Pressure Metrology in Mexico

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ABSTRACT. The National Metrology Centre of Mexico (Centro Nacional de Metrologia, CENAM) has five years of formal operation. Within this period, CENAM has installed four pressure laboratories which allow to carry out calibrations for the complete pressure range of the Mexican industry needs. The four laboratories that have been developed are:

a) vacuum (from high to low vacuum, down to 1 x 10^{-5} Pa).

b) barometric pressure (up to 120 kPa).

c) low pressure (up to 7 MPa in relative and absolute modes).

d) medium and high pressure (up to 500 MPa).

In these laboratories there have been set up primary standards, which are the national standards for traceability, as well as working standards for external calibration services.

This document presents the Mexican efforts been carried out to ensure formal pressure metrology application and assure the traceability chain for the quantity of pressure in Mexico. General results of the comparisons held and uncertainty of the pressure measurements performed at CENAM are here presented as well as the classification of the accredited secondary laboratories in Mexico.

1. Introduction.

Mexico joined the Meter Convention on 30th December 1890, with the purpose of warranting uniformity and equivalence in measurements for technical and commercial activities.

The National Accreditation System was initiated on 9th June 1980. The accreditation system is integrated by CENAM, the secondary laboratories and other experts.

CENAM was founded in July the 1st 1992. The Centre initiated operations officially in April 1994. CENAM is a government institution depending on the Ministry of Commerce and Industry.

The Force and Pressure Metrology Division (at CENAM) is the one responsible for the standards of absolute pressure, relative pressure and vacuum.

2. Pressure laboratories.

Deadweight balances for absolute and relative pressure are used to cover a measuring range starting from 2,5 kPa up to 500 MPa.

In these laboratories it is possible to make measurements and calibrations by cross floating or direct comparison having gas or liquid as pressure fluids.

2.1 Mercury Barometer. CNM-HG-6.

The new Mexican mercury barometer, called CNM-HG-6, is a type U mercury column, with a measuring range from 1 kPa to 120 kPa of absolute, relative and differential pressure with a measuring uncertainty (with $k = 2$) of ±1 Pa.

This mercury column uses an interferometric laser system to measure the height difference generated by the unknown pressure. The design makes possible the operation of the instrument in manual and automatic mode. In order to improve the operation of the system and the stability of the

measurements, the original design (which is Italian) was modified.

3. Vacuum laboratories.

The transfer standards vacuum laboratory has a measuring range from 1 x 10^{-5} Pa to 100 kPa by using the direct comparison method. The range is covered with an uncertainty of ±0,001 R. up to ±0,000 05 R. The standards used are a spinning rotor gage [SRG] (with a measuring range from 1 x 10^{-5} Pa up to 1 Pa) and a set of three capacitance diaphragm gages [CDG] (with measuring ranges of 1 Pa to 100 Pa, 100 Pa to 10 kPa and 1 kPa to 100 kPa).

3.1 Medium and High Vacuum Primary Standard. CNM-SEE-1.

The new Mexican vacuum primary standard, called CNM-SEE-1, is based on the static expansion technique. The standard covers medium and high vacuum measuring ranges from 1 x 10^{-6}Pa to 1 x 10^{3}Pa of absolute pressure with an estimated uncertainty (with k = 2) from ±0,008 R. up to ±0,000 5 R.

The CNM-SEE-1 consists of four vacuum chambers of know volumes. Two small volumes of 0,5 L and 1 L and two expansion chambers of 50 L and 100 L, this vacuum standard is the first LatinAmerica.

4. Accredited Secondary Pressure Laboratories.

To guarantee the adequate national traceability for industry, CENAM offers calibration services, mainly to secondary laboratories. To fulfil this activity in a better way, the pressure secondary laboratories have been classified into three groups (according to their standards used, environmental conditions, type of work and uncertainty of measurements). Up to now, there are 21 secondary pressure laboratories accredited.

To ensure national homogeneity, two national comparisons have been performed among the accredited

secondary pressure laboratories, with CENAM as the pilot laboratory.

4.1 Comparisons among Pressure Secondary Laboratories.

Two comparisons among the pressure secondary laboratories in relative pressure (7 MPa and 35 MPa) have been carried out. A digital manometer and a pressure balance (deadweights) were used as comparison standards, respectively.

The results obtained show that an acceptable state of concordance has been achieved among Mexican secondary laboratories.

4.1.1 Comparison up to 7 MPa.

The widest spread measurement range in industry and secondary laboratories is 7 MPa. The first national comparison was made in this range. The comparison standard used had a zero derive of 20 kPa in a 10 weeks period.

In this comparison 6 secondary laboratories level II participated.

Standard used for the Comparison.

Type:	Digital manometer.
Manufacturer:	METRON.
Measurement range:	7 MPa (1 000 psi) relative pressure.
Accuracy Class: (according to manufacturer)	±0,001 F. S. Resolution, 7 kPa (1 psi).
Operation fluid:	Air.

4.1.2 Comparison up to 35 MPa.

In this comparison all 4 laboratories level I participated.

Standard used for the comparison.

Type:	Pressure balance (deadweight).
Manufacturer:	AMETEK
Measurement range:	0,7 MPa to 35 MPa (100 to 5 000 psi) relative pressure.

Accuracy Class: (according to manufacturer)	±0,000 25 R. from 10% to 90% of the measuring range.
Operation fluid:	Distilled water.

4.2 Uncertainty Evaluation.

In order to evaluate the uncertainty of the measurements during calibrations and/or comparisons, secondary laboratories have to consider, at least, the following sources of uncertainty:

- Reference standard used for the measurement, including: effective area, masses, gravity acceleration, fluid column.
- Measurements repeatability.
- Comparison standard threshold (discrimination).

The calibration uncertainty is evaluated by following the recommendations of the **Guide ISO-IEC-BIPM-OIML/TAG4/WG3, 1995** *"Guide to the Expression of Uncertainty in Measurement".*

5.International Comparisons.

In order to achieve international homogeneity, we have carried out several international comparisons with other National Laboratories (e.g. Germany {PTB}, USA {NIST}, France {BNM-LNE}, China {NIM}, SIM {InterAmerican Metrology System}).

One is now under way within SIM, having CENAM as the pilot laboratory, the measuring range is up to 100 MPa using oil as the manometric fluid.

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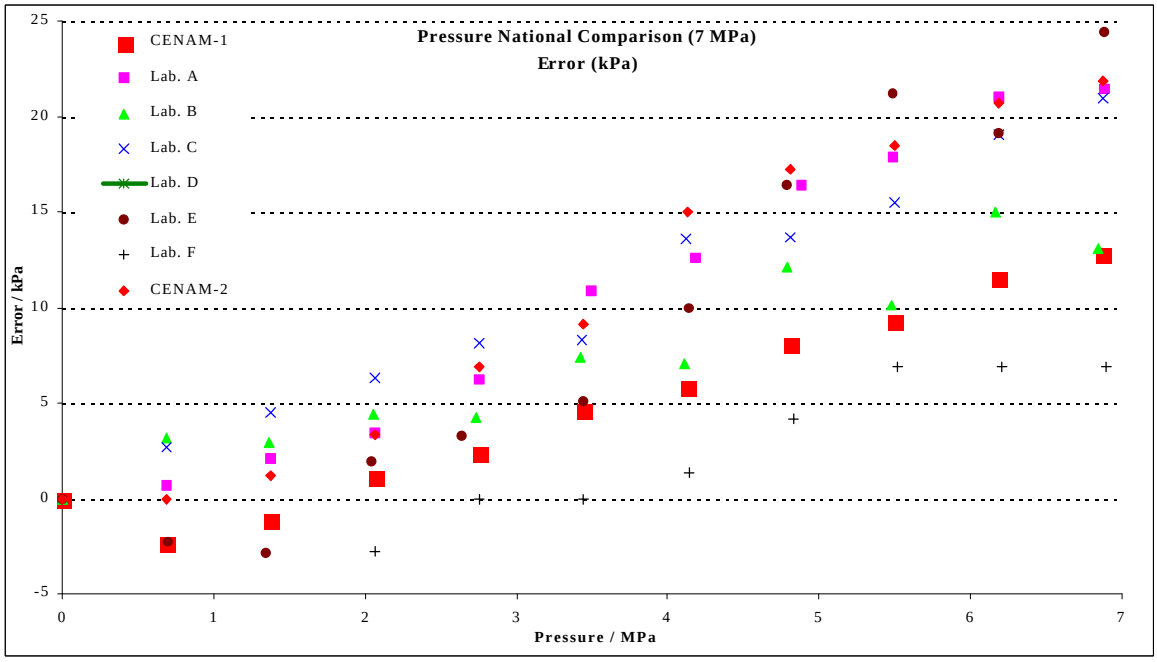

FIGURE 1. Mexican national comparison among secondary accredited laboratories, up to 7 MPa.

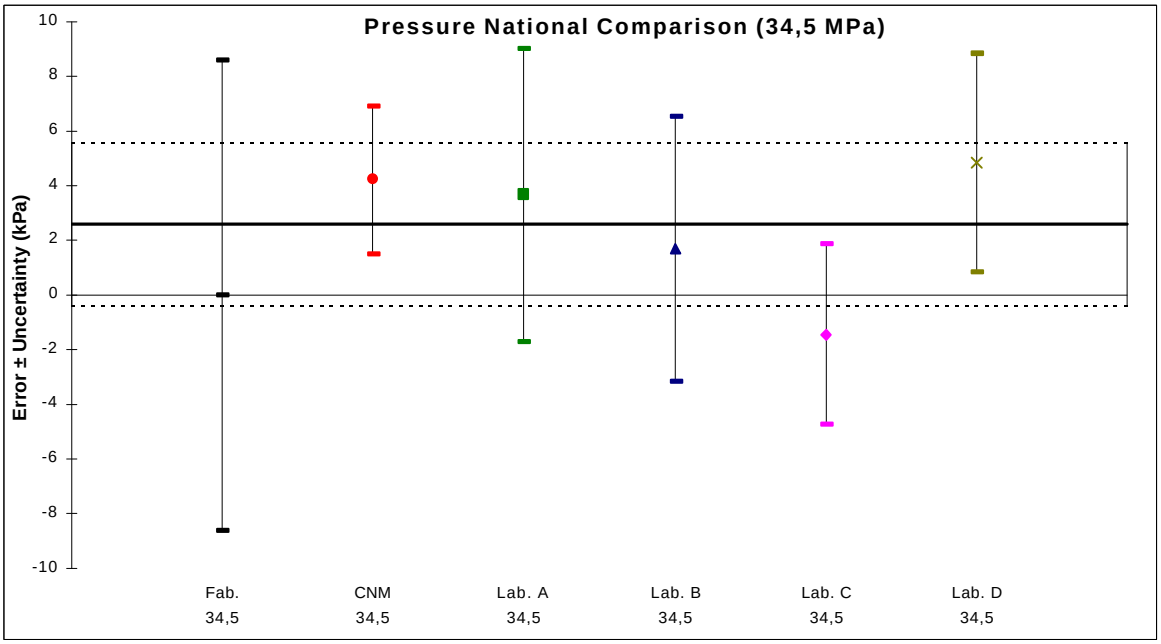

FIGURE 2. Mexican national comparison among secondary accredited laboratories, up to 35 MPa.