HOLTEC INTERNATIONAL

CONDITION 9 AIR FLOW TEST

Plan for Test and Equipment Calibration

a generation ahead by design

May 19, 2015

Condition 9 Requirement

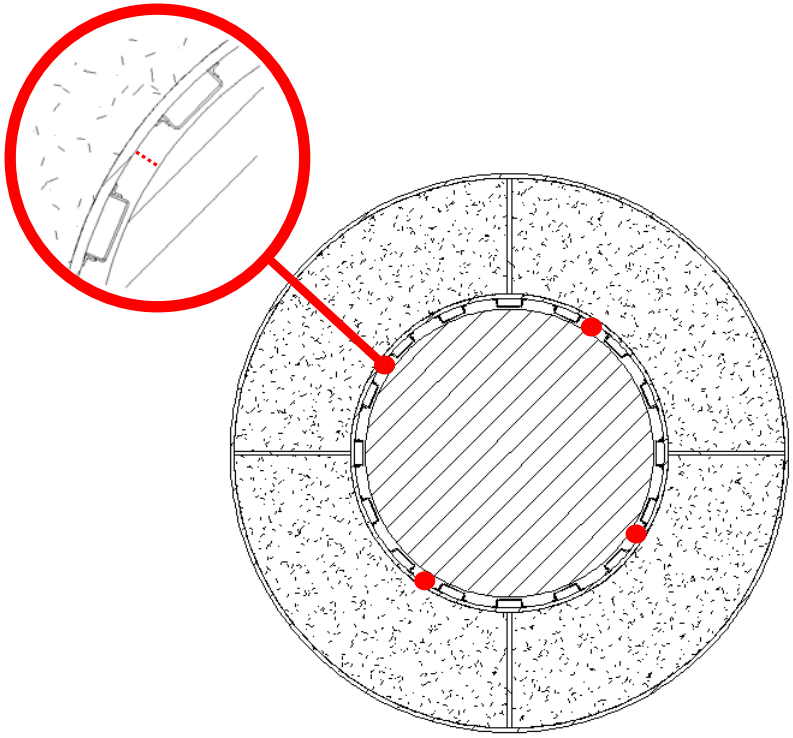
HI-STORM 100: Condition 9

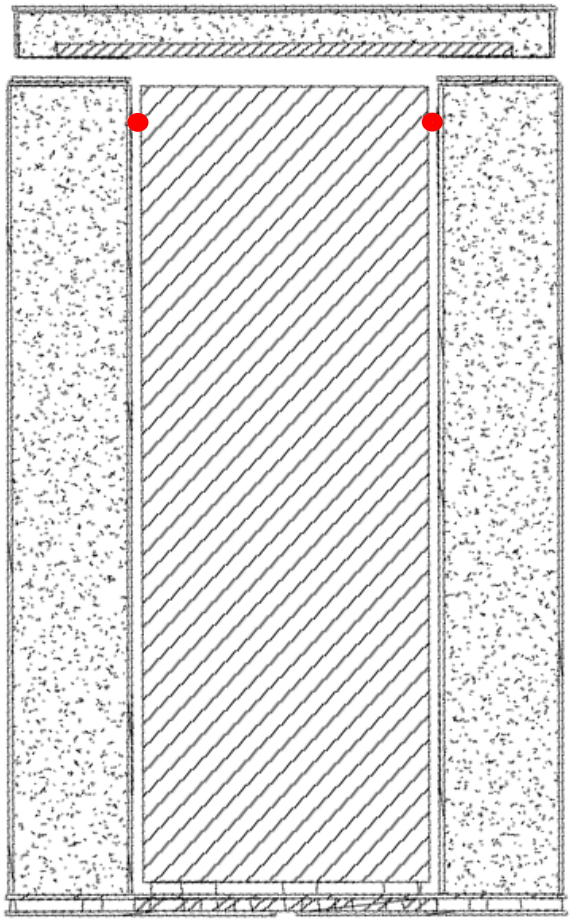
The air mass flow rate through the cask system will be determined by direct measurements of air velocity in the overpack cooling passages for the first HI-STORM Cask Systems placed into service by any user with a heat load equal to or greater than 20 kW. In the aboveground HI-STORM Models (HI-STORM 100, 100S, etc.), the velocity will be measured in the annulus formed between the MPC shell and the overpack inner shell. In the underground HI-STORM Model (HI-STORM 100U), the velocity will be measured in the vertical downcomer air passage. An analysis shall be performed that demonstrates the measurements validate the analytic methods and thermal performance predicted by the licensing-basis thermal models in Chapter 4 of the FSAR.

Technical challenges

- Velocity measurements required to be performed in a difficult-to-reach area: the annulus space between overpack and MPC.
- Limited options for measurement equipment that simultaneously meets requirements for high temperature, low velocity and physical access restrictions.
- Limited options for calibrating at low air velocities.

Air Flow Velocity Measurement Locations



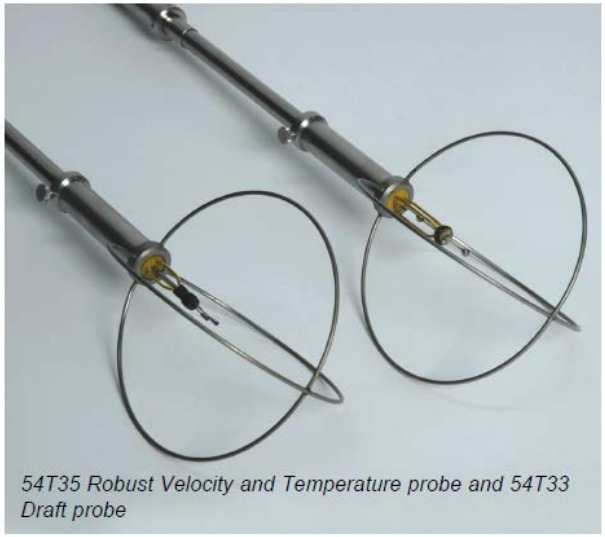


- Four positions in annulus, at outlet ducts
- Approximately 10 inches into annulus
- Eighth inch intervals across width of annulus
- Refer to HPP 5014-25 for test procedure

Air Velocity Measurement Equipment

54T33 Draft probe

Velocity range	0.05-5 m/s, indicates up to 10 m/s
Accuracy	0-1 m/s: ± 2% OR* ± 0.02 m/s 1-5 m/s: ± 5% OR* 5-10 m/s: ±10% OR*
Time constant	< 0.1 s
Frequency response (90%)	2 Hz
Acceptance angle - relative to probe axis	0-1 m/s : ±160° 1-5 m/s: +50° to +130°
Temp. reading range	-20ºC to +80°C
Accuracy at velocities above 0.1 m/s, radiation excluded	0ºC to +45°C: ± 0.2K -20ºC to +60°C: ± 0.3K +60°C to 80°C: ± 0.5K
Storage temperature	-30ºC to +80°C



54T35 Robust Velocity and Temperature probe and 54T33 Draft probe

Calibrations of DANTEC low-velocity probes are carried out in our two calibration windtunnels, DANTEC ref. no. 435-1010 (0.05 to 5 m/s) and DANTEC ref. no. 435-1018 (1.5 to 35 m/s). Calibrations are carried out according to our internal ISO 9001 procedures using reference instruments with calibrations traceable to accredited laboratories.

The traceability of our calibrations in the velocity range 0.05 to 1.5 m/s is checked at regular intervals by intercomparison with the tow-tank calibration facilities in the following accredited laboratories:

SINTEF, Norway – Norwegian Accreditation CAL014

Danish National Metrology Institute for Anemometry, Technological Institute - DANAK CAL reg. no. 200

The intercomparisons are carried out using our BCR Reference anemometer - DANTEC no. 435-1019 – as transfer standard.

Calibration Results

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Calibration performed per Holtec Procedure HPP 5014-26R2

M&TE Data Log Identifier	Average, Steady-State Tachometer Reading During Travel (rpm)	Tachometer Reading Calculated Velocity* (m/s)	Average Logged M&TE Velocity (m/s)	Tolerance (based on manufacturer's stated calibration tolerance) (±m/s)	Within Tolerance?
042015-10A	370	0.492	0.475	.02	Y
042015-15B	482	0.641	0.636	.02	Y
042015-20B	683	0.908	0.895	.02	Y
042015-25A	819	1.089	1.051	.053 (5%)	Y
042-015-30E	970	1.289	1.230	.062 (5%)	Y

*Tachometer Reading Calculated Velocity = RPM x 3.14 x (0.0254 / 60)

Calibration Results

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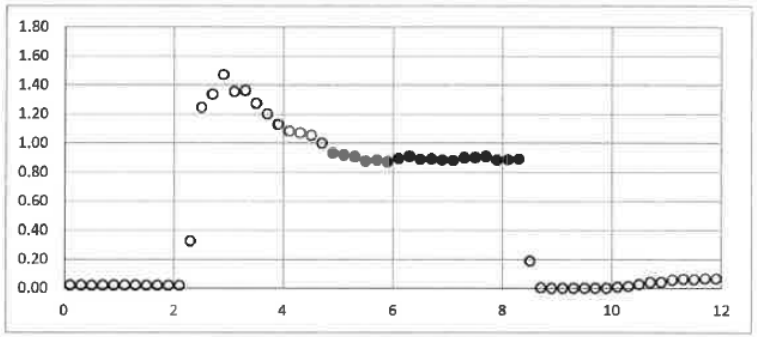
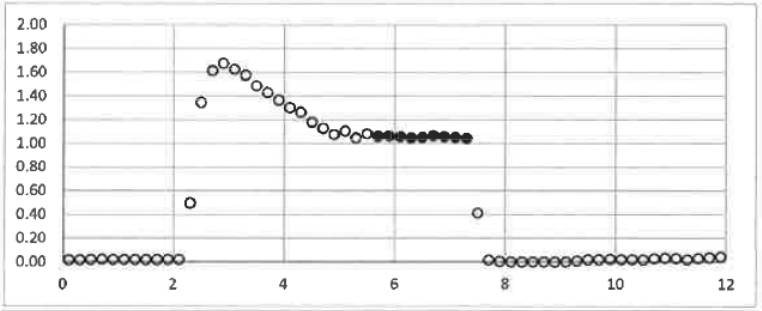
DATA LOG IDENTIFIER: 042015-20B

Average Steady-State Velocity (m/s):	0.895
Tachometer (rpm):	683
Tach Velocity (m/s):	0.908
Cal Tolerance (±m/s)	0.02
Max (m/s):	0.915
Min (m/s):	0.875
In Tolerance?:	YES



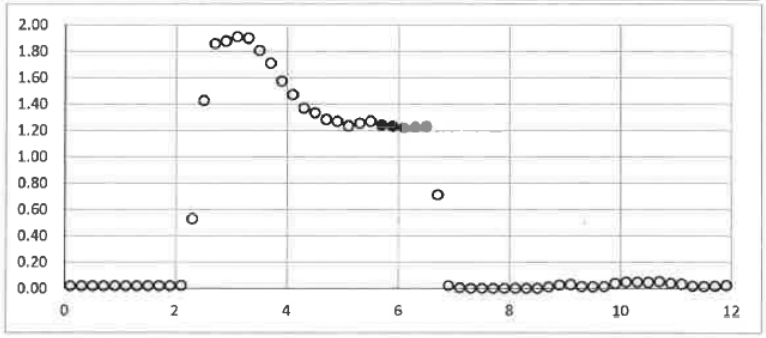
DATA LOG IDENTIFIER: 042015-25A

Average Steady-State Velocity (m/s):	1.051
Tachometer (rpm):	819
Tach Velocity (m/s):	1.089
Cal Tolerance (±%)	5
Max (m/s):	1.104
Min (m/s):	0.999
In Tolerance?:	YES



DATA LOG IDENTIFIER: 042015-30E

Average Steady-State Velocity (m/s):	1.230
Tachometer (rpm):	970
Tach Velocity (m/s):	1.289
Cal Tolerance (±%)	5
Max (m/s):	1.292
Min (m/s):	1.169
In Tolerance?:	YES



Evaluation of Test Data

- Calibration check per HPP-5014-26 confirms accuracy within manufacturer-stated range.
- Measured velocities will be reduced by maximum absolute value of measurement uncertainty.
- Reduced velocities will be used to compute mass flow rates. Air density will be based on measured temperatures.
- Computed mass flow rates will be compared to predictions using FSAR-consistent thermal model.