January 30, 2009

MEMORANDUM TO: Michael Scott, Acting Deputy Director
Licensing and Inspection Directorate
Division of Spent Fuel Storage and Transportation, NMSS

FROM: Pierre Saverot, Project Manager **/RA/**
Licensing Branch
Division of Spent Fuel Storage and Transportation, NMSS

SUBJECT: SUMMARY OF JANUARY 21, 2009, MEETING WITH HOLTEC INTERNATIONAL REGARDING THE HI-STAR 180 PACKAGE APPLICATION

Summary

On January 21, Holtec International, Inc. (Holtec) met with staff to present the main features of the HI-STAR 180 Type B(U) transport package. Holtec claimed to have (i) incorporated responses to all Open Technical Issues (OTIs) dated June 12, 2008, and (ii) included all the information needed to resolve the September 2008 Request for Additional Information (RAIs) on the HI-STAR 60 package since both packages present some commonalities pertaining to the containment boundary and the impact limiter design.

Holtec requested an expedited review to prevent disruption of NOK (Switzerland) fuel management plans. The discussion centered on the Metamic qualification studies, the structural, thermal, shielding, and criticality approaches chosen for the package design. Staff had previously indicated that there appeared to be a "success path" in Holtec's enhanced approach on moderator exclusion with each closure lid or penetration gasketed joint being leaktight per ANSI N14.5. However, staff expressed some concerns that (i) the proposed alternative to burnup measurement had never been fully discussed prior to the application submittal and (ii) the proposed loading conditions appear not to be symmetric. Staff also said that the HI-STAR 180 package application will be a complex review for a number of technical disciplines and that Holtec should rapidly issue supplements on (i) the number of samples for materials qualification, (ii) the alternatives to burnup measurements, (iii) the selection of misload analyses, and (iv) more restrictive language conditions in the Certificate of Compliance (CoC).

Discussion

Holtec described the HI-STAR 180 as a "groundbreaking package" for high burnup PWR fuel (66 GWD/MTU for UO_2 fuel; 61.5 GWD/MTU for MOX fuel) with a minimum cooling time of 3 years for the F-32 basket (4 years for the F-37 basket) and a heat load up to 32 KW. The cask design includes a leaktight double lid closure system and both lids are designated as redundant containment boundaries. Each closure lid is equipped with two independent metallic seals and the sealing surface of the gasket does not lose compression under any design accident conditions. A fuel impact attenuation device has been added to limit G-loads and an "improved" neutron shielding is provided by overlapping Holtite-B filled pockets.

Material Qualification Program for Metamic HT

Property measurements were performed on "as-manufactured" coupons as well as on "thermally aged" and "thermally aged and irradiated" coupons (irradiation testing was performed at the University of Massachusetts). This test program was initiated to address staff's OTIs of June 2008. Metamic physical properties such as the tensile strength, yield strength, elongation, Young's modulus, and lateral expansion were developed along with Minimum Guaranteed Values (MGV) for each property. Holtec said that MGVs for all critical characteristics of the material were determined by statistical analysis.

Staff questioned the adequacy of testing and of the test process when results are not those expected. In particular, staff questioned whether thermal aging and irradiation should have reduced the yield strength of the material whereas test results show an increase in value. Holtec explained that it went into the testing program expecting that properties would not degrade but only show some variations from one batch to another. Holtec stated that each batch is microscopically different, that MGVs are lower and that it will ensure that every batch meets the MGVs. Holtec also stated that (i) their QA program guarantees the quality of the data, (ii) Metamic is not a traditional alloy and thus there is no adverse effect on properties, (iii) the results confirm the manufacturing process with small, fine particle sizes, and (iv) testing will continue into the future.

Staff raised questions on (i) the small number of samples having been tested and (ii) the size of the specimens. Staff also noted that, according to Holtec data, a tensile strength presented with a mean value of 18.2 KSI could in fact be as low as 16.9 KSI. Holtec answered that each of the 6 samples were tested in each of the 3 orthogonal directions and that, as a consequence, there was in fact a total of 18 "samples." Holtec also said that the minimum guaranteed properties are based upon standard deviations from a mean value from a population of samples. Finally, regarding the size of the specimens size, Holtec stated that they were in compliance with a DOE's handbook on material properties.

Structural Design Considerations

Holtec presented the new results of the LS-DYNA impact limiter honeycomb model benchmarking, the effect of the new Fuel Impact Attenuator, the cask drop analyses, and the fuel rod integrity analyses.

Staff asked if the Holtec data was based on static testing or if the data captured dynamic effects by using both lower-bound and upper-bound material properties. Holtec said that (i) honeycomb material properties were either available or derived for the bi-directional core and either available or estimated by the supplier for the unidirectional core, (ii) results do not vary much (there is only a few percent difference in peak deceleration values), (iii) there is no need to put a strain rate curve, and (iv) by taking a broad range of data to include dynamic effects, e.g., +/- 50% on the expected shear strength, they found only a secondary effect.

Regarding the LS-DYNA analysis results that were presented, staff noted the increase in the peak top end drop deceleration from 68.25 g (LS-DYNA result) to 82 g (design

basis) and asked where those measurements were "made." Holtec answered that the measurements were made on the cask body itself, by calculating with LS-DYNA the maximum deceleration g-loads and following the process used in the certification of the HI-STAR 100 package.

Staff asked if Holtec had performed a "peer review" by looking at stresses on the basket because the basket integrity is the "driver" in this package evaluation. Holtec explained the new feature of the cask, i.e., the Fuel Impact Attenuator, to (i) ensure a zero gap between the fuel assembly and the inner closure lid in a top end drop and (ii) attenuate the impact force on the containment baseplate during a bottom end drop. Holtec stated that (i) the fuel basket is modeled as an elastic/plastic material, and (ii) the global maximum permanent deformation in the basket is less than 0.5 mm.

Staff asked Holtec if they would have obtained a bolt failure in the LS-DYNA model in relation to the demonstration that the bolt model (used to attach the impact limiter) could predict results up to failure. Holtec explained that (i) when the HI-STAR 100 ¼ scale model was drop-tested in 1997, they were "forced" to put the bolt under the direct load path of impact, (ii) they predicted failure for the original bolting configuration using LS-DYNA, (iii) attachment bolts are now designed not to be in the impact load path and are "protected as the weakest link" and, (iv) LS-DYNA results show that bolts do not yield. Holtec also explained that, in a side drop, the impact limiters are held in place by the skirt.

Thermal Evaluations

The HI-STAR 180 package contents are arranged to allow uniform and regionalized fuel loadings. Under uniform loading, every basket cell location is assumed to be loaded with fuel emitting heat at the maximum permissible level, while, under regionalized loading, the fuel decay heat is defined in specific tables of the SAR.

Staff questioned the loading patterns (as proposed by Holtec) which can lead to an infinite number of combinations. Staff expressed concern that the CoC limitations might not be covered by the patterns that were analyzed or that the calculations might not be bounded. Holtec answered that (i) they have to be able to load specific assemblies, (ii) they looked at the maximum heat load of the fuel assemblies that created a local temperature peak and (iii) the proposed CoC included permissible patterns, e.g., limits for each cell of the basket. Holtec also stated that it had analyzed bounding configurations and performed actual evaluations. However, Holtec will check again if appropriate restrictions can be included in the CoC to ensure (through a precise and restrictive language) that the CoC bounds all analyses.

Staff stated that it needs to be convinced that there are limits on loading and that the loading patterns given in the CoC add up to less than 32 kW. Staff indicated that the approach of restricting the total decay heat in the basket while having a maximum decay heat in each cell will potentially cause localized heating. Staff also expressed concern on a perfect symmetric heat load which Holtec claims was analyzed in the SAR with the proposed cell maximum and asked Holtec to define an acceptable symmetric loading.

Holtec explained that the seal was not modeled because temperature variations in the seal were small. Holtec also confirmed that 667°C (during an hypothetical fire accident) is the maximum temperature during both the fire and the post-fire cooldown because the neutron shield has already burned out. Holtec stated that it is using air conductivity for heat conduction during the post fire analysis. Holtec said that it has demonstrated that creep is not an issue and that it will request at a later time an amendment for an hypothetical period of 20-40 years of continuous transport, while proving that there is no degradation of properties for an extended service life e.g., 60 years. At this time, Holtec is only requesting a certification for a 5 year license for transport.

Shielding and Source Term Evaluations

Holtec indicated that a single bounding assembly could not be defined for this package because it has to load all spent fuel assemblies from this plant including MOX fuel, low and high burn up fuel, all fuel assemblies having different cooling times.

Staff questioned the derivation of uncertainties, e.g., from 7% in the gamma source terms to 15% in the neutron source terms due to variations in input data as well as from ORIGEN-S calculations. Holtec acknowledged that there is not much data on high burnup fuel and that some data had been "extrapolated to some extent." However, Holtec believes that the design basis calculations, as presented, are appropriate.

Criticality Safety

Holtec said that the F-37 basket required a moderate amount of actinide-only burnup credit for UO_2 assemblies. Holtec stated that the worst case scenario (a misloaded assembly facing two other fresh assemblies) leads to a k_{eff} of 0.9573. Staff showed some interest in Holtec's alternative to burnup measurement but stated that the package application needs to provide a full rationale, justification, and basis for not performing burnup measurements. For example, staff said that Holtec may "have a good basis for its alternative approach" but needs to explain the basis for the misload studies, e.g., for selecting only one misloaded fresh fuel assembly rather than 2 or 3, or for selecting 17 misloaded assemblies burned at 12 GWd/MTU together with 20 correctly loaded fresh fuel assemblies rather than any other combination, etc. Staff said that it will look at the application write-up in detail to see how "it pulls together" and that the Standard Review Plan does include provisions for vendors to propose alternatives.

The enclosures are the list of meeting attendees, and a copy of the slides Holtec presented at the meeting.

Docket No. 71-9325
TAC No. L24246

Enclosures:
1. List of Meeting Attendees
2. Presentation Slides

Holtec explained that the seal was not modeled because temperature variations in the seal were small. Holtec also confirmed that 667°C (during an hypothetical fire accident) is the maximum temperature during both the fire and the post-fire cooldown because the neutron shield has already burned out. Holtec stated that it is using air conductivity for heat conduction during the post fire analysis. Holtec said that it has demonstrated that creep is not an issue and that it will request at a later time an amendment for an hypothetical period of 20-40 years of continuous transport, while proving that there is no degradation of properties for an extended service life e.g., 60 years. At this time, Holtec is only requesting a certification for a 5 year license for transport.

Shielding and Source Term Evaluations

Holtec indicated that a single bounding assembly could not be defined for this package because it has to load all spent fuel assemblies from this plant including MOX fuel, low and high burn up fuel, all fuel assemblies having different cooling times.

Staff questioned the derivation of uncertainties, e.g., from 7% in the gamma source terms to 15% in the neutron source terms due to variations in input data as well as from ORIGEN-S calculations. Holtec acknowledged that there is not much data on high burnup fuel and that some data had been "extrapolated to some extent." However, Holtec believes that the design basis calculations, as presented, are appropriate.

Criticality Safety

Holtec said that the F-37 basket required a moderate amount of actinide-only burnup credit for UO_2 assemblies. Holtec stated that the worst case scenario (a misloaded assembly facing two other fresh assemblies) leads to a k_{eff} of 0.9573. Staff showed some interest in Holtec's alternative to burnup measurement but stated that the package application needs to provide a full rationale, justification, and basis for not performing burnup measurements. For example, staff said that Holtec may "have a good basis for its alternative approach" but needs to explain the basis for the misload studies, e.g., for selecting only one misloaded fresh fuel assembly rather than 2 or 3, or for selecting 17 misloaded assemblies burned at 12 GWd/MTU together with 20 correctly loaded fresh fuel assemblies rather than any other combination, etc. Staff said that it will look at the application write-up in detail to see how "it pulls together" and that the Standard Review Plan does include provisions for vendors to propose alternatives.

The enclosures are the list of meeting attendees, and a copy of the slides Holtec presented at the meeting.

Docket No. 71-9325
TAC No. L24246

Enclosures:
1. List of Meeting Attendees
2. Presentation Slides

Distribution: NRC Attendees

OFC	SFST	C	SFST	C	SFST			
NAME	PSaverot		MDeBose		EBenner			
DATE	01/29/2009		01/30/2009		1/30/2009			

G:\SFST\Saverot\HI-STAR180\HI-STAR 180 Meeting January 21, 2009.doc
C=Without attachment/enclosure E=With attachment/enclosure N=No copy **OFFICIAL RECORD COPY**

Meeting Between HOLTEC International and the
Nuclear Regulatory Commission
January 21, 2009
Meeting Attendees

NRC/NMSS/SFST

Andrew Barto	Andrew.Barto@nrc.gov
Eric Benner	Eric.Benner@nrc.gov
Gordon Bjorkman	Gordon.bjorkman@nrc.gov
Bill Brach	Bill.Brach@nrc.gov
Larry Campbell	llc3@nrc.gov
Geoffrey Hornseth	gph@nrc.gov
JoAnn Ireland	JoAnn.Ireland@nrc.gov
Peter Lien	Peter.Lien@nrc.gov
Ray Lorson	RKL@nrc.gov
Nader Mamish	Nader.Mamish@nrc.gov
Jason Piotter	jason.piotter@nrc.gov
Christopher Regan	Christopher.Regan@nrc.gov
Nathan Sanfilippo	Nathan.sanfilippo@nrc.gov
Pierre Saverot	pierre.saverot@nrc.gov
Michael Scott	michael.scott@nrc.gov
David Tang	david.tang@nrc.gov
Michael Waters	mdw1@nrc.gov

HOLTEC INTERNATIONAL

Stefan Anton	s.anton@holtec.com
Chuck Bullard	c.bullard@holtec.com
Debu Mitra Majumdar	d.majumdar@holtec.com
Luis Hinojosa	l.hinojosa@holtec.com
Indresh Rampall	I.Rampall@holtec.com
Kris Singh	k.Singh@holtec.com
Bill Woodward	B.Woodward@holtec.com
John Zhai	j.zhai@holtec.com

HOLTEC MANUFACTURING DIVISION

John Menhart	Jmenhart@holtecmfg.com

NANOTEC METALS INC.

Thomas Hugues III	metamicllc@msn.com

NOK

Pierre-Alexandre Monsigny 011-41-56-200-3945 pierre.monsigny@nok.ch

H322 Consulting

Wayne Hodges 301-977-7468 wayne@h322.com

CONSULTANT

Philip Blue philblue66@hotmail.com