MITTATEKNIIKAN KESKUS

CENTRE FOR METROLOGY AND ACCREDITATION

Julkaisu J3/2000

MASS COMPARISON M3

Comparison of 1 kg and 10 kg weights between MIKES and three FINAS accredited calibration laboratories

Kari Riski

Helsinki 2000

MITTATEKNIIKAN KESKUS
CENTRE FOR METROLOGY AND ACCREDITATION

Julkaisu J3/2000

MASS COMPARISON M3

Comparison of 1 kg and 10 kg weights
between MIKES and three FINAS accredited calibration laboratories

Kari Riski

Helsinki 2000

SUMMARY

A comparison of 1 kg and 10 kg weights between the Centre for Metrology and Accreditation (MIKES) and three accredited calibration laboratories (2 from Finland and 1 from Estonia), was carried between October and December 1999.

The agreement of the results was good. All normalized errors (E_n values) were below 0,3.

TIIVISTELMÄ

Mittatekniikan keskus (MIKES) ja kolme FINASin akkreditoimaa massan kalibrointilaboratoriota osallistuivat 1 kg:n ja 10 kg:n punnusten vertailumittaukseen. Vertailu järjestettiin loka-joulukuussa 1999.

Kaikille laboratorioille parhaasta mittauskyvystä lasketut normalisoidut virheet (E_n-arvot) olivat pienempiä kuin 0,3.

CONTENTS

MASS COMPARISON M3
Comparison of 1 kg and 10 kg weights between MIKES and three FINAS accredited calibration laboratories

1 INTRODUCTION

MIKES is responsible for the operation of national standards laboratories and for the dissemination of SI units in Finland. To find out the level of competence of calibration laboratories MIKES arrange comparisons of measurement standards. Usually accredited calibration laboratories in Finland are obliged to take part in these comparison. Comparison M3 tested the best measurement capability of calibration of 1 kg and 10 kg weights. The reference laboratory was MIKES.

During 1999 there were two FINAS accredited calibration laboratories for weights in Finland. Also in Estonia there is one laboratory accredited by FINAS.

2 STANDARDS

The mass standards used in the comparison fulfil the requirements of OIML class E_2. Their densities have been determined by hydrostatic weighing. The weights have been calibrated several times. The standards have a long history of stability.

3 PARTICIPANTS

The laboratories participating to the comparison are given in Table 1. Also the traceability of mass is given.

Table 1.

LABORATORY	FINAS NO	TRACEABILITY OF MASS	COMMENTS
MIKES		BIPM	Reference laboratory
Raute Precision Oy	K019	MIKES, PTB	
Inspecta Oy	K030	MIKES	
Metrosert SA, Tallin	K034	SP	10 kg comparison only

The scheme of the comparison was the following:
REF – LAB A – REF – LAB B – LAB C - REF.
The labels A, B and C are used just to give the order in which the laboratories took part in the comparison.

4 INSTRUCTIONS

Instructions for calibration, transport and handling of the weights are given as in an Annex to this document. No instruction for the method of calibration was given and no stabilisation time is recommended. The measurement results were asked to be given in the form of a calibration certificate. A detailed uncertainty budget was asked. The masses of the weights were to be given as conventional masses.

The measurement time for each laboratory was about two weeks.

5 RESULTS

The results for the 1 kg and 10 kg weights are shown in Tables 2 and 3. The results are also given in a grafical form in Figures 1 and 2.

Table 2. Results for the 1 kg weight.

LAB	*m*	*U*	*U*(bmc)	LAB-REF	E_n	*U*(calc)
REF	1 000 000,22 mg	0,1 mg				
LAB B	1 000 000,3 mg	1,5 mg	1,5 mg	0,07 mg	0,05	0,98 mg
LAB C	1 000 000,3 mg	0,5 mg	0,5 mg	0,07 mg	0,14	0,47 mg
REF	1 000 000,24 mg	0,1 mg				

Table 3. Results for the 10 kg weight.

LAB	*m*	*U*	*U*(bmc)	LAB-REF	E_n	*U*(calc)
REF	9 999 997,7 mg	2,0 mg				
LAB A	9 999 998,3 mg	6,6 mg	5 mg	0,6 mg	0,08	6,6 mg
REF	9 999 997,8 mg	2,0 mg				
LAB B	9 999 997 mg	20 mg	20 mg	-0,7 mg	-0,04	5,1 mg
LAB C	10 000 002 mg	15 mg	15 mg	3,3 mg	0,29	3,3 mg
REF	9 999 997,5 mg	2,0 mg				

In tables 2 and 3, *m* is conventional mass of the weight measured by the laboratory, *U* is the expanded uncertainty given in the certificate, *U*(bmc) is the smallest expanded uncertainty that the laboratory can give in certificates, it is usually called the best measurement capability (bmc), LAB-REF is the mass difference between the laboratory and reference laboratory, E_n is the normalized error for the laboratory and *U*(calc) is the separate uncertainty estimated by the laboratory. The normalized error was calculated from the formula:

$$E_n = \frac{LAB - REF}{\sqrt{U_{LAB}^2 + U_{REF}^2}}$$

For U_{LAB} the uncertainty of the calibration certificate was used. In all except one case it was equal to U(bmc). According to common rules E_n values should be less than one. When E_n values are determined from calculated uncertainties all other values except the 10 kg value of LAB B were less than 1.

A summary of the uncertainty components is given in Table 4.

Table 4. Uncertainty components and their numerical values.

LAB	A	B	C	REF
1 kg weight				
Reference weight (calibration)		0,25 mg	0,075 mg	0,04 mg
Reference weight (stability)			0,03 mg	0,02 mg
Mass difference		0,11 mg	[1)]	0,005 mg
Air Buoyancy		0,01 mg	0,003 mg	0,005 mg
Comparator		0,4 mg	0,23 mg	0,01 mg
10 kg weight				
Reference weight (calibration)	3,1 mg	2,5 mg	1 mg	0,8 mg
Reference weight (stability)	0,12 mg		0,1 mg	0,5 mg
Mass difference	0,3 mg	0,3 mg	[1)]	0,1 mg
Air Buoyancy	1 mg	0,01 mg	0,05 mg	0,01 mg
Comparator	0,1 mg	0,4 mg	1,3 mg	0,3 mg

[1)] Uncertainty component is included in the uncertainty of the comparator.

The mass comparators used in the comparison varied. Lab A used a 20 kg equal arm balance, with sensitivity 2,7 mg/scale division. Lab B used a 10 kg mass comparator with d=1 mg. Lab C used a 2 kg mass comparator with d=0,1 mg and a laboratory built 50 kg automated equal arm balance.

The number of measurements was not specified in most certificates.

6 CONCLUSIONS

The results of the comparison were satisfactory. The stability of the standards was good and no laboratory had E_n values larger than 1. Because the traceability of the 1 kg weights for LAB B and LAB C comes from MIKES the E_n values were as expected significantly less than one. Because of a new mass comparator in LAB B the calculated uncertainty is smaller than their present best measurement capability.

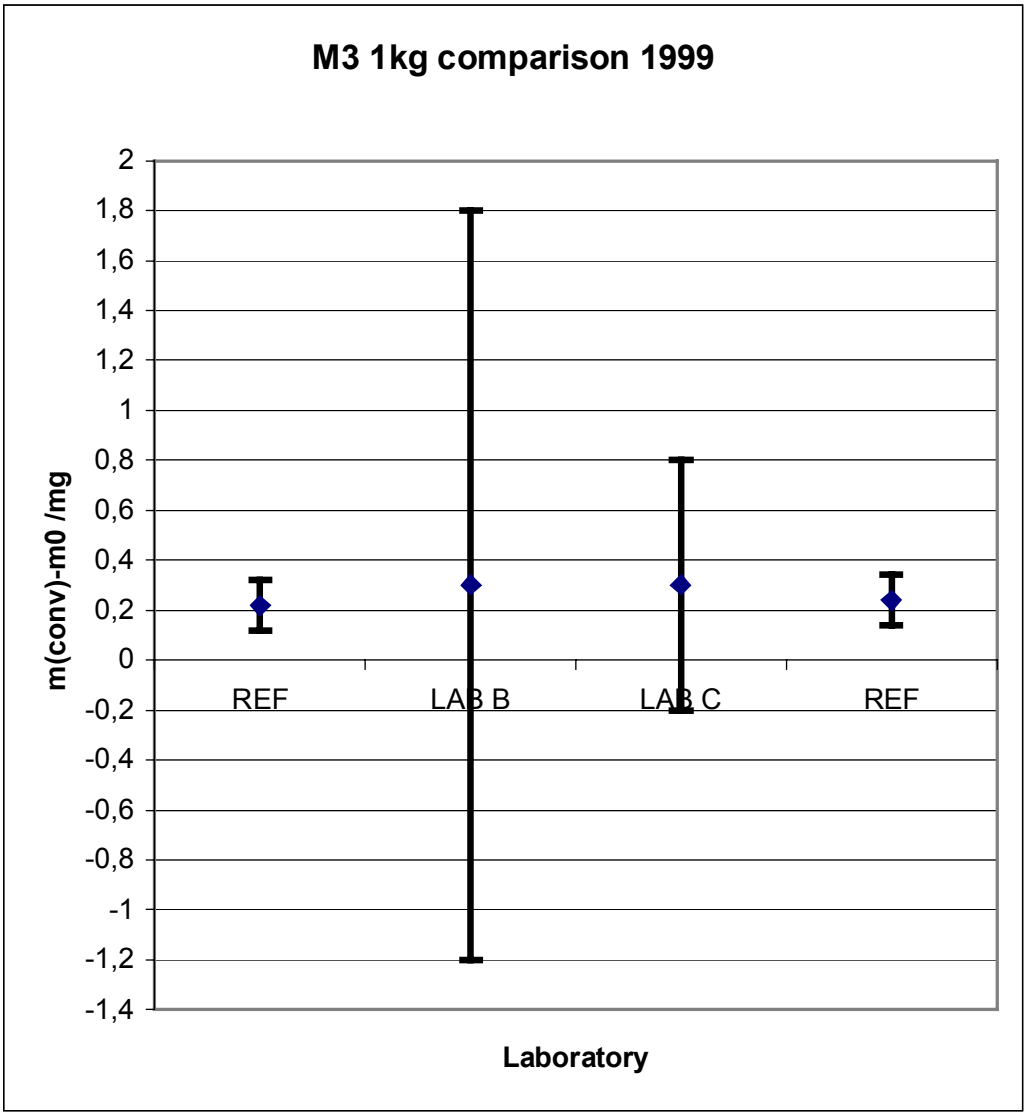
M3 1kg comparison 1999
m(conv)-m0 /mg
2
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
-0,2
-0,4
-0,6
-0,8
-1
-1,2
-1,4
REF
LAB B
LAB C
REF
Laboratory

FIG. 1.

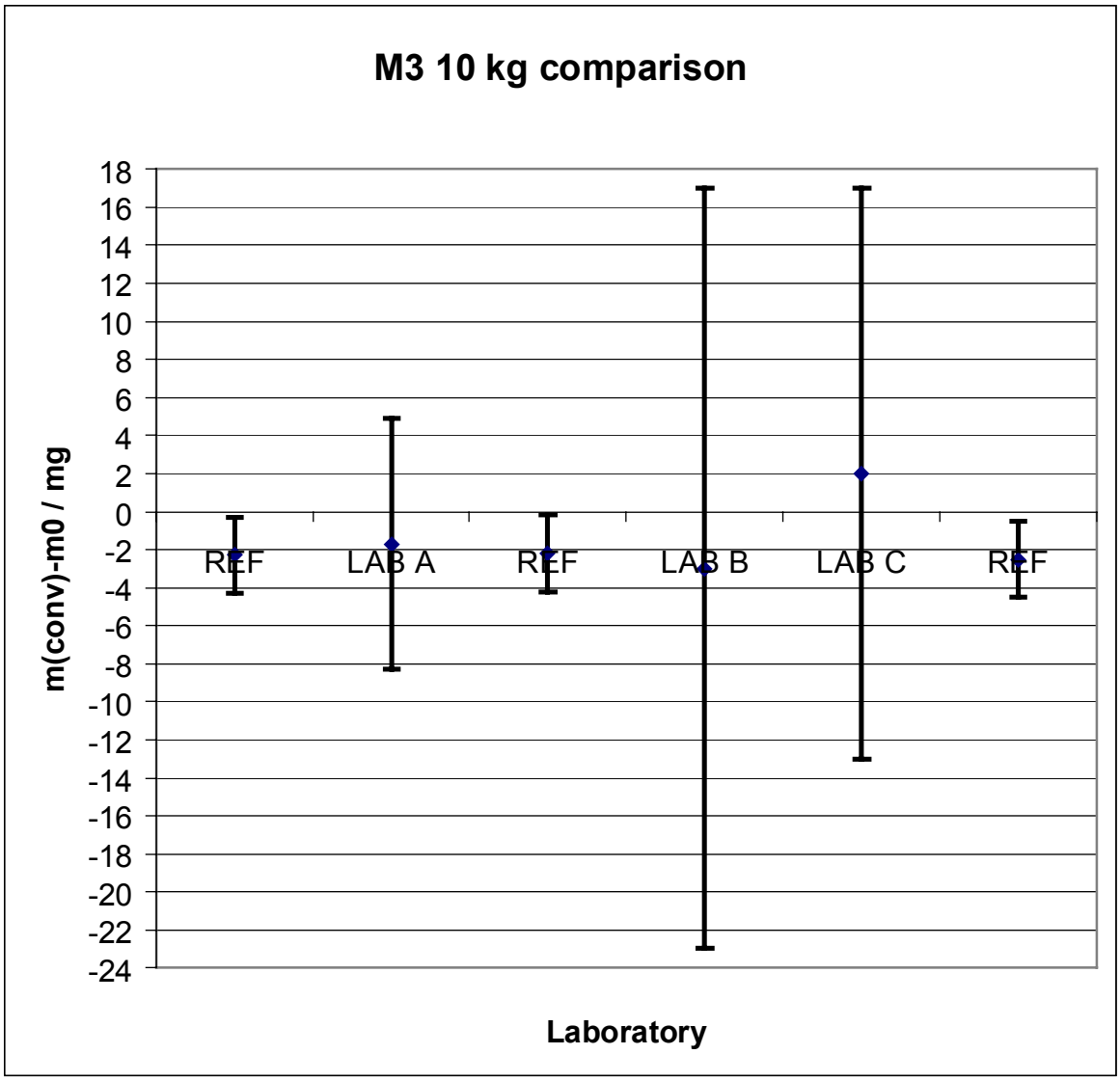

FIG. 2.

KR 9.6.2000

MITTATEKNIIKAN KESKUS
PL 239, 00181 Helsinki
Kari Riski
Puh. 6167452
Telefax. 6167467
Sähköposti: kari.riski@mikes.fi

Vertailumittaus M3
11.8.1999

Massan vertailumittauksen M3 mittausohje

Kalibroitavat punnukset: P8 1 kg ja P8 10 kg

Ominaisuudet:

Tunnus	**Nimellismassa**	**Tiheys ± epävarmuus (k=2)**
P8 1kg	1 kg	7965,8 kg/m^3 ± 0,5 kg/m^3
P8 10kg	10 kg	7957 kg/m^3 ± 3 kg/m^3

Käsittely:
- punnuksia säilytetään omissa säilytyslaatikoissaan
- punnuksia ei saa säilyttää tilassa, jonka suhteellinen kosteus on yli 60 % tai lämpötila alle + 15 /C.
- punnuksia saa nostaa vain punnusten nostoon soveltuvalla nostimilla tai puhtaalla liinalla.
- punnuksia ei saa liata eikä naarmuttaa
- punnuksia ei saa puhdistaa liuottimilla

Kuljetus:
- kuljetuksen aikana punnuslaatikkoja tulee käsitellä varovasti.
- kuljetuksen aikana punnusten lämpötila ei saa laskea ympäröivän ilman kastepisteen alapuolelle. Punnusten lämpötila ei myöskään saa laskea lämpötilan +10 °C alapuolelle.
- kuljetuksesta on sovittava erikseen Mittatekniikan keskuksen (Kari Riski tai Heikki Kajastie) kanssa
- kuljetus on järjestettävä henkilö- tai pakettiautolla

Lisätietoja: Kari Riski

Mitattavat seikat:
- punnusten konventionaalinen massa

Mittaustuloksista kirjoitetaan kalibrointitodistus, johon sisällytetään yksityiskohtaiset epävarmuuslaskelmat. Kalibrointi on tehtävä erikseen sovittavan vertailuaikataulun mukaisesti 2 viikon kuluessa punnusten saapumisesta. Kalibrointitodistus on toimitettava 2 viikon kuluessa kalibroinnin päättymisestä osoitteeseen:

Mittatekniikan keskus
FINAS
Eivor Koskinen
PL 239
00181 Helsinki

Julkaisut 1999 - 2000

J1/1999	Nordic Intercomparison in Barometric Pressure
J2/1999	Automaattisten punnustenvaihtimien suunnittelu, toteutus ja käyttö
J3/1999	Intercomparison of Gauge Pressure Measurements between SP/FFA and MIKES in the Range 32 kPa ... 132 kPa
J4/1999	Ainemäärän kansallisen mittanormaalijärjestelmän toteuttamista ja organisaatiota koskeva selvitys
J5/1999	Mikrobiologisen metrologian tilanneselvitys ja kehittämissuunnitelma
J6/1999	Finnish National Standards Laboratories FINMET. Annual Report 1998
J7/1999	Lämpötilan vertailumittaus L10, S-tyypin termoelementin kalibrointi
J8/1999	Mekaanisten värähtelyiden mittausten kartoitus
J9/1999	Intercomparison of the Hydrometer Calibration Systems at the IMGC and the MIKES
J10/1999	National Basis for Traceability in Humidity Measurements
J1/2000	Intercomparison of Temperature Standards of Lithuania and Finland
J2/2000	Finnish National Standards Laboratories FINMET. Annual Report 1999
J3/2000	Mass Comparison M3

Tilaukset toimistosihteeri Kirsi Tuomisto, puh. (09) 6167 457,
e-mail kirsi.tuomisto@mikes.fi.

MITTATEKNIIKAN KESKUS
CENTRE FOR METROLOGY AND ACCREDITATION
PL/P.O. Box 239
FIN- 00181 HELSINKI
Puh./Tel. +358 9 616 761
Telefax +358 9 616 7467

ISBN 952-5209-48-2
ISSN 1235-5704