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February 18, 2005

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Dry Storage Cask Annulus Air Flow Regime

References:
1. USNRC Docket No. 72-1014, TAC No. L23657
2. SFPO Meeting with Holtec International on 19 January 2005
3. Holtec Letter 5014544 from E. Rosenbaum, dated 21 October 2005
4. Holtec Letter 5014554 from E. Rosenbaum, dated 1 February 2005
5. Holtec Letter 5014557 from E. Rosenbaum, dated 14 February 2005

Dear Sir:

On 21 October 2004, we transmitted a topical report to the NRC (Reference 3). This topical report (Holtec Report HI-2043258r0) evaluated the results of an EPRI/INEL test program on an actual ventilated storage cask loaded with spent fuel. The purpose of this evaluation was to determine if the airflow through the annular cooling passages of the cask was turbulent or laminar. It is our conclusion that this airflow is turbulent and that it is appropriate to model the airflow in the HI-STORM 100 System as turbulent.

This topical report was discussed in a meeting between the Spent Fuel Project Office and Holtec International on 19 January 2005 (Reference 2). During the meeting, the SFPO Staff requested that we perform several additional analyses, to confirm the results presented in our topical report. Specifically, it was requested that the sensitivity of the model to the effective thermal conductivity of the MSB, the size of the inlet vents, and the computational mesh density be examined. We agreed to perform such sensitivity studies. Preliminary results of the requested sensitivity studies were transmitted to the NRC on 1 February 2005 and 14 February 2005 (References 4 and 5, respectively). All three sensitivity studies indicated that the examined parameters do not have a significant impact on the computed MSB shell temperatures.

During the January 19th meeting, the SFPO also requested that we examine our model to determine why it over-predicts the MSB shell temperatures by as much as 15%. We have completed our investigations for this final request. Three features of our model were identified as contributing to the observed temperature over-prediction:

Feature 1 – MSB Internal Radiation

Radiation heat transfer between the basket inside the MSB and the MSB vessel was not included in the model. There are gaps between the side of the basket and the MSB shell and between the top of the basket (including the tops of the stored consolidated fuel canisters) and the MSB lid.

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Radiation heat transfer across these gaps is an important heat transfer mechanism that was not previously included in the model.

Feature 2 – MSB Lid Neutron Shield Enclosure Ring

The MSB lid is a three-layer, composite structure with RX-277 neutron shield material between two carbon steel layers. There is a relatively thick, solid steel ring that surrounds the RX-277 and connects the two steel layers. This ring provides a high thermal conductivity heat transfer path that allows heat to flow around the low conductivity RX-277, and is important in correctly predicting heat transfer through the MSB lid.

Feature 3 – Orthotropic Basket Thermal Conductivity

Previous studies modeled the basket in the MSB with an equivalent homogeneous material with an isotropic thermal conductivity. Previous studies (Reference 4) indicated that the value of the thermal conductivity did not significantly affect the MSB shell temperatures. The assumption of an isotropic thermal conductivity did, however, under-predict the axial heat transfer of the basket. This resulted in a non-physical impediment to rejecting heat from the MSB lid.

We have modified our model to correct these three features to render a most accurate representation (i.e., best estimate) of the VSC-17 temperature and flow fields. A three-inch gap was introduced between the side of the basket and the MSB shell and a two-inch gap was introduced between the top of the basket and the MSB lid, with radiation heat transfer across these gaps enabled. The MSB lid neutron shield ring was added to the model. The axial thermal conductivity of the loaded consolidated fuel canisters was calculated and applied to the basket regions in the axial direction.

The modified model was evaluated for the vacuum condition (Run #6 from the EPRI/INEL tests). Both laminar airflow and turbulent airflow (standard k-ε model) were evaluated. In both cases, the MSB basket radial thermal conductivity was adjusted to obtain the correct peak fuel cladding temperature. As the previous sensitivity study (Reference 4) showed, this does not significantly affect the MSB shell temperatures. These evaluations using the best-estimate model indicated that turbulent airflow closely matches the measured MSB shell temperatures and that laminar airflow significantly over-predicts them. *Preliminary* results of these calculations are attached to this letter, in advance of their formal issuance in a future revision to the topical report, to allow the NRC to examine them as early as possible.

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We would appreciate the SFPO's expeditious review of the attached technical material to allow us to reach a consensus on this topic as quickly as possible. Please feel free to contact me if any questions arise or if you require any additional information.

Sincerely,

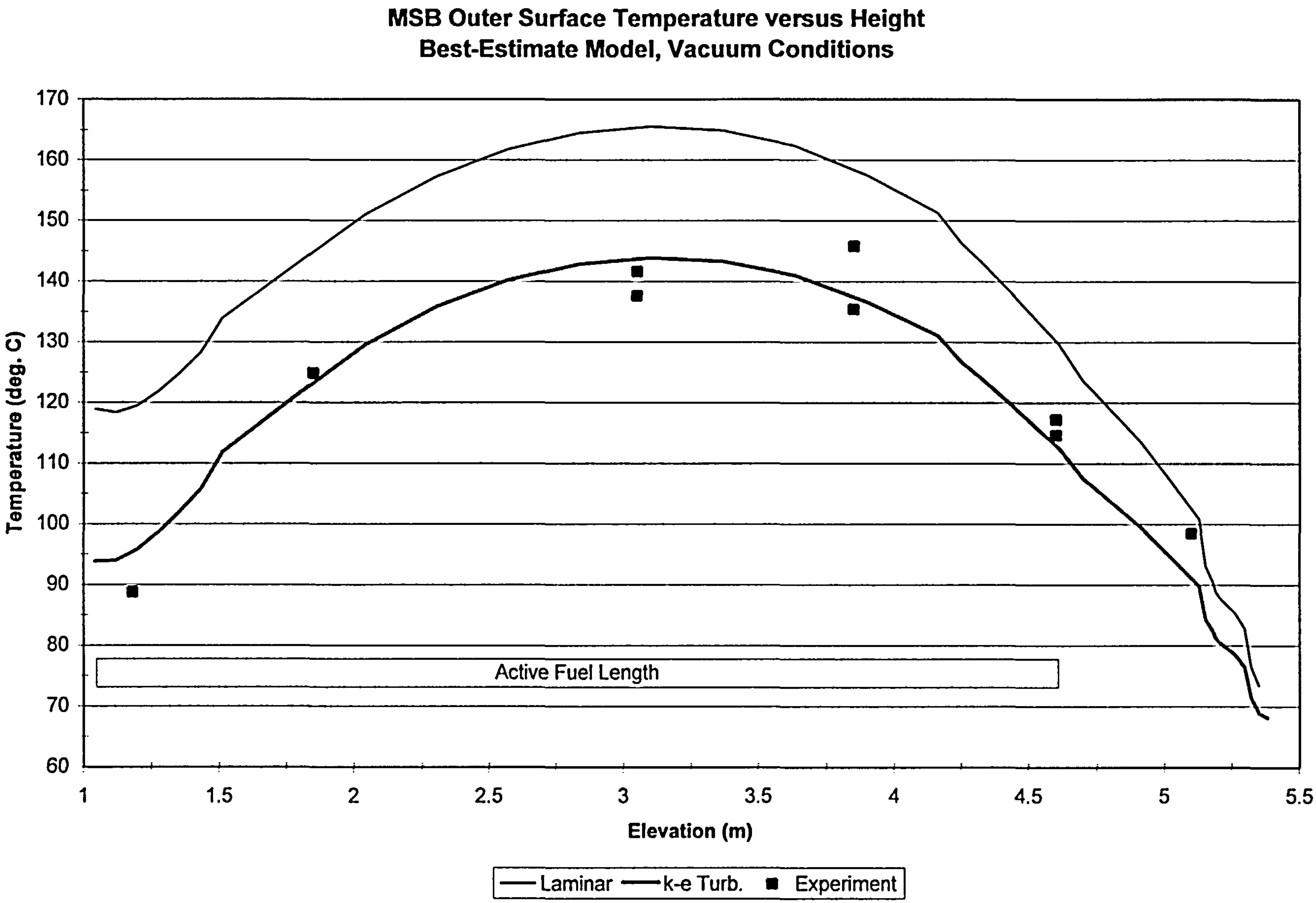
Evan Rosenbaum
Project Manager, LAR 1014-3

Technical Concurrence:

Dr. Debabrata Mitra-Majumdar
Principal Engineer

Attachment: Preliminary Best-Estimate Model Results (2 pages)

emcc: Mr. Larry Campbell, USNRC
Mr. Wayne Hodges, USNRC
Mr. John Monninger, USNRC
Mr. Christopher Regan, USNRC


MSB Outer Surface Temperature versus Height
Best-Estimate Model, Vacuum Conditions
170
160
150
140
130
120
110
100
90
80
70
60
Temperature (deg. C)
Active Fuel Length
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
Elevation (m)
Laminar
k-e Turb.
Experiment

	Experimentally Measured Values (see Note 1)	FLUENT Computed Results	
		k-ε Turbulence	Laminar
Average Air Outlet Temperature (see Note 2)	66.0°C	65.9°C	67.0°C
Temperature of VSC-17 Side Surface at 5.1 m (see Note 3)	45.9°C	43.3°C	42.7°C
Maximum Weather Cover Temperature	52.8°C	58.1°C	61.0°C
Maximum Clad Temperature	384.1°C	385.8°C	384.8°C

Notes:

1. According to the EPRI report (TR-100305), the measurement uncertainty for the experimental values is +/- 4°C for clad temperature and +/- 4.5°C for all other temperatures reported in this table. Computed values agree with measured values within this level of accuracy.
2. The observed agreement between the measured and computed air temperatures indicates that the model is accurately predicting the air flow rate and heat transfer into the air stream. While both laminar and turbulent conditions are close to the experimental value, the turbulent condition is in closer agreement.
3. The temperature at this elevation is compared because this is the elevation where the maximum measured side surface temperature occurs. While both laminar and turbulent conditions are close to the experimental value, the turbulent condition is in closer agreement.