XXI IMEKO World Congress "Measurement in Research and Industry"
August 30 - September 4, 2015, Prague, Czech Republic

DIGITAL MANOMETER CALIBRATION PROFICIENCY TEST FOR NEGATIVE PRESSURE FROM -7 kPa TO -70 kPa.

Torres-Guzmán J. C.[1], *Aranzolo Suárez J.*[2]

[1]Centro Nacional de Metrología, CENAM. El Marqués, Querétaro, México. e-mail: jorge.torres@cenam.mx
[2]Centro Nacional de Metrología, CENAM. El Marques, Querétaro, México. e-mail: jaranzol@cenam.mx

Abstract – A proficiency test, PT, was performed in Mexico among pressure calibration laboratories. The proficiency test was carried out in negative pressure from -7 kPa to -70 kPa. The PT was promoted by the Mexican accreditation body (EMA). CENAM, the Mexican national metrology institute, was the pilot laboratory. In this proficiency test 18 laboratories participated. The results compatibility was analyzed by means of the normalized error equation and all laboratories obtain results within +1 and -1.

Keywords: proficiency test, calibration, negative pressure, digital manometer.

1. INTRODUCTION

To support the Assessment Subcommittee of Temperature, Pressure and Humidity, the Mexican accreditation body, EMA, asked CENAM to organize a proficiency test on the calibration of a negative digital manometer from -7 kPa up to -70 kPa as a transfer standard [1, 2]. This proficiency test was coordinated and piloted by CENAM as the primary laboratory of the National Calibration System (SNC) of Mexico.

The measurements for this proficiency test were performed from August, 2013 to February, 2014, with the participation of 18 laboratories. The transfer standard was calibrated four times by the pilot laboratory, at the beginning and end of the test, and two intermediate calibrations.

The proficiency test purpose was to determine the concordance proximity from the calibration results of a digital pneumatic manometer, among the participating laboratories of the National Calibration System (SNC) in respect to the reference values provided [3, 4, and 5]. The reference values were proposed by the pilot laboratory, CENAM. In this test, the measurand of the calibration was the error and the expanded uncertainty.

2. CHARACTERISTICS OF THE PROFICIENCY TEST

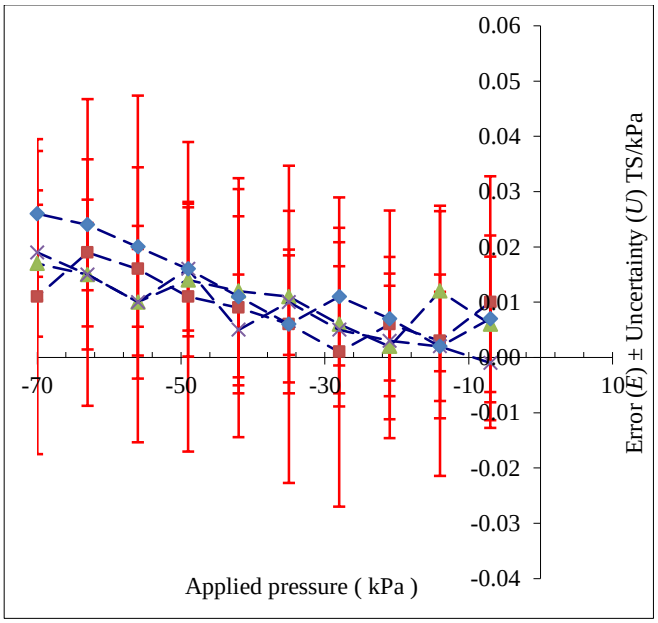
The participating laboratories were Mexican accredited or in the process of accreditation with measurement systems that allow the calibration of pneumatic manometers where the measurand is the error and uncertainty in an interval of indications from -7 kPa to -70 kPa.

The manometer that was used as a transfer standard (TS) was a Crystal, nV-4AA/nv-10KPSI with interval indications from -7 kPa to -70 kPa.

In the measurement method performed for this proficiency test 10 points were considered as pressure target points. All points were to be measured in an ascending and descending order, to complete a cycle. A total of 2 cycles were measured. The measuring pressure target points were (-7, -14, -21, -28, -35, -42, -49, -56, -63 and -70) kPa.

Graph 1 shows the behavior of the transfer standard during the period of this proficiency test, according to the four calibrations performed by CENAM. The maximum difference of the error found for the transfer standard in the 4 calibrations made by CENAM was less than 0.015 kPa.

The transfer standard (TS) had adequate performance during the period of measurements for this proficiency test since good reproducibility is observed among the four calibrations made by CENAM.



Graph 1. Behavior of the transfer standard.
Results of the 4 calibrations performed by CENAM.

3. PARTICIPANTS

The participating laboratories were all Mexican secondary pressure calibration laboratories.

The participating laboratories were located in different cities all around the Country.

In Table 1 the names of the participating laboratories in this proficiency test are included.

Table 1. Participating laboratories.

Name of the Laboratory
Certis Metría, S. A. de C. V.
MIDE, Metrología Integral y Desarrollo, S. A. de C. V.
CFE, LAPEM
Laboratorio de SECMETH
Centro de Validaciones y Calibraciones de Occidente, S. A. de C. V
Endress Hauser México, S. A. de C. V.
CISSET, S. A. de C. V.
Seico Soluciones Integrales, S. A. de C. V .
Metrología y Sistemas, S. A. de C. V.
Centro de Calibración y Pruebas - UT
Centro de Investigación Científica de Yucatán, A. C.
Metrotecnia, S. A. de C. V.
Compañía Mexicana de Servicios Ambientales, S. A. de C. V.
Validación y Metrología
Mundologic de México, S. A. de C. V.
Servicios Integrales de Calibración, S. A. de C. V.
Metrotecnica Industrial S. A. de C. V.
Mundo Metrológico

4. RESULTS

The results of the calibrations made to the transfer standard were required to be the error for each measuring pressure target point and the uncertainty assigned to it.

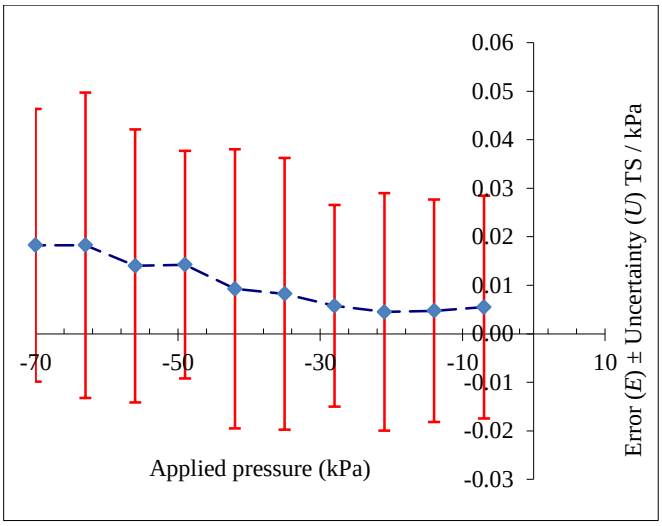
The results found by the participating laboratories were to be compared to the reference values assigned by CENAM by means of the Normalized Error Equation Method [6].

The reference values considered for this proficiency test were:

a) Error: the average of the obtained errors in the four calibrations performed by CENAM;
b) Measurement uncertainty: the maximum expanded uncertainty estimated for each point of measurement from the four calibrations, combined with the dispersion of values of the transfer standard during the whole test found for each pressure measuring target point, from the four calibrations made by CENAM.

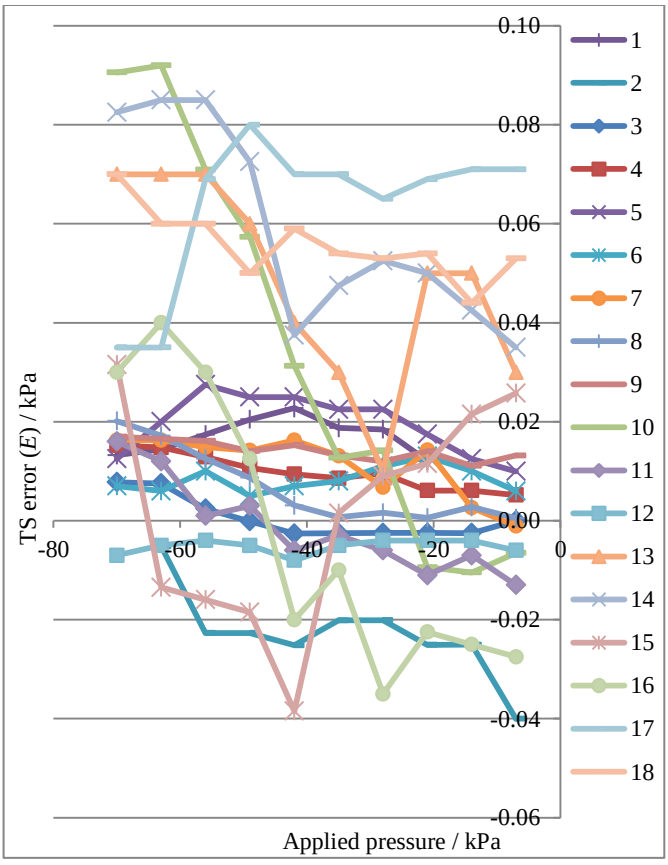
The Graph 2 shows the reference values for the error and the uncertainty of the transfer standard (TS) assigned by CENAM.

These reference values are set according to the results of the four calibrations made by CENAM, shown in Graph 1, and the considerations for error and uncertainty mentioned in this paragraph.



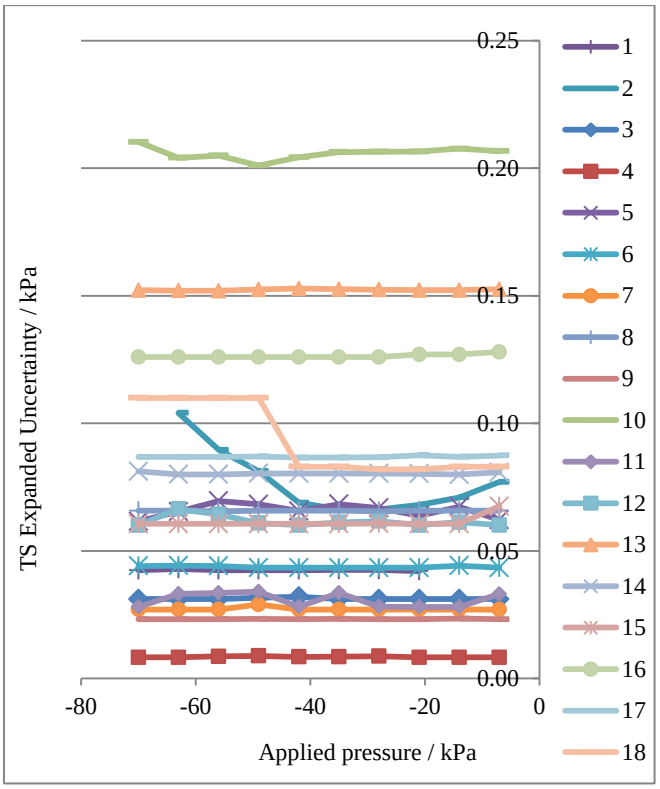
Graph 2. Reference error and uncertainty assigned by CENAM to the transfer standard, in kPa.

Graph 3 shows the errors assigned to the transfer standard by each participating laboratory.



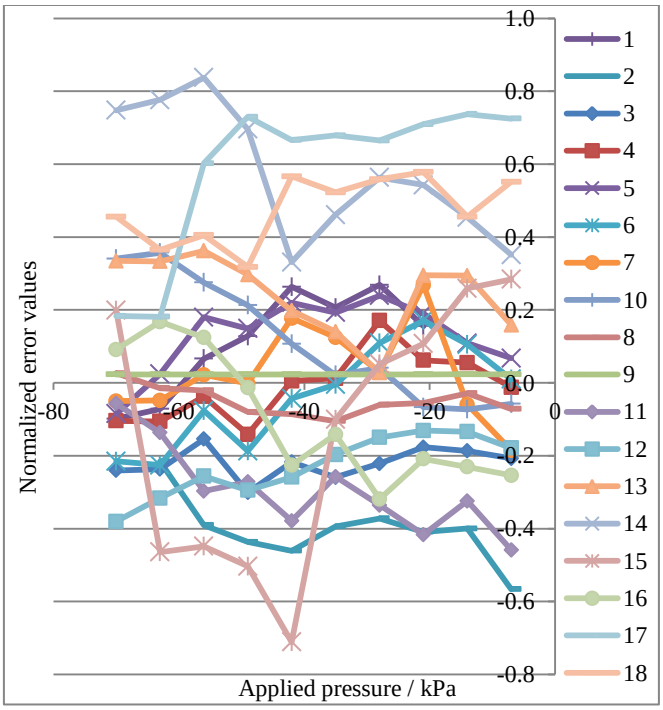
Graph 3. Errors of the transfer standard found by the participating laboratories for the TS, in Pa.

The expanded uncertainty assigned to the transfer standard (TS) by the laboratories is presented in Graph 4.



Graph 4. Expanded uncertainty assigned to the TS by the participating laboratories.

As mentioned at the beginning of this section, the performance of the laboratories in this PT were to be analyzed by means of the Normalized Error Equation Method (E_n). Graph 5 presents the values of E_n obtained by each laboratory for each measurement pressure target point.



Graph 5. Normalized error values of the participating laboratories. Values of E_n.

5. CONCLUSIONS

During the development of the proficiency test, the transfer standard had good reproducibility; therefore it was appropriate for the purposes of the test.

The reference uncertainty was reliable, since it was considered as CENAM´s greatest uncertainty (from the 4 calibrations performed) and the maximum difference in the errors, from each measurement point, was included as uncertainty due to dispersion in the combined uncertainty.

We can conclude that this proficiency test had a very good turnout, with 18 laboratories participating in the test.

All the laboratories obtained normalized errors E_n in the interval within -1 to +1, indicating good comparability of their results with the reference values assigned for this proficiency test.

This proficiency test is part of CENAM´s continues effort to homogenize measurement and calibration results of the Mexican secondary calibration laboratories.

CENAM will continue to perform such proficiency tests as well as training programs and advice sessions for Mexican secondary pressure calibration laboratories in order to improve their measurement quality and to increase their results reliability.

ACKNOWLEDGEMENTS

We thank the collaboration of Francisco Flores, who is part of the Pressure Team at CENAM. We appreciate the support received from EMA (the Mexican accreditation body) for promoting this proficiency test.

Finally, we thank the participating laboratories for their dedication, effort and for complying with the program of this proficiency test.

REFERENCES

[1] ISO/IEC 17025:2005. *General requirements for the competence of testing and calibration laboratories.*

[2] ISO/IEC 17043:2010. *Conformity assessment – General requirements for proficiency testing*.

[3] Torres Guzmán J. C., "Guía y Lineamientos Generales para Comparaciones de Patrones de Medición". *Memorias del Segundo Congreso Internacional Metrocal*. Concepcion, Chile. April, 2001.

[4] Torres Guzmán J. C., Olvera P., Forastieri J., Jungman D., "Comparación de Baja Presión entre México y Argentina". *Memorias de Segundo Congreso Internacional Metrocal*. Concepcion, Chile. April, 2001.

[5] Torres Guzmán J. C., Olvera P., "Ensayo de aptitud en presión neumática, de 20 kPa A 500 kPa, para calibración de manómetros digitales". *Simposio de Metrología 2010*. Queretaro, Mexico. October 2010.

[6] Wöger, W., "Remarks on the *En* - criterion used in measurement". *PTB-Mitteilungen*, 109, 24-27 (1999).