

**SIM MWG7 - Subworking group
Mass Standards**

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**REPORT ON CCM MASS STANDARDS WORKING GROUP MEETING
BIPM - April 18, 2008**

According to the agenda prepared by Dr. Philippe Richard from METAS, new Chairman of the WGM-CCM, were treated the following main points:

1 Presentation by each group member of R&D activities developed in the field of mass standards.

1.2 Inmetro's Report of Activities for 2005-2008 period:

- Realization of the mass scale from prototype Pt-Ir
- Study of the long term stability of stainless steel mass standards.
- Extension of calibration range of standard weights up to 50 kg E₁
- Construction of an load alternator for large mass calibration up to 500 kg

It was requested that representatives tell their perception about future developments and challenges in mass metrology for national metrology institutes. Inmetro's expressed:

- Redefinition of the kilogram - Impact to metrological laboratories and users.
- Traceability in nanotechnology applications.
- Improvement of level metrological knowledge to mass measurement users in Brazil.

1.3 Activities of other NMIs

The main topics presented by members were:

1.3.1 - NMIJ-Japan:

Development of tool for determining the volume of weights using acoustic principle. For the improved version the obtained uncertainty is suitable for Classe OIML E₂ weights.

1.3.2 - NPL-UK

- Development of method of cleaning weights using UV radiation and ozone
- This method presents cleaning efetivity equivalent to other methods of cleaning and washing. It is a dry process that can be applied in air or in vacuum at room temperature.

1.3.3 - NIM-China

- Acquisition of mass comparator Mettler Toledo M-One, volume comparator and air buoyancy artefacts.
- Susceptometer for weights up to to 50 kg
- Interest in participation in the watt balance project

1.3.4 - CENAM-Mexico

Development of method for determining the gravitational gradient using artefacts.

1.3.5 - PTB-Alemanha

Metrological characterization of comparators:

- Mettler Toledo *M-One*
- Sartorius 1007 FTC (standard deviation of 0,1 µg)

1.3.6 - LNE-France

- Analysis of metal alloys for the mass to be used in watt balance experiment for redefinition of the kilogram.

- The alloys that show the best features for this application are gold-platinum.
- Developed research suggests that *Bulk Metallic Glass* (large volume vitreous metal alloys) are appropriate for manufacturing of mass standards. These metal alloys show amorphous structure that give excellent resistance to wear and corrosion and besides show low magnetic susceptibility.
- Study of characteristics of *Nickel Based* alloys. Surfaces analysis is performed using the XPS technique.
- Metrological characterization of Sartorius comparator CCL 1007 (standard deviation of 0,1 µg)

1.3.7 - BEV-Austria

Development of robotic system for calibration of weights in the range of 1 mg to 20 kg.

1.3.8 - SMU-Slovakia

Development of an automated system for calibration of weights in the range of 1 mg to 10 kg using 4 mass comparators.

1.3.9 - NIST-USA

- Performing mass comparisons in air and in vacuum.
- Study of the stability of mass standards subject to the process of *Diamond-like Carbon Coating*.
- Development of a system for mass comparison in vacuum.
- Study of using a 500 g mass in watt balance experiment.
- Development of Robotic Controller for "weighing designs," in cooperation with KRISS-Korea.
- Study of transportation of mass standards in constant pressure and in vacuum.

1.3.10 - LATU-Uruguay

- Survey of pharmaceutical industry as users of mass measurements.

- Improvement of calibration capacity for weights from 1 mg to 1 kg class E₁ and 1 kg E₀.

1.3.11 - NMISA-South Africa

Acquisition of silicon sphere and expressed interest in participation in the watt balance project (partial approach)

1.3.12 - Australia-NMIA

Measurement of silicon spheres aiming Avogadro Project.

1.3.13 - MSL-Nova Zelândia

- Study of cleaning methods for stainless steel weights.
- Study of the *Soaxlet* washing method for mass standards using ethanol.
- Determination of volume and density within an airtight chamber
- Study of oscillatory and constant speed approaches in watt balance experiment.
- Study of the application of the pressure balance principle to the watt balance experiment.

Challenges:

- Practical realization of the kilogram
- Balances for large masses

1.3.14 - INRIM-Itália

Development of nanobalance

1.3.15 - METAS-Switzerland

- Development of experiments of watt balance and silicon sphere.
- Evaluation of methods for cleaning stainless steel weights.
- Evaluation of the influence of storage conditions of mass standards.

- Study of methods for transfer of mass standards in air and in vacuum.

2 Key Comparisons

- CCM.M-K5 Mass: 200 mg, 1 g, 50 g, 200 g and 2 kg, stainless steel standards. Report in progress "Draft B".
Participants in this KC whose representatives were present at the meeting evaluated the claims of two participant laboratories.

Future key comparisons:

- CCM.M-K4 Mass: 1 kg stainless steel cylindrical format. 4 groups, 1 petal/group, 2 standards/group
- CCM.M-K6 Mass 50 kg stainless steel (Repeat of CCM.M-K3 after 10 years 2001-2002)

3 Consequences of CIPMA-2007 formula for determining air density (transition from CIPM-81/91 to CIPMA-2007 formulas)

Dr. Richard Davis, who is in charge of the Mass Section of the BIPM mentioned that new values for argon molar fraction were published by two independent laboratories.

The main features of the CIPM-2007 formula are:

- Determination of uncertainty according to GUM.
- It uses updated reference values.
- Comparison with the experimental results applying Archimedes' principle
- Eliminated the difference between the experimental results and the ones provided by the formula.

The consequence of this updated CIPM formula for determining the air density is that the air buoyancy correction value of stainless steel mass standards in relation to the Pt-Ir national prototype grows approximately $6.8 \mu\text{g}$.

Suggestions to deal with this correction are:

- State in future calibration reports that the CIPM-2007 formula for the air density has been used, giving appropriate references.
- If appropriate, state in future calibration reports that the CIPM-2007 formula results in a small shift (less than 10 $\mu\text{g}/\text{kg}$) in stainless steel standards derived from the international prototype through the national prototypes.
- Update databases and Quality Procedures.

Dr. Davis presentation is attached to this report.
