STABILITY OF THE METROLOGICAL CHARACTERISTICS OF THE MASS COMPARATOR HRP 200.4Y.KO

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STABILITATEA CARACTERISTICILOR METROLOGICE ALE COMPARATORULUI DE MASĂ HRP 200.4Y.KO

Rezumat. Caracteristicile metrologice ale aparatelor de măsurat sunt caracteristicile care se referă la comportarea aparatului de măsurat în raport cu obiectul supus măsurării, cu mediul ambiant și cu operatorul uman. Astfel, având aceleași condiții în laborator și un personal bine instruit și competent, se studiază stabilitatea caracteristicilor metrologice ale comparatorului de masă pentru a demonstra stabilitatea acestuia în timp și a oferi o încredere sporită beneficiarilor ulteriori. Măsurările propriu-zise au fost efectuate pe perioada unui an în aceleași condiții, rezultatele acestora demonstrând că comparatorul de masă HRP 200.4Y.KO este capabil să asigure trasabilitatea unității de măsură.

Cuvinte-cheie: comparator de masă, caracteristici metrologice, stabilitate, cântărire.

Summary. The metrological characteristics of the measuring devices are the characteristics that refer to the behavior of the measuring device in relation to the object under measurement, the environment and the human operator. Thus, having the same conditions in the laboratory and a well-trained and competent staff, the stability of the metrological characteristics of the mass comparator is studied in order to demonstrate its stability over time and provide increased confidence to subsequent beneficiaries. The actual measurements were carried out over a period of one year under the same conditions, their results proving that the mass comparator HRP 200.4Y.KO is capable of ensuring the traceability of the measurement unit.

Keywords: mass comparator, metrological characteristics, stability, weighing.

INTRODUCTION

It is impossible to imagine how humanity would have lived without clocks, scales, meters, medical equipment and other means of measurement. Every activity in our life involves, to some extent, different means of measurement. We are already so used to them that we see them as something natural [1]. In order for the measurements in our lives to be accurate and traceable in any corner of the world, the means of measurement with which they are carried out are subject to checks, comparisons, calibrations.

Ensuring metrological traceability [2], as follows from theory and practice, from the recommendations of international metrology organizations, is constituted by the national standards of the measurement units, the existence of which in any state represents integral parts of economic sovereignty and independence.

In the Republic of Moldova, the National Metrology Institute maintains the National Standards, appro-

ved by decisions of the Ministry of Economy, upon the recommendation of the National Metrology Council. National standards are the source of metrological traceability for the measurement units that they materialize and reproduce. These are either primary achievements of the unit - situation in which they are directly compared to international primary achievements of the same kind, or secondary achievements - situation in which they are periodically calibrated in relation to primary standards owned by BIPM or other signatory National Institutes of Metrology of the Mutual Recognition Arrangement of National Standards and Calibration and Measurement Certificates of the International Committee for Weights and Measures [3], VIPM MRA.

MATERIALS AND METHODS

Comparators [4] are used both to ensure the traceability of measurements and to verify weights, in accordance with the principles of legal metrology.

The HRP comparator (figure 1) allows checking, calibrating and standardizing mass weights in accordance with OIML recommendations (R-111), with a maximum value of up to 200 kg for class F2, from 100 kg. up to 200 kg for class M1, from 50 kg up to 200 kg for class M2.

Mass comparators are made up of two components. The component containing the electronic module is connected to the high-precision measuring system. The separation of the two components ensures an isolation of the measurement system from the heating phenomenon of the electronic module.

Figure 1. Mass comparator, type HRP 200.4Y.KO [4].

The turntable is equipped with a self-centering system for the weights.

The HRP series features an intuitive menu that is easy for the user to use during instrument operation.

The technical data [5] of the Mass Comparator HRP 200.4Y.KO are presented in the table 1.

To perform measurements with the mass comparator HRP 200.4Y.KO [4], the direct measurement method is used in the „Flows and Volumes" laboratory. The direct measurement method [6] is a method by which the value of a mearurements is obtained directly, without performing additional calculations and

Table 1

Technical data of the mass comparator HRP 200.4Y.KO [5]

F2	200 kg
M1	100 kg ÷ 200 kg
M2	50 kg ÷ 200 kg
Maximum capacity (Max)	210 kg
Readability	0,5 g
Repeatability	0,6 g
Stabilization time	10 s
Pan Size	800×600 mm
Electric compensation range	0 ÷ 210 kg
Adjustment	external
Sensitivity drift	2 ppm/°C in temperature +15 ÷ +35°C
Working temperature	+15 ÷ +30 °C
Working temperature change rate	±0,5°C/12h (±0,3°C/h)
Atmospheric humidity	40% ÷ 60%
Atmospheric humidity change rate	±5%/4h
IP rating	IP 67
Power supply	100 ÷ 240 V AC 50 ÷ 60 Hz

Table 2

Metrological characteristics of scales [5]

Type/Model	Measurement range, g	Division value, g	Uncertainty, g
Mass comparator, type HRP 200.4Y.KO	4,0 ÷200000,0	0,2	0,21

is based on direct comparison with the measurement unit or with the help of a device graduated in the respective units. In this type of measurement, only one measurement is determined (table 2).

RESULTS AND DISCUSSION

In the "Flows and Volumes" laboratory, measurements were carried out with the mass comparator HRP 200.4Y.KO during a year in order to analyze and research the stability of its metrological characteristics. Thus, the measurement data [7] obtained on different days, but under the same conditions, will be presented below.

a) Measurements performed on March 17, 2017, presented in table 3, figure 2.

b) Measurements performed on June 13, 2017, presented in table 4, figure 3.

c) Measurements performed on March 13, 2018, presented in table 5, figure 4

d) Measurements performed on May 11, 2018, presented in table 6, figure 5.

e) Measurements performed on August 28, 2018, presented in table 7, figure 6.

Table 3

The values received as a result of the measurements performed on March 17, 2017 for the mass comparator, type HRP 200.4Y.KO

No.	The standard weight value, kg	Measured value before calibration (A), kg	Absolute error, kg	Measured value after calibration (B), kg	Absolute error, kg
1	0,02	0,0198	-0,0002	0,02	0,0000
2	3	2,9988	-0,0012	2,999	-0,0010
3	5	4,998	-0,0020	4,9994	-0,0006
4	10	9,9966	-0,0034	9,9996	-0,0004
5	20	19,9938	-0,0062	19,9998	-0,0002
6	30	29,9944	-0,0056	29,9989	-0,0011
7	70	69,9872	-0,0128	69,9996	-0,0004
8	100	99,9938	-0,0062	99,9996	-0,0004
9	140	139,992	-0,0080	139,9994	-0,0006
10	200	199,9924	-0,0076	199,999	-0,0010

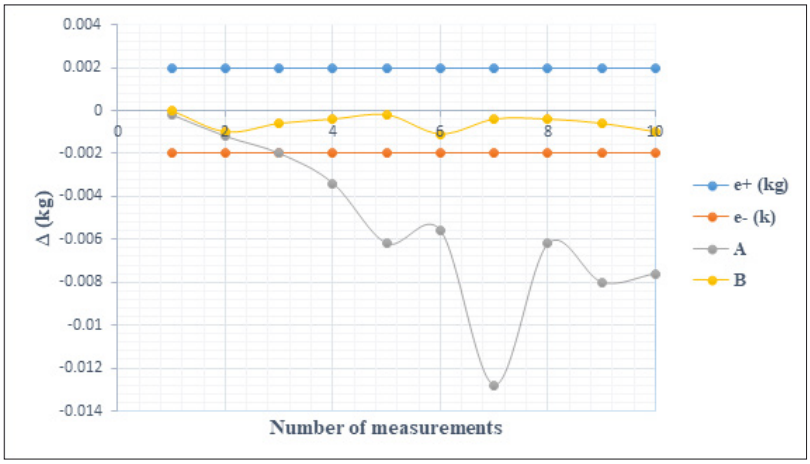

Figure 2. Graphical representation of the error curve following the measurements performed on 17.03.2017.

Table 4

The values received as a result of the measurements performed on June 13, 2017 for the mass comparator, type HRP 200.4Y.KO

No.	The standard weight value, kg	Measured value, kg	Absolute error, kg
1	0,02	0,0198	-0,0002
2	3	2,999	-0,0010
3	5	4,9996	-0,0004
4	10	9,9996	-0,0004
5	20	19,9996	-0,0004
6	30	29,9996	-0,0004
7	70	69,9993	-0,0007
8	100	99,9996	-0,0004
9	140	139,9994	-0,0006
10	200	199,9994	-0,0006

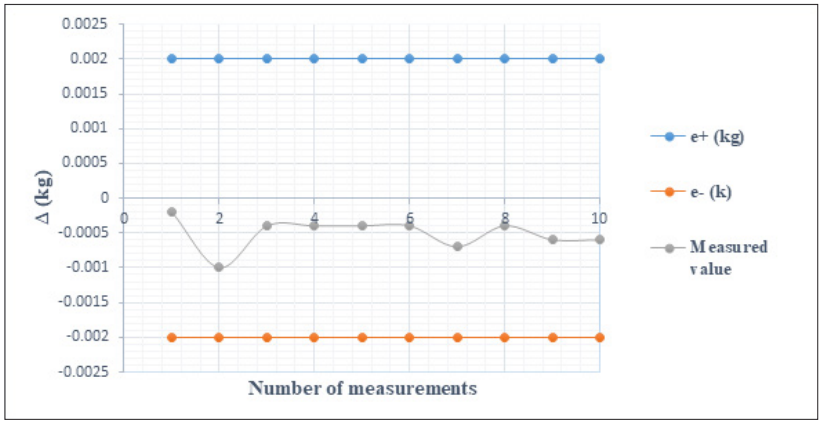

Figure 3. Graphical representation of the error curve following the measurements performed on 13.06.2017.

Table 5

The values received as a result of the measurements performed on March 13, 2018 for the mass comparator, type HRP 200.4Y.KO

No.	The standard weight value, kg	Measured value, kg	Absolute error, kg
1	1,00	1	0,0000
2	3,00	3,0004	0,0004
3	5,00	5,0002	0,0002
4	10,00	10,0002	0,0002
5	15,00	15,0004	0,0004
6	20,00	20,0002	0,0002
7	30,00	29,9986	-0,0014
8	50,00	49,9994	-0,0006
9	80,00	79,9994	-0,0006
10	100,00	99,9994	-0,0006
11	120,00	119,9992	-0,0008
12	150,00	149,9996	-0,0004
13	200,00	199,9998	-0,0002

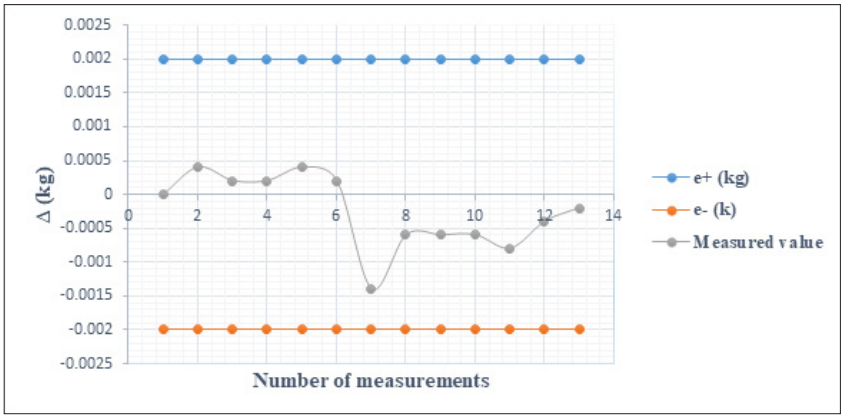

Figure 4. Graphical representation of the error curve following the measurements performed on 13.03.2018.

Table 6

The values received as a result of the measurements performed on May 11, 2018 for the mass comparator, type HRP 200.4Y.KO

No.	The standard weight value, kg	Measured value, kg	Absolute error, kg
1	1,00	1,0002	0,0002
2	3,00	3	0,0000
3	5,00	5,0004	0,0004
4	10,00	10,0008	0,0008
5	15,00	15,0006	0,0006
6	20,00	20,0006	0,0006
7	30,00	30,0012	0,0012
8	50,00	50,0008	0,0008
9	80,00	79,9996	-0,0004
10	100,00	99,9994	-0,0006
11	120,00	120,0002	0,0002
12	150,00	149,9994	-0,0006
13	200,00	199,9992	-0,0008

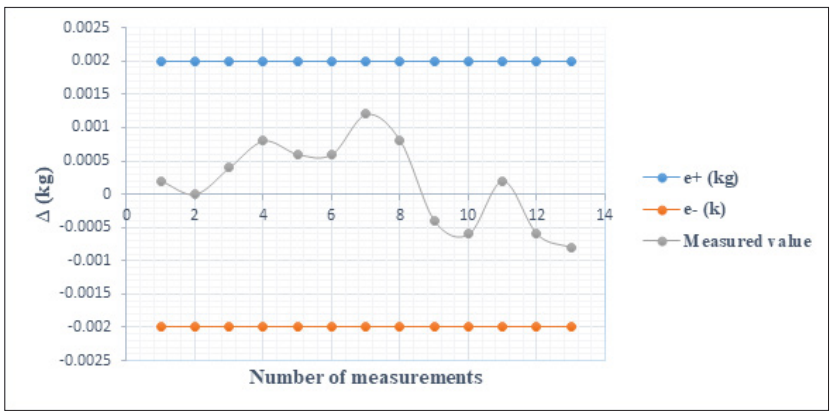

Figure 5. Graphical representation of the error curve following the measurements performed on 11.05.2018.

Table 7

The values received as a result of the measurements performed on August 28, 2018 for the mass comparator, type HRP 200.4Y.KO

No.	The standard weight value, kg	Measured value, kg	Absolute error, kg
1	1,00	1	0,0000
2	3,00	2,9998	-0,0002
3	5,00	5,0008	0,0008
4	10,00	10,0006	0,0006
5	15,00	15,0002	0,0002
6	20,00	20,0004	0,0004
7	30,00	30,0004	0,0004
8	50,00	49,9998	-0,0002
9	80,00	79,9994	-0,0006
10	100,00	99,9996	-0,0004
11	120,00	119,9992	-0,0008
12	150,00	149,9999	-0,0001
13	200,00	199,9992	-0,0008

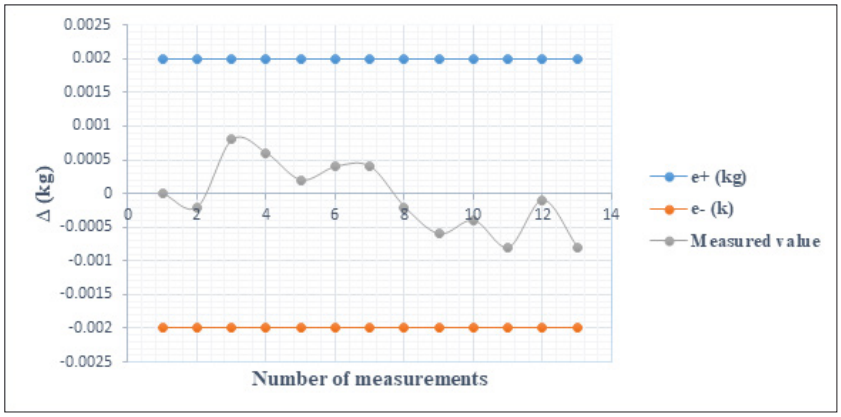

Figure 6. Graphical representation of the error curve following the measurements performed on 28.08.2018.

CONCLUSIONS

Following the measurements made with the mass comparator HRP 200.4Y.KO over a period of time, under the same conditions, it can be observed that on the first day of use of the comparator, following transport and installation in the room of the „Flow and Volume". The corrective actions that have been taken clearly demonstrate the staff's involvement in a functioning quality management system. It is understood that before the corrective actions a deep analysis and thinking process was carried out, a quality tool was used to identify the true cause of the appearance of critical results and to act specifically at the root of the problem. Laboratory, the results obtained exceed the permissible error limits of ±0.002 kg. In order to exclude this non-conformity, the calibration of the mass comparator was carried out and according to the results on the graph, the error curve after calibration fell within the admissible limits. Following the performed procedure, the mass comparator will be able to be used in the process of transmitting the measurement unit. These measurements being of high interest for the quality infrastructure of the Republic of Moldova, will allow the satisfaction of the needs of local economic agents at the moment, and, after the alignment in the European Union space, competitive measurements with partners from abroad. After calibrating the comparator, on the other days, when measurements were made with the comparator, it is observed that in the measurement range (0.004 ÷ 200.0 kg), it retains its metrological characteristics, thus, it can be used without any intervention.

These measurements demonstrate to us the stability of the comparator over time and ensure the uniformity of the measurement unit. Most important in

these measurements are not only the performance aspects of the equipment, but the philosophy of the approach by the specialists who performed the measurements. In order to get closer to good European practices, it is important to learn the true processes of management systems, which assume that continuous improvements can be achieved through adjustments, analyzes and reflections. These actions are clearly reflected in this paper.

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