February 12, 2013

MEMORANDUM TO: Anthony H. Hsia, Deputy Director
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

FROM: John Goshen, P.E., Project Manager **/RA/**
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

SUBJECT: SUMMARY OF JANUARY 16, 2013, HOLTEC INTERNATIONAL, INC. MEETING FOR THE HI-STORM 100 CASK SYSTEM, AMENDMENT REQUEST NO. 9 ON THERMAL ANALYSIS (TAC NO. L24476)

PURPOSE:

To provide Holtec International (Holtec) an opportunity to discuss the HI-STORM 100 Amendment Request No. 9 application thermal analysis with the U.S. Nuclear Regulatory Commission (NRC) staff (staff).

MEETING SUMMARY:

The meeting took place on January 16, 2013, from 9:00 a.m. to 1100 a.m., at the NRC's Executive Boulevard Building in Rockville, MD. Attendees included Holtec staff, and NRC's Division of Spent Fuel Storage and Transportation (SFST), one member from NRC's office of Research, and five members of the public. The attendance list is enclosed (Enclosure 2). The meeting began with introductions, introductory remarks by SFST staff and Holtec staff, and then moved to a discussion of staff issues concerning Holtec's thermal analysis submission (Enclosure 1).

Differences in computational fluid dynamics (CFD) modeling using FLUENT were discussed between NRC and Holtec staff. NRC staff provided a discussion of nuclear fuel element testing being performed by Sandia National Laboratory for the Organization for Economic Cooperation and Development (OECD) and the Electric Power Research Institute (EPRI). The NRC, as a member of EPRI, has been kept apprised of the progress of the specific testing. Data from the test indicate that several of Holtec's modeling assumptions for the on-site transfer evolution may be under-conservative.

Holtec is not a member of either the OECD or EPRI and has not had access to the specific data from the test. Holtec stated that their thermal analysis included benchmarking results to many data points provided by field measurements but that they would be willing to review the Sandia testing information if they could obtain a copy. The staff stated that they would work with their contacts in OECD to provide the data to Holtec, and that this should be available within several

weeks. The staff requested that Holtec officially request the data so that the NRC could formally respond to the request. Members of the public then provided feedback to Holtec on the information that would be most helpful to them. One member of the public requested that the NRC make this a high priority as it directly impacted his facility's ability to transfer spent fuel to dry storage this year. Another member of the public stated the NRC needed to provide a mechanism for all applicable external stakeholders to be provided the testing information.

No regulatory decisions were made at the meeting.

If you have any questions or comments, please contact me at (301) 492-3325 or John.goshen@nrc.gov.

Docket No. : 72-1014

TAC No. : L24476

Enclosures:
As stated

HI-STORM 100, Amendment Request No. 9

NRC Review of Holtec's Thermal Analysis of On-Site Transfer of the MPC

NRC Staff Position

The staff identified some modeling issues associated with Holtec's thermal analysis of the transfer cask. The issues and their potential impact on the predicted peak cladding temperature are identified below.

1 **Representation of water density using Boussinesq approximation.** Real fluid property as function of temperature and pressure should be implemented for the running fluids to assess the use of Boussinesq approach on the final Computational Fluid Dynamics (CFD) results.

2 **The representation of fuel rods using porous media and effective thermal conductivity.** In the porous media approximation, fuel rods were approximated hydraulically by using frictional and inertial resistance. Also effective thermal conductivity was used to model radiation and conduction heat transfer in the fuel assembly instead of representing the real geometry. Effective thermal conductivity was also used in the air gap between the MPC and the transfer cask. Calculations should be performed to assess the sensitivity on the final results (i.e., peak cladding temperature (PCT)) to possible changes in frictional losses, inertial losses, and use of effective thermal conductivity.

For example, the staff performed some sensitivity calculations in the use of effective thermal conductivity in the air gap between the MPC and the transfer cask. The FLUENT model provided by Holtec was modified to represent the air gap to allow air motion as well as heat transfer by conduction and radiation. The water density in the water jacket was represented by using water density as a function of temperature. With these changes, the staff obtained a peak cladding temperature of 745°F as compared to Holtec's result of 738°F for the bounding case (X=3) and an ambient temperature of 110°F. The PCT predicted by the staff is below the allowable limit but this result does not include the discretization error or the application error, as explained later.

In addition, the staff performed a FLUENT analysis of the thermal-hydraulic experiment performed at Sandia National Laboratory (SNL) for a 17X17 PWR fuel assembly. The SNL thermal-hydraulic experiment was performed for buoyancy driven flow. The analysis indicated that a viscous resistance factor of about a million would match the experimental data. Also, the staff performed a sensitivity calculation using a viscous resistance factor similar to the value used in the FLUENT analysis of the SNL experiment for the same basket storage cell width and obtained a PCT of about 782°F. The validation against the SNL experiment for a similar fuel assembly type and same storage cell width indicates that a viscous resistance factor of about one million adequately captures the fuel assembly pressure drop, as measured in the SNL experiment. Holtec should consider how it will justify the viscous resistance factors used in their thermal analysis to properly capture the fuel assembly pressure drop since, as indicated earlier based on experimental data, the values currently used in the thermal model appears to be non-conservative.

As indicated earlier, the analysis provided by Holtec does not include the discretization and the application errors. These should be quantified to assess their impact on the predicted PCT. These errors are described below.

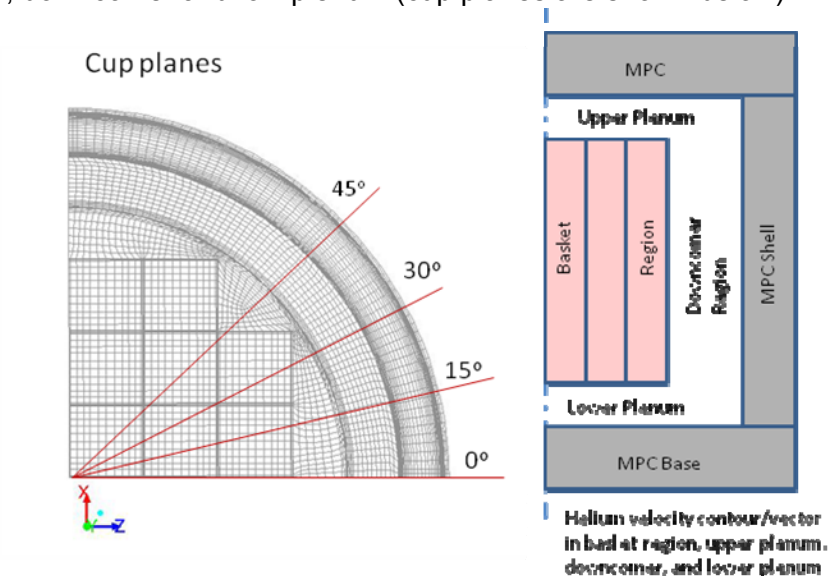
a Spatial discretization (numerical) errors. Discretized equations have a limited resolution in space. Increasing the number of cells will reduce the discretization error and therefore the results will be closer to the exact solution. Also, the higher the order of the scheme the closer the results will be to the exact solution. Grid Convergence Index method (ASME V&V 20-2009) can be used to assess the sensitivity of the solution to the grid density. Per ASME V&V 20-2009, when using the GCI method to estimate the discretization error, the following criteria should be met:

- The solution from the different grids used display monotonic convergence.
- The solution from the different grids used should be in the asymptotic range.

b Application uncertainties. Uncertainty in the applied boundary conditions may lead to errors and differences between the exact solution and the discretized equations. Calculations on the applied boundary conditions should be performed to assess their sensitivity to the predicted peak cladding temperature.

The applicant should provide the difference (to PCT) contributed by each uncertainty and provide the PCT for the bounding ambient temperatures (with and without insolation).

3. Provide helium velocity profiles (contours/vectors) in basket region, upper plenum, downcomer and low plenum (cup planes are shown below).



Helium velocity contour/vector in basket region, upper plenum, downcomer, and lower plenum

January 16, 2013
ATTENDANCE LIST

Name	Affiliation
Stephan Anton	Holtec
Debu Mitra-Majumdar	Holtec
Terry Sensue	Holtec
Yigiamg Lin	Holtec
Abrar Mohammed	Holtec
Venkata Venigalla	Trans Nuclear
John Goshen	NRC
Christian Araguas	NRC
Jorge Solis	NRC
Ghani Zigh	NRC
Michele Sampson	NRC
Jimmy Chang	NRC
Richard Hagler	PG&E
Raymond Termini	Exelon Corporation
Glenn Schwartz	PSE&G
Suzanne Leblang	Entergy

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Enclosures:
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