EURAMET TC Project
Final Report

Project Title

Bilateral comparison in the barometric absolute pressure range 800 to 1100 hPa

Coordinator, Institute, Country

Sari Saxholm, MIKES, Finland

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Subject Field

Mass and Related Quantities

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EURAMET 1206 FINAL REPORT

Bilateral comparison in the barometric absolute pressure range 800 to 1100 hPa

Project no.	EURAMET 1206
Participant(s)	MIKES (FI), MCCAA (MT)
Project Description, Abstract	MIKES and MSA-NMS performed a bilateral comparison in the barometric absolute pressure range 800 to 1100 hPa. The transfer standard was a barometer type PTB200 manufactured by Vaisala, owned by MIKES. All results agreed within the stated expanded uncertainties.
Transfer standard	Digital barometer - Manufacturer: Vaisala - Model: PTB200AD
Type of comparison	Bilateral comparison on absolute pressure calibrations.
Range of the comparison	800 hPa to 1100 hPa, absolute pressure
Date of measurements	25. October 2011 (MIKES) 2. - 3. November 2011 (MCCAA)
Completion date of the comparison	21.3.2013
Coordinator	Sari Saxholm Head of Pressure VTT MIKES Process Metrology
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Appendices	A: Calibration results reported by the laboratories.

Participants

Name	Acronym	Address
Centre for Metrology and Accreditation	MIKES	Tekniikantie 1 02151 Espoo, Finland
Malta Competition and Consumer's Affairs Authority	MCCAA	Kordin Business Incubation Centre, Corradino Industrial Estate, Kordin,PLA 3000, Malta

Nominal measurement points

In this comparison, pressure standards were compared to each other at the following nominal measurement points (absolute pressure):

800 hPa, 850 hPa, 900 hPa, 950 hPa, 1000 hPa, 1050 hPa and 1100 hPa

Reference equipment used in the comparison

Laboratory	Equipment id.	Description
MIKES	PG7601 p/c 277	Pressure balance DHI PG7601 no. 149: - Piston cylinder unit no. 277 - Mass set DHI no. 2376 - Mass carrier DHI no. 2376 - Integrated vacuum gauge inside pressure balance body Traceability to the international system of units (SI) is provided as follows: - The piston cylinder effective area is traceable to the French national measurement standards via the Finnish national measurement standards - The masses are traceable to the Finnish national measurement standards - The vacuum measurement is traceable to the German national measurement standards via the Finnish national measurement standards Uncertainty: - Effective area uncertainty is 27 ppm - Mass uncertainty is 5 ppm Measurement uncertainties are estimated according to GUM using the coverage factor $k = 2$, which for a normal distribution corresponds to a probability of approximately 95 %.

Laboratory	Equipment id.	Description
MCCAA	PG7601 p/c 1608	Pressure balance DHI PG7601 no. 149: - Piston cylinder unit no. 1608 - Mass set DHI no. xxxx - Mass carrier DHI no. xxxx - Integrated vacuum gauge inside pressure balance body Traceability to the international system of units (SI) is provided as follows: - The piston cylinder effective area, the masses and the vacuum measurement are traceable calibrated by the manufacturer Uncertainty: - Effective are uncertainty is 10 ppm - Mass uncertainty is 5 ppm Measurement uncertainties are estimated according to EURAMET Guide no. cg-17 v 2.0 using the coverage factor $k = 2$, which for a normal distribution corresponds to a probability of approximately 95 %.

Transfer standard

Model	Serial number
Digital barometer PTB200AD	533521

Comparison scheme

	Laboratory	Date
1.	MIKES	25. October 2011
2.	MCCAA	2. - 3. November 2011

The stability of the transfer standard was estimated from MIKES calibration results, which are performed for over five years.

Stability of the transfer standard

The stability of the transfer standard was estimated from MIKES calibration results. The transfer standard is owned by MIKES since 2005 and its stability is observed over the years. The value used for uncertainty due to instability is ±0,02 hPa.

Method for analyzing the results

Comparison of the laboratories

The analysis was carried out in the following way:

At each measurement point, the error (Δp_{lab}) for transfer standard was determined and reported as:

$$\Delta p_{\mathrm{lab}} = p_{\mathrm{ind}} - p_{\mathrm{ref,lab}} \quad (1)$$

where p_{ind} and $p_{ref,lab}$ are the reading of the instrument and corresponding actual pressure determined by the laboratory, respectively.

The difference between the laboratories (D_{lab}) was then determined:

$$D_{\mathrm{lab}} = \Delta p_{\mathrm{MCCAA}} - \Delta p_{\mathrm{MIKES}} \quad (2)$$

The uncertainty of the difference was taken as the combined uncertainty of the both laboratories and the estimated stability of the transfer standard:

$$u(D_{\mathrm{lab}}) = \sqrt{u^2(\Delta p_{\mathrm{MCCAA}}) + u^2(\Delta p_{\mathrm{MIKES}}) + u_{\mathrm{stab}}^2} \quad (3)$$

The standard uncertainty due to stability of the transfer standard (u_{stab}) during the comparison was estimated for each pressure point and taken into account as type B uncertainty component, rectangular distribution.

Significance of the observed differences

To analyse the significance of the differences calculated with equation (2), normalized error values (E_n) were calculated by dividing the difference with its expanded uncertainty ($k = 2$)

$$E_{\mathrm{n,lab}} = \frac{D_{\mathrm{lab}}}{U(D_{\mathrm{lab}})} = \frac{D_{\mathrm{lab}}}{2u(D_{\mathrm{lab}})} \quad (4)$$

If $-1 < E_n < 1$, the estimate for the difference is smaller than its expanded uncertainty.

Results of the comparison

Final results obtained with the transfer standard are in Table 1.

Table 1. Results obtained with the transfer standard. The uncertainty includes the estimated instability of the transfer standard.

Pressure p (hPa)	MCCAA - MIKES D_{LabX} (hPa)	$U(D_{LabX})$ [1] (hPa)	Normalized error E_n
800	0,03	0,04	0,65
850	0,01	0,04	0,29
900	0,02	0,04	0,53
950	0,02	0,04	0,57
1000	0,00	0,05	0,08
1050	-0,01	0,05	-0,22
1100	0,01	0,05	0,23

[1] Expanded uncertainty with the coverage factor of 2.

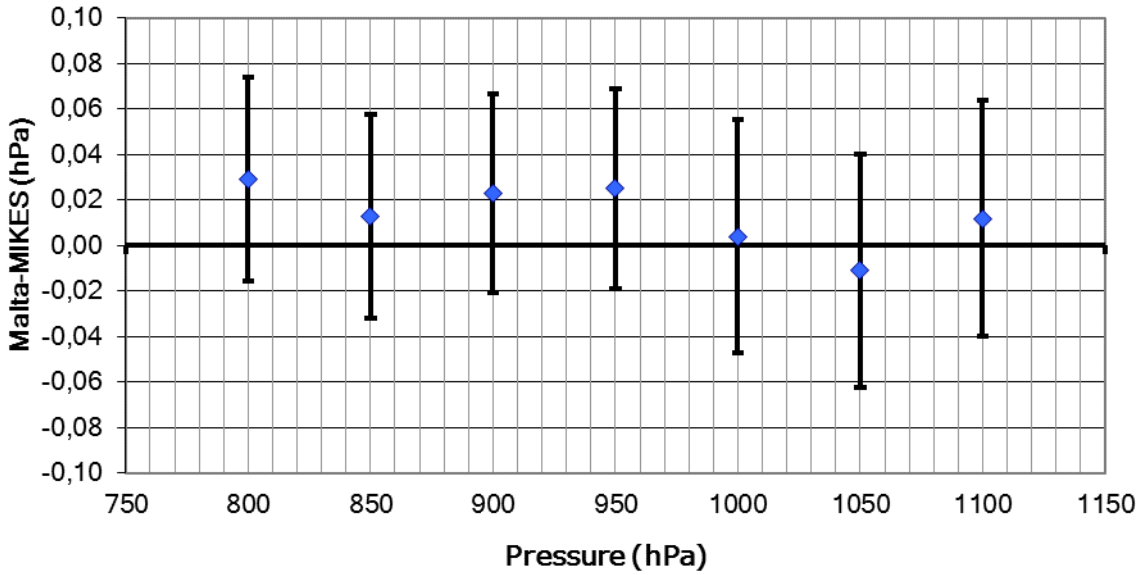

Figure 1. Results of the comparison. Error bars show the estimated expanded uncertainty ($k = 2$).

All the calculated En values are -1 < En < 1, which means there are no statistically significant differences between the results obtained by the laboratories.

Conclusions and discussion

All results agreed within the stated expanded uncertainties.

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APPENDIX A: Calibration results reported by the laboratories

MIKES

Calibration certificate no. M-11P102

Nominal pressure (hPa)	Error (hPa)	Uncertainty $k = 2$ (hPa)
800	-0,68	0,03
850	-0,68	0,03
900	-0,69	0,03
950	-0,70	0,03
1000	-0,69	0,04
1050	-0,67	0,04
1100	-0,65	0,04

MCCAA

Nominal pressure (hPa)	Error (hPa)	Uncertainty $k = 2$ (hPa)
800	-0,651	0,024
850	-0,667	0,024
900	-0,667	0,022
950	-0,675	0,022
1000	-0,686	0,022
1050	-0,681	0,022
1100	-0,638	0,024