

SIM KEY COMPARISON IN PNEUMATIC GAUGE PRESSURE FOR HIGH ACCURACY PRESSURE BALANCE UP TO 120 kPa, SIM.M.P-K6

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Abstract – This report describes the results of a pneumatic pressure standards key comparison among nine SIM National Metrology Institutes in order to determine their degree of equivalence in the pressure range from 10 kPa to 120 kPa in gauge mode. The pilot laboratory was the Centro Nacional de Metrología (CENAM, Mexico). All participating institutes used pneumatic pressure balances as their pressure standard. The transfer standard was a complete system including a pressure balance with a free-deformational piston-cylinder assembly and a set of masses. Eleven participants completed their measurements, although, only nine laboratories reported the pressure-dependent effective areas of the transfer standard at specified pressures with the associated uncertainties. NRC/Canada and BSJ/Jamaica withdrew the comparison by not sending their measurements. The results of the eight laboratories that sent their results were linked to the CCM.P-K6 comparison through the reference values provided by NIST, USA. The degrees of equivalence were evaluated by the relative deviations of the participants' results from those obtained by NIST. The results of six participating NMIs agree with the NIST reference values within their expanded uncertainties ($k=2$) in the entire pressure range from 10 kPa to 120.

Keywords: Comparison, pressure balances.

1. INTRODUCTION.

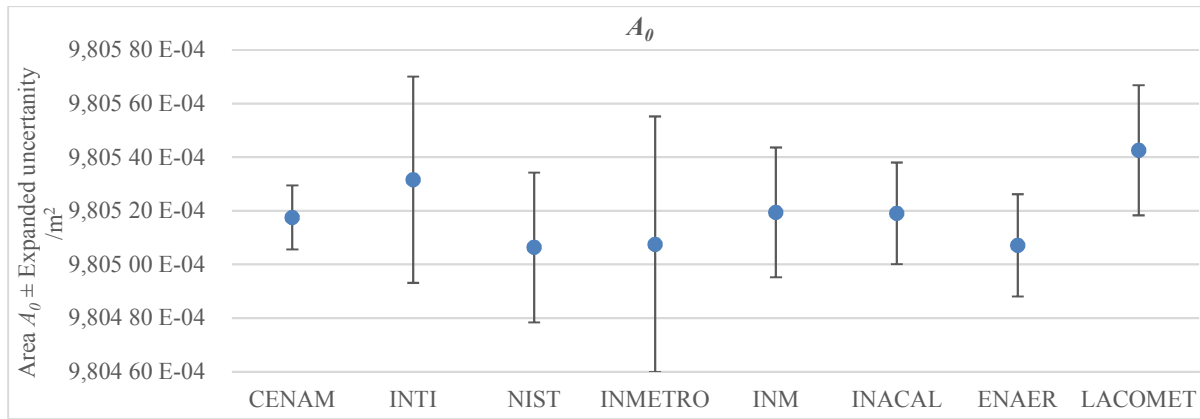
This comparison aimed to obtain the equivalence statements into SIM region derived from CCM key Comparison CCM.P-K6, in the range from 10 kPa to 120 kPa, in pneumatic gauge pressure. This comparison will provide the means to the laboratories to support their uncertainty statements given in their CMC Tables. The number of participants was eleven, three NMI from NORAMET, two from CAMET, one from CARIMET, two from ANDIMET and three from SURAMET. NRC/Canada and BSJ/Jamaica withdrew the comparison by not sending their measurements. The Centro Nacional de Metrología (CENAM), Mexico, was the pilot laboratory in this comparison. The Technical Protocol, prepared in accordance with the Guidelines for CIPM Key Comparisons, specified the procedure followed for the comparison.

2. MEASUREMENTS RESULTS

Table 1 and graph 1 present the results for A_0 and its corresponding expanded uncertainty for each participating NMI, m^2 . In table 1, laboratories in italics did not calculate A_0 (INMETRO, INM and CENAMEP). In order to compare results CENAM made the calculations by means of the lineal regression method. INMETRO used 23 °C as reference temperature. In order to better compare, results for this laboratory, a temperature correction was used to transfer their results to 20 °C reference temperature, as outlined in the Comparison Protocol.

Table 1. TS A_0 and its corresponding expanded uncertainty as obtained by each NMI, m^2 .

	A_0 / m^2	UA_0 / m^2	$b / 1/Pa$	$Ub / 1/Pa$
CENAM	9.805 18 E-04	1.2E-08	6.1E-11	2.7E-11
INTI	9.805 32 E-04	3.8E-08	-2.0E-10	9.7E-11
NIST	9.805 06 E-04	2.8E-08	0.0E+00	0.0E+00
<i>INMETRO</i>	9.805 07 E-04	4.8E-08	-9.0E-11	1.2E-10
<i>INM</i>	9.805 19 E-04	2.4E-08	5.5E-12	1.5E-11
INACAL	9.805 19 E-04	1.9E-08	-2.4E-14	3.2E-11
ENAER	9.805 07 E-04	1.9E-08	5.7E-11	1.9E-11
LACOMET	9.805 43 E-04	2.4E-08	-1.0E-07	4.8E-08
<i>CENAMEP AIP</i>	9.814 72 E-04	7.9E-07	2.4E-13	1.1E-08



Graph 1. TS A_0 and its corresponding expanded uncertainty as obtained by each NMI, m^2 .
For clarity, CENAMEP is not included.

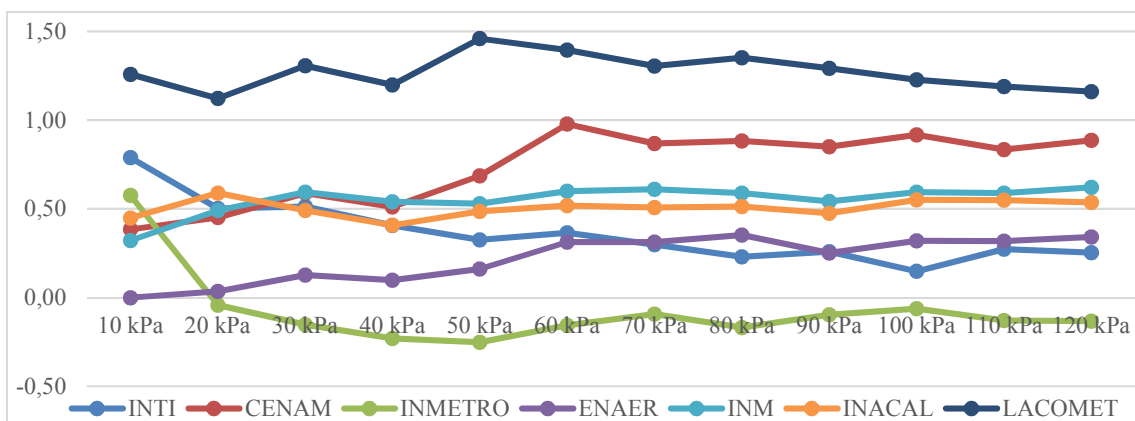
3. EVALUATION OF RESULTS AND CONCLUSIONS

For evaluation of the NMIs performance the normalized error equation (En) criteria was applied to their TS effective area results. Table 2 and graph 2 present the results of the normalized error equation. In this SIM comparison, 11 laboratories participated. From those, two did not send their measurement results (NRC/Canada and BSJ/ Jamaica). From the eight

laboratories which sent their results, six laboratories have compatibility of their results with the reference values provided by NIST, as it can be seen in graph 2 as well as in table 2. One laboratory (LACOMET) is just out of the compatibility zone (between 1 and 1.5) and one laboratory (CENAMEP) has no compatibility with the reference values or with those results of the other participating laboratories.

Table 2. Normalized error equation values of participating NMIs with respect to the reference (NIST) for Area (A_0).

NMI	10 kPa	20 kPa	30 kPa	40 kPa	50 kPa	60 kPa	70 kPa	80 kPa	90 kPa	100 kPa	110 kPa	120 kPa
INTI	0.79	0.50	0.51	0.41	0.33	0.37	0.30	0.23	0.26	0.15	0.27	0.25
CENAM	0.38	0.45	0.59	0.51	0.69	0.98	0.87	0.88	0.85	0.92	0.83	0.89
INMETRO	0.58	-0.04	-0.15	-0.23	-0.25	-0.16	-0.09	-0.17	-0.10	-0.06	-0.13	-0.13
ENAER	---	0.04	0.13	0.10	0.16	0.31	0.31	0.35	0.25	0.32	0.32	0.34
INM	0.32	0.49	0.60	0.54	0.53	0.60	0.61	0.59	0.54	0.59	0.59	0.62
INACAL	0.45	0.59	0.49	0.41	0.49	0.52	0.51	0.51	0.48	0.55	0.55	0.54
LACOMET	1.3	1.1	1.3	1.2	1.5	1.40	1.3	1.3	1.3	1.2	1.2	1.2
CENAMEP	98	28	29	34	43	56	64	730	81	94	103	112



Graph 2. Participating laboratories normalized error equation results with respect to NIST's reference values. For clarity, CENAMEP is not included.

REFERENCES

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