April 18, 2008

Ms. Tammy Morin, Licensing Manager
Holtec International
Holtec Center
555 Lincoln Drive West
Marlton, NJ 08053

SUBJECT: THERMAL REQUEST FOR ADDITIONAL INFORMATION FOR THE REVIEW OF THE HOLTEC INTERNATIONAL HI-STORM 100U SYSTEM AMENDMENT APPLICATION (TAC NO. L24085)

Dear Ms. Morin:

On April 27, 2007, Holtec International (Holtec) requested that Certificate of Compliance (CoC) No. 1014 be amended to allow inclusion of an underground design option to the HI-STORM 100 spent fuel dry cask storage system (HI-STORM 100U). On February 18, 2008, the U.S. Nuclear Regulatory Commission (NRC) issued a request for additional information (RAI) in order to continue its review of the re-submitted application. The RAI requested that, in part, Holtec address intermixing of inlet and outlet air in adjacent vertical ventilated modules (VVMs), and justify the application of a higher, off-normal temperature cladding limit for low-velocity wind conditions.

On March 27, 2008, Holtec met with NRC to discuss these thermal RAIs. Holtec disagreed with the basis of RAI Nos. 4-1 and 4-2. Holtec did not believe an analysis of intermixing of air between adjacent VVMs in a large array was warranted. Holtec indicated that the analytical assumption of a hypothetical cylinder above the module was appropriate, and that there would be little intermixing of air in a quiescent condition. In addition, Holtec discussed its position on addressing wind as a “long-term” normal condition. Holtec indicated wind should not be considered in “long-term” storage evaluations of the HI-STORM 100U because it is a time-varying phenomenon. Holtec stated that this type of consideration would be a “radical change” from the current accepted licensing approach. Holtec further concluded that analyses of a sustained wind at all velocities should be treated as an off-normal event. As a result of the meeting, NRC agreed to develop a response to the meeting presentation so that Holtec’s response to the RAIs may be informed by the staff’s position.

After further consideration of the information provided by Holtec in the meeting, NRC staff believes the underlying technical issues in RAI Nos. 4-1 and 4-2 need to be addressed to continue our review. The staff agrees with Holtec that sustained wind may be treated as an off-normal condition. However, Holtec needs to define both normal and off-normal conditions and support its definition by analysis. The application needs to address the thermal impact of intermixing of air between adjacent VMMs for the requested decay heat loads. The NRC confirmatory review indicates that intermixing of air could significantly increase inlet temperatures, above the assumed ambient inlet conditions for modules located in the center of large arrays with maximum requested heat loads. The application also needs to further demonstrate that normal condition temperature limits for the HI-STORM 100U are not exceeded for variable wind conditions that are realistically expected at a site during normal operations. As shown in Holtec’s own analyses, sustained wind velocities between 0 and 10 miles per hour (mph) across the HI-STORM 100U vent system significantly increases the calculated cladding temperatures. Holtec may refine its initial assumption of sustained wind in the thermal analyses, and take credit for a realistic magnitude and duration of wind, and any thermal inertia provided by the system. In this regard, a general licensee may have to verify that its site-specific meteorological conditions are bounded by the wind assumptions in the thermal analyses. Nonetheless, the effect of potential low-

velocity wind can not be completely neglected with respect to calculating normal condition temperatures at this time.

Finally, the ground-level, 360-degree openings in the lid and underground ventilation system of the HI-STORM 100U are remarkably different than traditional above-ground designs; and Holtec has shown that sustained, low-velocity winds across the openings significantly increase the temperature of fuel cladding. Therefore, the request for information in RAI Nos. 4-1 and 4-2 is warranted for this reason. The attached document provides a more in-depth discussion of these issues. The NRC staff agrees with your feedback that this request for information may not have been applied to other above-ground technologies with discrete vents. We will examine our current review procedures to determine whether the influence of wind should be examined closer in the thermal analyses for traditional above-ground systems that have discrete vents and small thermal margins.

If you have any comments or questions on this position, please contact me at (301) 492-3317. Please reference Docket No. 72-1014 and TAC No. L24085 in future correspondence related to this licensing action.

Sincerely,

/RA/

Stewart Brown, Senior Project Manager
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket No. 72-1014

TAC No. L24085

Enclosure: NRC Response to Holtec's Position on RAI-1 and RAI-2

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RESPONSE TO
HOLTEC'S POSITION ON REQUEST FOR ADDITIONAL INFORMATION
NOS. 4-1 AND 4-2 FOR THE HI-STORM 100U

RAI Nos. 4-1 and 4-2: Treatment of Low-Velocity Winds

Summary of Holtec position: For wind to be defined as a "normal long-term event," it must maintain a constant velocity over a long duration on the order of the week or more. Such conditions cannot be considered a credible normal event. Therefore, wind conditions are defined as off-normal conditions. Inclusion of wind would be a "radical change" from current approaches, and other applications approved by NRC, because NRC has used quiescent ambient condition for thermal evaluations. Inclusion of wind as part of the long-term normal storage evaluations would have significant implications on the predictions of the thermal response of casks with discrete inlet and outlet vents.

NRC Response: The staff considers the criteria in ANSI/ANS 57.9-1992 "Design Criteria for an Independent Spent Fuel Storage Installation," as the guiding principle for defining normal off-normal, and accident events. This includes mechanical failures, human error, and natural phenomena. Chapter 11 of the HI-STORM 100 safety analyses report (SAR) references ANSI/ANS 57.9, and defines off-normal events as those expected to occur once per calendar year. The staff notes that in the Amendment No. 3 request for the HI-STORM 100U, Holtec delineated a difference between normal wind and off-normal wind, and compared the results to corresponding temperature limits. For example, Revision No. 3 of the HI-STORM 100U SAR described and analyzed a "normal wind (i.e., non-quiescent) condition" up to 10 miles per hour (mph) and presented resulting temperatures for 2.5, 5, and 10 mph. The accident chapter of Revision No. 3, further described off-normal wind as that in the "range of 10 to 30 mph." In both cases, Holtec chose to analyze sustained winds in its FLUENT models, and noted that it was a conservative assumption. The revised thermal analyses in Revision No. 4 for this Amendment No. 6 request, has removed the normal condition analyses; states a 0 to 30 mph sustained wind is an off-normal event; and analyzes a different set of wind velocities. In addition, it appears that Holtec may not have evaluated the design basis heat load of 36.9 kw (X=0.5) for the wind evaluation based on further examination of the results presented in Table 4.I.7 of the current SAR and supporting FLUENT calculations. It appears a 30 kw heat load (X=3.0) was analyzed.

The staff considers a breeze or wind at low velocities to be a natural daily occurrence in many locations in the United States. Completely calm, non-windy conditions for long periods of time are relatively infrequent occurrences. As with all natural phenomena, the magnitude, duration, and direction are indeed realistically expected to vary day to day, and be different at each site. Therefore, this natural variation can be treated as a realistic, normal condition in analyzing the performance of the HI-STORM 100U. Holtec may refine its assumption of sustained wind in its thermal analyses, and take credit for a realistic magnitude and duration of wind, and the thermal inertia of the system. In this regard, a general licensee may have to verify that its site-specific meteorological conditions are bounded by the wind assumptions in the thermal analyses. More extreme gusts of wind that are expected to be infrequent may be considered off-normal events. Depending on the importance of these factors, the assumptions may be captured as a required Site-Specific Parameter Analyses in Section 3.4 of Appendix B of the HI-STORM 100 CoC.

Holtec may propose a method for determining average duration(s) at low-velocities up to 10 mph, and demonstrate the thermal inertia of the system (with the design-basis heat load) prevents the normal condition temperature limit from being exceeded. Analogous to the average annual ambient temperature assumption, each general licensee may have to verify that fluctuations in wind velocity and duration are bounded by the values assumed in the analyses. The staff is currently considering potential averaging methodologies, which may be dependent, in part, on the overall thermal inertia of the system demonstrated by Holtec.

Based on preliminary scoping calculations with Holtec's FLUENT model, staff believes cladding temperatures may be higher at velocities around 5 mph (sustained), and thus higher than the temperature limits for normal conditions. Holtec needs to determine the limiting velocity which will result in the maximum peak cladding temperature in the range of 0 to 10 mph. In addition, it is not clear how realistic changes in wind direction may affect the performance of the system. Section 4.I.6.1 of the current SAR states: "because the 100U ventilation openings are axisymmetric, the effect of wind on the inlets is the same regardless of direction."

RAI 4-1: Treatment of Intermixing between Adjacent VVMs

Summary of Holtec position: To maximize the mixing between hot and cold streams, the ambient air and exiting air from the HI-STORM U are artificially confined within a hypothetical cylinder (as modeled in FLUENT) around the cask above the concrete pad. In quiescent ambient conditions, lateral mixing between air above adjacent VVMs will be very small. Use of a hypothetical cylinder around a cask to restrict air flow has been previously reviewed and approved by NRC for the HI-STORM 100 system thermal evaluations. This approach was verified to be appropriate by Pacific Northwest National Laboratory (PNNL), who performed analyses (on behalf of NRC) for the ASLB hearings on the Private Fuel Storage Facility.

NRC Response: The ground-level, 360-degree openings and underground ventilation system of the HI-STORM 100U are remarkably different than traditional above-ground designs; and Holtec has shown that sustained, low-velocity winds across the vents clearly increase the temperature of fuel cladding. In the HI-STORM 100 above ground design, cool air enters through discrete inlets at the bottom of the cask, turns 90 degrees, flows up about 19 feet (ft), and makes a 90-degree turn to exit the heated air through discrete outlet vents. Therefore, there is about 19 ft separation between the air inlet and outlet vents. However, for the HI-STORM 100U design, cool air flows horizontally through 360-degree inlet vents near ground-level, turns downwards 90-degrees, flows downwards for about 18.6 ft and then flows upwards and exits the outlet vents. The outlet vents are separated only by about 1 ft from the inlet vents. Based on these design differences, applying a hypothetical cylinder in FLUENT may not be adequate for VVMs located in the center of large HI-STORM 100U arrays, where intermixing of inlet and outlet streams may occur.

The NRC has performed preliminary scoping calculations with Holtec's FLUENT model (modified for an array configuration), and believes that intermixing of air in a non-quiescent condition could significantly increase inlet temperatures in a large array. In addition, NRC staff has re-examined the case submitted by Holtec, and found that although, Holtec stated that the hypothetical cylinder assumption would yield conservative air inlet temperatures, NRC staff found no effect of the hypothetical cylinder assumption on the air inlet temperature. Holtec should consider modeling the impact and the effect of the proximity of other VVMs (for example, in a 5X5 array in a non-quiescent state). More than one VVM should be considered in the model

in order to support the conclusion that a hypothetical cylinder modeling assumption is adequate. For example, an infinite array should be considered given Holtec has requested an unlimited array size. Finally the reference to the PNNL study is inappropriate because of significant design differences between the HI-STORM 100 and HI-STORM 100U, and differences in the specific purpose and heating phenomena that PNNL was addressing in that study.