



UNITED STATES
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January 6, 2015

Dr. Stefan Anton
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SUBJECT: NRC STAFF COMMENTS ON HOLTEC INTERNATIONAL HI-STORM 100
CASK SYSTEM, CERTIFICATE OF COMPLIANCE NO. 1014, AMENDMENT
NO. 5, CONDITION NO. 9 AIR FLOW TEST (TAC NO. L60542)

Dear Dr. Anton:

By letter dated July 11, 2011, Holtec International (Holtec) submitted Holtec Report No. HI-2114925 Rev. 0, "HI-STORM 100 Cask System Thermal Performance Validation Using Air Flow Test Data" (ADAMS Accession No. ML111662010) to fulfill the requirements of Certificate of Compliance (CoC) No. 1014, Amendment No. 5, condition no. 9.

The staff has reviewed the report and has enclosed comments for Holtec's consideration.

If you have any questions, please contact me at (301) 287-9250.

Sincerely,

/RA/

John Goshen, P.E., Project Manager
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Docket No.: 72-1014

TAC No.: L60542

Enclosure: As stated

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HOLTEC INTERNATIONAL
DOCKET NO. 72-1014
LICENSE AMEMDMENT NO. 5
TO THE HI-STORM 100 CASK STORAGE SYSTEM
CONDITION NO. 9 AIR FLOW TEST COMMENTS

The following are NRC staff (staff) observations on the results of the Arkansas Nuclear One (ANO) measured air velocity data and Holtec's subsequent evaluation. The staff's observations are based on review of the following two listed references:

- 1) ANO - 2011-0034 letter "HI-STORM 100 MPC-24-052 Thermal Performance Test Data", dated June 15, 2011
- 2) Holtec Report No. HI-2114925 "HI-STORM 100 Cask System Thermal Performance Validation Using Air Flow Test Data"

Staff observations

- From an analysis of the raw data provided in Ref. (1) it appears that the air velocity measurements were obtained for a period of one minute. The measurements were taken in the air annulus between the canister and the overpack. These measurements were taken about one foot below the exit vents. By examining data provided in Ref. (1) the measured velocities had a huge variability (randomness) for the same location. In each location the ratio of the maximum velocity to the minimum velocity was as high as two to three. The measurements showed very wide fluctuations. The magnitude of the fluctuations reached twice the minimum value in some locations.
- The measurements in the four locations in the annulus (one foot below the exit vents) were not alike due to the large variability and randomness shown in the measurements.
- These results show much randomness which indicates no repeatability.
- This large measurement variability occurred through the entire time of the measurement.
- Therefore, using the arithmetic average value to describe the velocity at a particular point in space and comparing it to the steady state computational fluid dynamic calculation (Ref. 2) will not be a meaningful comparison to the NRC, when considering the huge uncertainty associated with these measurements, as it is observed by examining the measured values.
- Additionally the analysis described in Ref. (1) used different geometry (i.e. the air annulus was smaller than the cask used by ANO) to compare the results. In order to obtain meaningful results, the correct geometry should be used in the analysis and the

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integrated mass flow rate should be compared between the ANO measurements and analysis. The use of the correct geometry in the analysis will avoid data manipulation in order to compare the results as was done in the analysis described in Ref. (2).

Considerations for future air velocity measurements

- To obtain accurate measurements and to avoid mis-prediction of the total mass flow rate, consider measuring the velocity profile at the four inlet vents of the HI-STORM 100 overpack.
- To obtain uniform air flow upstream of the hot wire measurements, consider introducing additional ducting with honeycomb (i.e. an array of small tubes) at the inlet vents. Consider measuring the entire velocity profile across the duct.
- The calibration of the hot wire is a very important step towards the evaluation of the uncertainty of the measurement. Consider calibrating the instrument at air velocities similar to the flow range encountered in the HI-STORM 100 cask storage system.
- For the measurements consider including the systematic uncertainty as well as the random uncertainty of the measured values as pointed out by the American Society of Mechanical Engineers (ASME) standards on the subject of measurement methodology and uncertainties. (ASME PTC 19.1-2005).

For additional information on instrument calibration, the following references are provided:

- 1) NUREG/CR-7143 "Characterization of Thermal-Hydraulic and Ignition Phenomena in Prototypic, Full-Length Boiling Water Reactor Spent Fuel Pool Assemblies After a Postulated Complete Loss-of-Coolant Accident" (Appendix C)
- 2) NUREG/CR-7144 "Laminar Hydraulic Analysis of a Commercial Pressurized Water Reactor Fuel Assembly"
- 3) ASME V&V 20-2009 "Standard for Verification and Validation in Computational Fluid Dynamics and Heat Transfer"
- 4) ASME PCT 19.1-2005 " Test Uncertainty"