Physical Test Methods Sub-Group

Technical Report

2nd Round Robin Test for Multi-Capillary Ventilation Calibration Standards (2013/2014)

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1. Introduction and Background

The CORESTA Physical Test Methods (PTM) Sub-Group organizes a nominally annual cross-check that is open to the member laboratories that have a calibration laboratory to compare their capability to calibrate standards used in physical test instrumentation. This report covers the results of the 2nd ventilation (FV) standards cross-check conducted between June 2013 and September 2014. This testing provides a baseline of ventilation instrument performance across the industry, since this standard type is used in the pressure drop / ventilation instrumentation of each supplier. Each laboratory is also able to use the result set in internal and external audit assessments.

The four participating laboratories in 2013/2014 are listed in Table 1.

Table 1: Participating Laboratories

Participating laboratories	Function	Accreditation
Borgwaldt KC, Hamburg, Germany	Calibration lab & instrumentation supplier	ISO 9001 & 17025
Cerulean, Milton Keynes, UK	Calibration lab & instrumentation supplier	ISO 9001 & 17025
SODIM, Fleury-les-Aubrais, France	Calibration lab & instrumentation supplier	ISO 9001 & 17025
ZTRI of CNTC, Zhengzhou, PRC	Calibration laboratory	

The laboratory identities are coded in the results presented below.

The standards that were circulated between the four laboratories were a set of three ventilation standards at nominally:

- 20% tip ventilation
- 50% tip ventilation
- 80% tip ventilation

The three instrumentation suppliers use the same physical test piece design and test pieces that are all supplied from a single source, thus only a single set of standards is circulated.

2. Experimental Protocol

The protocol involved:

- acclimatisation of the standards to laboratory conditions
- testing to the method originally described in ISO 9512:2002 and updated in the latest draft version of CRM 6 (2014 revisions)
- making three ventilation determinations under repeatability conditions for each standard on two separate days.

After circulation of the calibration standards, the standards were re-checked by the original supplier.

3. FV Results 2013/2014

3.1 Overall results

The overall results of all the participants are presented below in Table 2 and as a scatterplot of global coefficient of variation (CoV) across all laboratories against the global mean ventilation of each test piece in Figure 1.

Note that ventilation is expressed as a percentage of the total flow at the outlet to the standard that has passed along the ventilation pathway. Where ventilation values are *compared* in percentage terms this is indicated as '% of value' or '% of mean' in the case of coefficient of variation (CoV).

Table 2: PTM FV X-Check 2013/4 – Overall Results

	Global Mean	Std Dev	CoV	Range	Range % of value
Nom 20%	18.3%	0.4%	2.36%	0.9%	5.17%
Nom 50%	50.9%	0.2%	0.36%	0.4%	0.71%
Nom 80%	77.5%	0.8%	1.04%	1.6%	2.07%

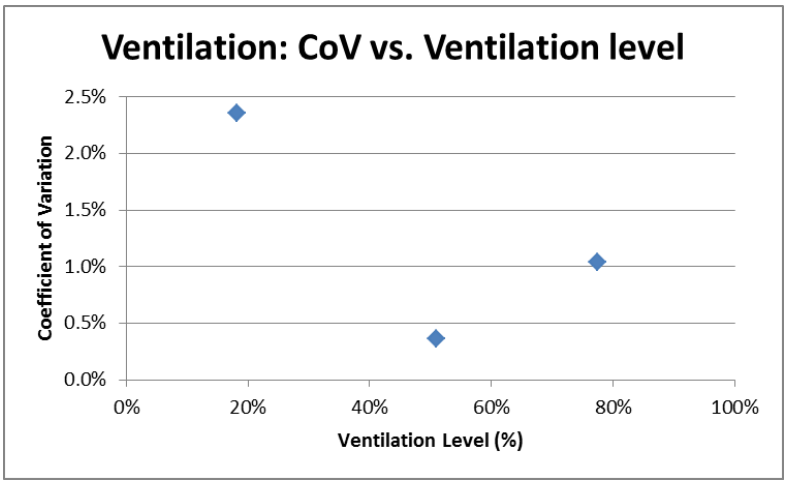


Figure 1: Ventilation CoV vs. Ventilation Level

3.2 Individual laboratory results

The individual mean values obtained by each laboratory for each FV calibration standard are shown in Table 3. The deviation of each laboratory from the global mean value was calculated and is shown in Table 4. The standard deviation and the coefficient of variation are shown per laboratory and calibration standard in Tables 5 and 6, respectively.

The deviation from the global mean is also shown per laboratory in Figure 2 and per calibration standard in Figure 3.

Table 3: PTM FV X-Check 2013/4 – Lab Mean by Sample

	LABORATORIES			
	A	B	C	D
Nom 20%	18.8%	17.8%	18.0%	18.5%
Nom 50%	51.1%	50.7%	51.0%	50.7%
Nom 80%	78.2%	78.1%	76.6%	77.0%

Table 4: PTM FV X-Check 2013/4 – Deviation from Sample Mean

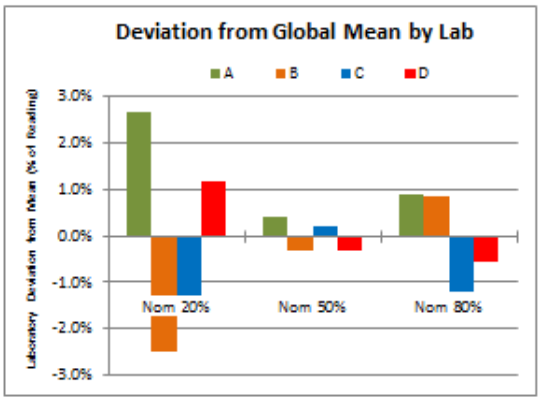
	LABORATORIES			
	A	B	C	D
Nom 20%	2.67%	-2.50%	-1.36%	1.19%
Nom 50%	0.40%	-0.31%	0.21%	-0.30%
Nom 80%	0.89%	0.85%	-1.18%	-0.55%

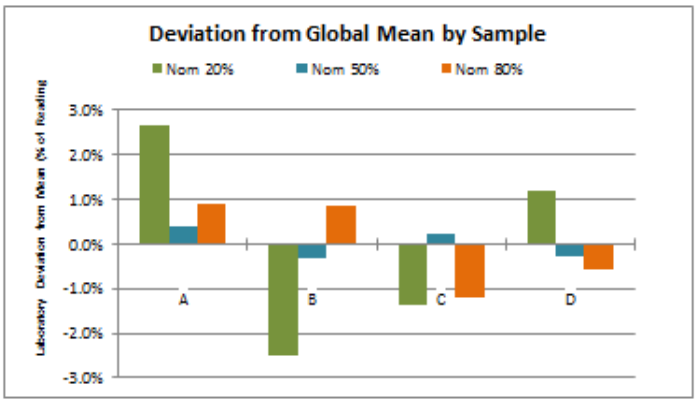
Table 5: PTM FV X-Check 2013/4 – Lab Std Deviation by Sample

	LABORATORIES			
	A	B	C	D
Nom 20%	0.02%	0.06%	0.07%	0.06%
Nom 50%	0.10%	0.02%	0.13%	0.09%
Nom 80%	0.11%	0.21%	0.23%	0.11%

Table 6: PTM FV X-Check 2013/4 – Lab CoV by Sample

	LABORATORIES			
	A	B	C	D
Nom 20%	0.12%	0.33%	0.40%	0.30%
Nom 50%	0.19%	0.05%	0.26%	0.18%
Nom 80%	0.14%	0.27%	0.29%	0.15%





Figures 2 (left) and 3 (right): Deviation from Global Mean by Lab & by Sample

3.3 Comparison between results from the 1st and 2nd cross-checks

A direct comparison between the results of the 1st (2011) and 2nd (2013/4) cross-checks is presented in Figure 4 in terms of the global CoV vs ventilation level for each standard.

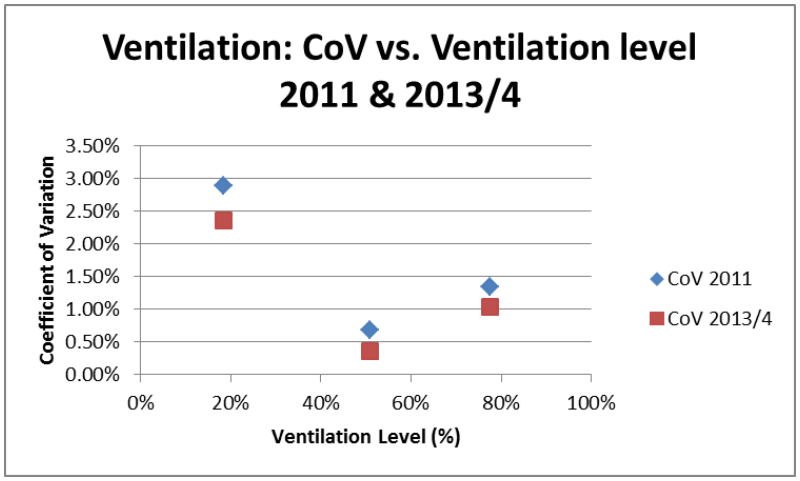


Figure 4: Ventilation – CoV vs. Ventilation Level

4. Comments on Results

The FV results in the 2nd cross-check contain an unusual outcome for the nominal 20% standard. It appears that this has increased in ventilation systematically (from 17.8% to 18.8%) as it has travelled between participants, including in the re-check when it was returned to the originator. With a standard deviation of less than 0.07% for the measurements on the calibration standard with a nominal ventilation of 20% the change during the circulation of the standard by 1% ventilation is statistically significant.

At the time of writing there is no ready explanation for this observation, although the CoV for this standard, like the others, was actually slightly lower in 2013/2014 than in 2011.

Further it can be observed that laboratory A consistently measured values above the global mean value, so that it is recommended to further investigate this point and define any appropriate actions.

It is notable that the relative variation (CoV) of up to 2.5% for FV standards is about ten times greater than that for PD standards. This is accounted for by the additional complexity of ventilation measurement, which:

a. is based on the ratio of two flows, one of which has to be corrected for pressure drop,
b. requires careful compensation to minimise the pressure differential between the inlets to the 'main' and ventilation flow paths, and
c. has not been studied to the same extent as PD calibration to develop a rigorous procedure to compensate a determination at local ambient conditions to the industry standard atmosphere of 22 °C, 1013.25 hPa, 60% RH.

Notwithstanding, and as for PD measurements, the contribution of instrumental offset deriving from the calibration of ventilation standards in different laboratories is acceptable compared to the reproducibility limit of approaching 8% exhibited for ventilation measurements in the PTM Proficiency Tests (2007 – 2011).