PARTICIPATION IN A NATIONAL INTERLABORATORY COMPARISON IN THE FIELD OF MASS MEASUREMENT, BIM-MM-M-2017-02

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Abstract: This report presents the results of the participation of Mechanical and Physicochemical Measurements, Metrology Assurance Department, Kozloduy NPP plc, in the national interlaboratory comparison BIM-MM-M-2017-02 for calibration of weights which was held in the period 15.01.2018 - 12.03.2018.

Key words: interlaboratory comparison, subject of the comparison, reference laboratory, reference value, normalization of deviation of each laboratory's result toward the reference value

1. Introduction

The interlaboratory comparison is organized by the Bulgarian Institute for Metrology (BIM), DG National Centre of Metrology (NCM), Mechanical Measurements Department, Mass Measurement.

The main goal of our participation in the interlaboratory comparison is to prove competence and build confidence for the results of the measurements in the clients of the laboratory for calibration in the field of mass measurement by comparing the results of our measurements and the results of the reference laboratory with a follow-up analysis and identification of measures, if necessary, for work quality improvement (correction of the best uncertainty (CMC) stated by the laboratory for the corresponding values, etc.)

2. Participants

Five accredited and non-accredited laboratories took part in the comparison.

3. Subject of the comparison

The subject is selected by the reference laboratory so that it ensures a small enough uncertainty of the reference value, covering the capabilities (CMC) of all participants in the comparison.

The travelling standard consists of five reference weights with nominal values 2 g, 200 g, 1 kg , 5 kg and 20 kg, density 7950 kg/m³ ± 140 kg/m³, manufacturer - Russia.

The stability of the travelling standard was tested in the reference laboratory and it was determined that it is good enough for the comparison's purposes. The method used to determine the reference values is a method of direct comparison between the mass of the calibrated weights and the mass of the reference weights with the same nominal values of higher accuracy level with an appropriate uncertainty.

4. Reference laboratory

4.1. Measurement results

The reference values, XREF, are determined by the reference laboratory and represent an arithmetic mean value of the performed measurements for each nominal value before and after the ones of the participating laboratories.

The results of the two measurements show that the stability of the travelling standard is enough for the period of the comparison. The obtained uncertainties of the reference values are good enough for the purposes of the comparison.

4.2. Uncertainty of the measurement

The reference value combined root square uncertainty is calculated in compliance with EA-4/02 Evaluation of the Uncertainty of Measurement in Calibration and is calculated according to the formula:

$$u_{\mathrm{REF}} = \sqrt{u^2\left(X_{\mathrm{REF}}\right) + u^2\left(X_{\mathrm{STAB}}\right)}, \qquad (1)$$

whereas

$u(X_{\mathrm{REF}})$ - measurement uncertainty of the reference laboratory;

$u(X_{\mathrm{STAB}})$ - contribution of uncertainty from the travelling standard's stability for the period in which the comparison is performed.

The expanded uncertainty of the reference value is:

$$U_{\mathrm{REF}} = 2 \cdot u_{\mathrm{REF}} \qquad (2)$$

5.Measurement and result processing

For the calibration of weights the Mechanical and Physicochemical Measurements Laboratory uses a comparative method of measurement adhering to all the instructions for performing the measurement which are included in the technical report, [1], and the requirements of the technical description of the travelling standard, and the results are processed in compliance with the methodology for calibration of weights of the laboratory.

The expanded uncertainty from a measurement is calculated as a product of the combined root square uncertainty and the coverage factor k=2, which for normal distribution corresponds to an interval of 95% level of confidence.

It contains contributions of uncertainty from:

• reference weight;

• drift of the reference weight;

• the difference between the conventional mass of the standard and that of the calibrated weight;

• the corrections due to the scale.

The contribution of the buoyant force of the air is not taken into account because it is negligibly low for the calibrated weights.

6. Criterion for comparison results evaluation

The evaluation of the results of the participating laboratories is performed through the criterion of the normalized deviation, En, which is calculated in compliance with БДС ISO/IEC 17043.

The criterion represents the normalized deviation of the result of each laboratory towards the reference value.

En is calculated according to the formula:

$$E_n = \frac{X_{LAB} - X_{REF}}{\sqrt{U_{LAB}^2 + U_{REF}^2}} \qquad (3)$$

whereas

X_{LAB} - value of the conventional mass of each weight obtained by the participating laboratory;

X_{REF} - reference value of the conventional mass of each weight obtained by the reference laboratory;

U_{LAB} - expanded uncertainty of the result of the participating laboratory for the relevant weight;

U_{REF} - expanded uncertainty of the reference value for the relevant weight.

At fulfilment of the condition $|En| \leq 1{,}0$ the result of the comparison for the relevant participating laboratory is considered satisfactory.

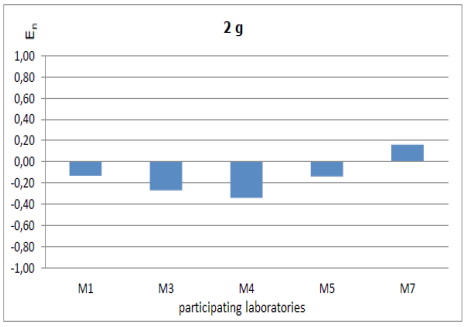
When $|En| > 1{,}0$ – the result of the comparison is considered unsatisfactory.

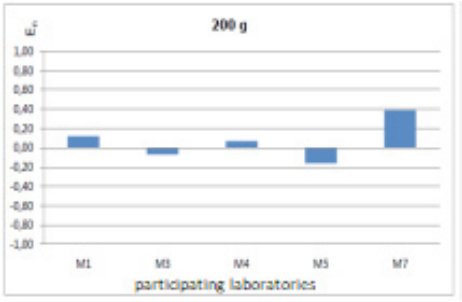
7. Results of the comparison

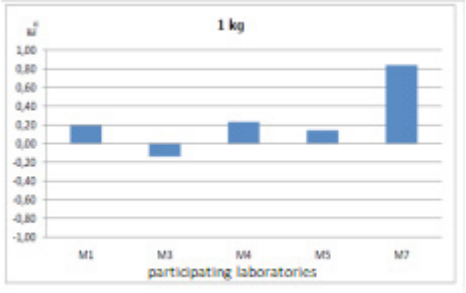
The participants in the comparison are identified randomly with codes M1, M3, M5, M7 and M4.

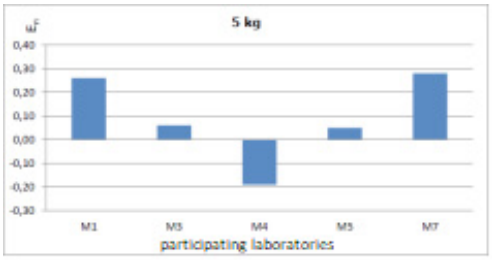
Mechanical and Physicochemical Measurements Laboratory is identified with M4.

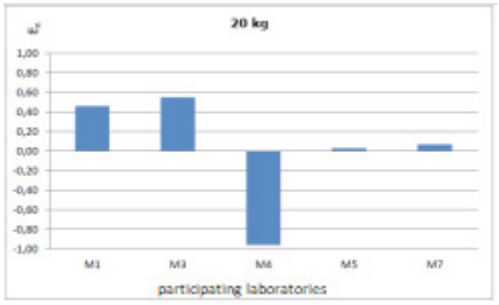
The results, according to the reports presented by the participants, reference values, En for each calibrated weight, are announced in the final report/ 16.04.2018 of the testing for serviceability through interlaboratory comparison BIM-MM-M-2017-02 for calibration of weights, [2], and presented graphically as follows:











8. Conclusion

Five laboratories took part in the interlaboratory comparison for calibration of weights.

The results of Mechanical and Physicochemical Measurements Laboratory fulfil the criterion for a satisfactory result $|En| \leq 1$ for all calibrated weights.

For some weights the obtained uncertainties during the measurements differ from the published capabilities of the laboratory for the corresponding nominal value and this became a reason for a re-evaluation of the stated CMC and for an analysis of the used mathematical model.

9. References

[1] Technical report of interlaboratory comparison BIM-MM-M-2017-02

[2] BIM, DG National Centre of Metrology, Final report/ 16.04.2018 of the testing for serviceability through interlaboratory comparison BIM-MM-M-2017-02 for calibration of weights

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