Interlaboratory comparison

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Abstract - This paper presents the results of the "Inter-laboratory comparison" in the pressure field. The comparison refers to the manometers with elastic element, in air, in the range (0 … 2.5) bar. The pilot laboratory was National Institute of Metrology, and the participated laboratories were from industry companies. The main goal was to demonstrate the capabilities of the industry laboratories and competence of these laboratories to supply pressure unit.

I. Introduction

Requirements in the quality assurance and traceability assurance of the standards involve with environmental condition are necessary but not sufficient for properly function of the industrial metrology laboratory.
For a proper development of the activities in a metrology laboratory, beyond the technical requirements, an important role consists in selection of the standards and adequate specific procedures.
Another aspect of the problem consist in the way to solve experimental results, and finally, especially for the users, the content and layout of the certificate of calibration.
All these aspects can be solved only inside of the inter-laboratory comparison. In this paper we will analyze the results obtain in an inter-laboratory comparison in the pressure field.

II. Conditions to progress the inter-laboratory comparison

Inter-laboratory comparison, initiated by the reference laboratory as a pilot laboratory, involves 8 industrial laboratories; each laboratory received a specific code: from B.1.1 to B.1.8 and these codes were used for the final data processing [1].
In the inter-laboratory comparison was chosen a manometer with elastic element, in air, in the range (0 … 2.5) bar, as a transfer standard. From the beginning the guide procedure [1] was created by the authors to create the framework of the inter-laboratory comparison. In order to create conditions for the calibration it was created a unique calibration procedure [2], with method of calibration and standards used. The methods of processing the experimental dates were added in another procedure [3].
As a measuring method was chosen direct comparison of the indications of the transfer standard with the indications of the pressure calibrator or with the pressures reproduced by the pressure balance, depending of the existent instrumentation in each laboratory.
Comparison was made at least 8 points, approximate uniformly distributed in the range. Each laboratory has the possibility to choose another pressure sequence, up to 11 points.

III. Results

The study presents briefly processing results of the comparison and the measurement uncertainties associated with measurement results received from 6 of 8 participant laboratories. These results are shown in figures 1, 2 and 3. Finally, we calculated the values of the coefficients E_i for each laboratory to provide compatibility level between the each laboratory and the pilot laboratory. Compatibility level or calibration equivalence performed by participant laboratories are established by the difference between the results of two participant laboratories it must be smaller than extended uncertainty associated with these differences [4; 6]. The value coefficients E_i calculated for each laboratory is shown in figure 4.

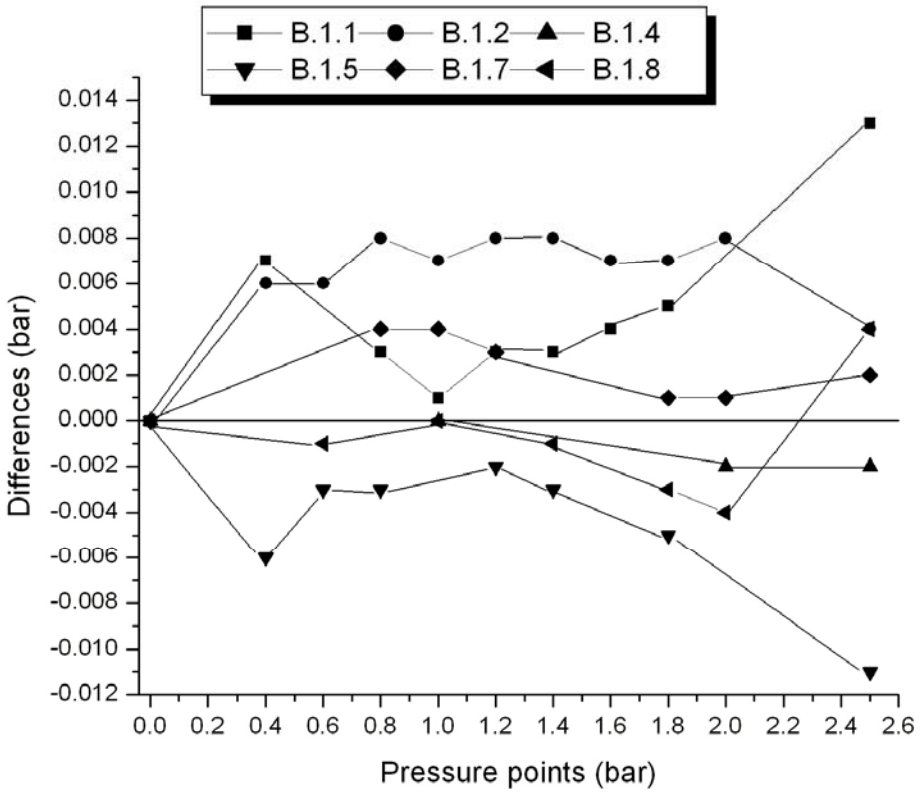

Figure 1 - Differences between pilot laboratory and industrial metrology laboratories

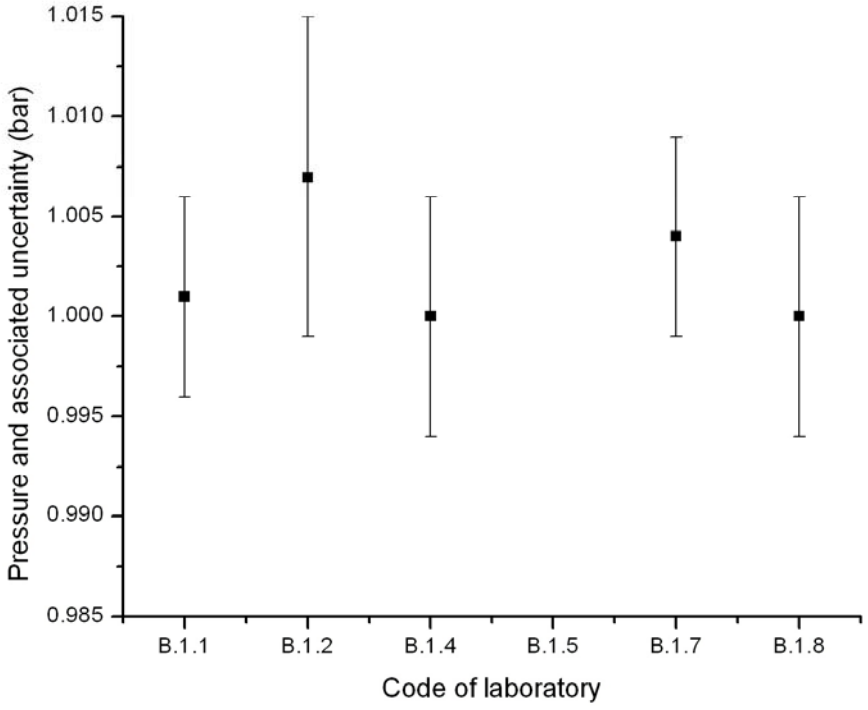

Figure 2 – Associated uncertainty for pressure point of 1.0 bar

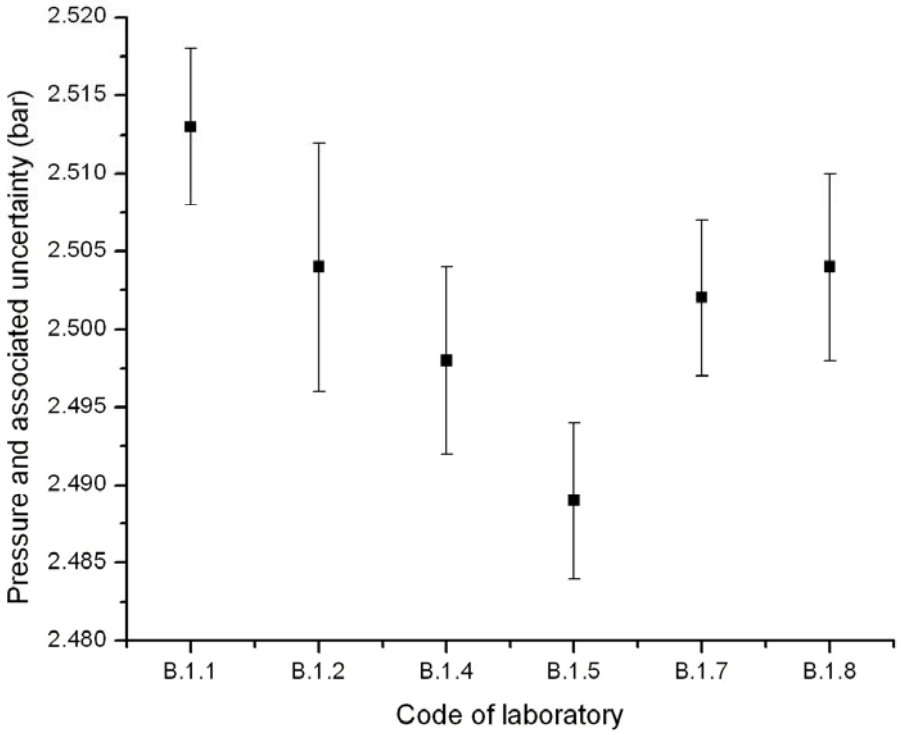

Figure 3 – Associated uncertainty for pressure point of 2.5 bar

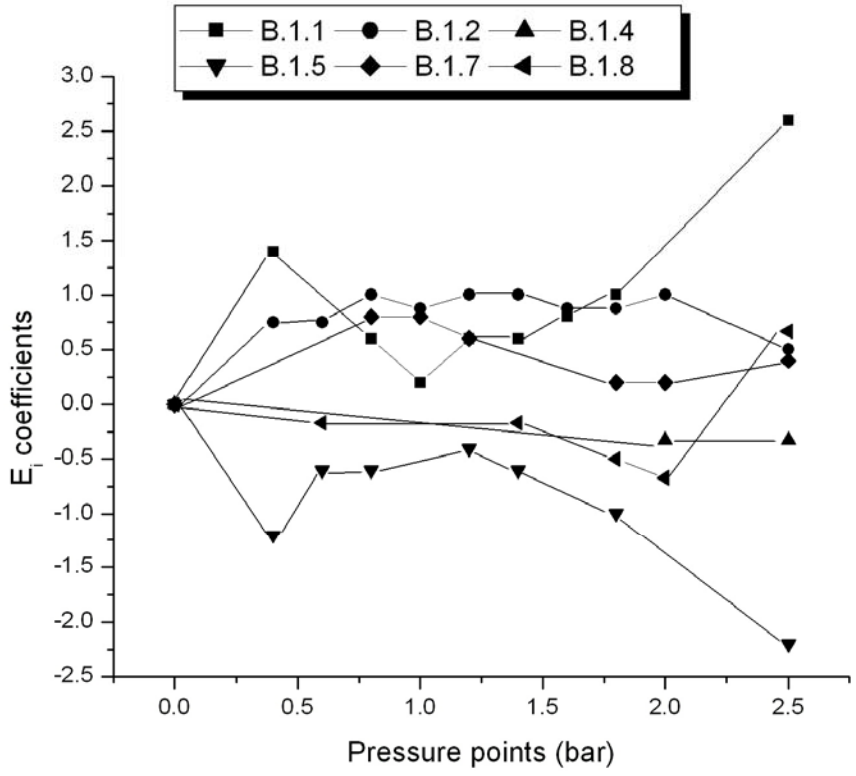

Figure 4 - E_i coefficients for each participant laboratory

IV. Conclusion

The main goal of the inter-laboratory comparison consists in testing the competence of the participant laboratories in dissemination of the pressure unit using manometers with elastic sensing element the way in that the measurement results and associated measurement uncertainties are calculated and reported. Individual result, reported by each participant laboratory, characterizes compatibility between the participant laboratory and pilot laboratory, which is in terms of the value coefficient E_i [1]:

$$E_i = \frac{x_i - x_{ref}}{\sqrt{\left(U_i^2 + U_{ref}^2\right)}} \tag{1}$$

where:

E_i is the value coefficient of the *i* laboratory;
x_i is the value of the transfer standard obtain by the *i* laboratory;
x_{ref} is the value of the transfer standard obtain by the reference laboratory;
U_i is the extended uncertainty evaluated by the *i* laboratory;
U_{ref} is the extended uncertainty evaluated by the reference laboratory;
i is the code for the each participant laboratory.

Each laboratory had the possibility to choose the value of points from the pressure sequence. From this reason, some of the laboratories chosen partially or integrally the calibration points use by the pilot laboratory. This fact didn't influence the quality of the final results shown in figure 4.
The E_i value coefficients obtain in this inter-laboratory comparison for the participant laboratories which provide, in schedule time, the valid results, is in the range [-2.2; +2.6]. The qualifying value for the E_i coefficient is in the range [-1; +1], which means a good compatibility between the pilot laboratory and participant laboratories. Considering these aspects, participant laboratories with code B.1.2, B.1.4, B.1.7 and B.1.8 are compatible with the pilot laboratory. The participant laboratories with code B.1.1 and B.1.5 are not compatible with the pilot laboratory.

References

[1] PC 01-05 *"Guide procedure for inter-laboratory comparison"*, National Institute of Metrology;
[2] PE 01-05 *"Calibration of the manometers with elastic sensing element – fluid air"*, National Institute of Metrology;
[3] PCI 01-05 *"Methods of calibration uncertainty calculus on the manometers with elastic sensing elements - fluid air"*, National Institute of Metrology;
[4] ISO ENV 13005:1999 *Guide to the expression of uncertainty in measurement (GUM)*;
[5] *International Vocabulary of basic and general terms in metrology (VIM);*
[6] EA-4/02 *"Expression of the Uncertainty of Measurement in Calibration"* , 1999.