-SB-637, “Specification for Precipitation-Hardening Nickel Alloy Bars Forgings and Forging Stock for High-Temperature Service” acceptable for the trunnions, inasmuch it provides reasonable assurance for safety of the package in accordance with ASME SECTION II B.

The staff concludes that the material properties of the structures, systems, and components of the Model No. HI-STAR 180 package are in compliance with 10 CFR Part 71, and that the applicable design and acceptance criteria have been satisfied.

The evaluation of the material properties provides reasonable assurance the package will allow safe transportation of spent fuel. This finding is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable ASME Codes and standards, and accepted engineering practices.

2.3 Friction Stir Welding

Welding, unless it involves Metamic-HT, is performed using weld procedures that have been qualified in accordance with ASME Code, Section IX, and the applicable ASME Code, Section III Subsections. Welding of welds identified as NITS welds may be performed using weld procedures that have been qualified in accordance with AWS D1.1 or AWS D1.2, as applicable.

Welds are examined in accordance with ASME Code, Section V, with acceptance criteria per ASME Code, Section III. Acceptance criteria for NDE are in accordance with the applicable Code for which the item was fabricated. Weld inspections are detailed in a weld inspection plan that identifies the weld and the examination requirements, the sequence of examination, and the acceptance criteria. All weld inspections are performed in accordance with written and approved procedures by personnel qualified in accordance with SNT-TC-1A.

As is generally true of metal matrix composites, Friction Stir Welding (FSW) is known to provide predictable and stronger joint strength on a repeatable basis compared to classic welding methods such as metal inert gas or tungsten inert gas welding. Accordingly, the FSW process is used for joining Metamic-HT panels with the requirement that the welding procedure and welders are appropriately qualified.

Metamic-HT welding qualifications, requirements, and examinations are made in accordance with the notes of the licensing drawing, paragraph 1.2.1.6.1, and Section 8.1.2 of the application. The applicant referenced the ASME 2007 edition of the Code for Metamic-HT welds. However, the staff found that the ASME Code did not address the FSW Process until the 2013 edition.

Although the applicant has committed to meet the requirements of ASME Code, Section IX, 2013 edition, for the FSW procedure qualification of the basket Metamic-HT ITS welds, the staff also determined that neither the 2007 nor the 2013 ASME Code, Section III, design code contained NDE acceptance criteria for FSW. Therefore, it was the applicant's responsibility to develop a written procedure and perform a demonstration to verify that the visual inspection technique was capable of detecting discontinuities typical of FSW fabrication conditions that will satisfy the requirement of ASME Code, Section V, Article I, T-150.

After a site visit to the Orrvilon, Inc., fuel basket fabrication facility, the staff determined that the applicant had developed a FSW Visual Inspection Procedure - HSP-638, Revision 3, that met the requirement of ASME Code, Section V, Article I, paragraph T-150. The staff also determined that the procedure is capable of finding typical fabrication FSW visual defects (ADAMS Accession No.: ML14101A295).

The procedure qualification protocol, provided in the Metamic-HT Manufacturing Manual, has been established to accord with the unique bonding characteristics of Metamic-HT and to ensure that the required minimum joint strength is realized with full assurance in the production of the fuel baskets.

The staff concludes that the applicant has demonstrated that the FSW procedure qualification of welding procedures, welder operators, and welder qualifications for the basket Metamic-HT ITS welds meet the requirements of ASME Code, Section IX, 2013, edition and that the FSW fabrication process is capable of producing structurally sound Metamic-HT basket welds.

2.4 Evaluation Findings

On the basis of the review of the Metamic-HT Sourcebook, Revision No. 2, the applicant's responses and the statements and representations in the application, the staff concludes that the package is adequately described and evaluated to demonstrate that its structural capabilities meet the requirements of 10 CFR Part 71.

The data contained in the Metamic-HT Sourcebook is accepted by the NRC staff only for the HI-STAR 180 package application to the extent that it has been used to make a safety determination. As indicated above, the staff has noted deficiencies in the content of the Sourcebook with respect to materials characterization and the Sourcebook is not sufficient by itself to make a safety determination for Metamic-HT.

3.0 THERMAL REVIEW

The objective of the review is to verify that the thermal performance of the Model No. HI-STAR 180 package has been adequately evaluated for the tests specified under both normal conditions of transport (NCT) and hypothetical accident conditions (HAC) and that the package design satisfies the thermal requirements of 10 CFR Part 71.

3.1 Description of the Thermal Design

3.1.1 Packaging Design Features

The design criteria for the Model No. HI-STAR 180 package cover both NCT and HAC conditions (fire). To provide adequate heat removal capability, the Model No. HI-STAR 180 package is designed with the following design features:

1. Helium backfill gas for heat conduction which also provides an inert atmosphere to prevent spent fuel cladding oxidation and degradation.

2. Minimum heat transfer resistance through the basket by fashioning the basket like a honeycomb structure that is welded completely from the basket base to the top.

3. Top and bottom plenums for transverse flow of helium gas aiding in convective heat transfer. Buoyancy-induced convective heat transfer is enhanced by low pressure drop flow passage within the open space of cask cavity.

4. Continuous axial metal heat conduction provided by the basket structure.

5. Flexible aluminum heat conduction elements for heat transfer from the basket periphery to the primary containment shell.

3.1.2 Codes and Standards

Appropriate codes and standards are referenced by the applicant throughout the application.

3.1.3 Content Heat Load Specification

The Model No. HI-STAR 180 package design includes two baskets, i.e., F-32 and F-37, for the transport of 32 and 37 PWR spent fuel assemblies, respectively. The package decay heat limits are understated to limit radiation dose from hot (short cooled) spent fuel. This is accomplished by specifying fuel loading patterns in compliance with both the decay heat and burnup limits of Tables 1.2.8 and 1.2.9 of the application for the F-32 and F-37 baskets, respectively. Fuel loading can be done under uniform and regionalized loadings. The total heat load under all transport configurations is limited to 32 kW.

The thermal loads are different for NCT and HAC: the surface thermal load (combustion heat) is external during a fire accident, while the surface thermal load (insolation) is applied continuously during NCT.

The staff reviewed all the external heat loads into the package. These heat loads are expected and acceptable.

3.1.4 Summary Tables of Temperatures

The summary tables of the package component temperatures, i.e., Tables 3.1.1 and 3.1.3 of the application, were verified. The components include spent fuel cladding, spent fuel basket, containment shell, neutron shield, cask surface, impact limiters, primary closure lid, secondary closure lid, containment base plate, and primary and secondary lid seals and aluminum basket shims. The temperatures are consistently presented throughout the application for both NCT and HAC conditions. For HAC, the applicant presented the pre-fire, during-fire, and post-fire component temperatures. With the exception of the impact limiters and neutron shield, all components remain below their material property limits listed in Table 3.2.10 to 3.2.12 of the application.

3.1.5 Summary Tables of Pressures in the Containment System

The summary tables of the containment pressure under NCT and HAC (i.e., Tables 3.1.2 and 3.1.4 of the application) were reviewed and found consistent with the pressures presented in the General Information, Structural Evaluation, and Containment Evaluation chapters of the application. These tables report the Maximum Normal Operating Pressure (MNOP) for NCT and HAC (fire).

3.2 Material Properties and Component Specifications

3.2.1 Material Properties

The application provides material thermal properties such as thermal conductivity, density, and specific heat for all modeled components of the package. The staff finds these properties acceptable. The applicant specifies the natural convection heat transfer coefficient as a function of the product of Grashof and Prandtl numbers. This product is a function of length scale, surface-to-ambient temperature difference, and air properties. Regarding the thermal stability and radiation resistance of the neutron shield material, Holtite-B, the applicant states that a qualification testing was conducted to confirm that Holtite-B would not degrade at elevated temperature and would not be affected by high neutron fluence and megarad gamma doses. The staff accepted the qualification testing based on the test conditions and the computed weight loss of 2.6% after 40 years simulation. The thermal properties used for the analysis of the package are appropriate for the materials specified and for the package conditions required by 10 CFR Part 71 during NCT and HAC.

3.2.2 Technical Specifications of Components

The package materials and components are summarized in Chapter 2 and Chapter 3 of the application. These materials are required to be maintained below maximum pressure and temperature limits for safe operation. The staff reviewed and accepts these specifications.

3.2.3 Thermal Design Limits of Package Materials and Components

Maximum pressure and temperature limits of package materials and components are provided by the applicant. The staff verified that they are used consistently in the application. The applicant states that components and materials would not degrade under an extreme low temperature of -40°C (-40°F). The application also describes the long-term stability of Holtite-B under NCT and the leak tightness of the closure lids through the use of metallic seals. Peak cladding temperature compliance for moderate and high burnup spent fuel is demonstrated.

The staff reviewed and confirmed that the maximum allowable temperatures for components critical to the package containment, radiation shielding, and criticality are specified. The staff verified that the design basis spent fuel cladding temperature of 570ºC (1058°F) for accident conditions is observed. This temperature limit is based on the Pacific Northwest National Laboratory (PNNL) report, PNL-4835, which is a methodology accepted by the staff.

3.3 Thermal Evaluation Methods

3.3.1 Evaluation by Analyses

A detailed three dimensional (3-D) thermal model of the HI-STAR 180 system was developed by the applicant using FLUENT finite volume and ANSYS finite element codes. Transfer of heat from the spent fuel assemblies to the environment is through heat conduction from spent fuel through the spent fuel basket, the helium gap, the aluminum shim, the primary containment shel,l and the enclosure neutron shield. The spent fuel assembly is modeled through the effective thermal conductivity (Keff) approach (i.e., modeling the detailed spent fuel assembly geometry and gaps between spent fuel rods as a uniform medium with equivalent thermal conductivity under different temperature conditions). Heat rejection from the cask surface to the ambient is modeled by including natural convection and thermal radiation heat transfer from the vertical and top cover surfaces. Solar heat is included by adding a volumetric heat source in the thin layer of the outer shell to comply with the regulations. The staff finds the overall analysis approach and assumptions acceptable.

For NCT, the maximum bounding cladding temperature is obtained for the F-32 basket under the pattern A/B heat load. The steady-state analysis produces a maximum cladding temperature of 314°C (597ºF) which is below the allowable limit of 400°C. For HAC, the analysis shows a maximum cladding temperature of 352°C (666ºF) occurring during the post-fire cooldown. This is below the allowable limit of 570°C for accident conditions. The staff also reviewed all component temperature limits and maximum temperatures. All the maximum temperatures comply with the temperature limits for both normal conditions of transport and accident scenario.

3.3.2 Evaluation by Tests

The first fabricated HI-STAR 180 unit shall be thermally tested to confirm its heat transfer capability. Section 8.1.7 of the application provides a basic description of the testing sequence and the condition for its acceptability.

For each package, a periodic thermal performance test is also performed at least once within the 5 years prior to each shipment to demonstrate that the thermal capabilities of the package remain within its design basis.

3.3.3 Temperatures

See Section 3.1.4

3.3.4 Pressures

See Section 3.1.5

3.3.5 Thermal Stresses

Thermal stresses are evaluated in Section 3.4.4 of the application. The applicant uses high conductivity materials to minimize temperature gradients and large fit-up gaps to allow unrestrained thermal expansion of the package internals during NCT. The differential thermal expansion is evaluated in Section 7.4 of the Holtec Report No. HI-2073649, "Thermal Analysis for HI-STAR 180." Basket-to-cavity radial and axial growths are evaluated based on the thermal expansion coefficients at the worst conditions. The evaluation results are presented in Table 3.4.2 of the application. For HAC fire conditions, the gap growth in the radial and axial directions is bounded by the NCT.

The methods presented are standard and the evaluation is done under the worst operating conditions. The results show adequate margin to exclude safety concern. The staff finds the evaluation methods acceptable.

3.3.6 Confirmatory Analyses

The staff reviewed the applicant's thermal models used in the analyses. The staff checked the code input in the calculation packages and confirmed that the proper material properties and boundary conditions are used. The engineering drawings were also consulted to verify that proper geometry dimensions were translated to the analysis model. The material properties presented in the application were reviewed to verify that they are appropriately referenced and used.

3.4 Evaluation of Accessible Surface Temperature

Under NCT, the package is designed and constructed such that the surface temperature is 105°C, with the design basis heat load and no solar insolation. This temperature is above 85°C specified in 10 CFR 71.43(g) requirements. According to Section 7.1.3 of the application, a personnel barrier is installed if the package surface temperature and the dose rates are within 10 CFR 71.43 and 10 CFR 71.47 requirements.

3.5 Thermal Evaluation under NCT

The applicant performs the thermal evaluation using the FLUENT Computational Fluid Dynamics (CFD) code. 3-D models were developed to analyze the F-32 and F-37 spent fuel baskets and various heat loading patterns, i.e., uniform and regionalized, were experimented to establish a bounding configuration. The bounding configuration conservatively assumes high heat UO_2 fuel in the interior cells and high heat MOX in the Region 1 peripheral fuel locations. Inside a spent fuel cell, the detailed PWR spent fuel assembly is replaced with an equivalent square section characterized by an effective thermal conductivity in the planar and axial directions.

The temperature dependent thermal conductivities are obtained using a two dimensional conduction-radiation ANSYS thermal model. The turbulent condition is satisfied based on the product of Grashof and Prandtl numbers and a temperature difference of about 10°F between the package surface and the ambient. Therefore, applicable turbulent heat transfer coefficient correlations are chosen to model the package convective heat transfer to the ambient. For solar heating, the applicant used the 12-hour daytime insolation, as specified in 10 CFR Part 71, averaged over a 24-hour period to account for the dynamic time lag. A solar absorption coefficient of 1.0 is applied to the package exterior surface.

The HI-STAR 180 package 3D thermal model includes several features to conservatively predict the maximum temperature, e.g,. a half-symmetric array of fuel storage cells, a uniform gap between the fuel rods in the basket cells, 3 mm helium gaps for shims-to-basket and shims-to-cavity, detailed 3-D components (i.e., neutron shield pockets, lids, base plates, impact limiters, etc.), no internal convection in the package cavity, and FLUENT discrete ordinates radiation model. The applicant also used an adequate number of cells to model the package, particularly in the areas of high thermal resistance, i.e., spent fuel region and basket shims. The staff finds the approach acceptable.

3.5.1 Heat

Under a 38ºC (100°F) ambient temperature, still air, and solar heat, the applicant predicted the maximum temperatures of the fuel cladding, fuel basket, containment boundary and lid seals, and aluminum basket shim and neutron shielding. These temperatures are listed in Table 3.1.1 of the application. The staff confirms that these maximum temperatures are below the material temperature limits with sufficient margin and find them acceptable.

3.5.2 Cold

With no decay heat and an ambient temperature of -40°C (-40°F), the entire package approaches uniformly the steady-state ambient temperature. Package components, including the seals, are not adversely affected by exposure to cold temperatures.

3.5.3 Maximum Normal Operating Pressure (MNOP)

The MNOP is determined by different sources of gases – initial backfill helium, water vapor, release of fission products, and spent fuel rod failures. Generation of flammable gas is not considered. Based on the heat condition, 38ºC (100°F), still air, and insolation specified in 10 CFR 71.71(c)(1) and the design heat load, the MNOP is 67.6 kPa (9.8 psia) for normal conditions and 89.6 kPa (13 psia) for 3% rod rupture. The MNOP is well below the containment design pressure of 552 kPa (80 psig), as reported in Table 2.1.1 of the application.

3.6 Thermal Evaluation for Short Term Operations

3.6.1 Time-to-Boil Limits

The applicant determined time limits for completion of wet operations upon removal of a loaded HI-STAR 180 package from the pool to prevent water boiling inside the HI-STAR 180 cavity. The applicant performed an adiabatic heat up using the combined thermal inertia of the package. Table

3.3.5 of the application provides a summary of the maximum allowable time limits at several representative pool initial temperatures. To verify the time limits based on the adiabatic heat up approach, the applicant performed a CFD analysis using the design basis decay heat and the bounding heat load pattern. The applicant's CFD results confirmed that the approach outlined in the application is conservative.

Based on the application, the staff finds the applicant's approach for obtaining the time-to-boil limits acceptable for this package application.

3.6.2 Cask Drying

The application provides two methods for drying the cask cavity: a conventional vacuum drying approach for packages containing moderate burnup assemblies only, and forced helium dehydration (FHD) for packages with high burnup fuel.

Table 3.3.6 of the application presents the maximum fuel cladding temperature of 485ºC (905ºF), under vacuum drying operations, which is below the ISG-11 limit with adequate margin.

The enhanced heat transfer occurring during operation of the FHD system ensures that the fuel cladding temperature will remain well below the peak cladding temperature under NCT, which is itself below the high burnup cladding temperature limit of 400ºC (752ºF) for all loading combinations authorized in the package. Thus, the fuel cladding temperature will remain below the ISG-11 limits for high burnup fuel.

The staff reviewed the applicant's approach to perform the thermal evaluation of the Model No. HI-STAR 180 package short-term operations and finds it acceptable.

3.7 Thermal Evaluation under HAC

The applicant performed the regulatory fire analysis using a 3-D FLUENT model of the limiting F-32 basket thermal loading in two stages: a 30-minute engulfing fire and a post-fire cooldown.

The accident scenario considers the cumulative damage from the drop test and penetration test. Localized crushing of the impact limiter and rupture of neutron shield pockets are considered by maximizing the heat input during the fire and minimizing the heat rejection in the post-fire analysis. To maximize the fire heat input, the neutron shield conductivity is overstated and impact limiters are assumed to be solid aluminum. To minimize the heat rejection during the post fire cooldown, the neutron shield and impact limiters are replaced by air and surface emissivity of bare carbon steel is assumed. The analysis simulates the engulfing fire by prescribing a combination of radiation and convection heat transfer on the cask surface. The Sandia National Laboratory fire experiment convection heat transfer coefficient is adopted for the calculation ("Thermal Measurements in a Series of Large Pool Fires", Sandia Report SAND85 –0196 TTC – 0659 UC 71, August 1971). The ambient temperature during the fire is set at 802ºC (1475°F).

3.7.1 Initial Conditions

The applicant performed a transient thermal analysis to evaluate the package under hypothetical accident conditions. The initial conditions of the package, prior to the start of the fire accident, are based on the bounding NCT temperature distribution, i.e. a 38ºC (100°F) ambient temperature and the insolation prescribed in 10 CFR 71.71(c)(1).

During the fire, the surface emissivity of the package is assumed to be 0.9. After the 30-minute fire, the 38ºC (100°F) ambient temperature is restored and the damaged package is allowed to proceed through a post-fire cooldown phase. In the post-fire cooldown phase, no credit is taken for conduction through the Holtite neutron shield and a solid air zone is substituted instead. The ending condition of the 30-min fire analysis is used as initial condition for the post-fire cooldown.

3.7.2 Maximum Temperatures and Pressure

The maximum temperatures calculated by the applicant are listed in Table 3.1.3 of the application. The accident temperatures in the table reflect the peak temperature of a specified component from the time the fire was extinguished to the time the package reached steady-state conditions. For both normal and accident conditions, the inner cavity was assumed to be filled with helium.

Under normal conditions, all of the materials remain below their respective melting temperatures. For accident conditions, all of the materials, with the exception of the aluminum impact limiter and the neutron shield, remain below their respective materials temperature limits. Although the impact limiter was shown to exceed its limit, the applicant assumed the material did not melt during the fire, thus maximizing the amount of heat to have entered the package. Based on these analyses and review, the staff has reasonable assurance that the cladding integrity will not be compromised during the fire or post-fire cooldown.

The applicant calculated the MNOP assuming that 100% of the fuel rods fail, all rod fill gas and 30% of the gaseous fission products are available for release. The lower bound cavity free volume is used. The MNOP under HAC is 883.7 kPa (128.2 psia), based on the average cavity gas temperature of 270ºC (518°F). The MNOP is lower than the pressure limit listed in Table 2.1.1 of the application and therefore is acceptable.

3.7.3 Maximum Thermal Stresses

The Model No. HI-STAR 180 package is designed to ensure a low state of thermal stress with high conductivity materials to minimize temperature gradient and large fit-up gaps to allow unrestrained thermal expansion of cask internals. The differential thermal expansion analysis of the basket during NCT transport bounds the fire condition because the thermal effect on the basket is isolated by the outer cask and more expansion is expected in the outer cask. Therefore, the gap is expected to be larger in the fire analysis. The staff reviewed and accepted this argument.

The staff finds acceptable the applicant's analysis of HAC.

3.7 Evaluation Findings

The staff reviewed the package description, the material properties, component specifications and the methods used in the thermal evaluation, and found reasonable assurance that they are sufficient to provide a basis for evaluation of the package against the thermal requirements of 10 CFR Part 71. The staff reviewed the accessible surface temperatures of the package as it will be prepared for shipment and found reasonable assurance that the temperatures satisfy 10 CFR 71.43(g) for packages transported by exclusive-use vehicle. The staff reviewed the package preparations for shipment and found reasonable assurance that the package material and component temperatures will not extend beyond the specified allowable limits during normal conditions of transport, consistent with the tests specified in 10 CFR 71.71. The staff also found reasonable assurance that the package material and component temperatures will not exceed the specified allowable short-time limits during hypothetical accident conditions, consistent with the tests specified in 10 CFR Part 71.73

4.0 CONTAINMENT REVIEW

The objective of the review is to verify that the Model No. HI-STAR 180 package containment design is adequately described and evaluated under NCT and HAC, as required per 10 CFR Part 71.

4.1 Areas of Review

The applicant requested the approval of a containment boundary Technetics metallic seal design “Option 2”, with critical parameters for each of the containment boundary seals included in Appendix 4.A of the application, “Containment Boundary Seal Data” that is incorporated by reference in the CoC.

The American Seal & Engineering metallic seal “Option 1” critical parameters for each of the containment boundary seals has also been included in Appendix 4.A and had been previously approved. Although, for seal “Option 1”, the containment boundary sealing surface finish range and groove tolerances were expanded upon, in accordance with seal manufacturer’s drawings, the two seal designs described in Appendix 4.A of the application are each unique designs. Other seal designs cannot be used, or seal “field changes” cannot be made, for the Model No. HI-STAR 180 package without approval from the NRC because containment boundary seals are important to safety components and modifying an important to safety component would result in an unanalyzed condition.

Critical parameters in Appendix 4.A for each of the two seal designs include:

(i) the seal manufacturer,

(ii) the part / drawing number,

(iii) the seal and groove dimensions and tolerances,

(iv) the seal seating load, and

(v) the surface finish for sealing surfaces, and

(vi) component materials for the seal core, jacket, and lining.

The staff verified that the Technetics seal design “Option 2” had been completely described both in Appendix 4.A and on the licensing drawings. The Technetics seal design included Nimonic-90 for the seal core and aluminum for the seal jacket. These material choices do not impact the seal temperature limits shown in Table 3.2.12 of the application; therefore, the seals do not exceed the maximum allowable temperature limits.

An additional sealing critical parameter, i.e., “Containment Boundary Bolted Joint Data,” is included in Table 2.2.12 of the application and incorporated in the CoC by reference. This parameter includes the minimum useful springback, or the amount a seal can unload without the leakage rate exceeding the required value. In this case, the seal is leaktight which is equal to 1×10^{-7} ref-cm^3/sec of air, in accordance with ANSI N14.5.

Section 2.7 of the application demonstrates that both seal options will remain leaktight under HAC conditions because the maximum predicted springback is less than the minimum useful springback. The containment boundary seal grooves have been shown, by analysis, to not plastically deform during HAC.

A fabrication leakage rate test is performed on the entire containment boundary in accordance with ANSI N14.5 to the leaktight acceptance criterion as described in Tables 8.1.1 and 8.1.2 of the application. ANSI N14.5 periodic, maintenance, and pre-shipment leakage rate tests are also described in Table 8.1.2 of the application.

4.2 Evaluation Findings

The staff has reviewed the Technetics metallic seal design and Appendix 4.A "Containment Boundary Seal Data" and concluded that no significant galvanic, chemical, or other reactions will occur between the seal and the packaging or its contents.

The staff has reviewed the evaluation of the containment system under NCT and concludes that the package is designed, constructed, and prepared for shipment so that under the tests specified in 10 CFR 71.71, the package satisfies the containment requirements of 10 CFR 71.43(f) and 10 CFR 71.51(a)(1) for NCT, with no dependence on filters or a mechanical cooling system.

The staff has reviewed the evaluation of the containment system under HAC and concludes that the package satisfies the containment requirements of 10 CFR 71.51(a)(2) for HAC, with no dependence on filters or a mechanical cooling system.

In summary, the staff has reviewed the Containment Evaluation section of the application and concludes that the package has been described and evaluated to demonstrate that it satisfies the containment requirements of 10 CFR Part 71, and that the package meets the containment criteria of ANSI N14.5.

5.0 SHIELDING REVIEW

The objective of the review is to verify that the shielding of the Model No. HI-STAR 180 package provides adequate protection against direct radiation from its contents and that the package design meets the external radiation limits of 10 CFR Part 71 under NCT and HAC. The applicant requested a modification of the minimum Holtite pocket thickness from 75 mm to 70 mm, and corrected errors in the previous shielding evaluation, identified as a small offset of the source region (sdef card) in the MCNP model for the F37 basket.

5.1 Shielding Design Features

The HI-STAR 180 package shielding consists of the fuel basket, the steel and lead shells of the overpack, the two lids, the Holtite neutron shield, and part of the impact limiters. Gamma shielding is provided by the steel of the containment shell, base plate, closure flange, the closure lids, the steel monolithic shield cylinder; the bottom steel and lead gamma shields, and the primary closure lid lead gamma shield.

The fuel basket and the basket supports also provide additional gamma shielding. The gamma and neutron shielding was explained in detail in the staff's SER for Revision No. 0 of the CoC. The gamma and neutron sources are the same as those explained in the previous SER.

5.2 Shielding Evaluation

The MCNP-4A code, a continuous energy, three-dimensional, coupled neutron-photon-electron Monte Carlo transport code, is used for all of the shielding analyses, including the new analysis for the F37 basket. The calculated energy dependent source term is used explicitly in the MCNP model, but separate calculations are performed for each of the three source terms (i.e., decay gamma, neutron, and ^{60}Co). The combined dose rate for all source terms and uncertainties associated with analyses are given in Tables 5.1.1 through 5.11.8 of the application.

Dose rates are calculated using a two-step process: the dose rate is first calculated for each location for each energy group per particle, then the resulting dose rate is multiplied by the source strength in each group and the sum is taken for all groups and basket locations in each detector location. These results and the standard deviations of the various results are statistically combined to determine the standard deviation of the total dose rate in each detector location. This 2-step process allows for the consideration of the neutron and gamma source spectra, the axial segment of, and the location of the individual assemblies in the package.

External dose rates on the surface of the package are presented in Tables 5.1.1 and 5.1.2 of the application for the F-32 and F-37 baskets, respectively. Table 5.1.3 for the F-32 basket and Table 5.1.4 for the F-37 basket show the external dose rates at 2 meters from the package during NCT. For HAC, the maximum dose rates at 1 meter from the surface of the package are also calculated to ensure that all dose rates comply with 10 CFR 71.51(a)(2)).

5.3 Evaluation Findings

The staff reviewed the description of the package design features related to shielding and the source terms for the design basis fuel and found them acceptable. The methods used are consistent with accepted industry practices and standards. The staff reviewed the maximum dose rates for both NCT and HAC and determined that the reported values were below the regulatory limit in 10 CFR 71.47 and 71.51

6.0 CRITICALITY REVIEW

This section presents the findings of the criticality safety review for an application to authorize shipment of the Model No. HI-STAR 180 transportation package under a criticality analysis using credit for fuel burnup.

The staff evaluated the package for its ability to meet the fissile material requirements of 10 CFR Part 71, including the general requirements for fissile material packages in 10 CFR 71.55, and the standards for arrays of fissile material packages in 10 CFR 71.59.

The staff reviewed the criticality safety analysis presented in the package application, and also performed independent calculations to confirm the applicant's results. The staff's review considered the criticality safety requirements of 10 CFR Part 71, as well as the review guidance presented in NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel."

Holtec submitted an amendment request for the Model No. HI-STAR 180 package to clarify the purpose of certain fuel assembly characteristics, change the general information and acceptance tests on Metamic-HT basket and panel material, change the design and function of the fuel impact attenuator, some of the acceptance criteria for the containment boundary components, and the strength properties of fuel basket support shims. The result of some of these changes may result in potential gaps where basket components are expected to be in direct contact.

6.1 Areas of Review

The applicable regulations considered in the review of the criticality safety portion of this application include the fissile material requirements in 10 CFR Part 71, specifically the general requirements for fissile material packages in 10 CFR 71.55, and the standards for arrays of fissile material packages in 10 CFR 71.59.

The requested changes apply predominantly to the material and structural characteristics of the basket and packaging. Criticality was analyzed with the addition of gaps between the basket components. Staff reviewed the changes and the information contained in the application and verified that the information is consistent and that all descriptions, drawings, figures, and tables are sufficiently detailed to support an in-depth staff evaluation. The staff evaluated the effect of such changes on the criticality safety of the package.

Staff also noted three editorial discrepancies (mismatch) between Tables 1.2.3 (Fuel Assembly and Package Payload Physical Characteristics) and Table 6.2.1 (General PWR Fuel Characteristics); and between Table 6.2.1 and Table 6.2.2 (Reactivity Effect of Variations in Fuel Dimensions). In Table 6.2.1, the clad ID should be 0.961 cm (not 0.958 cm) to match the maximum value in Table 6.2.2 shown in the row identified as variation 2. In Table 1.2.3, the fuel rod clad I.D. should be 9.61 mm (not 9.58 mm) to match the value in Table 6.2.1 per above clarification. The Guide/Instrument Tube Thickness should be 0.285 mm (not 0.325 mm) to match the bounding values used in the analysis per Table 6.2.1.

These changes are called editorial because these values are used in the safety analysis and are properly reflected in other tables in the application. Table 6.2.1 lists the bounding dimensions, while Table 6.2.2, listing the reference case that bounds all in terms of reactivity, is used in the analysis.

6.1.1 Packaging and Design Features

Packaging and design features important to criticality control are unchanged.

6.1.2 Summary Table of Criticality Evaluations

The changes in calculated k_{eff} from criticality analysis accounting for those gaps in various scenarios are presented in Tables 6.3.15 and 6.3.15a of the application.

6.1.3 Criticality Safety Index (CSI)

The applicant demonstrated that an infinite array of packages with the most reactive contents in both NCT and HAC remains adequately subcritical. Therefore, the CSI is 0.0 in accordance with 10 CFR 71.59(b).

6.2 Fissile Material Contents

There is no change to the analyzed fissile material contents.

6.3 General Considerations

6.3.1 Model Configuration

Aside from the gap between the basket components, the model is largely unchanged from previous analysis.

6.3.2 Material Properties

No change in material properties is assumed to result from the proposed changes.

6.3.3 Computer Codes and Cross-Section Libraries

The applicant used MCNP4a and CASMO-4. CASMO was used to evaluate changes in parameters, and MCNP was used to evaluate the worst combination of tolerances. The cross-section library used was the continuous energy library based on ENDF/B-V nuclear data. Both software and cross-section library have been previously evaluated and found to be appropriate for use in this application.

6.3.4 Demonstration of Maximum Reactivity

The applicant's analysis included several scenarios which varied, among other things, fuel and moderator density. In all cases, the effect of reactivity was shown to be very small, often within the statistical variation expected in Monte Carlo analysis.

6.3.5 Confirmatory Analysis

Staff ran a simple arbitrary array of pin cells with a Metamic border of approximately the same thickness as the basket walls. Two mm spheres of water were introduced into the corners of the Metamic material at regular 264 mm intervals.

The staff's result showed no statistically significant change to the system k_{eff}.

6.4 Single Package Evaluation

The single package evaluation is unchanged from the previously reviewed application.

6.5 Evaluation of Package Arrays Under NCT

The evaluation of package arrays under NCT is unchanged from the previously reviewed application.

6.6 Evaluation of Package Arrays Under HAC

The evaluation of package arrays under HAC is unchanged from the previously reviewed application.

6.7 Air shipment

This package is not permitted for air transport.

6.8 Benchmark Evaluations

Aside from an editorial correction to the number of benchmarking experiments, the evaluation is unchanged from the previously reviewed application.

6.9 Evaluation Findings

The staff has reviewed the description of the packaging design and verified that the proposed changes have minimal effects on the results of the criticality evaluation.

The staff has reviewed the applicant's changes and assessed their impact to the criticality evaluation. The previously reviewed analyses of a single package and infinite arrays under both NCT and HAC sufficiently show it will remain subcritical under the most reactive credible conditions.

The staff has reviewed the benchmark evaluation of the calculations and concludes that they are sufficient to determine an appropriate bias and uncertainty for the criticality evaluation.

Therefore, the applicant has shown and the staff agrees that the Model No. HI-STAR 180 package meets the fissile material requirements of 10 CFR 71.55 for single packages, and 10 CFR 71.59 for arrays of packages with a CSI of 0.0.

7.0 PACKAGE OPERATIONS

Chapter 7 of the application provides a summary description of package operations, including package loading and unloading operations, to ensure that the package is operated in a safe and reliable manner under NCT and HAC conditions of transport. The preparation of an empty package for shipment is also described.

The staff reviewed the Operating Procedures in Chapter 7 of the application to verify that the package will be operated in a manner that is consistent with its design evaluation. On the basis of its evaluation, the staff concludes that the combination of the engineered safety features and the operating procedures provide adequate measures and reasonable assurance for safe operation of the package in accordance with 10 CFR Part 71.

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

Chapter 8 of the application identifies the inspections, acceptance tests, and maintenance programs to be conducted on the Model No. HI-STAR 180 package and verifies their compliance with the requirements of 10 CFR Part 71.

8.1 Acceptance Tests

The structural (ITS) welds on the Metamic-HT basket using the FSW process are considered Category C per ASME Section III, NG-3351.3 and permissible weld Type III according to Table NG-3352-1. Specific weld geometry and details are provided in the licensing drawings. Fabrication welds are visually examined with an acceptance criterion per ASME Section III, NG 5260 and ASME Section V, Article 1, Paragraph 150, and both the weld criteria and inspection criteria procedures are part of the Metamic-HT Manufacturing Manual.

Staff verified that the Metamic-HT Sourcebook documents the tensile strength of Metamic-HT welds per the testing protocol of ASME Code Section IX, 2013, and that the performance of FSW is based on actual weld qualification testing performed per Section IX. Further, the applicant took no exceptions to FSW welding meeting all applicable requirements of ASME Section IX, 2013 Edition, i.e.:

(1) FSW Procedure Qualification Record (PQR) meeting the essential variable requirements of QW-267;

(2) Weld Procedure Specification (WPS) meeting the essential variable requirements of QW-267, QW-361.1(e) and QW-361.2;

(3) FSW welder operator performance qualifications meeting the essential variable requirements of QW-361.2; and

(4) FSW PQR being qualified by a test coupon or a coupon from the initial production welding within the limitations of QW-304 and QW-305.

The applicant applied the tensile strength penalty factor in ASME Section III, NG 3000, Table NG-3352-1, and the use of weld tensile strength from coupon testing in the structural analysis. Staff reviewed the evaluation on cyclic stresses in the basket to address the fatigue reduction factor in Table NG-3352-1.

Staff also verified that a visual examination inspection was stated in the basket drawings for the ITS FSW corner welds, and that the basket corner FSW welds were classified as Category C per ASME Section III, NG 3000, NG-3351.3, Type III, in Table-3352-1.

As indicated in Section 8.3 of the application, ASME Code, Section IX, 2007, is only called out for the tensile testing protocol because the testing was already done.

In order to verify that fabrication has been performed in accordance with the drawings, specific weld requirements shall be observed as follows:

The containment boundary welds shall be examined in accordance with ASME Code, Section V, Article 9, with acceptance criteria per ASME Code, Section III, Subsection NB, Article NB- 5300. Examinations, Visual (VT), Radiographic (RT), and Liquid Penetrant (PT) or Magnetic Particle (MT), apply to these welds as defined by the code. These welds shall be repaired in accordance with the requirements of the ASME Code, Section III, Article NB- 4450, and examined after repair in the same manner as the original weld.

The structural welds in the package and the impact limiters shall be examined in accordance with ASME Code, Section V, Article 9, with acceptance criteria per ASME Code, Section III, Subsection NF, Article NF-5300. These welds shall be repaired in accordance with ASME Code, Section III, Article NF-4450, and examined after repair in the same manner as the original weld.

The ITS basket welds shall be examined and repaired in accordance with NDE specified in the drawings, and with written and approved procedures developed specifically for welding Metamic-HT with acceptance criteria per ASME Section, V, Article 1, paragraph T-150, subparagraph a (2007 Edition). The ITS basket welds, made by the Friction Stir Weld process, are classified as Category C per NG-3351.3 and Type III in Table NG-3352-1.

By incorporating the requirements above into the licensing documents and the production welding handbook, as well as into the Metamic-HT manufacturing manual, staff is satisfied that sound welds will be produced using the FSW process.

8.2 Evaluation findings

The application includes a high level description of a sampling plan to verify the acceptability of Metamic-HT panels and a detailed sampling plan HTSOP-108 “HT Sampling Plan” is contained in the Metamic-HT manufacturing manual. Test results are appropriately documented and part of the package final quality documentation report. The staff has reviewed the Metamic-HT acceptance testing criteria, and finds them adequate for the application.

The staff requested that the package containment boundary leakage testing be performed in accordance with the requirements of ANSI N14.5-1997 to determine compliance with 10 CFR 71.51, and the applicant revised Section 8.1.4 of the application.

Based on the statements and representations in the application, the staff concludes that the acceptance tests for the packaging meet the requirements of 10 CFR Part 71. Further, the certificate of compliance is conditioned to specify that each package must meet the Acceptance Tests and Maintenance Program of Chapter 8 of the application.

CONDITIONS

The following changes were made to the conditions of the certificate of compliance:

The address of Holtec International was updated.

PWR fuel assembly characteristics were noted as nominal in Table 1 of the CoC since the dimensions do not account for the manufacturer’s fuel specification and fabrication tolerances. The value for design initial heavy metal mass is also clarified to be a maximum value. Note 1 has been added to the table to provide further clarification.

The Reference Section was modified to include Holtec “Safety Analysis Report on the HI-STAR 180 Package,” dated April 21, 2014, and referenced HI-2073681, Revision No. 6.

CONCLUSION

Based on the statements and representations contained in the application, and the conditions listed above, the staff concludes that the Model No. HI-STAR 180 package has been adequately described and evaluated and that the package meets the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9325, Revision No. 1,
on May 9, 2014.