



## PROTOCOL OF MASS SUPPLEMENTARY COMPARISONS BETWEEN CENAM, CESMEC AND INDECOPI

### 1. General Information

This comparison is being carried out between CENAM, CESMEC AND INDECOPI in order to compare the degree of equivalence in mass and conventional mass calibration of high accuracy mass standards.

### 2. Data of the National Laboratories and Technical Contacts for the Comparison

Table 1  
Information of the National Laboratories

<b>1</b>	<b>National Metrology Institute</b>	<b>Centro Nacional de Metrología (CENAM) / México.</b>
	Technical Contacts	Luis Omar Becerra / Luis Manuel Peña
	Address	km. 4,5 carretera a los Cués, Mpio El Marqués, Qro. México, C.P. 76241
	Phone / Fax	+52 442 2 11 05 00 al 04 ext 3602 +52 442 2 11 05 68
	Email	<a href="mailto:lbecerra@cenam.mx">lbecerra@cenam.mx</a> <a href="mailto:lpena@cenam.mx">lpena@cenam.mx</a>
<b>2</b>	<b>National Metrology Institute</b>	<b>Instituto Nacional de Defensa de la competencia y de la protección de la propiedad intelectual (INDECOPI) / Perú</b>
	Technical Contacts	Aldo Quiroga / Luz Cori Almonte
	Address	Calle de la Prosa 104, San Borja - Lima
	Phone / Fax	51-1-2247800 Anex: 1662
	Email	<a href="mailto:aquiroga@indecopi.gob.pe">aquiroga@indecopi.gob.pe</a> <a href="mailto:lcori@indecopi.gob.pe">lcori@indecopi.gob.pe</a>
<b>2</b>	<b>National Metrology Institute</b>	<b>Centro de Estudios de Medición y Certificación de Calidad (CESMEC) División de Metrología</b>
	Technical Contacts	Francisco J. García Leoro / Raúl Hernandez
	Address	Av. Marathon 2595, Macul - Santiago, CHILE
	Phone / Fax	+56 2 350 21 85 +56 2 350 21 83
	Email	<a href="mailto:fgarcia@cesmec.cl">fgarcia@cesmec.cl</a> <a href="mailto:rhernandez@cesmec.cl">rhernandez@cesmec.cl</a>

### 3. General Considerations and Procedure

In order to evaluate the degree of equivalence between CENAM, CESMEC and INDECOPI in calibration of high accuracy mass standards, an exercise will be performed in this comparison:

#### 1. Mass and conventional mass determination

For this comparison INDECOPI-Peru agreed to act as Pilot Laboratory and CENAM-Mexico accepted to be the Support Laboratory.

Two weights of mass standards will be used as traveling standards for this comparison. 2 kg and 10 kg are the nominal values of the traveling standards. The weights were provided by Indecopi.

When the traveling standards arrive at the participating laboratory, a visual inspection should be made of the surfaces, and the findings should be recorded on the corresponding sheet (see Annex E).

Figure 1  
The traveling standard for the mass comparison of 2 kg



The traveling standards are shown in figure 1 and figure 2. These are will be circulated between all participating laboratories.

The traveling standards must be always handled with tweezers, pincers or lifters but never with the bare hands.



The traveling standards should be stored at a place near to the balance under glass bell jars (or under a similar protective covering). It should be protected from dust, vapor etc.

The measurements should be made after an appropriate period of acclimatization, (at least 3 days after receiving them).

The calibrations must be done in mass value and the conventional mass should be calculated from the mass value.

Air density must be determined with **CIPM-2007 formula**, in order to correct the air buoyancy effect.

The value for the volume thermal expansion coefficient for all the traveling standards (set 1 and set 2) will be  **$48 \times 10^{-6} \text{ }^{\circ}\text{C}^{-1}$** .

The volume of the weights will be sent to the participating laboratories before to their participation in order to apply the corresponding buoyancy corrections.

Magnetic properties of the traveling standards will be measured at INDECOPI in order to verify that all of them are in accordance with magnetic specifications the E2 accuracy class according to OIML-R111:2004.

**During the circulation between the participating laboratories volume or magnetic susceptibility of the weight must not be measure by any participant.**

The participating laboratories should determine the mass and conventional mass and their associated uncertainties for the traveling standard. The evaluation of the uncertainty should be done by each participating laboratory according to the own calibration system and at the best laboratory capability.

**Laboratories must not wash or rub the traveling standards with any substance in order to clean them**, the only possibility, if it is necessary to passing a soft brush over the surface of the weight in order to take off dust or any other impurity over the weight.



#### 4. Transportation

The traveling standards will be placed in two special boxes for transportation purpose.

Indecopi staff will carry the travelling standard weight from Indecopi to CENAM. All participating institutes are responsible for their own costs for the measurements as well as any damage that may occur while staying in its Laboratory. The overall costs of organizing the comparison, insurance, including the provision of the transfer devices are covered by the Pilot Laboratory.

In case of damage to the travelling standard weight, all parties will be informed as soon as possible.

#### 5. Results

All laboratories should calibrate the traveling standards in **Mass and conventional mass value** applying all corrections according with their own calibration systems and procedures.

Forms are attached in order to report the results of measurements, data of environmental conditions, used instruments and the traceability of reference standards.

Once the measurements of the traveling standard have been carried out by participating laboratories, they should submit their results (Annex A form) by e-mail or by fax to pilot laboratory.

Both laboratories will have a maximum period of three weeks after they have finished their measurements to send their results to pilot laboratory.

The information of Annexes A, B and C will be send directly to the pilot laboratory.

The report of the comparison will be written and presented to the Mass Working Group of SIM.

#### 6. Analysis of Results

The pilot laboratory will gather the results of all participants and will draft a report of the comparisons. This draft will be circulated between all participants for comments before to write the final report.

For the reference value, if the uncertainty reported by CENAM is at least one third of the uncertainty reported by the other participants, CENAM will establish this reference value, otherwise the reference values will be proposed for the pilot laboratory and calculated from results of participants (e.g. by weighted mean of largest consistent values).

## 7. Schedule of Comparison

The traveling standard will circulate joint according to the schedule of table 3.

Table 3

Circulation of the traveling standard of 2 kg

NMI	Date of arrival	Date of departure	Date of sending results
INDECOPI	-----	14/09/2012	05/10/2012
CENAM	17/09/2012	12/10/2012	02/11/2012
CESMEC	22/10/2012	09/11/2012	30/11/2012
INDECOPI	19/11/2012	-----	14/12/2012

Circulation of the traveling standard of 10 kg

NMI	Date of arrival	Date of departure	Date of sending results
INDECOPI	-----	12/10/2012	02/11/2012
CENAM	15/10/2012	02/11/2012	23/11/2012
CESMEC	12/11/2012	30/11/2012	21/12/2012
INDECOPI	10/12/2012	-----	28/12/2012

## Annexes

- A. Calibration Results, environmental conditions during the calibration.
- B. Characteristics of the balances used on the measurement and instruments for measuring the environmental conditions.
- C. Traceability
- D. Uncertainty Budget.
- E. Records of the surface description of the traveling standards.



## Annex A

2 kg

### Calibration Results, Environmental Conditions during the Calibration

Laboratory:		Date:	
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### Calibration Results

Nominal Value	Mass Correction Value mg	Conventional Mass Correction Value mg	Standard uncertainty $u_m (k=1)$ mg	Measurement Method
2 kg				

### Environmental Conditions during the Calibration

Register the upper and lower limits of the environmental parameters and their standard uncertainties ( $1\sigma$ ).

Nominal Value	Temperature $t / ^\circ\text{C}$	Barometric pressure /Pa	Relative humidity $h / \%$	Air density $\rho / \text{g/cm}^3$
2 kg				



**10 kg**

**Calibration Results, Environmental Conditions during the Calibration**

Laboratory:		Date:	
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**Calibration Results**

Nominal Value	Mass Correction Value mg	Conventional Mass Correction Value mg	Standard uncertainty $u_m (k=1)$ mg	Measurement Method
10 kg				

**Environmental Conditions during the Calibration**

Register the upper and lower limits of the environmental parameters and their standard uncertainties ( $1\sigma$ ).

Nominal Value	Temperature $t / ^\circ\text{C}$	Barometric pressure /Pa	Relative humidity $h / \%$	Air density $\rho / \text{g/cm}^3$
10 kg				



## Annex B

2 kg

### Characteristics of the Balances used for the Measurements and Instruments for Measurement the Environmental Conditions for Mass Determination

Laboratory:		Date:	
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### Characteristics of the Balances

Nominal Value	Manufacturer	Type	Range	Resolution	Standard Deviation
2 kg					

### Characteristics of the Equipment for the Measurement of the Environmental Conditions for Mass Determination (for the air density evaluation)

	Manufacturer	Type	Range	Resolution	Standard uncertainty $1\sigma$
Temperature $t / ^\circ\text{C}$					
Barometric pressure $p / \text{Pa}$					
Relative humidity $h / \%$					





10 kg

**Characteristics of the Balances used for the Measurements and Instruments for Measurement the Environmental Conditions for Mass Determination**

Laboratory:		Date:	
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**Characteristics of the Balances**

Nominal Value	Manufacturer	Type	Range	Resolution	Standard Deviation
10 kg					

**Characteristics of the Equipment for the Measurement of the Environmental Conditions for Mass Determination (for the air density evaluation)**

	Manufacturer	Type	Range	Resolution	Standard uncertainty $1\sigma$
Temperature $t / ^\circ\text{C}$					
Barometric pressure $p / \text{Pa}$					
Relative humidity $h / \%$					



**Annex C**

**2 kg**

**Traceability for Mass Determination**

Laboratory:		Date:	
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(Write the traceability of the reference standards up to national standards)

**2 kg**

Identification	Mass value m	Uncertainty $U_m (k=2)$	Traceability and Date of Calibration

Please add lines as necessary.

**10 kg**

**Traceability for Mass Determination**

Laboratory:		Date:	
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(Write the traceability of the reference standards up to national standards)

**10 kg**

Identification	Mass value m	Uncertainty $U_m (k=2)$	Traceability and Date of Calibration

Please add lines as necessary.



**Annex D**

Laboratory:		Date:	
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**Uncertainty Budget for Mass determination**

**2 kg**

<b>Influence quantity</b>	Mean value	Unit	Standard uncertainty	Unit	Degrees of freedom	Uncertainty in mass (g)
Mass standard		g		g		
Instability of the mass standard		g		g		
Density of the mass standard		g/cm <sup>3</sup>		g/cm <sup>3</sup>		
Density of the mass under test		g/cm <sup>3</sup>		g/cm <sup>3</sup>		
Air density		g/cm <sup>3</sup>		g/cm <sup>3</sup>		
Mass difference		g		g		
Sensibility of the balance		g		g		
Resolution of the balance		g		g		
Repeatability		g		g		
Eccentricity		g		g		
Additional uncertainty component 1						
Additional uncertainty component 2						
<b>Mass</b>						

Please add rows as necessary



MASS SUPPLEMENTARY COMPARISON  
BETWEEN CENAM, CESMEC AND INDECOPI

Laboratory:		Date:	
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**Uncertainty Budget for Mass determination**

**10 kg**

Influence quantity	Mean value	Unit	Standard uncertainty	Unit	Degrees of freedom	Uncertainty in mass (g)
Mass standard		g		g		
Instability of the mass standard		g		g		
Density of the mass standard		g/cm <sup>3</sup>		g/cm <sup>3</sup>		
Density of the mass under test		g/cm <sup>3</sup>		g/cm <sup>3</sup>		
Air density		g/cm <sup>3</sup>		g/cm <sup>3</sup>		
Mass difference		g		g		
Sensibility of the balance		g		g		
Resolution of the balance		g		g		
Repeatability		g		g		
Eccentricity		g		g		
Additional uncertainty component 1						
Additional uncertainty component 2						
<b>Mass</b>						

Please add rows as necessary

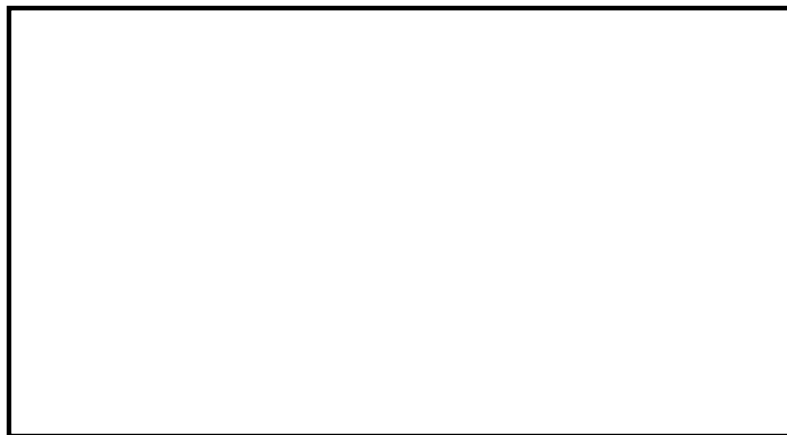
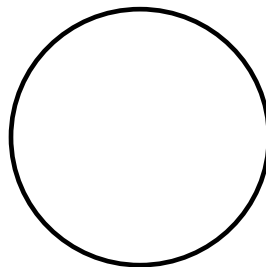
### Annex E

#### Surface Description of the Traveling Standards

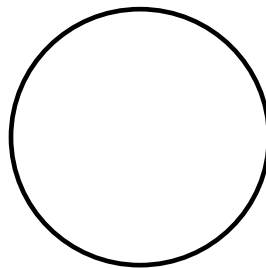
Laboratory:		Date:	
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**2 kg**

Top



Bottom





**Surface Description of the Traveling Standards**

Laboratory:		Date:	
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**10 kg**

