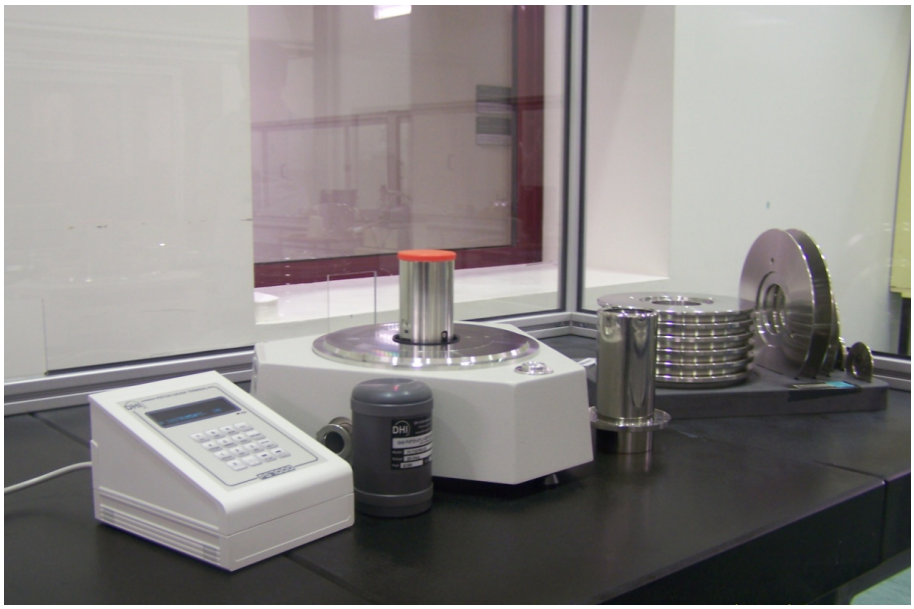
Pressure standard comparison gas media and gauge mode from 0,7 MPa to 7 MPa.

EURAMET project no. *1179*
*KCDB SC no. EURAMET.M.P-K1.*c



Introduction

This Euramet project no. 1179 (KCDB SC no. EURAMET.M.P-K1.c) is co-ordinated by DANIAmet-FORCE and TÜBITAK UME. The pressure standards of the participating laboratories will be compared in the pressure range 0,7 MPa to 7 MPa in gauge mode using a DHI PG-7601 transfer standard with mass set provided by TÜBITAK UME. Monitoring of transfer standard's performance will be checked by TÜBITAK UME, acting as a co-pilot of the comparison.

At each calibration point the parameter to be compared is the effective area of the piston cylinder assembly determined by each participant corrected to 20 °C. Additionally, the zero pressure effective area, A_0, and the distortion coefficient with the associated uncertainties will have to be determined.

The comparison form a Key Comparison within the Euramet region which, it is anticipated, will link to the CCM Key Comparison CCM.P K1c (80 kPa – 7 MPa).

Equipment

The transfer standard is a DHI piston-cylinder unit belonging to TÜBITAK-UME, together with the ancillary equipment.

The equipment must be handled with care, i.e., only by qualified metrology personnel.

Additional equipment required for the measurements, for example ruler etc, shall be provided by the participating laboratory.

Transfer Standard		**Piston Cylinder**	
TÜBITAK-UME Inventory Number		08583	
Type		PG-7100/7600-200	
DH Instruments Part Number		401564	
Serial Number		440	
Nominal Area		50 mm^2	
Linear Thermal Expansion Coefficient (α+β)		9 x 10^{-6} $°C^{-1}$	
Conventional mass		199,995 g (u=1,0 mg)	
Mean piston density		8030 kg/m^3 (u= 80 kg/m^3)	
Fall rate at 0,3 MPa		< 0,05 mm/min	
Fall rate at 7,0 MPa		< 0, 50 mm/min	
Deceleration (70 to 30 rpm) at 0,3 MPa		> 5 min	
Base			
Type		PG-7601	
Part Number		400480	
Serial Number		430	
TÜBITAK-UME Inventory Number		20272	
Terminal			
Type		PG TERMINAL (PG7000)	
Serial Number		N/A	
Part Number		401284	
Mass Set			
Serial Number		2067	
Density 5 kg, 4,5 kg, 2 kg and 1 kg		8000 kg/m^3 (u= 40 kg/m^3)	
Density 500 g, 200 g and 100 g		7920 kg/m^3 (u= 40 kg/m^3)	
TÜBITAK-UME Inventory Number		01043	
Mass Carrying Bell			
Serial Number		654	
Conventional mass		299,9719 g (u=1,0 mg)	
Density		5013 kg/m^3 (u= 50 kg/m^3)	
Mass number	**Virtual number**	**Conventional Mass**	**Uncertainty (k=2)**
5 kg – 1	1	5000,0089 g	10,0 mg
5 kg – 2	2	5000,0164 g	10,0 mg
5 kg – 3	3	5000,0225 g	10,0 mg
5 kg – 4	4	5000,0090 g	10,0 mg
5 kg – 5	5	4999,9987 g	10,0 mg
4.5 kg	6	4500,0232 g	8,0 mg
2 kg – 1	7	2000,0163 g	4,0 mg
2 kg – 2	8	2000,0108 g	4,0 mg
1 kg	9	1000,0031 g	2,5 mg
500 g	10	500,0028 g	1,5 mg
200 g – 1	11	200,0014 g	1,5 mg
200 g – 2	12	200,0010 g	1,5 mg
100 g	13	99,9997 g	1,0 mg

The uncertainties quoted for the masses include the calibration of the masses plus an estimate for their reproducibility (based on the experience of TÜBITAK UME). If the reproducibility is found to be significantly different following the completion of the comparison then the uncertainties will be revised.

Please ensure that the weights are handled using gloves in order to avoid contamination.

The correction value of the temperature probe is 0,001 ± 0,02 °C.

NOTE: A hard copy of the manufacturer's instruction manual will be sent with the equipment.

Transportation, cost and insurance

The equipment is sent in one main box consisting of three boxes, 1 box for the base and 2 boxes for the masses. The size of the main box is 110x100x87 cm and the weight is 150 kg.

Figure 1 Picture of the box for the base and boxes for the masses.

Each participating institute is responsible for its own costs for the measurements, transportation and any customs charges as well as any damage that may occur within its country.

A warning note should be attached to the package indicating that the package should be opened only by laboratory personnel.

The participating institutes are responsible for the transport to the next institute according to the circulation scheme. The method of transport as defined in the instructions shall be respected.

- Before dispatching the package, each participant must inform the next participant and the pilot institute, giving transportation details.
- If an ATA carnet is used, it must be used properly. Upon each movement of the package the person organizing the transit must ensure that the carnet is presented to customs on

leaving the country, and upon its arrival in the country of destination. When the package is sent unaccompanied the carnet must be included with the other forwarding documents so that the handling agent can obtain customs clearance. **In no case should the carnet be packed with the device in the package.**

- After arrival of the package, the participating institute shall inform the pilot institute of this by completing and returning a form which is included in the package. Immediately after receipt, the participating institute shall check for any damage of the standards, in particular scratches and rust, and report this to the pilot institute.

Schedule

The pilot laboratory contacts each participant at least 4 weeks before they are due to receive the transfer standard to request confirmation that the participant is still able to undertake the measurements according to the schedule. **If confirmation is not received participant will be dropped from the schedule and the equipment will be forwarded to the following participant.** Participants are requested to use the supplied progress report sheet (listed in Annex A in excel file EURAMET.M.P-K1.c.xlsm) to keep the pilot laboratory informed at each stage of the work (as listed on the form). In the event of any problems the pilot laboratory shall be informed immediately.

In the event of unforeseen delays, for example due to customs problems or problems with a participant's standard, the pilot laboratory will inform the remaining participants and attempt to revise the schedule. However, due to the restricted time available it may be necessary for the laboratory to forward the transfer standards to the next destination without making their measurements. The pilot laboratory will then endeavour to add that laboratory to the end of the schedule, but this cannot be guaranteed.

Period		Laboratory	Country
36, 37, 38, 39	**2011**	**UME**	**Turkey**
40, 41, 42, 43	2011	PTB	Germany
44, 45, 46, 47	2011	DANIAmet-FORCE	Denmark
48, 49, 50, 51	2011	BEV	Austria
1, 2, 3, 4	2012	METAS	Switzerland
5, 6, 7, 8	2012	SMD	Belgium
9, 10, 11, 12	2012	MSA	Malta
13, 14, 15, 16	2012	CEM	Spain
17, 18, 19, 20	**2012**	**UME**	**Turkey**
21, 22, 23, 24	2012	FSB-LPM	Croatia
25, 26, 27, 28	2012	MIRS/IMT/LMT	Slovenia
29, 30, 31, 32	2012	SMU	Slovakia
33, 34, 35, 36	2012	IMBiH	Bosnia-Herzegovina
37, 38, 39, 40	2012	INM	Romania
41, 42, 43, 44	2012	MKEH	Hungary
45, 46, 47, 48	2012	EIM	Greece
49, 50, 51, 52	**2012**	**UME**	**Turkey**
1, 2, 3, 4	2013	INRIM	Italy
5, 6, 7, 8, 9	2013	SP	Sweden
10, 11, 12, 13	2013	NPL	United Kingdom
14, 15, 16, 17	2013	NML	Ireland
18, 19, 20, 21	2013	CME	Tunisia
22, 23, 24, 25	2013	NIS	Egypt
26, 27, 28, 29	**2013**	**UME**	**Turkey**

Pre-calibration

Receipt and inspection of equipment

The transfer standard shall only be unpacked by qualified personnel. On receipt of the equipment participants shall complete the relevant section of the progress report sheet and send the email to the pilot laboratory. Immediately on receipt the equipment shall be inspected and the pilot laboratory notified of any damage or missing items straight away.

Cleaning

Prior to calibration, it is important that the piston and cylinder are cleaned thoroughly. This should be done in accordance with the manufacturer's instructions.
Ensure that the cleaning solvent or soap does not leave a residue.
Following cleaning, the piston-cylinder should be left for at least one hour prior to use in order to reach thermal equilibrium.
In the report to the pilot laboratory participants shall briefly describe the processes used to clean the pistons and cylinders.

Checks for magnetism

The surface magnetism of the piston-cylinder shall be checked according to the institute's normal procedure.
The magnetic flow density at the piston-cylinder surfaces should not exceed 2E-4 Tesla. If the levels of magnetism are considered to be high then the components should be demagnetized. The values of the magnetization before and after demagnetization shall be included in the participating laboratory's report to the pilot laboratory, along with details of where on the components the magnetism was detected.

Calibration

Calibration gas

Calibrations shall be carried out using dry, filtered nitrogen.

Calibration pressures and rotational speed

The nominal calibration pressures, together with the required weights, are shown in the following table:

Number	Nominal pressure MPa	Weights combination number	Rotational speed rpm
1	6,77	1,2,3,4,5,6,7,8,10	30 – 40
2	6,45	1,2,3,4,5,6,7,10,11,12	30 – 40
3	5,28	1,2,3,4,5,9,11,12	30 – 40
4	4,12	1,2,3,6,9	40 – 50
5	2,94	1,2,6	40 – 50
6	1,77	1,8,9,10	40 – 50
7	1,08	1	40 – 50
8	0,73	7,9,12	40 – 50

The nominal pressure points are calculated from the nominal effective area. Use the weights combination to generate the pressure.

Calibration procedure

The calibrations shall be performed in both 5 ascending series and 5 descending series, totally 80 single measurements. Participants may start the calibration at either the highest pressure or the lowest pressure depending on their normal procedure.
To simplify the data handling, participants are requested that, wherever reasonably possible, the masses on the laboratory's standard should be adjusted to obtain cross-float equilibrium (rather than the masses on the transfer standard).

Data recording

In order to ensure that the required information is presented to the pilot laboratory in a consistent form, it is requested that copies of the calibration results sheet (Annex B in excel file EURAMET.M.P-K1.c.xlsm) are used to record the data.

For each calibration cycle the following information shall be recorded:

- Identification of the laboratory's standard - if more than one laboratory standard is used during a calibration then the pressures which were generated by each standard shall be identified
- Height difference between the laboratory's standard and the transfer standard, together with its associated standard uncertainty
- Gravity ± standard uncertainty

For each measurement the following information shall be recorded:

- Measurement number (No).
- Pressure, as measured by the laboratory's standard, corrected to the datum level of the transfer standard (P').
- Uncertainty of the pressure measured by the laboratory u(P').
- Total conventional mass on the transfer standard including the mass of the floating elements (Σm).
- Atm. Pressure ± uncertainty.
- Humidity ± uncertainty.
- Temperature of the laboratory's standard (T)
- Temperature of the transfer standard (T')
- Effective area of the transfer standard piston-cylinder at the reference pressure and corrected to 20 °C (A_p')
- Date and time of measurement

Report

The participating institutes must report the results to the pilot laboratory as soon as possible and at the latest six weeks after the measurements are completed, however, UME and PTB shall wait until FORCE Technology have sent their results to PTB. The measurement results together with the uncertainties and any additional information required should be reported in the format given in the Annex B, Annex C and Annex D.

Presentation of results

NOTE: All uncertainties should be reported for a coverage factor, k-=1

- Details of the laboratory's standards against which the transfer standards were calibrated, including:
  - Nature of the standard's traceability to the SI (for example from dimensional metrology, mercury column, calibration at another NMI)
  - Name of NMI providing traceability to SI
  - Relative standard uncertainty of the standard.
- A short description of the methods of calibration including the method used to determine the effective area of the transfer standard.
- The complete equations used to calculate the pressure generated by the reference standards and the effective area of the transfer standards.
- Details of the method for calculating the measurement uncertainty in the reference pressures and the effective areas of the transfer standards.
- A description of the processes used to clean the pistons and cylinders.
- A record of the magnetism checks and any demagnetisation of the transfer standards. If any component was demagnetised, then the location and the values before and after demagnetisation shall be reported.
- The method used to determine the height difference between the laboratory's standard and the transfer standard, indicating whether the transfer standard was above or below the laboratory's standard.
- Method used to determine the operating position of the piston, for example a cathetometer or estimation by eye.
- For each measurement the information recorded on the calibration results sheets (Annex B in excel file EURAMET.M.P-K1.c.xlsm) shall be included.
- A summary of the calibration of each transfer standard shall be provided using the form in Annex C in excel file EURAMET.M.P-K1.c.xlsm.
  - The effective area parameters of the calibrated piston cylinder assemblies must be provided.
    - The calculated effective area at null pressure A_0 ± the standard uncertainty.
    - The calculated pressure distortion coefficient λ ± the standard uncertainty.
    - If it exists, the covariance between both parameters A_0 and λ.
  - For each nominal pressure following information shall be included:
    - Average reference pressure.
    - The standard uncertainty of the reference pressure.
    - The effective areas A_p of the transfer standard at the reference pressure and corrected to 20 °C.
    - The uncertainty of the effective area.
    - The estimate $\hat{A}_p = A_0 \cdot (1+\lambda \cdot P)$ of A_p.
  - The standard uncertainties of the estimate: $u(\hat{A}_p)$.

Participants

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