Final Report

Supplementary Comparison COOMET.M.P-S5 of Hydraulic Gauge Pressure Standards from 5 MPa to 34 MPa

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April 2018

Abstract:

This report describes the results of bilateral interlaboratory comparison(BILC) denoted as COOMET.M.P-S5 (also known as supplementary comparison COOMET 723/AZ/17). The comparison measurements between the two participants, Czech Metrology Institute(CMI) (pilot laboratory) and Azerbaijan İnstitute of Metrology(AzMI),started in April 2017 and finished in June 2017.The transfer standards was a digital manometer, Crystal XP 2i with the gauge pressure range(0 ÷ 34000) kPa.

The organization and evaluation of the ILC program have been made in accordance with the EN ISO/IEC 17043:2010 Conformity assessment - General requirements for proficiency testing.The comparison measurements were carried out to demonstrate the metrological and technical competence , as well as equivalence of the pressure standard of the Pressure calibration laboratory of AzMİ with that of CMI. It was realized in context of a COOMET project. Agreement between the two participants is satisfactory: more than 90% of the values agreed within two standard uncertainties.

Participants

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Participating laboratory
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Mrs. Fidan Hasanova (Head metrologist)

Time schedule of comparisonmeasurements

The transfer standard - digital manometer was measured at CMI in April 2017. The digital manometerwas sent to AzMI inApril 2017. Calibration by AzMI was performed in May 2017. The second measurement at CMI was performed in June 2017.

BILC transfer-standard

Test item:	Digital manometer
Manufacturer:	Crystal
Type:	XP 2i
Serial number:	755636
Range:	(0 ÷34000) kPa
Test item owner:	CMI, Regional Inspectorate Brno

Fig. 1 : The transfer standard

Documents with the BILC participant measurement results

Calibration CertificateNo: AZ № 000038

Date of issue: 14.06.2017

Measurement procedure: Internal calibration procedure № 03-AzMI 05L-010

Documents with the reference laboratory measurement results

Calibration CertificateNo: 6013-KL-C0270-17 and 6013-KL-C0435-17

Date of issue: 20.04.2017 and 08.06.2017

Measurement procedure: internal calibration procedure№601-MP-C046

Laboratory standard of AzMI pressure laboratory

Type:	Piston Gauge PG 7302
Manufacturer:	DH Instruments
Serial №:	513
Indent. №:	05-L-TILIE-01
Measuring range:	(0.1 ÷ 70) MPa
Measuring uncertainty:	0.005kPa + 0.0033% of measured value (k = 2)
Calibration:	piston cylinder - PTB 33031\13; mass set- BY 01 586-47

The laboratory standard is traceable to PTB in terms of its effective area and to AzMI in terms of the loaded masses.

Reference standard of CMI pressure laboratory

Type:	Piston Gauge PG 7302
Manufacturer:	DH Instruments
Serial №:	0118/2077
Measuring range:	(0.5 ÷ 50) MPa
Measuring uncertainty:	0.0018% of measured value (k = 2)
Calibration:	piston cylinder –6013-KL-P0006-16; mass set –6013-KL-H0001-17

The reference standard was described during its former comparisons, see [1,2]. It is traceable to CMI primary standard of pressure in gas medium in terms of its effective area and to CMI in terms of the loaded masses.

Measurement results and uncertainties

In each laboratory, measurements were performed at usual laboratory conditions. The measurement results had to bestated in the calibration certificates mentioned above. Both laboratories measured three series, both in loading and unloading. The calibration certificateshad to be issued according to principles of EN ISO IEC 17025, containing traceability of the laboratory standard to a standard of a higher metrology quality. The calibration certificates had to be sent to ILC Department within 14 days after the date of the measurement completion at the latest.

The results can be seen fromTable 1 to Table 3. The measurement result had to be delivered with associated measurement uncertainties U_{lab} and U_{ref} stated according to EA-4/02 document preferably.

Table1. Results of the participating laboratory

16 May2017		loading			unloading	
p_{con}	p_{lab}	x_{lab}	U_{lab}	p_{lab}	x_{lab}	U_{lab}
kPa	kPa	kPa	kPa	kPa	kPa	kPa
0	0	0	1	-1	-1	1
5000	4999	-1	1	4998	-2	1
10000	9995	-5	1	9995	-5	1
15000	14992	-8	1	14991	-9	3
20000	19990	-10	1	19990	-10	1
25000	24989	-11	2	24988	-12	2
30000	29987	-13	2	29986	-14	1
34000	33985	-15	2	33985	-15	2

Table2: 1st results of the reference laboratory

20 Apr 2017		loading			unloading	
p_{con}	p_{ref1}	x_{ref1}	U_{ref1}	p_{ref1}	x_{ref1}	U_{ref1}
kPa	kPa	kPa	kPa	kPa	kPa	kPa
0	0.0	0.0	0.6	-0.3	-0.3	1.5
5000	4997.7	-2.3	0.6	4997.0	-3.0	1.5
10000	9994.5	-5.5	1.6	9993.5	-6.5	1.6
15000	14991.3	-8.7	1.6	14990.7	-9.3	1.6
20000	19989.9	-10.1	1.6	19989.2	-10.8	0.7
25000	24988.8	-11.2	1.6	24988.5	-11.5	0.7
30000	29987.4	-12.6	1.6	29987.4	-12.6	1.7
34000	33985.3	-14.7	1.5	33985.3	-14.7	1.5

Tab.3: 2nd results of the referencelaboratory

8 Jun 2017		loading			unloading	
p_{con}	p_{ref2}	x_{ref2}	U_{ref2}	p_{ref2}	x_{ref2}	U_{ref2}
kPa	kPa	kPa	kPa	kPa	kPa	kPa
0	0.0	0.0	0.6	0.0	0.0	0.6
5000	4997.6	-2.4	0.6	4997.3	-2.7	1.6
10000	9994.1	-5.9	1.7	9994.1	-5.9	1.7
15000	14991.3	-8.7	1.7	14990.3	-9.7	1.4
20000	19989.1	-10.9	0.7	19988.8	-11.2	1.6
25000	24988.4	-11.6	0.8	24987.4	-12.6	0.8
30000	29987.0	-13.0	1.8	29986.4	-13.6	1.7
34000	33985.3	-14.7	1.5	33985.3	-14.7	1.5

Reference values and uncertainties

Before a determination of the reference values, the long-term stability of the transfer-standard was checked, seeTable 4. Firstly, the differences between the first and the second calibrations by the pilot were calculated:

$$d_{stab} = |x_{ref1} - x_{\Delta ref2}|.$$

Then the associated uncertainty was calculated :

$$U_{stab} = 2\frac{d_{stab}}{2\sqrt{3}}.$$

This uncertainty was compared withU_{ref} (taken as maximum of U_{ref1} and U_{ref2}), seeTable 4. It was significantly smaller and could be neglected.

Table.4: Long-term stability of the transfer-standard

stability		loading			unloading	
p_{con}	d_{stab}	U_{stab}	U_{ref}	d_{stab}	U_{stab}	U_{ref}
kPa	kPa	kPa	kPa	kPa	kPa	kPa
0	0.0	0.00	0.6	0.3	0.17	1.5
5000	0.1	0.06	0.6	0.3	0.17	1.6
10000	0.4	0.23	1.7	0.6	0.35	1.7
15000	0.0	0.00	1.7	0.4	0.23	1.6
20000	0.8	0.46	1.6	0.4	0.23	1.6
25000	0.4	0.23	1.6	1.1	0.64	0.8
30000	0.4	0.23	1.8	1.0	0.58	1.7
34000	0.0	0.00	1.5	0.0	0.00	1.5

As the reference values and their uncertainties, the results of the reference laboratory were used. The reference laboratory values x_{ref} were taken as average of x_{ref1} and x_{ref2}, the reference laboratory uncertaintiesU_{ref} are described above, seeTable 5. The type-B part of the reference uncertainties consists of the uncertainty of the reference standard and the uncertainty due to the resolution of the transfer standard (the same is valid also for the type-B part of the uncertainty U_{lab}).

Table5: The final reference values

average	loading		unloading	
p_{con}	x_{ref}	U_{ref}	x_{ref}	U_{ref}
kPa	kPa	kPa	kPa	kPa
0	0.0	0.6	-0.2	1.5
5000	-2.4	0.6	-2.9	1.6
10000	-5.7	1.7	-6.2	1.7
15000	-8.7	1.7	-9.5	1.6
20000	-10.5	1.6	-11.0	1.6
25000	-11.4	1.6	-12.1	0.8
30000	-12.8	1.8	-13.1	1.7
34000	-14.7	1.5	-14.7	1.5

Criteria of evaluation

The evaluation of the measurement results was performed according to EN ISO/IEC 17043:2010 Conformity assessment – General requirements for proficiency testing, using En number, which is given by the mathematic formula:

$$E_n = \frac{x_{lab} - x_{ref}}{\sqrt{U_{lab}^2 + U_{ref}^2}},$$

where:

x_{lab} means the value measuredby the participatinglaboratory,

x_{ref} means the referencevalue,

U_{lab} means the uncertainty of the value measured by the participating laboratory,

U_{ref} means the final reference uncertainty

If $|E_n| \leq 1$, the measurement result is considered as **satisfactory (A).**

If $|E_n| > 1$, the measurement result is considered as **unsatisfactory(N).**

Table 6 contains the evaluation of the measurement results based on E_n numbers. The capital letter**«A»** represents a satisfactory measurement result, the capital letter**«N»** represent an unsatisfactory measurement result. This Annex contains all the measured values and stated uncertainties including the final reference values and final reference uncertainties.

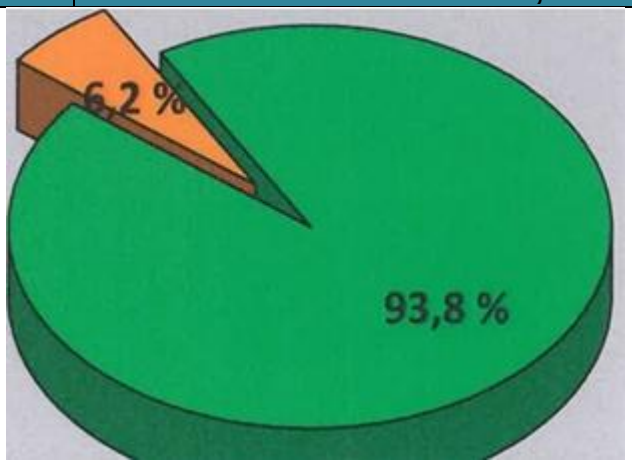
On the basis of the evaluation of BILCresults, the participant was successful, if the percentage of the satisfactory measurement results of the participating laboratory was equal or greater than 90%. This criterion was fulfilled, see also Fig. 2.

Tab.6:Evaluationofmeasurementresultsusing En score

Conventional value of pressure (kPa)	x_{lab} (kPa)	U_{lab} (kPa)	x_{ref} *) (kPa)	U_{ref} **) (kPa)	x_{lab}-x_{ref} (kPa)	E_n	Evaluation
0	0	1	0.0	0.6	0.0	0.00	A
5000	-1	1	-2.4	0.6	1.4	1.16	N
10000	-5	1	-5.7	1.7	0.7	0.35	A
15000	-8	1	-8.7	1.7	0.7	0.35	A
20000	-10	1	-10.5	1.6	0.5	0.26	A
25000	-11	2	-11.4	1.6	0.4	0.16	A
30000	-13	2	-12.8	1.8	-0.2	-0.07	A
34000	-15	2	-14.7	1.5	-0.3	-0.12	A
34000	-15	2	-14.7	1.5	-0.3	-0.12	A
30000	-14	1	-13.1	1.7	-0.9	-0.46	A
25000	-12	2	-12.1	0.8	0.1	0.02	A
20000	-10	1	-11.0	1.6	1.0	0.53	A
15000	-9	3	-9.5	1.6	0.5	0.15	A
10000	-5	1	-6.2	1.7	1.2	0.61	A
5000	-2	1	-2.9	1.6	0.9	0.45	A
0	-1	1	-0.2	1.5	-0.9	-0.47	A

***)**	Arithmeticaveragestatedfrom the twoseries of the measurementresults		
****)**	Maximum value of uncertaintystatedfrom the twoseries of the measurementresults		
x_{lab}, x_{ref}	Measurementerror	**U_{lab}, U_{ref}**	Measurementuncertainty

Assessment	
Number of values :	**16**
Number of A values :	**15**
Number of N values :	**1**
Final score :	**93,8**



Percentage of the satisfactorymeasurementresults

Percentage of the unsatisfactorymeasurementresults

Evaluation of the BILCand conclusion

The organization and evaluation of the ILC program have been made in accordance with the EN ISO/IEC 17043:2010 Conformity assessment - General requirements for proficiency testing.

The management system of the ILC Department has been accredited by the Czech Accreditation Institute in accordance with this international standard (as a Proficiency Testing Provider No.7002).

The AzMI HAS MET THE REQUIREMENTS stated for this bilateral interlaboratory comparison within the relevant range and so it is issued the CERTIFICATE on participation in the bilateral interlaboratory comparison№:0318-OV-A017-17.

Note:AzMIside expresses gratitude to the Czech colleagues for their cooperation.

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Baku April 2018

References

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