Euromet Project No. 419

Final Report

Contents

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Intercomparison of calibrations of a G250 rotary-meter

1. INTRODUCTION

A G250 Rotary Gas Meter shall be cirkulated to 14 laboratories in Europe for calibration.
The laboratories use their usual calibration procedure, and shall, after the calibration produce a report containing a description of their installation and the calibration data for their measuring equipment.
NMI has provided the meter, And FORCE-institute has prepared the proposal, and finished the final report.

2. PRESENTATION AF THE INTERCOMPARISON

2.1. The participating laboratories

Denmark:
FORCE Institute
Navervej 1
6600 Vejen

Italy:
Instituto di Metrologia "G. Colonnetti"
Consiglio Nazionale delle Ricerche
Strada delle Cacce 73
10135 Torino

Netherlands:
NMI
PO Box 394
3300 AJ Dordrecht

Hungary:
Országos Mérésügyi Hivatal
H-1535
Budapest Pf. 919

France:
Gaz De France
1. chemin de Villeneuve
94140 Alfortville

Czech Rep.:
Czech Metrological Institute
Prumyslova 455
530 03 Pardubice

France:
CESAME-LNE QUEST
43. route de l'aérodrome
86000 Poilitiers

Germany:
PTB
Postfach 3345
38023 Braunschweig

Belgien:
Ministére des Affaires Economiques
Service de la Métrologi
Chaussée de Haecht 1795
1130 Bruxelles

Slovakian:
Slovak Institute of Metrology
Karloveska 63
84255 Bratislava

Switzerland:
Eidg. Amt für Messwesen
Lindenweg 50
3084 Wabern

Poland:
Central Office of Measures
Division of Thermodynamics
ul. Elektroralna 2
00950 Warszawa

Austria:
BEV
Arltgasse 35
Postfach 20
1163 Wien

United Kingdom
NEL
East Kilbride
Glasgow G75 OQU

2.2. The Calibration object

Description of the meter G250 (Rotarymeter)

Manufactor:	Instromet
Pipe size:	4”
Max Pressure:	10 bar
Capacity:	2-400 m^3/h
Pulse generators:	1689,5 imp = 1 m^3 (2 · namur marked 1 and 2)
Pressure tapping:	Pr (inlet). - P (outlet)
Temperature measurement:	2 * d downstream the meter
Number:	001

2.3. Definitions

The way to calculate the error of the meter are:

$$E_m = \frac{\text{Indicated Volume - Real Volume}}{\text{Real volume}} \cdot 100\%$$

Indicated Volume are:

$$V_{im} = \frac{\text{Number of HF - Pulses}}{\text{Pulsevalue for the meter}^*} \ (m^3)$$

* Pulsevalue 1689,5 pulse/1 m^3

Real Volume:

Volume Calculated from the standards which are used in the laboratory.

2.4. The transfer of the standard

In the end of march 1998 FORCE Institutes did the first calibration of the meter.

All the laboratories was responsible for the transfer of the meter to the nest laboratory.

The meter was calibrated as listed below:

Laboratory	Day of calibration	Received	Send
NMI, Netherlands	97.07.03		
FORCE Institute, Denmark	98.03.23/27		98.05.12
Gaz de France, France	98.06.02/03	98.05.13	
CESAME-LNE OUEST, France	98.07.06	98.06.18	98.07.07
Ministére des Affaires Economiques, Belgien	98.	98.07.10	98.08.04
Eidg. Amt für Messwesen, Switzerland	98.08.20/21	98.08.10	98.08.26
BEV, Austria	98.09.01	98.08.28	98.09.17
Instiuto de Metrologia “G, Colonnetti”, Italy	98.11.06	98.09.29	98.11.09
PTB, Germany	99.01.05	98.12.02	99.02.05
NEL, United Kingdom	99.03.09/31	99.02.18	99.04.12
Slovak Institute of Metrology, Slovakian		99.07.27	99.10.04
Czech Metrological Institute, Czech Rep.		99.10.27	99.12.06
Országos Mérésügyi Hivatal, Hungary	00.01.21	99.12.10	00.01.31
Central Office of Measures, Poland	00.03.06/07	00.02.05	

3. CALIBRATION PROCEDURE

The meter has to be calibrated in 11 points carried out 3 times.
The conditions is under atmospheric pressure and 20°C.
The flowrates is 2-5-10-20-40-80-120-160-240-320 and 400 m^3/h.

The flowrate must be regulated within ± 2%, and the calibration shall be carried out starting with 400 m^3/h then go down to 2 m^3/h, go up to 400 m^3/h again and then chose the flowrate by random.

Before the calibration starts, the meter shall be exercised minimum 1 hours at 240 m^3/h.
The meter shall be calibrated without oil.

After the exercising a pressure drop test shall be made at 240 m^3/h, the value shall be in the range 415-425 Pa.

Results of the pressure test shall be send to the projectmanager before the meter leave the laboratory.

The temperature must not vary more than 0.2°C under any calibration point, and the calibration temperature must be within 20°C ± 2°C.

The pressure measuring must be at the Pr point.

For pulsregistration we use pulse generator namur: 1 m^3 = 1689,5 pulses.
(Use the enclosed VSL-LD 3 and/or 4).

Under the calibration, following data shall be registered.

Barometric pressure in **Pa** or **mbar.**
Pressure (abs) at the Pr point in PA **or mbar.**
Pressure loss over the meter from Pr. to P in **Pa.**
Flow at the meter (indicated) in **m^3/h.**
Temperature at the meter (2* d downstream) in **°C.**
Error at the meter: (indicated volume - real volume)/real volume * 100%.

Uncertainty in accordance with Wecc 19.
Used calibration equipment with data.
Traceability for all measuring equipment.

Adresses and timeschedule for the participating laboratories: Enclosure 1.

4. EQUIPMENT

4.1. Description of the installation

4.1.1. FORCE Institutes, Denmark.

The meter was calibrated against working standards:

The standard meters run in parallel (on meter at the time) and the meter to which have to bee calibrated, run in series with the standard meters. After each standard meter, and the meter under test a thermistor measure the temperature.

A Difference pressure transmitter measure the pressure-difference between the meter under test and the relevant standard meter.

Under the calibration, high frequency pulses from the meter, and the relevant standard meter are registered by a microcomputer which also registered temperature and pulses.

Everything runs automatically.

The whole calibration system have been calibrated against our National Standards meter.

4.1.2. NMI, Netherlands

4.1.3. Gaz de France, France

Gas de Franc have calibrated the meter at Natural gas type H. The main components have an average concentration (% molaire)

N_2	CH_4	CO_2	C_2H_6	C_3H_8
1,849	87,584	1,454	6,428	1,900

Density = 0,640 ρ_n = 0,8276 kg/m^3 (n)

- a low pressure = 40 mbar
- the pipe (Ø 50 mm) length upstream CVM meter is = 1,60 m (32 DN)
- the laboratory is air conditioned and the temperature are regulated within 20ºC ±2ºC. The temperature of the gas are 20,1ºC, with a standard deviation of ±0,1ºC.

The equipment used for calibration are a system and sonic nozzles in parallel.

4.1.4. CESAME-LNE QUEST, France

A set of Venturi nozzle operating in sonic conditions is used for the determination of the standard mass-flowrate.
Compressed dry air stored in a 110 m^3 vessel under 200 bar is used as the test fluid.
The meter under test is placed on a pipeline downstream the nozzles.
The pressure and the temperature are measured at the level of the meter in test in order to determine the volumetric flowrate.

4.1.5. Ministére des Affaires Economiques, Belgium

On the graduated scale of the bell are fixed reflecting flags separated each other by a length corresponding to a volume of the bell of 1 m^3. When the bell moves downwards, these flags passed in front of a photoelectric cell and electric pulses are generated. The obtained pulses are used to start and stop the meter pulse counters. It is possible to program the volume of air used up the meter and the volume used for the test of the meter. The measurements of the temperature and the pressure of the bell are used to calculate the mass of air flowing out of the bell prover. The real volume of air flowing through the meter is calculated from the mass of air and the measurements of temperature and pressure of the meter. The pulses from the meter and their frequency give the indicated volume and the indicated meter flowrate.

Just after the connection of the meter and its pipes to the test rig, a leak test is realized.

4.1.6. Eidg. Amt für Messwesen, Switzerland

A 10m^3 bell prover blows the air through the meter under test. The bell prover is calibrated with 1000 litre oil filled volume standard. The immersion of the bell prover is measured with an electro-optic ruler (Heidenhain). The gage pressure of the air in the prover is 20 mbar. The temperatures of the air leaving the bell prover and of the air at the meter under test, the gage pressure of the bell prover, the pressure drop from the bell prover to the meter under test and the barometric pressure are registered every second. The pulses of the meter under test are counted with two counters. The totalizing of these pulses of the meter meter depends on a signal given from the electro-optic ruler of the bell prover (start-stop). A HP 310-computer calculates the volume at the meter under test by taking into account the mean values of the temperature and pressure differences, the influences of the drift of the barometric pressure, and the leak rate. Finally, the computer calculates the error of the meter under test and writes all the relevant data on a printer.

4.1.7. Bundesamt für Eich und Vermessungswesen, Austria

Equipment used for the calibration:

Flowrange 0,1 m^3/h to 1000 m^3/h under atmospheric conditions.
N1 = Turbine meter G650
N2 = Turbine meter G250

N3 = Rotary seal meter G65
N4 = Rotary meter G16
N5 = Drum meter NB3

4.1.8. Instiuto de Metrologia "G, Colonnetti", Italy

The standard /1/ used by the IMGC is a prover, whose volumetric device is a 1000 mm diameter and 1630 mm long piston. This is forced by a brushless motor and a lead screw to sink downwards at a pre-set and controlled velocity into a measurement chamber, whence it displaces known volumes of gas in known time intervals. Actual operation is as follows.

First of all piston is raised up to the top end of its stroke, while filtered air is admitted into the measurement chamber. The pressure is atmospheric; a period of a few minutes is allowed for the temperature to stabilize. Then the admission valve is closed and a large output valve (100 mm nominal diameter) connected to the bottom of the cylindrical measurement chamber is opened. The gas meter under test is located downstream this output valve, being inserted in a 100 mm bore horizontal pipe; the straight lengths are 15 D upstream and 10 D downstream the meter. The pipe is externally coated with 3 cm thick neoprene.

Then, the digital electronic accelerates rapidly the motor up to the pre-set constant velocity, while pressure in the chamber builds up and air bigins to flow through the gas meter. As soon as gas pressure, flowrate and gas revolution speed are stabilized to their steady-state values, measurenments are started by gating a pre-setnumber of pulses (ranging between 400 and 900) from the gasmeter. In the same time interval, measured by a clock (and herafter called useful measurement period), the pulses emitted by a rotating encoder fitted to the female screw of the piston drive are counted. Signals from four manometers and 14 temperatur transducers of the PRT type acquired are acquired as well at various times.

/1/ Cignolo, G., Rivetti, A., Martini, G., Alasia, F., Birello, G., La Piana, G. "The national standard gas provers of the IMGC-CNR", Flomeko 2000, Salvador (Brazil), June 2000

4.1.9. Országos Mérésügyi Hivatal, Hungary

OMH have calibrated the meter at OMH's Verification Laboratory situated at Budapest Gas Company.
The test rig was set up with rotarymeter upstream of the reference meters. Temperatur was measured upstream and 5D downstream of the meters. Pressure was measured at the p_r.
The kind of reference standards:
1. Turbine gas meter (60 - 500 m3/h)
2. Rotary gas meter (2,4 - 50 m3/h)

4.1.10. Czech Metrological Institute, Czech Rep.

The testing bench with sonic nozzles consists of 14 nozzles which are situated in 3 blocks. The vacuum is generated by two centrifugal fans and by one vacuum pump. The clamping system of gas meter is pneumatic. There are one barometric pressure meter and six gauge pressure sensors. Three of gauge pressure sensors measure the underpressure in blocks of nozzles, one of them measures the tightness of lines which are out of operation, one measures the underpressure in gas meter (p_r) and the last one measures the pressure loss of gas meter. Five temperature sensors measure the temperature in blocks of nozzles, in the gas meter and in the input of air to testing bench. Besides the humidity in the input of air to the testing bench and the time of test are measured, too.

4.1.11. PTB, Germany

The gas meter test rig with critical nozzles.
The critical nozzles for flowrate up to 100 m^3/h are calibrated by direct installation into the primary standard bell prover of PTB without any additional steps, the larger nozzles by a precise step-by-step procedure using the small nozzles and very stable CVM gas meters. The uncertainty of the secundary standard test rig is 0,08% (expanded uncertainty with k=2 in accordance with WECC 19)

4.1.12. Slovak Institute of Metrology, Slovakian.

Volume flowrate: 0,02 to 20 m3/h
Manufacture: Justur, Stara Tura, Slovak republic
Test fluid: air under atmospheric conditions, is sucked from laboratory to test rig by vacuum pumps
Standards: 10 critical Venturi nozzles in parallel with individual flowrates between 0,02 to 7 m3/h
Operation: The equipment is portable box with pressure and teperature transmiters and vacuum pumps
Control and data acquistion: in-line by PC
Traceability for critical nozzles: to PTB´s primary standards, Braunschweigh, Germany in March 1999.

Description of the equipment: Rotary meter G 100
The rotary gas meter, with rotary chambers (CVM system), size G 100
Volume flowrate: 16 to 160 m3/h
Manufacture: Elster AG Production, Mainz-Kastel, Germany
Pipe conection: DN 80
Manuf. Number: 19.970.709
Year of manuf.: 1998
Test fluid: air under atmospheric conditions
Traceability for meter: to PTB´s primary standards, Braunschweigh, Germany in May 1998.

Description of the equipment: Turbine meter G 650
The axial turbine gas meter, size G 650
Volume flowrate: 100 to 1 000 m3/h
Manufacture: Elster AG Production, Mainz-Kastel, Germany
Pipe conection: DN 150
Manuf. Number: 83.026.952
Year of manuf.: 1998
Test fluid: air under atmospheric conditions
Traceability for meter: to PTB´s primary standards, Braunschweigh, Germany in May 1998.

Place of calibration:
The rotary meter Instromet have been calibrated at metrological laboratory of Premagas, Stara Tura, Slovak republic, by SMÚ´s standards (Sonic nozzles) and turbine and rotary standards of Premagas. From August 1999 the SMÚ´s test rig for higher flowrates is not function, because in gas laboratory

of our institue was built chamber with new primary standards.

4.1.13. Central Office of Measures, Poland

The bell prover used for calibration is characterised by the following parameters:

- Maximum measured volume - 65 m^3
- Minimum measured volume - 5 m^3
- Pressure at the bell - 4 kPa
- The length of the scale - 5 m
- Method of selecting volume - electromechanical contacts
- Seal of the bell - by water
- Flow range - 9 to 7000 m^3/h
- The stability of the gas pressure inside the bell - by cone-shaped compensation pipe
- Operating mode - manual

4.1.14. NEL, United Kingdom

The test rig was set up with the positive displacement (PD) meter placed downstream of the reference sonic nozzles, Temperature and pressure were measured upstream of the reference meter. At the PD meter pressure was measured at the p, while temperature was measured 5D downstream of the meter. The differential pressure across the PD meter was measured between points Pr and P.

4.2. Uncertainty

The uncertainty of the different installation are put in the scheme as combined uncertainty.

Laboratory	Flow m^3/h	Combined %
FORCE Institutes Denmark	2 – 10 10 – 400	0,17 0,13
NMI Netherlands	2 - 400	0,10?
Gaz de France France	10 20 - 400	0,38 0,34
CESAME-LNE OUEST France	10-400	0,22
Ministére des Affaires Economiques, Belgian	2 – 400	0,19??
Eidg. Amt für Messwesen Switzerland	2 – 5 10 – 400	0,18 – 0,13 0,10 – 0,11
BEV Austria	2 – 400	0,30
IMGC Italy	5 10 – 40 80 120 160	0,06 0,025 0,075 0,1
Országos Mérésügyi Hivatal Hungary	2 – 400	0,31
Czech Metrological Institute Czech Rep.	2 - 400	0,26
PTB Germany	2 – 400	0,08
Slovak Institute of metrology Slovakian	2 – 160 240 - 400	0,21 0,22
Central Office of Measures Poland	9 - 400	0,22 – 0,26
NEL United Kingdom	2 – 400	0,37

5. STABILITY OF THE METER

The meter was calibrated three times at the FORCE-Institute

First time 98.03.26/27
Sekund time 99.06.01/03
Third time 00.04.10

The stability is within 0,05% in the range from 5 – 400 m^3/h.

Results: error in %

Flow (m^3/h)	First time	Sekund time	Third time	Average
2	**-0,41**	**-0,72**	**-0,76**	**-0,63**
5	**-0,06**	**-0,14**	**-0,06**	**-0,09**

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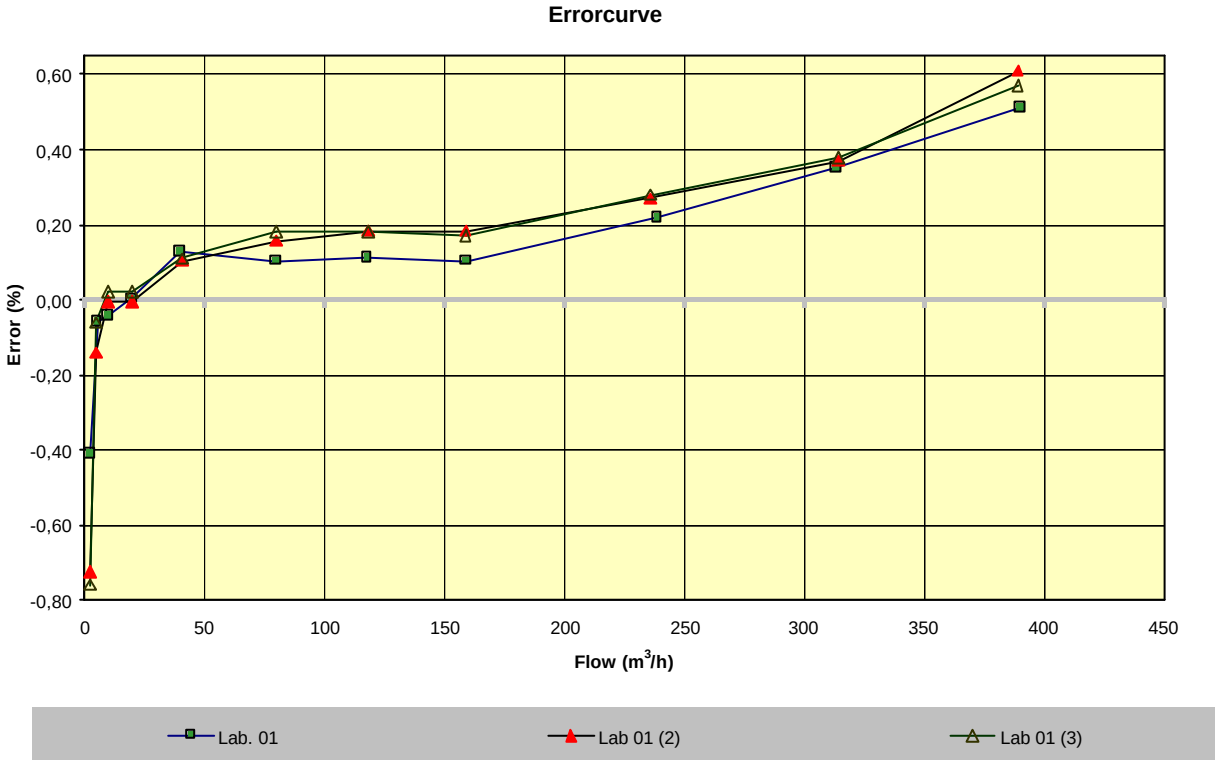
10	-0,04	-0,01	0,02	-0,01
20	0,00	-0,01	0,02	0,00
40	0,13	0,10	0,11	0,11
80	0,10	0,16	0,18	0,15
120	0,11	0,18	0,18	0,16
160	0,10	0,18	0,17	0,15
240	0,22	0,28	0,28	0,26
320	0,35	0,39	0,38	0,37
400	0,51	0,61	0,57	0,56



In this project only results from the first calibration is used in the comparison.

CALBRATION RESULT

6.1 Each laboratory

Calibration result for all the participating laboratories are listed on the following pages.

6.1.1 Lab. 1. FORCE Institute, Denmark

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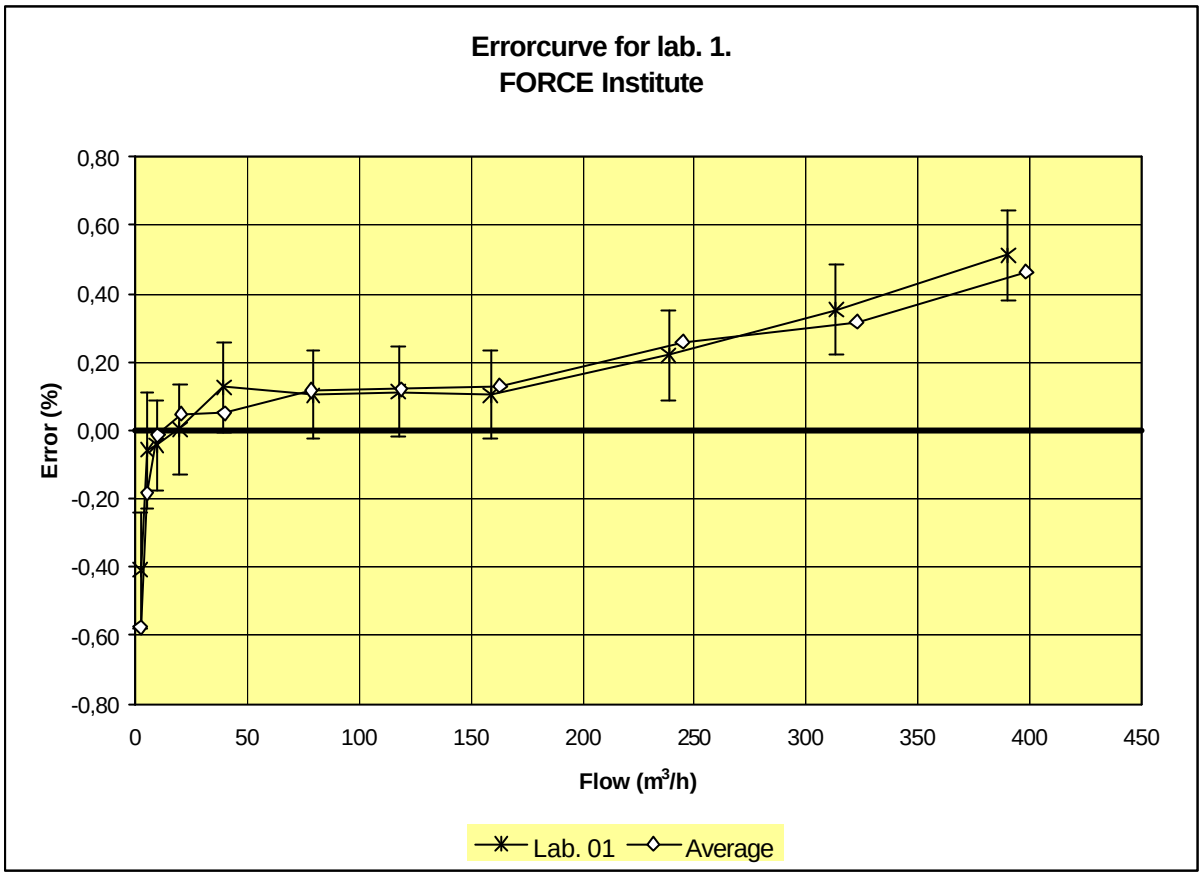
	Flow real	Pressure abs. at Pr	Pressure drop. Pr-P	Temperature	Error	Standard diviation
	m³/h	mbar	Pa	°C	%	%
max. - min.	2,5	1017,0	1,0	20,0	-0,50	
min. - max	2,2	1017,0	1,0	20,0	-0,39	
random	2,1	1016,1	1,0	20,0	-0,34	
Average	**2,3**	**1016,7**	**1,0**	**20,0**	**-0,41**	**0,08**
max. - min.	5,3	1017,0	1,0	20,0	-0,04	
min. - max	5,0	1017,0	1,0	20,0	0,02	
random	5,2	1016,1	3,0	20,0	-0,15	
Average	**5,2**	**1016,7**	**1,7**	**20,0**	**-0,06**	**0,09**
max. - min.	9,7	1017,0	2,0	20,0	-0,04	
min. - max	9,7	1017,0	2,0	20,0	-0,04	
random	9,2	1016,1	1,0	20,1	-0,05	
Average	**9,5**	**1016,7**	**1,7**	**20,0**	**-0,04**	**0,01**
max. - min.	19,9	1017,0	4,0	20,0	0,00	
min. - max	19,7	1017,0	4,0	20,0	0,00	
random	19,6	1016,1	4,0	20,0	0,01	
Average	**19,7**	**1016,7**	**4,0**	**20,0**	**0,00**	**0,01**
max. - min.	40,5	1017,0	12,0	20,0	0,13	
min. - max	40,0	1017,0	12,0	19,9	0,13	
random	38,3	1016,1	12,0	20,0	0,12	
Average	**39,6**	**1016,7**	**12,0**	**20,0**	**0,13**	**0,01**
max. - min.	80,5	1017,0	49,0	20,0	0,09	
min. - max	79,1	1017,0	49,0	19,9	0,11	
random	79,0	1016,1	48,0	20,0	0,11	
Average	**79,5**	**1016,7**	**48,7**	**20,0**	**0,10**	**0,01**
max. - min.	117,0	1017,0	101,0	20,0	0,11	
min. - max	118,0	1017,0	101,0	19,9	0,11	
random	118,0	1016,1	104,0	20,0	0,12	
Average	**117,7**	**1016,7**	**102,0**	**20,0**	**0,11**	**0,01**
max. - min.	160,0	1017,0	181,0	19,9	0,10	
min. - max	161,0	1017,0	181,0	19,9	0,11	
random	156,0	1016,1	179,0	20,0	0,10	
Average	**159,0**	**1016,7**	**180,3**	**19,9**	**0,10**	**0,01**
max. - min.	237,0	1017,0	414,0	19,9	0,22	
min. - max	237,0	1017,0	414,0	20,0	0,22	
random	242,0	1016,1	418,0	20,0	0,22	
Average	**238,7**	**1016,7**	**415,3**	**20,0**	**0,22**	**0,00**
max. - min.	311,0	1017,0	725,0	19,9	0,34	
min. - max	312,0	1017,0	725,0	19,9	0,35	
random	317,0	1016,1	725,0	20,0	0,37	
Average	**313,3**	**1016,7**	**725,0**	**19,9**	**0,35**	**0,02**
max. - min.	391,0	1017,0	1112,0	20,0	0,52	
min. - max	390,0	1017,0	1112,0	19,9	0,50	
random	390,0	1016,1	1135,0	20,0	0,52	
Average	**390,3**	**1016,7**	**1119,7**	**20,0**	**0,51**	**0,01**

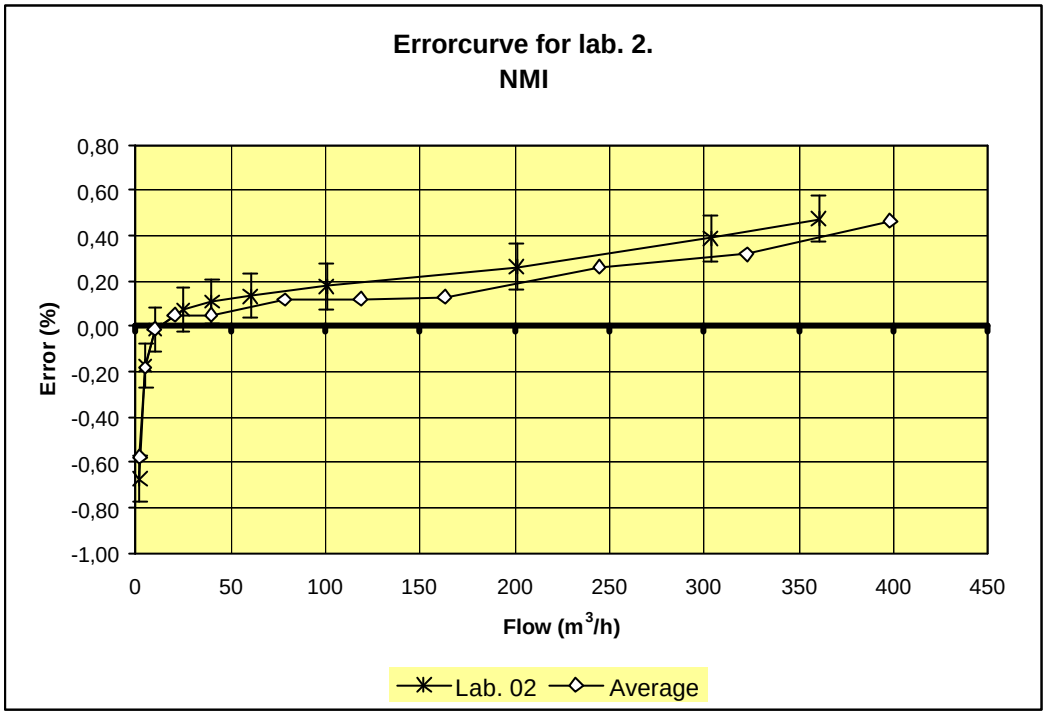
Calibration result for Qmax. to Qmin., Qmin. to Qmax. and random


Errorcurve for lab. 1.
FORCE Institute
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
-0,60
-0,80
Error (%)
0
50
100
150
200
250
300
350
400
450
Flow (m3/h)
Lab. 01
Average

6.1.2 Lab. 2. NMI

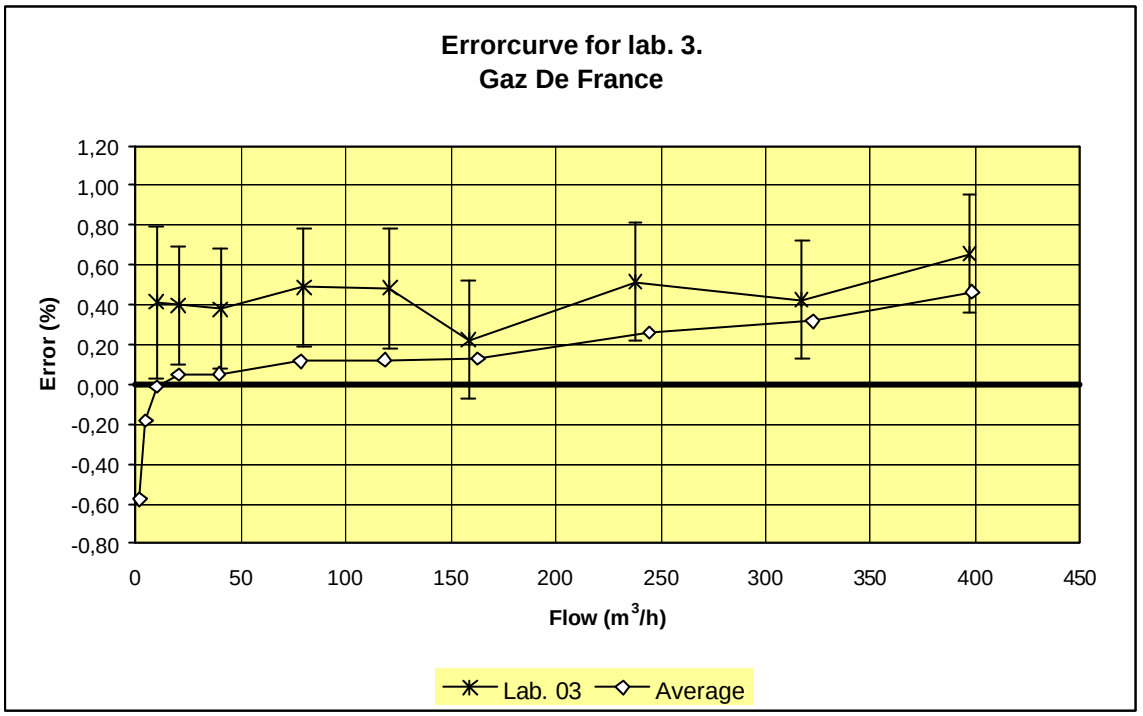
	Flow real	Pressure abs. at Pr	Pressure drop. Pr-P	Temperature	Error	Standard diviation
	m³/h	mbar	Pa	℃	%	%
124	2,01	1046,0	1,0	20,6	-0,73	
125	2,01	1046,0	1,0	20,6	-0,71	
14	2,00	-	-	-	-0,58	
Average	**2,01**	**1046,0**	**1,0**	**20,6**	**-0,67**	**0,08**
46	5,1	1012,4	2,0	-	-0,17	
47	5,1	1012,4	2,0	-	-0,18	
48	5,1	1012,4	2,0	-	-0,17	
Average	**5,1**	**1012,4**	**2,0**	**-**	**-0,17**	**0,01**
40	10,2	1012,4	3,0	-	-0,04	
41	10,2	1012,4	3,0	-	-0,04	
42	10,2	1012,4	2,0	-	0,04	
Average	**10,2**	**1012,4**	**2,7**	**-**	**-0,01**	**0,05**
36	25,1	1012,4	8,0	-	0,07	
37	25,0	1012,4	8,0	-	0,06	
38	25,0	1012,4	8,0	-	0,09	
Average	**25,0**	**1012,4**	**8,0**	**-**	**0,07**	**0,02**
32	40,3	1012,4	16,0	-	0,09	
33	40,3	1012,4	16,0	-	0,09	
34	40,3	1012,4	16,0	-	0,14	
Average	**40,3**	**1012,4**	**16,0**	**-**	**0,11**	**0,03**
26	60,5	1012,4	32,0	-	0,14	
27	60,5	1012,4	32,0	-	0,14	
28	60,5	1012,4	32,0	-	0,12	
Average	**60,5**	**1012,4**	**32,0**	**-**	**0,13**	**0,01**
23	100,8	1012,4	80,0	-	0,18	
24	100,7	1012,4	80,0	-	0,17	
25	100,7	1012,4	80,0	-	0,18	
Average	**100,7**	**1012,4**	**80,0**	**-**	**0,18**	**0,01**
20	201,2	1011,8	292,0	-	0,25	
21	201,0	1011,8	292,0	-	0,27	
22	201,4	1011,8	294,0	-	0,26	
Average	**201,2**	**1011,8**	**292,7**	**-**	**0,26**	**0,01**
17	304,6	1011,8	667,0	-	0,39	
18	303,7	1011,8	662,0	-	0,38	
19	302,4	1011,8	656,0	-	0,39	
Average	**303,6**	**1011,8**	**661,7**	**-**	**0,39**	**0,01**
15	360,5	1011,8	945,0	-	0,47	
16	360,9	1011,8	945,0	-	0,47	
74	360,3	1011,8	946,0	-	0,48	
Average	**360,6**	**1011,8**	**945,3**	**-**	**0,47**	**0,01**
	-	-	-	-	-	
	-	-	-	-	-	
	-	-	-	-	-	
Average	**-**	**-**	**-**	**-**	**-**	**-**

Calibration in points 25, 60, 100, 200, 300 and 360 m^3/h instead of 20, 80, 120, 160, 240 and 320 m^3/h.


Errorcurve for lab. 2.
NMI
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
-0,60
-0,80
-1,00
Error (%)
0
50
100
150
200
250
300
350
400
450
Flow (m3/h)
Lab. 02
Average

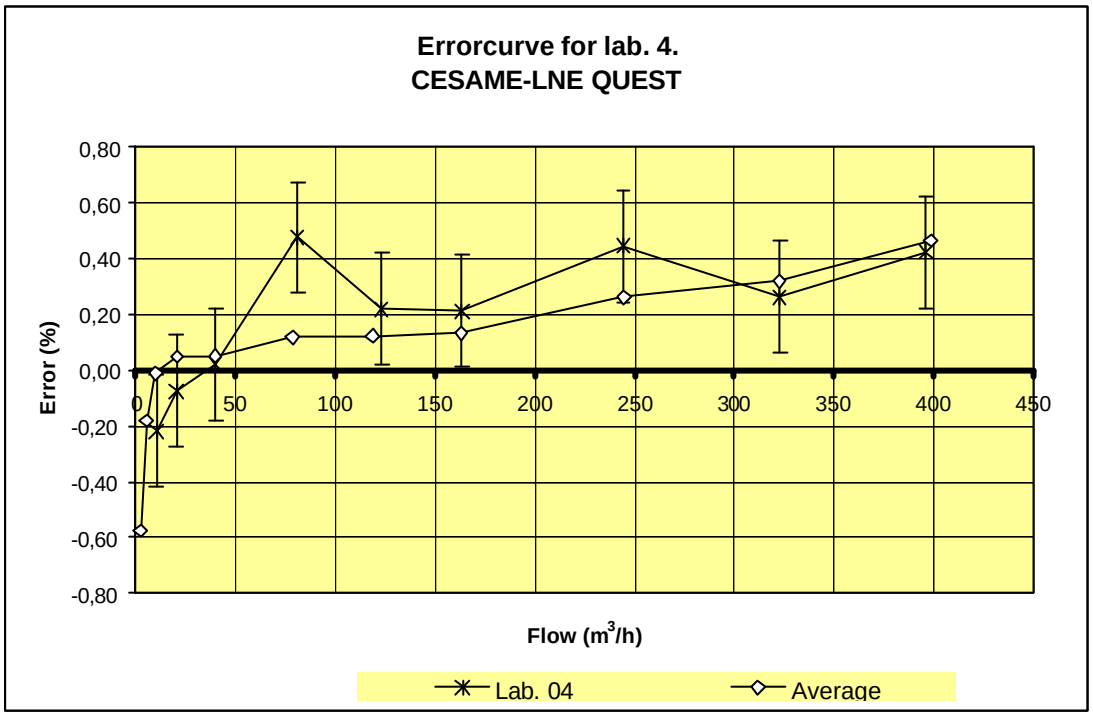
6.1.3 Lab. 3. Gaz de France, France

	Flow real	Pressure abs. at Pr	Pressure drop. Pr-P	Temperature	Error	Standard diviation
	m³/h	mbar	PA	℃	%	%
	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Average	**-**	**-**	**-**	**-**	**-**	**-**
	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Average	**-**	**-**	**-**	**-**	**-**	**-**
14	10,08	1005	400	20,2	0,43	
15	10,08	1005	400	20,2	0,40	
16	10,08	1005	400	20,3	0,41	
Average	**10,08**	**1005**	**400**	**2,0**	**0,41**	**0,02**
55	20,42	1012	100	19,2	0,36	
54	20,44	1012	100	19,1	0,41	
53	20,44	1012	100	19,1	0,42	
Average	**20,43**	**1012**	**100**	**19,1**	**0,40**	**0,03**
61	40,42	1012	100	20,4	0,37	
60	40,43	1012	100	20,4	0,37	
59	40,47	1012	100	20,4	0,40	
Average	**40,44**	**1012**	**100**	**20,4**	**0,38**	**0,02**
21	79,97	1005	100	20,2	0,49	
22	80,26	1005	100	20,2	0,48	
23	80,45	1005	100	20,2	0,49	
Average	**80,23**	**1005**	**100**	**20,2**	**0,49**	**0,01**
17	121,1	1005	600	20,3	0,51	
19	121,2	1005	600	20,2	0,45	
18	121,2	1005	600	20,2	0,49	
Average	**121,2**	**1005**	**600**	**20,2**	**0,48**	**0,03**
65	158,5	1011	200	20,5	0,24	
66	158,7	1011	200	20,4	0,22	
67	158,8	1011	200	20,3	0,21	
Average	**158,7**	**1011**	**200**	**20,4**	**0,22**	**0,02**
51	237,9	1012	400	18,1	0,51	
52	237,9	1012	400	18,1	0,57	
50	238,1	1012	400	18,0	0,47	
Average	**238,0**	**1012**	**400**	**18,1**	**0,52**	**0,05**
64	317,0	1012	600	18,8	0,44	
63	317,3	1012	600	18,9	0,45	
62	317,4	1012	600	19,1	0,39	
Average	**317,2**	**1012**	**600**	**18,9**	**0,43**	**0,03**
56	395,9	1012	900	18,4	0,68	
57	396,9	1012	900	18,1	0,62	
58	398,7	1012	900	18,1	0,67	
Average	**397,2**	**1012**	**900**	**18,2**	**0,66**	**0,03**


Errorcurve for lab. 3.
Gaz De France
Error (%)
1,20
1,00
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
-0,60
-0,80
0
50
100
150
200
250
300
350
400
450
Flow (m3/h)
Lab. 03
Average

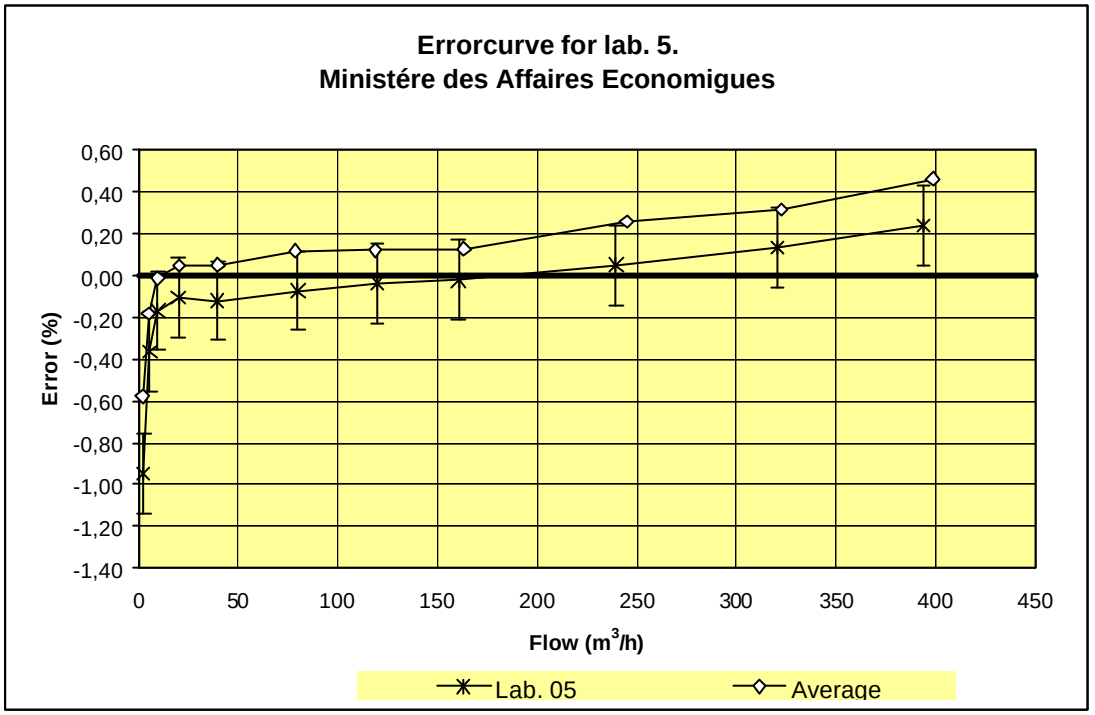
6.1.4 Lab. 4. CESAME-LNE QUEST, France

	Flow real	Pressure abs. at Pr	Pressure drop. Pr-P	Temperature	Error	Standard diviation
	m³/h	mbar	Pa	°C	%	%
-	-	-	-	-	-	
-	-	-	-	-	-	
-	-	-	-	-	-	
Average	**-**	**-**	**-**	**-**	**-**	**-**
-	-	-	-	-	-	
-	-	-	-	-	-	
-	-	-	-	-	-	
Average	**-**	**-**	**-**	**-**	**-**	**-**
max-min	10,079	993,80	0,0	20,7	-0,30	
random	10,057	995,90	-	20,6	-0,17	
random	10,057	996,00	-	20,6	-0,19	
Average	**10,064**	**995,23**	**0,0**	**20,6**	**-0,22**	**0,07**
max-min	20,200	993,70	0,0	20,6	-0,03	
random	20,179	993,90	-	20,6	-0,09	
random	20,179	994,00	-	20,7	-0,11	
Average	**20,186**	**993,87**	**0,0**	**20,6**	**-0,08**	**0,04**
max-min	39,867	993,80	10,0	20,5	0,07	
random	39,676	995,90	-	20,6	0,01	
random	39,676	996,00	-	20,6	-0,02	
Average	**39,740**	**995,23**	**10,0**	**20,6**	**0,02**	**0,05**
max-min	80,971	994,40	60,0	20,2	0,49	
random	80,971	994,80	-	20,3	0,46	
random	81,013	994,90	-	20,4	0,47	
Average	**80,985**	**994,70**	**60,0**	**20,3**	**0,47**	**0,02**
max-min	121,776	996,00	130,0	19,9	0,22	
random	123,693	995,20	-	20,4	0,23	
random	123,587	995,20	-	20,3	0,20	
Average	**123,019**	**995,47**	**130,0**	**20,2**	**0,22**	**0,02**
max-min	161,728	996,40	230,0	19,9	0,20	
random	164,072	996,10	-	20,8	0,23	
random	164,179	996,20	-	20,5	0,20	
Average	**163,326**	**996,23**	**230,0**	**20,4**	**0,21**	**0,02**
max-min	242,060	999,80	520,0	21,0	0,47	
random	245,469	999,20	-	20,3	0,46	
random	245,469	998,90	-	20,1	0,40	
Average	**244,333**	**999,30**	**520,0**	**20,5**	**0,44**	**0,04**
max-min	321,965	1003,40	930,0	19,5	0,21	
random	323,030	1003,00	-	20,4	0,25	
random	323,244	1003,00	-	19,9	0,32	
Average	**322,746**	**1003,13**	**930,0**	**19,9**	**0,26**	**0,06**
max-min	400,805	1009,60	1390,0	20,1	0,44	
random	393,560	1016,20	-	20,0	0,39	
random	394,199	1016,20	-	20,2	0,44	
Average	**396,188**	**1014,00**	**1390,0**	**20,1**	**0,42**	**0,03**


Errorcurve for lab. 4.
CESAME-LNE QUEST
Error (%)
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
-0,60
-0,80
0
50
100
150
200
250
300
350
400
450
Flow (m3/h)
Lab. 04
Average

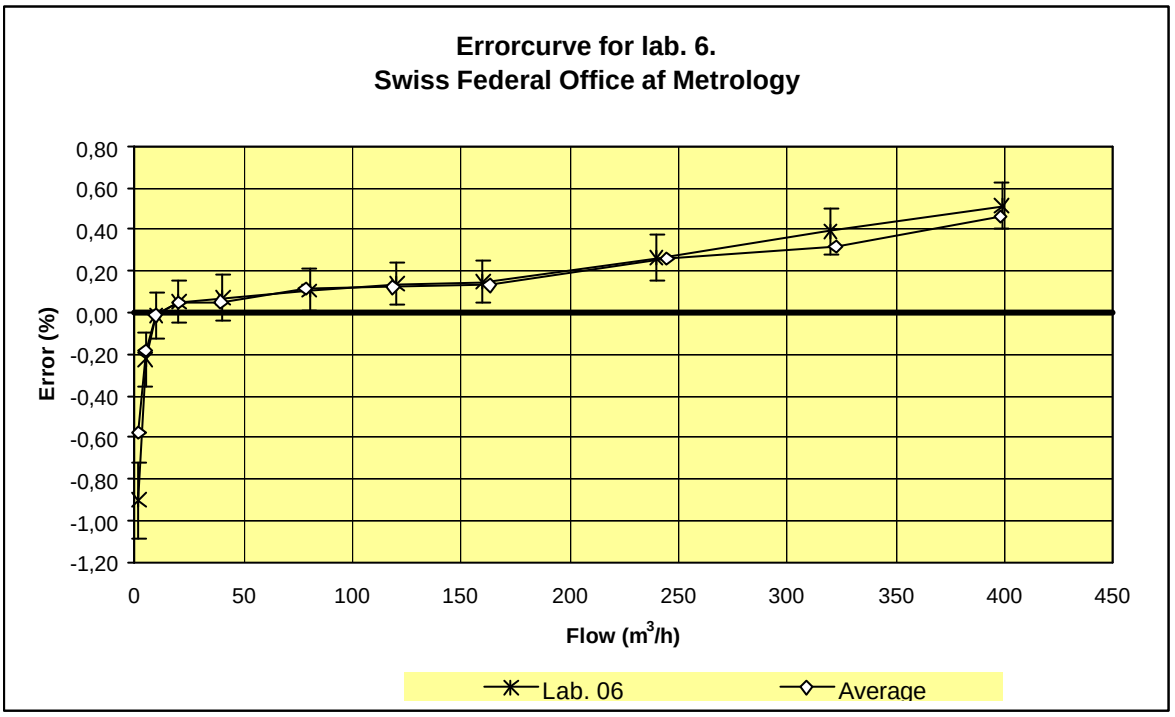
6.1.5 Lab. 5. Ministére des Affaires Economiques, Belgium

	Flow real	Pressure abs. at Pr	Pressure drop. Pr-P	Temperature	Error	Standard diviation
	m³/h	mbar	Pa	°C	%	%
max. - min.	2,700	1023,87	1,0	22,0	-0,91	
min. - max	-	-	-	-	-	
random	2,040	1024,83	1,0	21,6	-0,99	
Average	**2,370**	**1024,35**	**1,0**	**21,8**	**-0,95**	**0,06**
max. - min.	5,350	1023,80	1,4	22,0	-0,39	
min. - max	6,200	1013,95	1,6	21,6	-0,41	
random	4,980	1019,94	1,5	21,8	-0,30	
Average	**5,510**	**1019,23**	**1,5**	**21,8**	**-0,36**	**0,06**
max. - min.	8,940	1023,67	1,8	22,1	-0,23	
min. - max	10,600	1023,26	2,0	21,7	-0,16	
random	10,010	1020,16	2,0	22,6	-0,11	
Average	**9,850**	**1022,36**	**1,9**	**22,1**	**-0,17**	**0,06**
max. - min.	20,050	1024,02	4,0	21,7	-0,12	
min. - max	19,830	1031,20	4,0	21,5	-0,10	
random	20,110	1024,00	4,0	21,4	-0,09	
Average	**19,997**	**1026,41**	**4,0**	**21,5**	**-0,10**	**0,01**
max. - min.	39,280	1026,04	12,0	21,9	-0,14	
min. - max	39,770	1031,40	13,0	21,3	-0,08	
random	39,420	1023,50	12,5	21,0	-0,15	
Average	**39,490**	**1026,98**	**12,5**	**21,4**	**-0,12**	**0,04**
max. - min.	79,650	1025,73	44,5	21,9	-0,11	
min. - max	80,370	1033,16	46,0	21,2	-0,01	
random	79,970	1023,69	46,0	21,2	-0,09	
Average	**79,997**	**1027,53**	**45,5**	**21,5**	**-0,07**	**0,05**
max. - min.	119,760	1024,92	97,0	21,9	-0,08	
min. - max	120,460	1032,82	98,0	21,1	0,01	
random	118,970	1019,70	95,0	22,5	-0,04	
Average	**119,730**	**1025,81**	**96,7**	**21,8**	**-0,04**	**0,04**
max. - min.	159,580	1024,92	163,0	21,9	-0,09	
min. - max	160,670	1032,80	166,0	21,1	0,00	
random	161,070	1023,21	165,0	21,7	0,03	
Average	**160,440**	**1026,98**	**164,7**	**21,6**	**-0,02**	**0,06**
max. - min.	240,010	1024,07	360,0	21,7	0,05	
min. - max	241,240	1032,14	365,0	21,0	0,12	
random	237,470	1022,19	356,0	20,9	-0,02	
Average	**239,573**	**1026,13**	**360,3**	**21,2**	**0,05**	**0,07**
max. - min.	319,760	1025,11	655,0	22,1	0,08	
min. - max	321,080	1033,19	665,0	21,0	0,18	
random	320,540	1020,85	655,0	20,7	0,14	
Average	**320,460**	**1026,38**	**658,3**	**21,3**	**0,14**	**0,05**
max. - min.	394,140	1023,87	1002,0	22,3	0,19	
min. - max	393,890	1031,88	1015,0	20,8	0,27	
random	393,280	1034,50	1010,0	21,2	0,27	
Average	**393,770**	**1030,08**	**1009,0**	**21,4**	**0,24**	**0,05**


Errorcurve for lab. 5.
Ministére des Affaires Economigues
Error (%)
0,60
0,40
0,20
0,00
-0,20
-0,40
-0,60
-0,80
-1,00
-1,20
-1,40
0
50
100
150
200
250
300
350
400
450
Flow (m3/h)
Lab. 05
Average

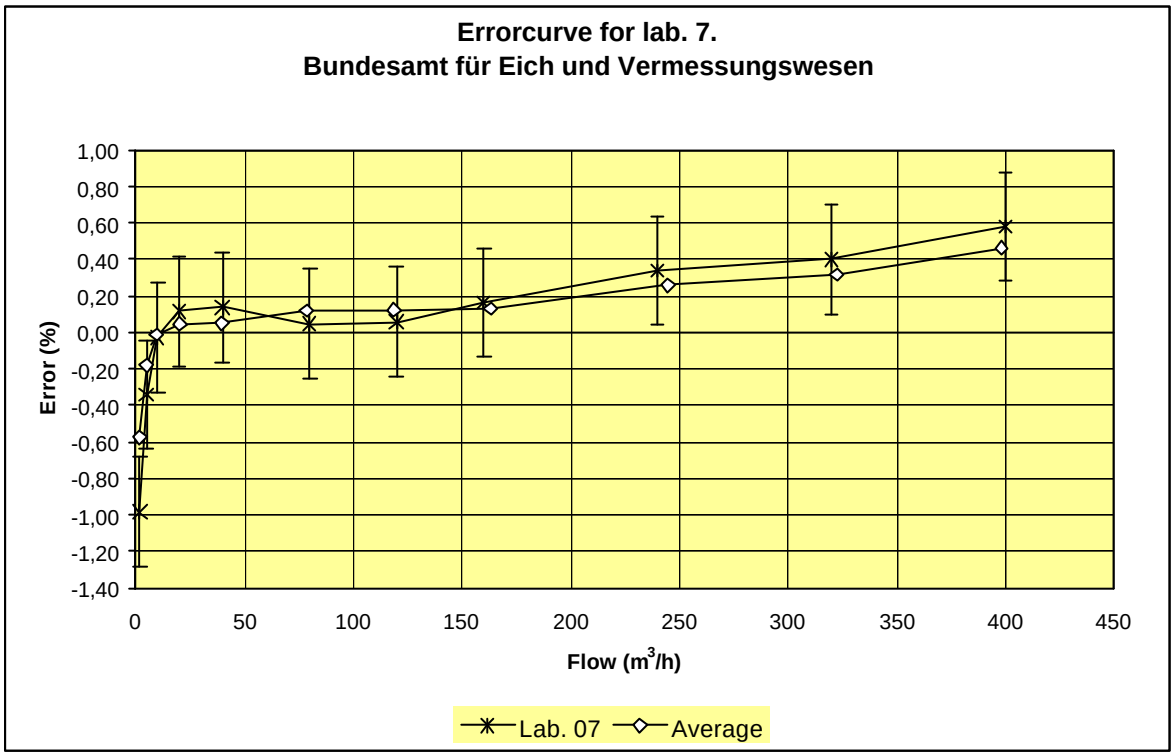
6.1.6 Lab. 6. Eidg. Amt für Messwesen, Switzerland

	Flow real	Pressure abs. at Pr	Pressure drop. Pr-P	Temperature	Error	Standard diviation
	m³/h	mbar	Pa	°C	%	%
7	2,008	952,441	1,7	20,349	-0,85	
8	1,972	952,282	1,6	20,328	-0,93	
44	1,988	953,570	1,0	20,285	-0,93	
Average	**1,989**	**952,764**	**1,4**	**20,321**	**-0,90**	**0,05**
14	5,079	952,229	2,8	20,277	-0,25	
15	5,054	952,211	2,3	20,321	-0,21	
42	5,049	954,136	2,3	20,232	-0,21	
Average	**5,061**	**952,859**	**2,5**	**20,277**	**-0,22**	**0,02**
21	10,067	951,532	2,2	20,304	0,00	
22	10,070	951,406	2,1	20,326	-0,01	
23	10,073	951,381	2,2	20,348	-0,03	
Average	**10,070**	**951,440**	**2,2**	**20,326**	**-0,01**	**0,02**
28	20,290	950,411	3,3	20,269	0,05	
29	20,292	950,424	3,2	20,255	0,05	
45	20,152	955,112	3,8	19,994	0,05	
Average	**20,245**	**951,982**	**3,4**	**20,173**	**0,05**	**0,00**
33	40,738	956,212	15,0	20,193	0,08	
34	40,747	956,105	14,8	20,193	0,07	
35	40,751	956,014	14,9	20,208	0,06	
Average	**40,745**	**956,110**	**14,9**	**20,198**	**0,07**	**0,01**
39	80,611	954,617	49,3	20,167	0,11	
40	80,616	954,463	49,6	20,162	0,10	
41	80,614	954,355	49,4	20,162	0,11	
Average	**80,614**	**954,478**	**49,4**	**20,164**	**0,11**	**0,01**
36	119,953	955,863	104,8	20,165	0,14	
37	120,887	955,724	106,3	20,162	0,13	
38	120,885	955,647	106,8	20,162	0,14	
Average	**120,575**	**955,745**	**106,0**	**20,163**	**0,14**	**0,01**
30	159,850	956,374	181,4	20,219	0,14	
31	160,405	956,282	181,3	20,193	0,15	
32	160,415	956,269	181,5	20,178	0,15	
Average	**160,223**	**956,308**	**181,4**	**20,197**	**0,15**	**0,01**
24	240,162	950,933	393,8	20,247	0,25	
25	240,114	950,851	393,8	20,240	0,27	
26	240,085	950,802	393,9	20,224	0,27	
Average	**240,120**	**950,862**	**393,8**	**20,237**	**0,26**	**0,01**
17	320,111	951,898	711,8	20,109	0,39	
18	320,070	951,891	713,2	20,132	0,38	
19	320,184	951,867	712,6	20,131	0,40	
Average	**320,122**	**951,885**	**712,5**	**20,124**	**0,39**	**0,01**
2	398,962	953,730	1132,6	20,356	0,52	
3	399,118	953,748	1120,5	20,320	0,52	
4	398,568	953,597	1139,1	20,284	0,50	
Average	**398,883**	**953,692**	**1130,7**	**20,320**	**0,51**	**0,01**


Errorcurve for lab. 6.
Swiss Federal Office af Metrology
Error (%)
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
-0,60
-0,80
-1,00
-1,20
0
50
100
150
200
250
300
350
400
450
Flow (m3/h)
Lab. 06
Average

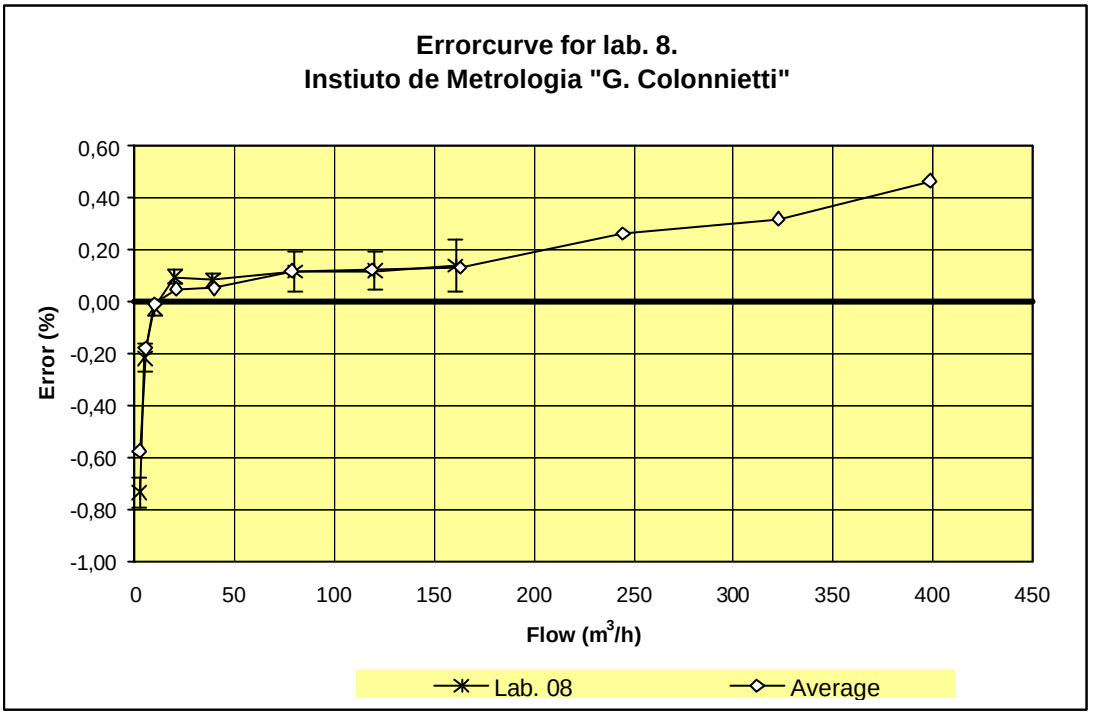
6.1.7 Lab. 7. Bundesamt für Eich und Vermessungswesen, Austria

	Flow real	Pressure abs. at Pr	Pressure drop. Pr-P	Temperature	Error	Standard diviation
	m³/h	mbar	Pa	°C	%	%
max. - min.	2	990,7	0,0	21,7	-0,99	
min. - max	2	993,6	0,0	21,1	-0,99	
random	2	995,0	0,0	21,4	-0,98	
Average	**2**	**993,1**	**0,0**	**21,4**	**-0,99**	**0,01**
max. - min.	5	990,7	0,0	21,7	-0,33	
min. - max	5	993,6	0,0	21,1	-0,33	
random	5	995,0	0,0	21,3	-0,36	
Average	**5**	**993,1**	**0,0**	**21,4**	**-0,34**	**0,02**
max. - min.	10	990,7	10,0	21,7	-0,02	
min. - max	10	993,6	10,0	21,1	-0,03	
random	10	995,0	10,0	21,3	-0,03	
Average	**10**	**993,1**	**10,0**	**21,4**	**-0,03**	**0,01**
max. - min.	20	990,7	10,0	21,6	0,12	
min. - max	20	993,6	10,0	21,1	0,12	
random	20	995,0	10,0	21,2	0,10	
Average	**20**	**993,1**	**10,0**	**21,3**	**0,11**	**0,01**
max. - min.	40	990,7	20,0	21,6	0,13	
min. - max	40	993,6	20,0	21,2	0,15	
random	40	995,0	20,0	21,1	0,13	
Average	**40**	**993,1**	**20,0**	**21,3**	**0,14**	**0,01**
max. - min.	80	990,7	50,0	21,5	0,07	
min. - max	80	993,6	50,0	21,2	0,06	
random	80	995,0	50,0	21,0	0,00	
Average	**80**	**993,1**	**50,0**	**21,2**	**0,04**	**0,04**
max. - min.	120	990,7	110,0	21,5	0,03	
min. - max	120	993,6	110,0	21,2	0,07	
random	120	995,0	110,0	21,0	0,07	
Average	**120**	**993,1**	**110,0**	**21,2**	**0,06**	**0,02**
max. - min.	160	990,7	180,0	21,3	0,16	
min. - max	160	993,6	180,0	21,3	0,17	
random	160	995,0	180,0	20,9	0,16	
Average	**160**	**993,1**	**180,0**	**21,2**	**0,16**	**0,01**
max. - min.	240	990,7	410,0	21,2	0,34	
min. - max	240	993,6	410,0	21,4	0,35	
random	240	995,0	410,0	20,8	0,32	
Average	**240**	**993,1**	**410,0**	**21,1**	**0,34**	**0,02**
max. - min.	320	990,7	720,0	21,2	0,40	
min. - max	320	993,6	720,0	21,4	0,40	
random	320	995,0	720,0	20,7	0,40	
Average	**320**	**993,1**	**720,0**	**21,1**	**0,40**	**0,00**
max. - min.	400	990,7	1140,0	21,1	0,58	
min. - max	400	993,6	1140,0	21,4	0,59	
random	400	995,0	1140,0	20,6	0,57	
Average	**400**	**993,1**	**1140,0**	**21,0**	**0,58**	**0,01**


Errorcurve for lab. 7.
Bundesamt für Eich und Vermessungswesen
Error (%)
1,00
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
-0,60
-0,80
-1,00
-1,20
-1,40
0
50
100
150
200
250
300
350
400
450
Flow (m3/h)
Lab. 07
Average

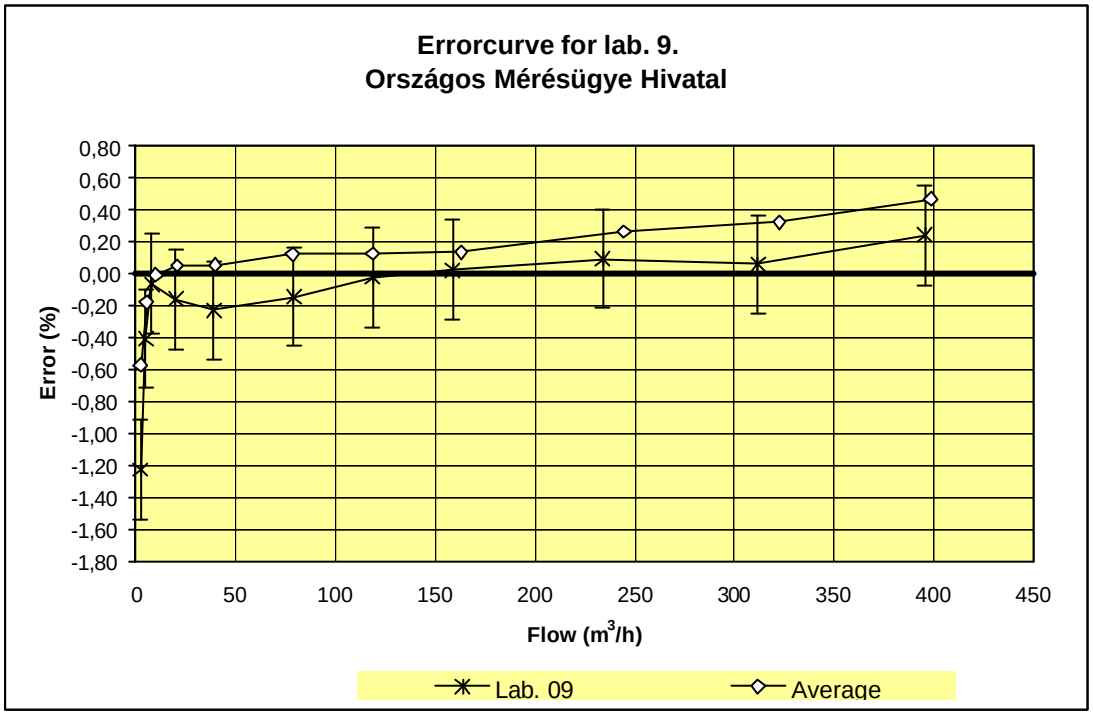
6.1.8 Lab. 8. Instiuto de Metrologia “G, Colonnetti”, Italy

	Flow real	Pressure abs. at Pr	Pressure drop. Pr-P	Temperature	Error	Standard diviation
	m³/h	mbar	Pa	°C	%	%
max. - min.	2,090	996,16	1,4	19,9	-0,74	
min. - max	2,080	996,14	1,0	19,9	-0,75	
random	2,090	995,91	1,3	20,1	-0,72	
Average	**2,087**	**996,07**	**1,2**	**20,0**	**-0,74**	**0,02**
max. - min.	5,000	996,14	1,1	19,8	-0,21	
min. - max	5,000	996,10	1,4	20,0	-0,23	
random	5,000	994,41	5,0	20,3	-0,22	
Average	**5,000**	**995,55**	**2,5**	**20,0**	**-0,22**	**0,01**
max. - min.	9,900	996,14	2,0	19,8	-0,02	
min. - max	9,890	996,09	2,0	20,0	-0,04	
random	9,910	996,03	2,0	20,0	-0,02	
Average	**9,900**	**996,09**	**2,0**	**19,9**	**-0,03**	**0,01**
max. - min.	20,080	996,15	4,7	19,8	0,10	
min. - max	20,080	996,07	4,6	20,0	0,10	
random	20,090	993,98	1,4	20,3	0,08	
Average	**20,083**	**995,40**	**3,6**	**20,0**	**0,09**	**0,01**
max. - min.	38,980	996,20	13,8	19,7	0,09	
min. - max	39,000	996,07	13,4	20,0	0,08	
random	39,020	995,81	13,6	20,1	0,07	
Average	**39,000**	**996,02**	**13,6**	**19,9**	**0,08**	**0,01**
max. - min.	80,110	996,25	50,0	19,7	0,13	
min. - max	80,190	996,75	51,1	20,0	0,11	
random	80,240	996,01	51,0	20,1	0,10	
Average	**80,180**	**996,34**	**50,7**	**19,9**	**0,11**	**0,02**
max. - min.	120,300	996,28	109,1	19,7	0,14	
min. - max	120,490	996,08	104,8	20,0	0,10	
random	120,550	995,73	106,5	20,1	0,11	
Average	**120,447**	**996,03**	**106,8**	**19,9**	**0,12**	**0,02**
max. - min.	160,600	996,30	185,8	19,6	0,19	
min. - max	160,940	996,07	185,8	20,0	0,13	
random	161,060	994,41	190,5	20,3	0,09	
Average	**160,867**	**995,59**	**187,4**	**20,0**	**0,14**	**0,05**
max. - min.	-	-	-	-	-	
min. - max	-	-	-	-	-	
random	-	-	-	-	-	
Average	**-**	**-**	**-**	**-**	**-**	**-**
max. - min.	-	-	-	-	-	
min. - max	-	-	-	-	-	
random	-	-	-	-	-	
Average	**-**	**-**	**-**	**-**	**-**	**-**
max. - min.	-	-	-	-	-	
min. - max	-	-	-	-	-	
random	-	-	-	-	-	
Average	**-**	**-**	**-**	**-**	**-**	**-**


Errorcurve for lab. 8.
Instiuto de Metrologia "G. Colonnietti"
0,60
0,40
0,20
0,00
-0,20
-0,40
-0,60
-0,80
-1,00
Error (%)
0
50
100
150
200
250
300
350
400
450
Flow (m3/h)
Lab. 08
Average

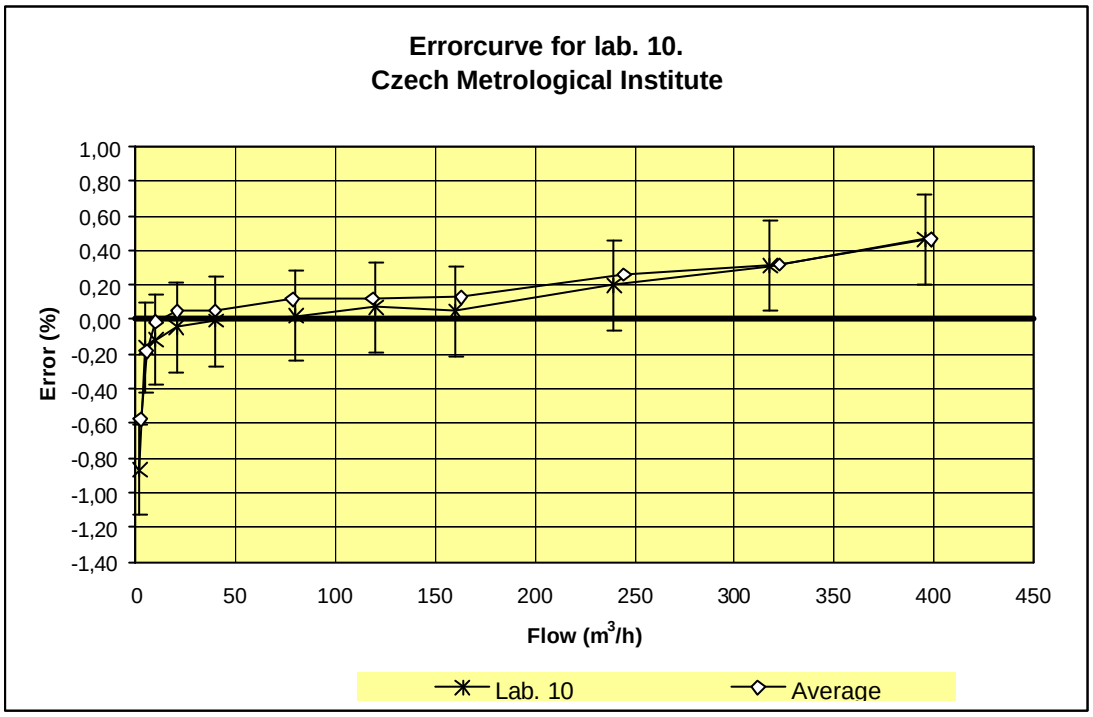
6.1.9 Lab. 9. Országos Mérésügyi Hivatal, Hungary

	Flow real	Pressure abs. at Pr	Pressure drop. Pr-P	Temperature	Error	Standard diviation
	m³/h	mbar	Pa	°C	%	%
12	2,360	995,00	0,0	21,3	-1,23	
1	1,990	994,80	0,0	21,4	-1,43	
1	2,110	995,50	0,0	21,2	-1,02	
Average	**2,153**	**995,10**	**0,0**	**21,3**	**-1,23**	**0,21**
11	4,760	994,90	0,0	21,2	-0,51	
2	4,850	994,90	0,0	21,3	-0,31	
2	4,820	994,30	0,0	21,0	-0,41	
Average	**4,810**	**994,70**	**0,0**	**21,2**	**-0,41**	**0,10**
10	8,080	994,50	3,0	21,2	-0,15	
3	8,110	995,20	3,0	21,2	0,05	
3	7,910	994,90	3,0	21,1	-0,10	
Average	**8,033**	**994,87**	**3,0**	**21,2**	**-0,07**	**0,10**
8	20,040	994,70	5,0	21,1	-0,20	
5	19,800	994,90	5,0	21,2	-0,14	
5	20,080	993,30	5,0	21,0	-0,15	
Average	**19,973**	**994,30**	**5,0**	**21,1**	**-0,16**	**0,03**
7	39,800	994,90	15,0	21,0	-0,22	
6	38,360	994,80	15,0	21,1	-0,23	
6	38,670	995,40	15,0	21,0	-0,25	
Average	**38,943**	**995,03**	**15,0**	**21,0**	**-0,23**	**0,02**
6	79,720	994,20	50,0	20,9	-0,14	
7	79,070	994,50	50,0	20,9	-0,14	
7	78,300	992,70	50,0	21,0	-0,16	
Average	**79,030**	**993,80**	**50,0**	**20,9**	**-0,15**	**0,01**
5	120,120	994,50	110,0	20,9	-0,02	
8	120,900	994,40	110,0	20,9	-0,02	
8	114,980	995,80	110,0	20,9	-0,04	
Average	**118,667**	**994,90**	**110,0**	**20,9**	**-0,03**	**0,01**
4	161,340	994,10	190,0	20,9	0,02	
9	158,080	994,20	190,0	20,9	0,01	
9	157,460	995,70	190,0	20,9	0,03	
Average	**158,960**	**994,67**	**190,0**	**20,9**	**0,02**	**0,01**
3	236,870	993,40	410,0	20,9	0,08	
10	233,460	993,70	410,0	20,8	0,10	
10	231,710	995,80	410,0	20,9	0,09	
Average	**234,013**	**994,30**	**410,0**	**20,9**	**0,09**	**0,01**
2	320,170	992,30	710,0	20,9	0,07	
11	308,080	993,10	710,0	20,8	0,05	
11	308,170	996,20	710,0	20,8	0,05	
Average	**312,140**	**993,87**	**710,0**	**20,8**	**0,06**	**0,01**
1	399,660	991,30	1220,0	20,8	0,26	
12	396,120	991,90	1220,0	20,9	0,25	
12	390,590	996,30	1220,0	20,8	0,20	
Average	**395,457**	**993,17**	**1220,0**	**20,8**	**0,24**	**0,03**


Errorcurve for lab. 9.
Országos Mérésügye Hivatal
Error (%)
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
-0,60
-0,80
-1,00
-1,20
-1,40
-1,60
-1,80
0
50
100
150
200
250
300
350
400
450
Flow (m3/h)
Lab. 09
Average

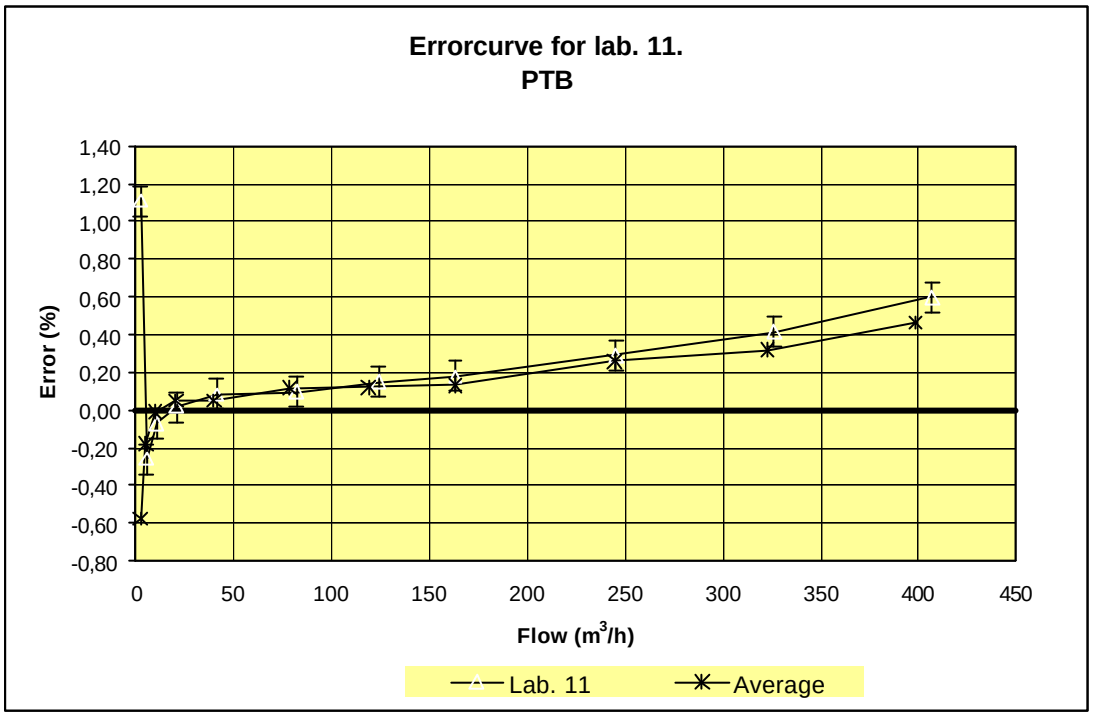
6.1.10 Lab. 10. Czech Metrological Institute, Czech Rep.

	Flow real	Pressure abs. at Pr	Pressure drop. Pr-P	Temperature	Error	Standard diviation
	m³/h	mbar	Pa	°C	%	%
-	1,980	1003,41	0,0	21,1	-0,85	
-	1,980	1003,22	0,0	21,2	-0,88	
-	1,980	1003,41	0,0	21,3	-0,88	
Average	**1,980**	**1003,35**	**0,0**	**21,2**	**-0,87**	**0,02**
-	5,030	1003,39	0,0	21,1	-0,18	
-	5,030	1003,22	0,0	21,2	-0,18	
-	5,030	1003,53	0,0	21,3	-0,12	
Average	**5,030**	**1003,38**	**0,0**	**21,2**	**-0,16**	**0,03**
-	10,030	1003,42	0,0	21,1	-0,12	
-	10,020	1003,25	0,0	21,1	-0,13	
-	10,020	1003,33	0,0	21,3	-0,11	
Average	**10,023**	**1003,33**	**0,0**	**21,2**	**-0,12**	**0,01**
-	20,050	1003,42	0,0	21,1	-0,04	
-	20,390	1003,21	0,0	21,1	-0,06	
-	20,420	1003,37	0,0	21,3	-0,03	
Average	**20,287**	**1003,33**	**0,0**	**21,2**	**-0,04**	**0,02**
-	39,940	1003,41	2,0	21,1	-0,01	
-	39,920	1003,22	2,0	21,1	-0,02	
-	39,950	1003,43	2,0	21,5	0,01	
Average	**39,937**	**1003,35**	**2,0**	**21,2**	**-0,01**	**0,02**
-	80,250	1003,31	30,0	21,1	0,02	
-	80,250	1003,13	31,0	21,2	0,03	
-	80,260	1003,21	30,0	21,3	0,01	
Average	**80,253**	**1003,22**	**30,3**	**21,2**	**0,02**	**0,01**
-	120,290	1003,17	90,0	21,1	0,07	
-	120,260	1003,04	92,0	21,2	0,08	
-	120,290	1003,07	91,0	21,3	0,07	
Average	**120,280**	**1003,09**	**91,0**	**21,2**	**0,07**	**0,01**
-	160,150	1003,02	165,0	21,1	0,05	
-	160,130	1002,87	164,0	21,2	0,05	
-	160,160	1003,05	167,0	21,3	0,04	
Average	**160,147**	**1002,98**	**165,3**	**21,2**	**0,05**	**0,01**
-	239,750	1002,79	378,0	21,1	0,20	
-	239,720	1002,79	391,0	21,2	0,20	
-	239,690	1002,94	384,0	21,3	0,19	
Average	**239,720**	**1002,84**	**384,3**	**21,2**	**0,20**	**0,01**
-	318,150	1002,06	693,0	21,1	0,30	
-	318,020	1001,86	706,0	21,1	0,32	
-	318,010	1001,96	690,0	21,1	0,31	
Average	**318,060**	**1001,96**	**696,3**	**21,1**	**0,31**	**0,01**
-	395,320	1001,12	1104,0	21,0	0,48	
-	395,440	1000,93	1117,0	21,3	0,45	
-	395,640	1001,16	1107,0	21,4	0,46	
Average	**395,467**	**1001,07**	**1109,3**	**21,2**	**0,46**	**0,02**


Errorcurve for lab. 10.
Czech Metrological Institute
1,00
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
-0,60
-0,80
-1,00
-1,20
-1,40
Error (%)
0
50
100
150
200
250
300
350
400
450
Flow (m3/h)
Lab. 10
Average

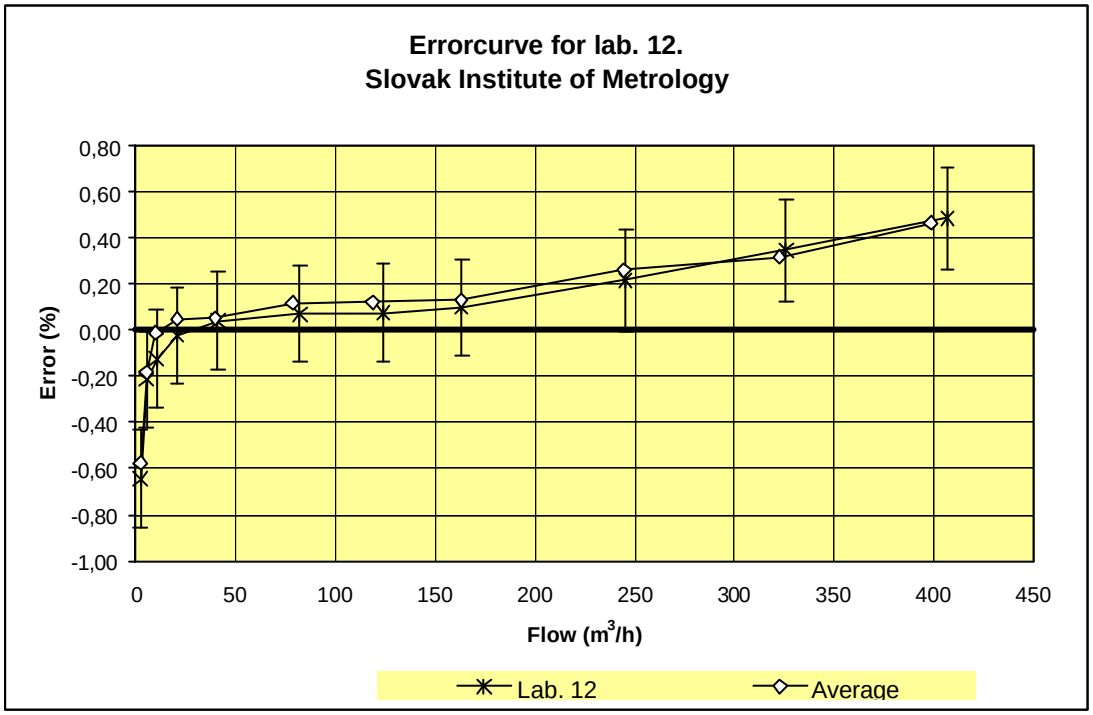
6.1.11 Lab. 11. PTB, Germany

	Flow real	Pressure abs. at Pr	Pressure drop. Pr-P	Temperature	Error	Standard diviation
	m³/h	mbar	Pa	°C	%	%
11	2,122	1003,76	1,0	20,5	1,26	
12	2,105	1003,71	1,0	20,5	0,44	
23	2,129	1003,80	1,0	20,5	1,63	
Average	**2,119**	**1003,76**	**1,0**	**20,5**	**1,11**	**0,61**
10	5,217	1003,74	1,0	20,6	-0,26	
13	5,216	1003,74	1,0	20,5	-0,26	
26	5,216	1003,90	2,0	20,5	-0,26	
Average	**5,216**	**1003,79**	**1,3**	**20,5**	**-0,26**	**0,00**
9	10,307	1003,74	2,0	20,6	-0,07	
14	10,306	1003,69	2,0	20,6	-0,08	
28	10,304	1003,87	2,0	20,4	-0,07	
Average	**10,306**	**1003,77**	**2,0**	**20,5**	**-0,07**	**0,00**
8	20,596	1003,75	5,0	20,6	0,02	
15	20,592	1003,77	5,0	20,6	0,01	
30	20,592	1003,86	5,0	20,4	0,02	
Average	**20,593**	**1003,79**	**5,0**	**20,5**	**0,02**	**0,00**
7	41,160	1003,73	15,0	20,6	0,09	
16	41,155	1003,75	15,0	20,6	0,08	
32	41,152	1003,86	15,0	20,3	0,08	
Average	**41,156**	**1003,78**	**15,0**	**20,5**	**0,08**	**0,00**
6	82,224	1003,69	52,0	20,6	0,10	
17	82,219	1003,62	52,0	20,6	0,10	
25	82,202	1003,70	52,0	20,5	0,09	
Average	**82,215**	**1003,67**	**52,0**	**20,6**	**0,10**	**0,00**
5	124,016	1003,54	113,0	20,7	0,15	
18	123,967	1003,47	113,0	20,5	0,14	
33	123,916	1003,60	112,0	20,3	0,15	
Average	**123,966**	**1003,54**	**112,7**	**20,5**	**0,15**	**0,00**
4	163,125	1003,31	190,0	20,7	0,18	
19	163,060	1003,25	191,0	20,5	0,18	
31	163,020	1003,33	191,0	20,4	0,18	
Average	**163,068**	**1003,30**	**190,7**	**20,5**	**0,18**	**0,00**
3	245,590	1002,83	422,0	20,7	0,29	
20	245,442	1002,60	422,0	20,4	0,29	
24	245,491	1002,70	423,0	20,5	0,29	
Average	**245,508**	**1002,71**	**422,3**	**20,5**	**0,29**	**0,00**
2	326,251	1001,96	751,0	20,7	0,41	
21	326,070	1001,72	749,0	20,4	0,41	
29	326,006	1003,78	750,0	20,3	0,41	
Average	**326,109**	**1002,49**	**750,0**	**20,5**	**0,41**	**0,00**
1	406,928	1000,79	1193,0	20,6	0,60	
22	406,846	1000,61	1188,0	20,4	0,60	
27	406,650	1000,60	1189,0	20,3	0,60	
Average	**406,808**	**1000,67**	**1190,0**	**20,4**	**0,60**	**0,00**


Errorcurve for lab. 11.
PTB
Error (%)
1,40
1,20
1,00
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
-0,60
-0,80
0
50
100
150
200
250
300
350
400
450
Flow (m3/h)
Lab. 11
Average

6.1.12 Lab. 12. Slovak Institute of Metrology, Slovakian

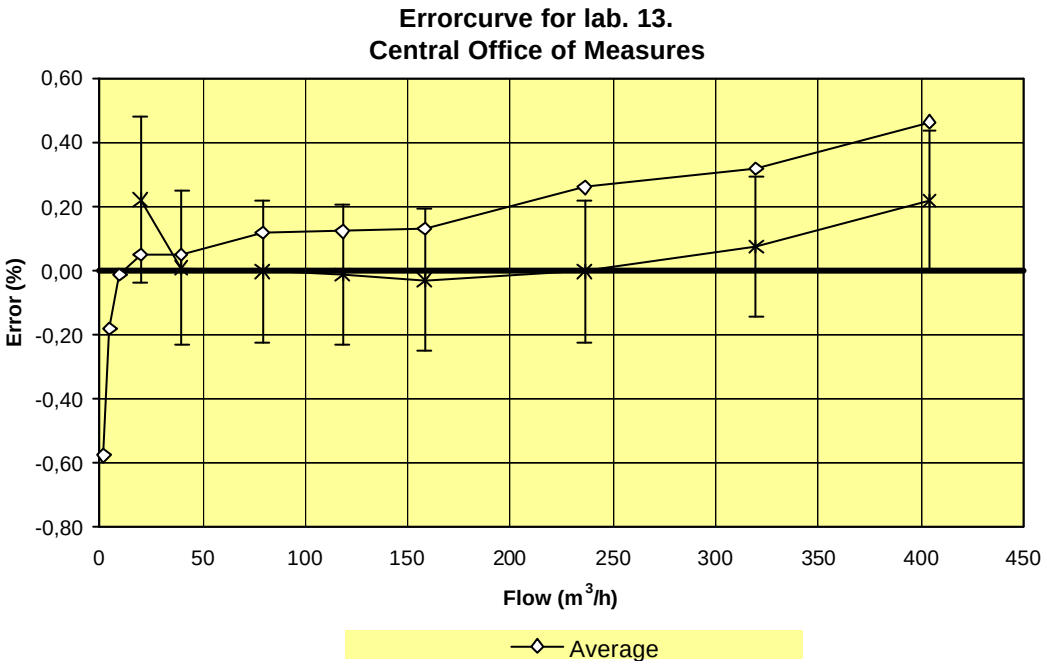
	Flow real	Pressure abs. at Pr	Pressure drop. Pr-P	Temperature	Error	Standard diviation
	m³/h	mbar	Pa	°C	%	%
31-33	1,970	989,90	0,0	22,6	-0,64	
34-36	1,970	989,30	0,0	22,6	-0,65	
-	-	-	-	-	-	
Average	**1,970**	**989,60**	**0,0**	**22,6**	**-0,65**	**0,01**
28-30	5,191	990,40	0,0	22,6	-0,20	
37-39	5,192	989,30	0,0	22,6	-0,23	
-	-	-	-	-	-	
Average	**5,192**	**989,85**	**0,0**	**22,6**	**-0,22**	**0,02**
25-27	10,170	991,50	5,0	22,6	-0,12	
40-42	10,170	989,20	5,0	22,6	-0,13	
-	-	-	-	-	-	
Average	**10,170**	**990,35**	**5,0**	**22,6**	**-0,13**	**0,01**
22-24	20,080	991,65	10,0	22,6	-0,02	
43-45	20,080	989,15	10,0	22,6	-0,03	
-	-	-	-	-	-	
Average	**20,080**	**990,40**	**10,0**	**22,6**	**-0,03**	**0,01**
19-21	40,060	988,90	20,0	21,8	0,05	
46-48	40,060	987,60	20,0	22,2	0,03	
-	-	-	-	-	-	
Average	**40,060**	**988,25**	**20,0**	**22,0**	**0,04**	**0,01**
16-18	80,270	989,00	70,0	22,0	0,08	
49-51	80,270	987,40	60,0	22,2	0,06	
-	-	-	-	-	-	
Average	**80,270**	**988,20**	**65,0**	**22,1**	**0,07**	**0,01**
13-15	120,400	988,80	140,0	21,7	0,07	
52-54	120,400	987,10	140,0	22,2	0,08	
-	-	-	-	-	-	
Average	**120,400**	**987,95**	**140,0**	**22,0**	**0,08**	**0,01**
10-12	160,500	988,70	250,0	21,9	0,09	
55-57	160,600	986,90	250,0	22,2	0,11	
-	-	-	-	-	-	
Average	**160,550**	**987,80**	**250,0**	**22,0**	**0,10**	**0,01**
7-9	240,800	988,10	550,0	22,0	0,22	
58-60	240,900	986,40	560,0	22,1	0,21	
-	-	-	-	-	-	
Average	**240,850**	**987,25**	**555,0**	**22,0**	**0,22**	**0,01**
4-6	321,000	987,40	980,0	22,1	0,35	
61-63	321,100	985,60	990,0	22,1	0,34	
-	-	-	-	-	-	
Average	**321,050**	**986,50**	**985,0**	**22,1**	**0,35**	**0,01**
1-3	401,600	986,50	1500,0	22,0	0,49	
64-66	401,800	984,60	1530,0	22,1	0,48	
-	-	-	-	-	-	
Average	**401,700**	**985,55**	**1515,0**	**22,0**	**0,49**	**0,01**


Errorcurve for lab. 12.
Slovak Institute of Metrology
Error (%)
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
-0,60
-0,80
-1,00
0
50
100
150
200
250
300
350
400
450
Flow (m3/h)
Lab. 12
Average

6.1.13 Lab. 13. Central Office of Measures, Poland

Central Office of Measures
Lab. 13

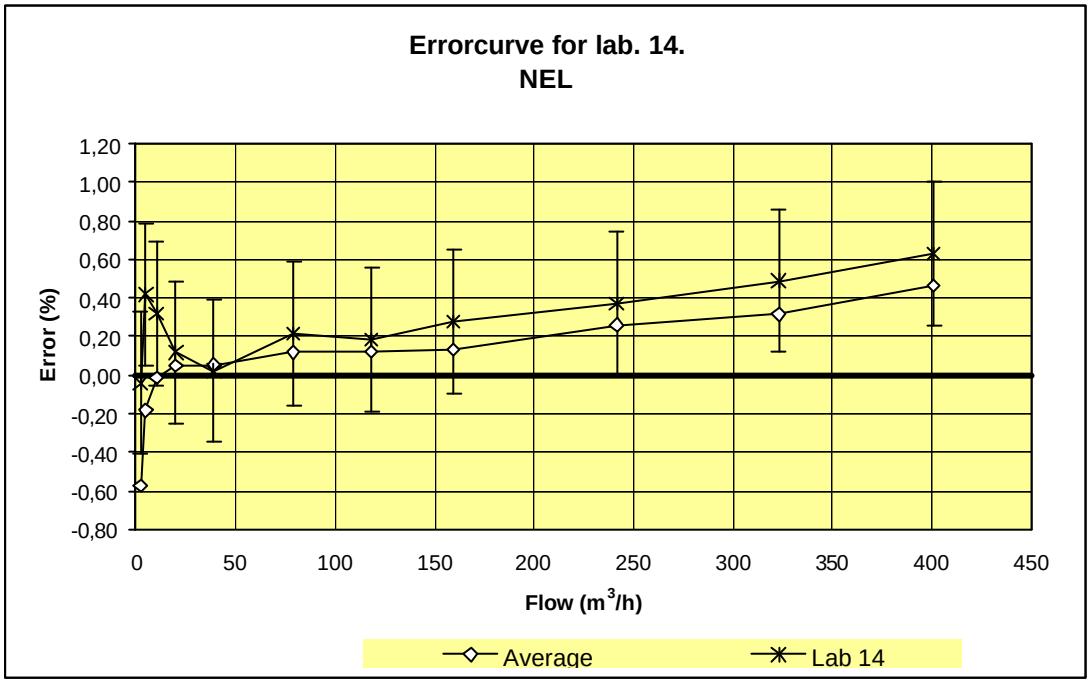
	Flow real	**Pressure** abs. at Pr	**Pressure** drop. Pr-P	**Temperature**	**Error**	**Standard diviation**	**U**
	m³/h	mbar	Pa	℃	%	%	%
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
Average	**-**	**-**	**-**	**-**	**-**	**-**	
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
Average	**-**	**-**	**-**	**-**	**-**	**-**	
-	-	-	-	-	-		
-	-	-	-	-	-		
-	-	-	-	-	-		
Average	**-**	**-**	**-**	**-**	**-**	**-**	
8	20,040	1057,60	-	20,9	0,17		
1	20,130	1057,60	-	20,8	0,18		
8	20,070	1071,40	-	21,0	0,31		
Average	**20,080**	**1062,20**	**-**	**20,9**	**0,22**	**0,08**	**0,26**
7	41,150	1057,50	-	20,9	0,00		
2	39,130	1057,50	-	20,8	0,01		
7	39,260	1071,35	-	21,0	0,01		
Average	**39,847**	**1062,12**	**-**	**20,9**	**0,01**	**0,01**	**0,24**
6	79,290	1057,40	-	20,9	0,02		
3	80,080	1057,40	-	20,8	-0,04		
6	78,600	1071,20	-	21,0	0,01		
Average	**79,323**	**1062,00**	**-**	**20,9**	**0,00**	**0,03**	**0,22**
5	118,210	1057,25	-	20,9	-0,01		
4	118,810	1057,30	-	20,7	-0,02		
5	118,530	1071,15	-	21,0	-0,01		
Average	**118,517**	**1061,90**	**-**	**20,9**	**-0,01**	**0,01**	**0,22**
4	161,050	1057,10	-	20,9	-0,02		
5	157,180	1057,10	-	20,7	-0,01		
4	157,250	1070,90	-	21,0	-0,06		
Average	**158,493**	**1061,70**	**-**	**20,9**	**-0,03**	**0,03**	**0,22**
3	238,750	1056,50	-	20,9	0,01		
6	236,330	1056,60	-	20,7	0,01		
3	233,670	1070,40	-	21,0	-0,03		
Average	**236,250**	**1061,17**	**392**	**20,9**	**0,00**	**0,02**	**0,22**
2	323,130	1056,00	-	20,9	0,15		
7	318,340	1055,80	-	20,8	0,03		
2	317,360	1069,60	-	21,0	0,04		
Average	**319,610**	**1060,47**	**-**	**20,9**	**0,07**	**0,07**	**0,22**
1	404,460	1054,80	-	20,9	0,24		
8	405,010	1054,80	-	20,8	0,20		
1	402,870	1068,60	-	21,0	0,21		
Average	**404,113**	**1059,40**	**-**	**20,9**	**0,22**	**0,02**	**0,22**


Errorcurve for lab. 13.
Central Office of Measures
0,60
0,40
0,20
0,00
-0,20
-0,40
-0,60
-0,80
Error (%)
0
50
100
150
200
250
300
350
400
450
Flow (m3/h)
Average

6.1.14 Lab. 14. NEL, United Kingdom

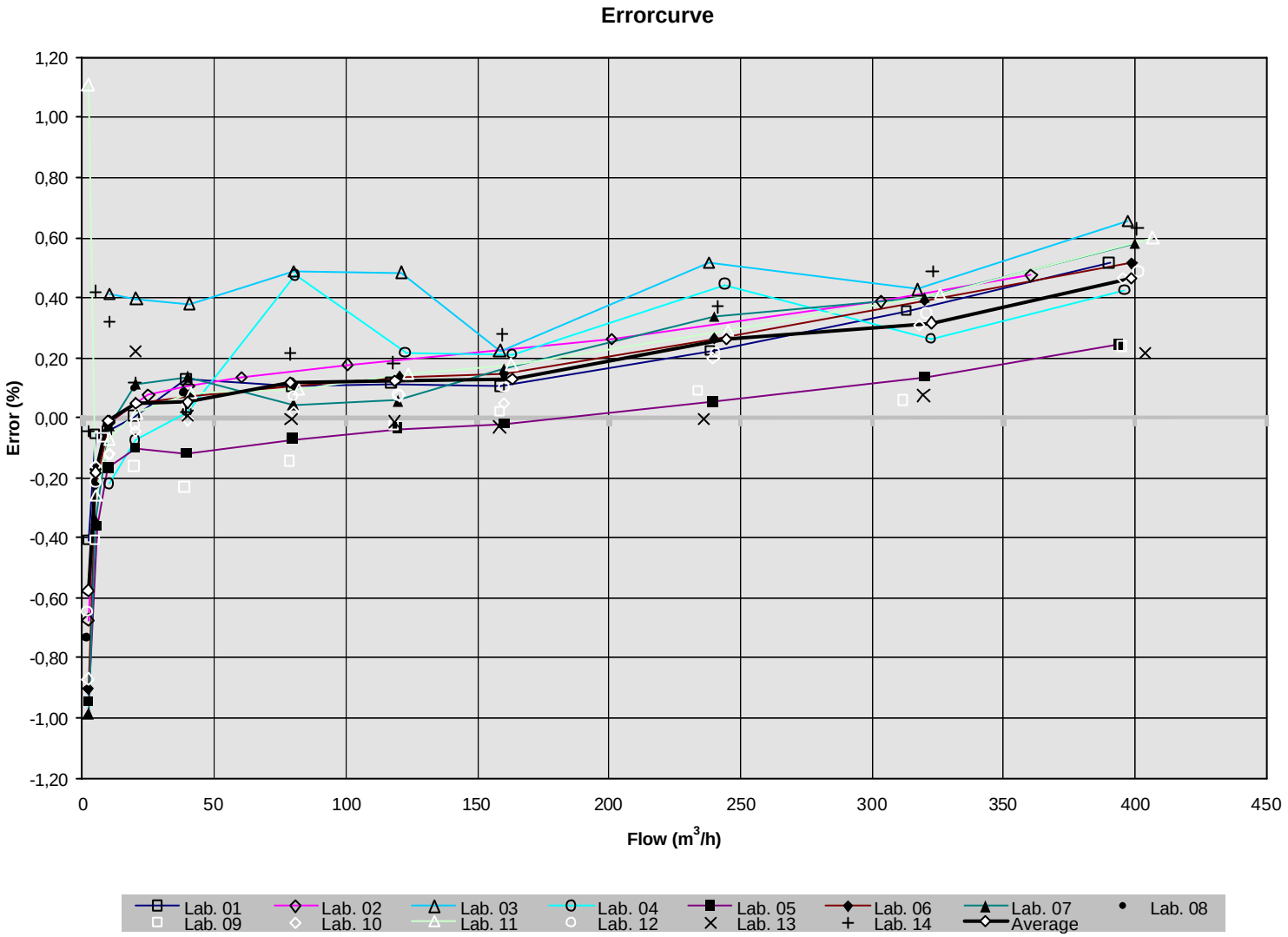
NEL
Lab. 14

	Flow real	**Pressure** abs. at Pr	**Pressure** drop. Pr-P	**Temperature**	**Error**	**Standard diviation**	**U**
	m³/h	mbar	Pa	°C	%	%	%
33	2,110	-	1,0	21,6	-0,02		
35	2,100	-	1,0	21,4	-0,02		
36	2,100	-	1,0	21,3	-0,09		
Average	**2,103**	**-**	**1,0**	**21,4**	**-0,04**	**0,04**	**0,37**
31	5,060	-	1,0	22,1	0,53		
32	5,060	-	1,0	21,9	0,36		
34	5,060	-	1,0	21,5	0,37		
Average	**5,060**	**-**	**1,0**	**21,8**	**0,42**	**0,10**	**0,37**
1	10,060	-	1,0	21,2	0,27		
2	10,070	-	1,0	20,7	0,39		
3	10,050	-	1,0	20,1	0,30		
Average	**10,060**	**-**	**1,0**	**20,7**	**0,32**	**0,06**	**0,37**
4	19,940	-	6,0	21,8	0,11		
6	19,990	-	6,0	21,2	0,14		
8	19,910	-	6,0	21,4	0,10		
Average	**19,947**	**-**	**6,0**	**21,5**	**0,12**	**0,02**	**0,37**
5	39,300	-	16,0	21,6	-0,01		
7	39,250	-	16,0	21,0	0,04		
9	39,220	-	16,0	21,4	0,03		
Average	**39,257**	**-**	**16,0**	**21,3**	**0,02**	**0,03**	**0,37**
11	79,050	-	59,0	19,1	0,18		
14	78,990	-	60,0	19,0	0,24		
15	79,060	-	60,0	19,0	0,22		
Average	**79,033**	**-**	**59,7**	**19,0**	**0,21**	**0,03**	**0,37**
10	118,270	-	126,0	19,1	0,19		
12	118,110	-	127,0	18,7	0,16		
13	118,150	-	127,0	19,0	0,20		
Average	**118,177**	**-**	**126,7**	**18,9**	**0,18**	**0,02**	**0,37**
16	158,680	-	219,0	18,2	0,26		
23	159,670	-	220,0	19,7	0,30		
27	160,280	-	218,0	20,1	0,27		
Average	**159,543**	**-**	**219,0**	**19,3**	**0,28**	**0,02**	**0,37**
17	240,570	-	500,0	17,7	0,35		
22	241,700	-	501,0	19,8	0,39		
26	242,380	-	500,0	20,1	0,37		
Average	**241,550**	**-**	**500,3**	**19,2**	**0,37**	**0,02**	**0,37**
18	323,460	-	890,0	21,5	0,49		
21	322,420	-	889,0	20,2	0,50		
25	323,350	-	891,0	20,7	0,47		
Average	**323,077**	**-**	**890,0**	**20,8**	**0,49**	**0,02**	**0,37**
19	400,980	-	1402,0	19,6	0,62		
20	400,550	-	1404,0	18,6	0,63		
30	401,150	-	1403,0	19,4	0,64		
Average	**400,893**	**-**	**1403,0**	**19,2**	**0,63**	**0,01**	**0,37**


Errorcurve for lab. 14.
NEL
Error (%)
1,20
1,00
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
-0,60
-0,80
0
50
100
150
200
250
300
350
400
450
Flow (m3/h)
Average
Lab 14

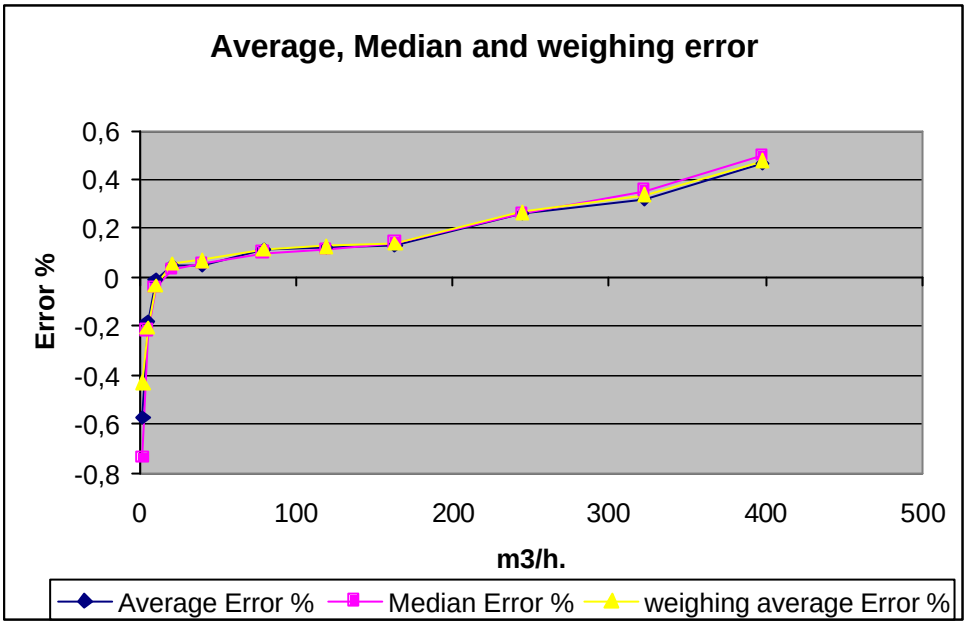
6.1.15 All the laboratories

Flow	Error %													
nominel	Lab1	Lab2	Lab3	Lab4	Lab5	Lab6	Lab7	Lab8	Lab9	Lab10	Lab11	Lab12	Lab13	Lab14
2	-0,41	-0,67			-0,95	-0,90	-0,99	-0,74	-1,23	-0,87	1,11	-0,65		-0,04
5	-0,06	-0,17			-0,36	-0,22	-0,34	-0,22	-0,41	-0,16	-0,26	-0,22		0,42
10	-0,04	-0,01	0,41	-0,22	-0,17	-0,01	-0,03	-0,03	-0,07	-0,12	-0,07	-0,13		0,32
20	0,00	0,07	0,40	-0,08	-0,10	0,05	0,11	0,09	-0,16	-0,04	0,02	-0,03	0,22	0,12
40	0,13	0,11	0,38	0,02	-0,12	0,07	0,14	0,08	-0,23	-0,01	0,08	0,04	0,01	0,02
80	0,10	0,13	0,49	0,47	-0,07	0,11	0,04	0,11	-0,15	0,02	0,10	0,07	0,00	0,21
120	0,11	0,18	0,48	0,22	-0,04	0,14	0,06	0,12	-0,03	0,07	0,15	0,08	-0,01	0,18
160	0,10	0,26	0,22	0,21	-0,02	0,15	0,16	0,14	0,02	0,05	0,18	0,10	-0,03	0,28
240	0,22	0,39	0,52	0,44	0,05	0,26	0,34		0,09	0,20	0,29	0,22	0,00	0,37
320	0,35	0,47	0,43	0,26	0,14	0,39	0,40		0,06	0,31	0,41	0,35	0,07	0,49
400	0,51		0,66	0,42	0,24	0,51	0,58		0,24	0,46	0,60	0,49	0,22	0,63



6.1.16 Average error, Median erro and weighing error

Flow	Average Error	Median Error	weighing average Error
m³/h.	%	%	%
2	-0,58	-0,74	-0,43
5	-0,18	-0,22	-0,21
10	-0,01	-0,04	-0,03
20	0,05	0,03	0,06
40	0,05	0,06	0,07
79	0,12	0,10	0,11
119	0,12	0,12	0,13
163	0,13	0,14	0,14
245	0,26	0,26	0,27
323	0,32	0,35	0,34
398	0,46	0,50	0,48



Jesper Busk
FORCE Technology