

The torque metrology management in Brazil

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Abstract

In 2001, in order to improve the confidence level and the accuracy of the torque calibration systems in Brazil, the Force, Torque and Hardness Laboratory (Lafor/Inmetro) acquired a Torque Primary Standard Machine from 20 N·m up to 3000 N·m of nominal range, in clockwise and in anti-clockwise, where it was qualified by PTB/Germany in 2004. Since then, some steps have been done to disseminate the improved torque results to the users. The present work has the objective to demonstrate how Inmetro/Lafor is preparing to manage the torque metrology in Brazil due to the best measurement capabilities obtained and the increasing of the demand by the accredited laboratories and industries which are upgrading their torque equipment in order to get better uncertainties together with decreasing measurement costs.

Keywords: Torque traceability, torque dissemination, primary standard.

1. Introduction

The National Metrology Institutes (NMI's) have the commitment to disseminate the measurement units of *Système International* (SI) with the requested metrological reliability for their users, as well as evidencing technical competence, through the compatibility of results in key comparisons with its congeners, seeking the Mutual Recognition Agreement (MRA), coordinated by the "Bureau International des Poids et Mesures" (BIPM).

As the reference laboratory for Torque Metrology in Brazil, the "Force, Torque and Hardness Laboratory" (Lafor), that belongs to the "National Institute of Metrology, Standardization and Industrial Quality" (Inmetro), has been working in that direction.

In 2001, in order to improve the confidence level and the accuracy of the dissemination for torque measurement instruments in Brazil, the Inmetro/Lafor acquired a Torque Primary Standard Machine (TSM) with nominal range from 20 N·m up to 3000 N·m. It was qualified by PTB/Germany in 2004, where it reached the target of 0,01 % for maximum expanded uncertainty, and as a consequence, Inmetro/Lafor was able to participate in the first BIPM key comparison, occurred in 2006. The results obtained are the first step to include the Brazilian NMI on the Appendix C of the CMCs for torque measurements, what is in plan to be reached in the next year.

The implementation of the new TSM and a best measurement capability (BMC) that Inmetro could provide to the users in this field, come to attend to the torque devices improvement happened during the last few years on the field of accredited laboratories in Brazil. That happens due to the expansion of industry diversification on the field of torque application and measurement, what bring to these accredited laboratories the need for acquiring new machines and standards with higher accuracy levels.

2. Equipment and Methodology

Following, are presented the main line for the torque traceability from Inmetro/Lafor, examples of new equipment and demand, and the first steps taken to harmonization of the quantity in Brazil.

In order to detail the current situation of torque metrology in Brazil, in what refers to equipment and uncertainty budget, it's shown below the main standards used by Inmetro to disseminate the quantity to the accredited laboratories.

- a. Torque Primary Standard Machine (TSM) from 20 N·m up to 3000 N·m ($U = 0,01 \%$)
 - High sensitive transducers (4 laboratories)
- b. Reference Torque Transducers from 50 N·m up to 3000 N·m ($0,01 \% \leq U \leq 0,015 \%$)
 - Direct loading machines (6 laboratories)
 - Secondary Standards for transducer calibration
- c. Reference Torque Wrenches from 100 N·m up to 3000 N·m ($0,05 \% \leq U \leq 0,2 \%$)
 - Systems for fasteners verification (3 laboratories)
 - Secondary Standards for torque wrench calibration (21 laboratories)

Nowadays Brazil is passing through a hybrid situation, where at the same time that new equipment and standards are being acquired by accredited laboratories, there are still in use very old calibration standards for torque wrenches and transducers. From this information we can highlight some points.

These old devices, especially for torque wrench calibration, do not have such a sensitive system and don't permit (or are not allowed) a simple coupling to the TSM, and to solve this situation, the reference torque wrenches appears to be the better option to calibrate those torque systems. These special reference torque wrenches have been successful in the market because it is practical, versatile and confident transfer calibration tool. To calibrate these tools in the TSM, Inmetro acquired a special assembly (figure 01) in order to maintain and disseminate the standard uncertainty in this application still in 0,01 %.

Although nowadays there are only few laboratories using high sensitive transducers, it's a tendency that others begin using these equipments and apply them in secondary standards for torque transducers calibration, systems which are still not found in Brazil today.

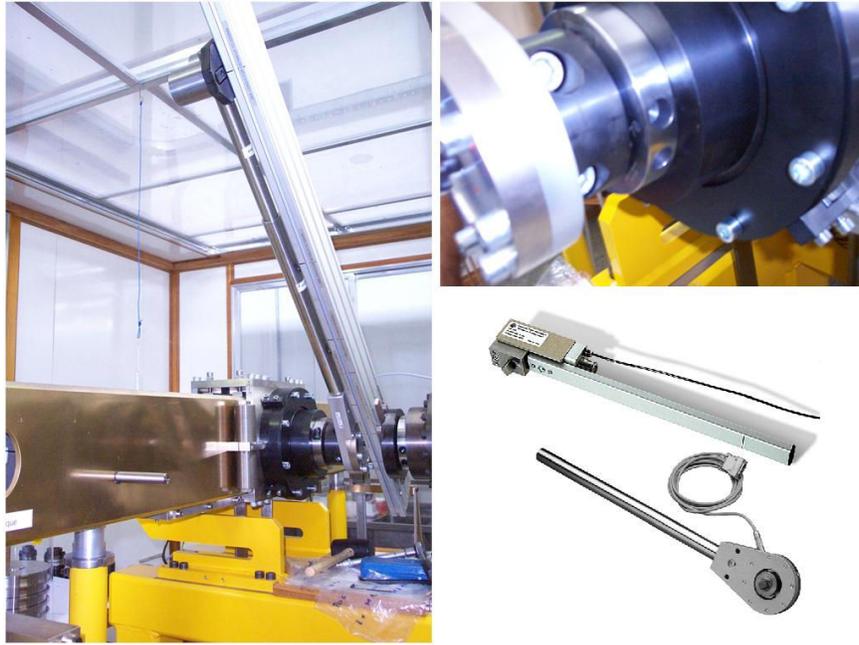


Figure 01 – System for calibration of Reference Torque Wrenches in the TSM (detail of the centralization parts and example of instruments).

With these new machine standards and torque equipments with higher accuracy levels, where in the past a good secondary standard system with classes between 0.5 and 5 ($0,1 \% \leq U \leq 1 \%$) was more than enough, now this is not very true because the new calibration equipment with undefined and interpolating scale can attend the classes 0.05 and 0.1 ($0,01 \% \leq U \leq 0,02 \%$), according to the guideline EA-10/14, what demands better primary standards and Inmetro is in that way.

Some examples can be posted to illustrate the today new torque demand in Brazil. In the industrial level is possible to perceive that new sectors has been working with generator groups or bench testing where in the electrical motors testing and in the engine combustion laboratories as well, are time to time replacing their dynamometer calibration and verification systems, that normally use lever and mass or force transducer to generate the torque, to dynamic torque transducers in line that makes the whole system more confident with minor uncertainty components and less onerous to the users. In this way besides trying to take care to provide the better values to all participant of the torque metrological traceability chain in Brazil, Inmetro also stimulates those new practices. The figure 2 shows a testing bench for combustion engines in the “Engines and Fuels Laboratory of Inmetro” (Lamoc/Inmetro) where an in line dynamic torque transducer is used to measurements.



Figure 02 – Engine test bench of Lamoc/Inmetro (in line torque transducer mounted inside)

The differences between the BMC's declared by accredited laboratories to the same type of service, for example, the calibration of torque wrenches in the range of 1000 N·m has BMC's declared from 0,06% up to 0,42%, is also a consequence of having different kinds of standards with different quality.

Considering the above mentioned, in order to establish the new torque values, Inmetro has been planning for 2008 the first national interlaboratorial comparison (ILC) in torque quantity joining all accredited laboratories in Brazil, where it should be used one artefact for each calibration service. For torque wrench calibrators, the reference torque wrench device should be used. For transducers calibration machines, a high precision reference transducer (class 0.05 or 0.1) should be the artefact. The first protocol proposal sequence of measurement should be in star type. One of the goals of this interlaboratorial comparison is provide the BMC values between the similar as well as to identify the necessities in the system improvements used in the country, that means, new characterisation of these system, mainly the ones related to direct loading machine, where the uncertainty budget definition is not so clear as it is normally done for other secondary systems that uses torque transducers as reference standards.

3. Considerations

Considering what was exposed, we can emphasize that the torque laboratory of Inmetro is bringing to the country what are the most important points in what refers to new equipment and discussions on torque metrology. Of course, things run fast and the lab is already working on the project of new standards, for instance, lower and higher range torque machines and also calibrators for torque multiplier equipments.

In the same way, as a general consequence of the interlaboratorial comparison, the Inmetro/Lafor will generate a new systematic to offer characterisation service of the accredited laboratories torque systems, where should be used the high sensitive reference transducers.

Because of this identified demand in Brazil today for new and modern torque systems for medium and high capacity, that requires the improvement of the reference torque value to be disseminate to the users, there is a great

necessity to review the standard guides and develop new ones with more accurate information to use these equipments, as well to calibrate them.

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