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Torque proficiency test among accredited laboratories in Mexico

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Abstract

A torque proficiency test among accredited laboratories in Mexico was performed starting in January 2007. The main objectives of this exercise were to estimate the level of agreement for the dissemination of the quantity among laboratories and to evaluate the compatibility, including the uncertainty associated to its measurements, of the laboratories results with the set references values. The Centro Nacional de Metrologia, CENAM (Mexico) was the pilot laboratory and responsible for the coordination of this program. The maximum torque measurement for this proficiency test was 800 N·m. The torque standard TS used for the proficiency test was a torque wrench with a range up to 800 N·m. In this torque proficiency test 5 Mexican torque accredited laboratories participated. The results of the test showed good agreement among the laboratories and also with the reference values set by the national metrology institute (CENAM).

Keywords: Torque, proficiency test, accredited laboratories.

1. Introduction

Proficiency tests among accredited laboratories are carried out in order to demonstrate their performance in measuring and/or calibrating with confidence and accuracy within their declared best measurement capability [1]. The participant laboratories in this proficiency test belong to the National System of Calibration (SNC), and are torque accredited laboratories.

For this proficiency test, each laboratory carried out a calibration of a torque transfer standard (TTS), and its results were compared with the reference values set by the Mexican National Metrology Institute (CENAM). The compatibility of results was assessed by means of the normalized error equation method and according to other international exercises carried out [2, 3].

The proficiency test can be used by the accreditation body as part of the assessment processes, to evaluate the ability of the laboratories to knowledgeably carry out tasks for which its accreditation has been applied for. This test is a complement of the laboratory assessment program, being a part of it carried out by technical experts *in situ*.

2. Scope of Work

2.1 Objective

To calibrate a torque transfer standard (TTS) within the range from 50 N·m up to 800 N·m; to evaluate the conformity of the results obtained by the laboratories against the reference values.

2.2 Participating Laboratories

Table 1 shows the participating laboratories. Not all the laboratories measured the TTS up to its maximum range.

Table 1
Participating Laboratories

	Laboratory	Location
1	Servicios Profesionales de Calibración (Seprocal)	Queretaro
2	Kalibrix	Queretaro
3	Caltechnix de México	Mexico City
4	Arjessiger de México	Mexico City
5	Soluciones de Metrología (Solumetro)	Monterrey

2.3 Torque Transfer Standard

The technical characteristics of the TTS are presented in Table 2.

Table 2
Torque transfer standard data

Instrument Type:	Torquimeter (torque wrench)
Range:	0 to 813
Units:	N·m
Resolution:	0.1
Accuracy Class:	1 % of F. S.
Manufacturer:	CDI
Model:	AR-6004CF-II
Serial number:	11068039

2.4 Program Period

The proficiency test was carried out from January to September 2007.

2.5 General Guidelines and Procedure

Each participant laboratory performed its measurements according to the reviewed protocol included in the General Guidelines, prepared by CENAM [4]. Each accredited laboratory, made a calibration of the torque transfer standard (TS) in its facilities at the proposed torque target points. The readings were performed in the Clockwise (CW) direction and in the Counter Clockwise (CCW) direction.

The protocol included preloads before starting the measurements. Three preloads in 0° position, one in 90°, 180° and 270° positions were carried out. See figure 1.

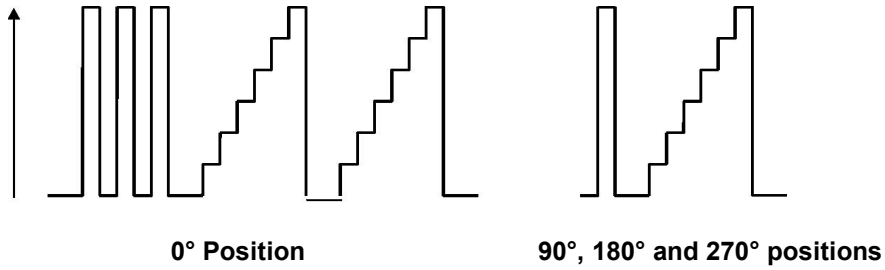

Figure 1. Torque application sequences.

Some other metrological properties such as repeatability and reproducibility were also evaluated.

All measurements made by each laboratory were entered into their own Measurement Data File and sent to the pilot laboratory for the analysis of results. The participating laboratory results were compared with the reference values.

The analysis compared only the results of measurements at the calibration points by way of the normalized error equation; no attempt from the pilot laboratory was made to find out the differences in the facilities used by the accredited laboratories.

Upon finishing the analysis of the results, a formal individual report was issued to each participant laboratory.

3. Results

The deviations against the reference values found by the participating laboratories in the calibration of the TTS are presented in a graph in figure 2. Most of the deviations found by the laboratories were below 1% of the reading; only one point of one laboratory was above 1%R for the CCW direction.

In the CW direction 2 laboratories had deviations above 1% of the reading in the low end of the range; although, one of them has best measurement capabilities declared with big uncertainties.

Only 2 laboratories were able to make the calibration up to the maximum range of 800 N·m, with the total of 6 torque target points (50 N·m, 100 N·m, 200 N·m, 400 N·m, 600 N·m and 800 N·m). Two laboratories measured the minimum permissible of 3 torque target points; they measured the low end of the proposed range.

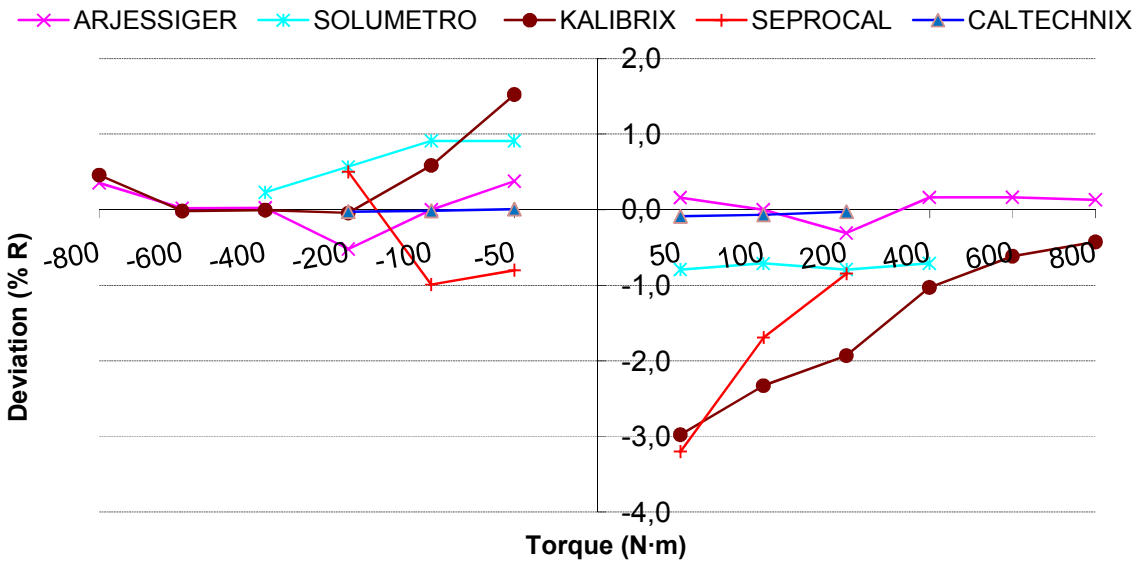

Figure 2. Deviations found by the laboratories against the reference values.

5. Discussion

The degree of equivalence between the results of the measurements made by the laboratories against the reference values was evaluated using the normalized error equation according to Equation 1.

$$E_n = \frac{E_{laboratory} - E_{CENAM}}{\sqrt{\left(U_{laboratory}\right)^2 + \left(U_{CENAM}\right)^2}} \qquad (1)$$

Where,

E_n - Normalized error calculated at each calibration pressure.
E_{CENAM} - CENAM's estimated error.
$E_{laboratory}$ - Participating laboratory's estimated error.
U_{CENAM} - CENAM's estimated expanded uncertainty.
$U_{laboratory}$ - Participating laboratory's estimated expanded uncertainty.

The results of the normalized error equation application are shown in Table 3.

Table 3
Maximum normalized error equation degree of equivalence calculated between laboratories and CENAM. CW and CCW directions

Laboratory	E_n (CW)	E_n (CCW)
Servicios Profesionales de Calibración (Seprocal)	-0.9	0.5
Kalibrix	-1.9	1.0
Caltechnix de México	0.6	0.3
Arjessiger de México	-0.6	1.0
Soluciones de Metrología (Solumetro)	-0.9	1.0

For a better view, the data presented in Table 3 is drawn in Figure 3. This figure includes all measured torque target points made by the participating laboratories. For better resolution of the graph, only the results within 1 and -1 are presented.

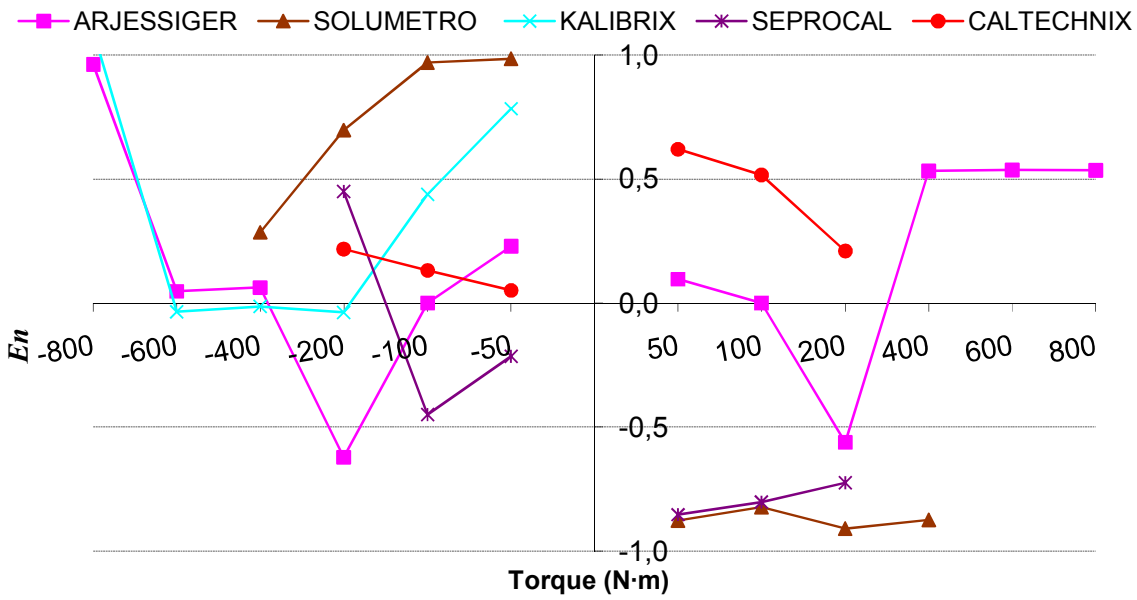

Figure 3. Graphical representation of the normalized error equation.

This graph provides a better view of the comparison results and of the equivalence of measurements among the participating laboratories.

It is important to notice that no measured torque point had a value of the normalized error equation greater than 1 (absolute value) in the CCW direction. Also, all but one of the participating laboratories had values of the normalized error equation above 1 (absolute value) for the CW direction.

Conclusions

This proficiency test constitutes the third one performed in Mexico. The participation of accredited laboratories involves at least the next technical components:

i) The standard facilities used in the calibration of the TS;
ii) The capabilities in the calibration of these TS; and
iii) The ability of the laboratory to generate technically valid results.

The normalized error equation showed to be a good tool to analyze the results. The laboratories results were in agreement with those of the reference values considering the deviations and uncertainties reported by the laboratories and accredited by the corresponding body.

Only one laboratory, and only in one of the directions tested, had values above 1 of the normalized error equation; also, no one of its measurements had a value above 2 of the normalized error equation.

There is still much work to be carried out in Mexico to achieve compatibility of results among torque secondary laboratories [5] but this exercise certainly is a good lap towards this objective.

References

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