Bilateral Comparison of Mass Standards

Between TÜBİTAK UME and SASO NMCC

“5 mg, 2 g, 50 g, 1 kg, 2 kg”

Final Report

GULFMET M.M-S2

(UME-KU-D3-2.4.6.b)

January 2018

Abstract

A bilateral comparison of mass standards of 5 mg, 2 g, 50 g, 1 kg and 2 kg was carried out in 2017 between TÜBİTAK UME and SASO NMCC. TÜBİTAK UME was the pilot laboratory and the transfer standards were provided by TÜBİTAK UME. For all mass standards, the results show adequate agreement between the laboratories except 1 kg and 2 g.

Table of Contents

1. Introduction

It was planned to organise a bilateral comparison on mass calibration between SASO NMCC and TÜBİTAK UME, in the frame of the Project of Development and Realization Measurement and Calibration System for the National Measurement and Calibration Center (NMCC) at Saudi Standards, Metrology and Quality Organization (SASO).

The objectives of the present bilateral comparison were to evaluate the metrological equivalence between TÜBİTAK UME and SASO NMCC and so to compare the agreement of mass measurements established between them.

The comparison was carried out using mass standards of the following five nominal values:

5 mg, 2 g, 50 g, 1 kg, 2 kg

2. Organisation

2.1. Participants

This bilateral comparison was carried out between TÜBİTAK UME, Turkey, and SASO NMCC, Saudi Arabia.

2.2. Comparison scheme

The travelling scheme was the following: TÜBİTAK UME-SASO NMCC-TÜBİTAK UME. At TÜBİTAK UME, the mass value of the transfer standards was determined two times. The measurements were used to monitor the stability of the mass standards.

2.3. Description of the transfer standards

The transfer standards supplied by TÜBİTAK UME comprised five weights made from non- magnetic stainless steel and with the form and quality recommended by OIML [1] for weights of accuracy class E_1. The transfer standards, within a purpose-built wooden box, were transported by courier between the participating laboratories.

3. Results and comparison

3.1. Stability of the transfer standards

TÜBİTAK UME mass laboratory monitored the stability of the transfer standards by measuring against their own primary mass standards. These comparisons were made at the beginning and at the end of the circulation. The results obtained are

shown in Table 1. The drift of each transfer standard is less than the standard uncertainty. Therefore, no correction was made for the drift in the transfer standards.

Table 1. The mass stability value of the mass value of the transfer standards and their uncertainties (k=2)

nominal value	on date 01.06.2017 mass value *m* *mg*	on date 23.11.2017 mass value *m* *mg*	average value *mg*	drift value *mg*	measurement uncertainty *U* (k=2) *mg*
2 kg	-1,65	-1,72	-1,69	-0,07	0,15
1 kg	-0,806	-0,806	-0,806	0,000	0,050
50 g	-0,084	-0,083	-0,084	0,001	0,003
2 g	0,0083	0,0077	0,0080	-0,0006	0,0015
5 mg	-0,0074	-0,0078	-0,0076	-0,0002	0,0004

3.2. Results reported by the participants

Tables 2 and 3 shows the mass value of the transfer standards and the uncertainties for TÜBİTAK UME, Turkey, and SASO NMCC, Saudi Arabia respectively. The participants have used the coverage factor *k*=2.

Table 2. TÜBİTAK UME results

nominal value	mass value *m* *mg*	measurement uncertainty *U*(k=2) *mg*
2 kg	-1,69	0,15
1 kg	-0,806	0,050
50 g	-0,084	0,003
2 g	0,0080	0,0015
5 mg	-0,0076	0,0004

Table 3. SASO NMCC results

nominal value	mass value *m* *mg*	measurement uncertainty *U*(k=2) *mg*
2 kg	-1,71	0,206
1 kg	-0,666	0,102
50 g	-0,087	0,006
2 g	0,002	0,0025
5 mg	-0,007	0,0006

3.3. Mass difference and uncertainty between participants and normalised deviation

Table 4 gives the mass difference and uncertainties and E_n normalised deviation between TÜBİTAK UME and SASO NMCC for the transfer standards [2].

Table 4. Difference $\Delta_{m\ SASONMCC-\ TÜBİTAKUME}$ for the transfer standards and the corresponding expanded uncertainties and normalised deviation

nominal value	mass difference $\Delta_{m\ SASONMCC-\ TÜBİTAKUME}$ *mg*	TÜBİTAK UME measurement uncertainty *U*(k=2) *mg*	SASO NMCC measurement uncertainty *U*(k=2) *mg*	normalised deviation E_n
2 kg	-0,02	0,15	0,206	**0,08**
1 kg	0,14	0,05	0,102	**1,23**
50 g	-0,003	0,003	0,006	**0,44**
2 g	0,006	0,0015	0,0025	**2,06**
5 mg	0,0006	0,0004	0,0006	**0,83**

4. Mass comparators used by the participants

Table 5 gives some information on the technical properties of the mass comparators.

Table 5. Details of the balances used for the 2 kg, 1 kg, 50 g, 2 g and 5 mg measurements

Participant	Model	Capacity	Resolution	Standard deviation
TÜBİTAK UME	Mettler UMT 5	5,1 g	0,1 µg	0,2 µg
	Sartorius C50S	50,5 g	1 µg	1,0 µg
	Sartorius C1000S	1000,5 g	1 µg	1,0 µg
	Sartorius C10000S	10050 g	100 µg	50 µg
SASO NMCC	Sartorius C10-1000	10 g	0,1 µg	0,11 µg
	Sartorius C10-1000	1 kg	1,0 µg	1,7 µg
	Mettler AX10005	10 kg	10 µg	40 µg

5. Transfer standards used in comparison

Some details of mass standards used in this comparison are given in Table 6.

Table 6. The transfer standards used for comparison

Nominal value *m*	Density *ρ*	Uncertainty *U*(k=2)
	$kg.m^{-3}$	$kg.m^{-3}$
2 kg	8047,05	1,7
1 kg	8010,1	1,3
50 g	8039,1	2,8
2 g	8042	29
5 mg	2650	5%

6. Environmental Conditions

The list of equipment used for determining air density at the time of weighing is given in Table 7.

Table 7. The equipments used for determining air density at the time of weighing

Quantity Measured	Manufacturer	Type	Range	Resolution	Uncertainty (k=1)
TÜBİTAK UME					
Temperature	Vaisala	PRT	0 – 30 °C	0,01 °C	0,05°C
Pressure	Desgranges et Huot	54028	0 – 3000 mbar	0,001 mbar	0,5 Pa
Humidity	Vaisala	38 E	30 % - 80 %	1 %	0,5 %
CO_2		Assumed 400 ppm ± 20 ppm			
SASO NMCC					
Temperature	Meteolabor	KLIMET-A30	14-26 °C	0,001 °C	0,005 °C
	Sartorius	YCM16H1	14-26 °C	0,001 °C	0,005 °C
	Sartorius	YCM16H2	14-26 °C	0,001 °C	0,005 °C
Pressure	Sartorius	YCM16P	800-1100 mbar	0,01 mbar	0,075 mbar
	Meteolabor	KLIMET-A30	800-1100 mbar	0,01 mbar	0,075 mbar
Humidity	Sartorius	YCM16H1	40 – 60%	0,1 %	0,5 %
	Sartorius	YCM16H2	40 – 60%	0,1 %	0,5 %
CO_2		-			

7. Conclusion

The result of the comparison shows agreement between TÜBİTAK UME and SASO NMCC except 1 kg and 2 g.

References

[1] OIML R-111 Weights of classes E_1, E_2, F_1, F_2, M_1, M_{1-2}, M_2, M_{2-3} and M_3, Part 1: Metrological and technical requirements, 2004.

[2] Evaluation of measurement data - Guide to the Expression of Uncertainty in Measurement (GUM), JCGM 100, First edition, September 2008(available on the

BIPMwebsite:http://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf).