

PROTOCOL OF MASS COMPARISON WITHIN SIM CARIMET

1. General Information

This supplementary comparison is being carried out among five (5) SIM NMIs in order to compare the degree of equivalence in the calibration of high accuracy mass standards.

2. Data of the National Metrology Institutes and Technical Contacts for the Comparison

The participant NMIs to this mass comparison are listed in table 1.

Table 1: Participant National Metrology Institutes

1	National Metrology Institute	Bureau of Standards of Jamaica (BSJ)
	Technical Contacts	Carl Hall
	Address	6 Winchester Road, Kingston 10, Jamaica, W.I.
	Phone / Fax	(876) 926-3140-5 ext. 3016
	Email	chall@bsj.org.jm
2	National Metrology Institute	Centro Nacional de Metrología (CENAM)
	Technical Contacts	Luis Manuel Peña Pérez
	Address	km 4.5 Highway to Los Cués, El Marqués Municipality, Querétaro, Mexico 76246
	Phone / Fax	(+52) 442.211.05.00 ext. 3604
	Email	lpena@cenam.mx
3	National Metrology Institute	Guyana National Bureau of Standards (GNBS)
	Technical Contacts	Edward Melville
	Address	Flat 15 Exhibition Complex, Sophia, Georgetown
	Phone / Fax	011-592-219-0062/64/66
	Email	emelville@gnbsgy.org
4	National Metrology Institute	Saint Lucia Bureau of Standards (SLBS)
	Technical Contacts	Anselm Gittens
	Address	National Agricultural Diagnostic Facility (NADF), Union P.O. Box CP 5412, LC-Castries Saint Lucia, W.I.
	Phone / Fax	1-758-453-0049, 1-758-456-0546
	Email	a.gittens@slbs.org
5	National Metrology Institute	Trinidad and Tobago Bureau of Standards (TTBS)
	Technical Contacts	Frederick King
	Address	1-2 Century Drive, Trincity Industrial Estate Macoya, Tunapuna, Trinidad, W.I.
	Phone / Fax	(868) 662-TTBS (8827), 4481/2, 663-4835/6; ext. 2309
	Email	frederick.king@ttbs.org.tt

3. General Considerations and Procedure

In order to evaluate the degree of equivalence amongst SIM NMIs in calibration of mass standards of Class E₂, a mass comparison was planned among five National Metrology Institutes from the SIM region.

The goal is to evaluate the degree of equivalence between participant results on the calibrations of stainless-steel weights in conventional mass value.

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

A set of mass standards, property of the BSJ and TTBS, will be used for this comparison.

These travelling standards have the following nominal values and identification (see table 2):

Table 2: Set of travelling standards.

Nominal value	ID No.	Serial No.	Manufacturer	
5 kg	-	16914	Troemner	TTBS
2 kg	A	1321008	Häfner	BSJ
1 kg	A			
200 g	A			
50 g	A			
200 mg	Hook			

The travelling standards will be circulated amongst all participating laboratories. When the travelling standards arrive at each participating laboratory, a visual inspection shall be made of the surfaces, and the findings shall be recorded on the corresponding form (see Annex E).



Fig. 1: BSJ travelling standards.



Fig. 2: TTBS travelling standard.

The travelling standards must always be handled with tweezers, pincers, lifters but never with the bare hands. Acid free or lint free paper is also provided.

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

The measurements shall be made after an appropriate period of acclimatization, (at least 24 hrs after receiving them).

Values for the density and volume of the travelling standards will be measured by CENAM.

Table 3. Density of travelling standards

Nominal value	Density	Std. Unc. (k=1)
5 kg		
2 kg		
1 kg		
200 g		
50 g		
200 mg		

Regarding the magnetic properties of the weights, all the travelling standards are in accordance with specifications for class OIML E₂.

The participant laboratories do not need to measure the volume neither the magnetic susceptibility of the travelling standard during the comparison.

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

4. Transportation

The travelling standards will be shipped in an appropriate traveling case and circulated among participant laboratories. Each CARIMET laboratory will be responsible for the delivery of the travelling standards to the next national metrology laboratory according to the schedule of the comparison (see table 4). In the case of shipping the travelling standards from the support laboratory CENAM – Mexico to the pilot laboratory BSJ – Jamaica, CROSQ will be responsible for handling the payment of the shipping costs.

Acid free/-lint free paper will be included in these boxes as well as cotton gloves, pincers and lifters for handling in the event that it becomes necessary to do so while the standards are being transported between participating laboratories.



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Once the travelling standards arrive to the laboratory, the technical contact should make inspection of all the weights and complete the form in Annex E and immediately send the records to Pilot laboratory via email.

5. Results

Participating laboratories should calibrate each travelling standard in **conventional mass value with the associated uncertainty** applying all corrections according to their own calibration systems and procedures, and at the best laboratory capability.

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

Once the measurements of the travelling standards have been carried out by participating laboratories, they shall submit their results (Annex A form) by e-mail to Pilot laboratory.

Participating laboratories will have a maximum period of ten business (10) days after they have received the weights to complete their measurements, prepare the weights to be shipped and send their results to the Pilot laboratory (see table 3).

The information in Annexes A, B and C will be sent directly to the Pilot laboratory. The information in all Annexes (A to E) should be kept as records for the various laboratories and should be readily available if there is any issue or need for review.

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 writing the final report.

The reference values will be established by CENAM. The Pilot laboratory will receive all the information from participants for the analysis and the elaboration of the corresponding report of the mass comparison.

Drift analysis will be conducted on the initial and final results obtained from the Pilot and support lab using the Normalized Error. The degree of equivalence will be determined by calculating the E_n value between the individual laboratories and the reference value.

7. Schedule of Comparison

The travelling standards will be circulated among participants according to the schedule shown in table 4.

Table 4: Circulation of the travelling standards

No.	National Metrology Institute	Expected Arrival	Sending of results
1.	CENAM – Mexico	Oct 23 rd	Dec 4 th
2.	BSJ – Jamaica	Jan 8 th	Jan 22 nd
3.	SLBS – Saint Lucia	Feb 5 th	Feb 19 th
4.	TTBS – Trinidad and Tobago	Mar 4 th	Mar 18 th
5.	GNBS – Guyana	Apr 2 nd	Apr 16 th
6.	BSJ – Jamaica	Apr 30 th	(Draft A report) – May 22 nd

The participating laboratories have two (2) weeks (10 working days) to perform the measurements. The mass standards must be shipped to the next laboratory immediately after the measurements have been finalized. The laboratory is required to submit the results to the pilot laboratory by the respective date indicated in Table 4.

The mass comparison is organized in one loop. After the first measurements by the support laboratory CENAM, the mass standards are to be circulated to the laboratories of BSJ (Pilot), SLBS, TTBS, and GNBS. After their return to the BSJ, the second measurement will be performed by the pilot laboratory. BSJ will prepare a final report containing the analysis of results of the participating laboratories.

8. Annexes

- Calibration Results, environmental conditions during the calibration.
- Characteristics of the balances used on the measurement and instruments for measuring the environmental conditions.
- Traceability
- Uncertainty Budget.
- Records of the surface description of the travelling standards.

Annex A

Calibration Results, Environmental Conditions during the Calibration

Laboratory:		Date:	
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Calibration Results

Nominal Value	Mass correction (Conventional Mass) mg	Expanded uncertainty $u_m (k=2)$ mg
5 kg		
2 kg		
1 kg		
200 g		
50 g		
200 mg		

Environmental Conditions during the Calibration

Record the mean value of the environmental parameters and their expanded uncertainty at measurement ($k = 2$).

Nominal Value	Temperature $t / ^\circ\text{C}$	Barometric pressure p / Pa	Relative humidity $h_r / \%$	Air density $\rho / \text{g/cm}^3$
5 kg				
2 kg				
1 kg				
200 g				
50 g				
200 mg				

Annex B

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
5 kg					
2 kg					
1 kg					
200 g					
50 g					
200 mg					

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 at calibration $k = 1$
Temperature t /°C					
Barometric pressure p /Pa					
Relative humidity h_r /%					

Annex C

Traceability for Mass Determination

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

5 kg

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

Please add lines as necessary.

2 kg

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

Please add lines as necessary.

1 kg

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

Please add lines as necessary.

200 g

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

Please add lines as necessary.



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50 g

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

Please add lines as necessary.

200 mg

Identification	Conventional 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

5 kg

Influence quantity	Mean value	Unit	Standard uncertainty	Unit	Degrees of freedom	Uncertainty in mass (g)
Conventional Mass standard		g		g		
Instability of the mass standard		g		g		
Density of the mass standard		g/cm ³		g/cm ³		
Density of the mass under test		g/cm ³		g/cm ³		
Air density		g/cm ³		g/cm ³		
Mass difference		g		g		
Sensitivity 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						
Conventional Mass						

Please add rows as necessary

Annex D

Laboratory:		Date:	
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Uncertainty Budget for Mass determination

2 kg

Influence quantity	Mean value	Unit	Standard uncertainty	Unit	Degrees of freedom	Uncertainty in mass (g)
Conventional Mass standard		g		g		
Instability of the mass standard		g		g		
Density of the mass standard		g/cm ³		g/cm ³		
Density of the mass under test		g/cm ³		g/cm ³		
Air density		g/cm ³		g/cm ³		
Mass difference		g		g		
Sensitivity 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						
Conventional Mass						

Please add rows as necessary

Annex D

Laboratory:		Date:	
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Uncertainty Budget for Mass determination

1 kg

Influence quantity	Mean value	Unit	Standard uncertainty	Unit	Degrees of freedom	Uncertainty in mass (g)
Conventional Mass standard		g		g		
Instability of the mass standard		g		g		
Density of the mass standard		g/cm ³		g/cm ³		
Density of the mass under test		g/cm ³		g/cm ³		
Air density		g/cm ³		g/cm ³		
Mass difference		g		g		
Sensitivity 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						
Conventional Mass						

Please add rows as necessary

Annex D

Laboratory:		Date:	
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Uncertainty Budget for Mass determination

200 g

Influence quantity	Mean value	Unit	Standard uncertainty	Unit	Degrees of freedom	Uncertainty in mass (g)
Conventional Mass standard		g		g		
Instability of the mass standard		g		g		
Density of the mass standard		g/cm ³		g/cm ³		
Density of the mass under test		g/cm ³		g/cm ³		
Air density		g/cm ³		g/cm ³		
Mass difference		g		g		
Sensitivity 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						
Conventional Mass						

Please add rows as necessary

Annex D

Laboratory:		Date:	
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Uncertainty Budget for Mass determination

50 g

Influence quantity	mean value	Unit	Standard uncertainty	Unit	Degrees of freedom	Uncertainty in mass (g)
Conventional Mass standard		g		g		
Instability of the mass standard		g		g		
Density of the mass standard		g/cm ³		g/cm ³		
Density of the mass under test		g/cm ³		g/cm ³		
Air density		g/cm ³		g/cm ³		
Mass difference		g		g		
Sensitivity 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						
Conventional Mass						

Please add rows as necessary

Annex D

Laboratory:		Date:	
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Uncertainty Budget for Mass determination

200 mg

Influence quantity	mean value	Unit	Standard uncertainty	Unit	Degrees of freedom	Uncertainty in mass (g)
Conventional Mass standard		g		g		
Instability of the mass standard		g		g		
Density of the mass standard		g/cm ³		g/cm ³		
Density of the mass under test		g/cm ³		g/cm ³		
Air density		g/cm ³		g/cm ³		
Mass difference		g		g		
Sensitivity 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						
Conventional Mass						

Please add rows as necessary

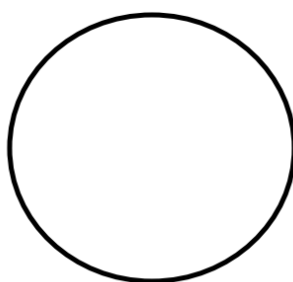
Annex E

Surface Description of the Travelling Standards

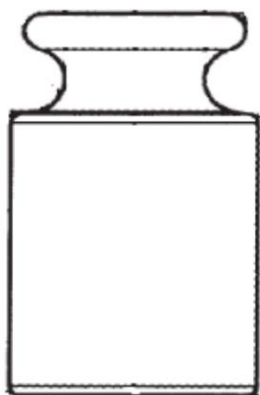
Laboratory:		Date:	
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5 kg

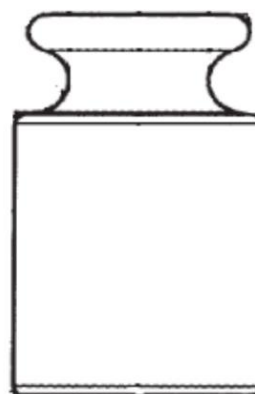
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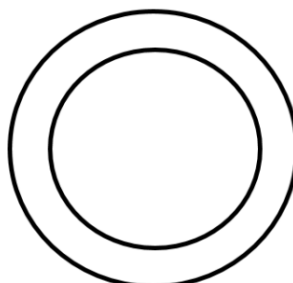
Front



Back



Bottom



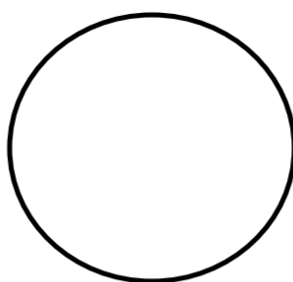
Annex E

Surface Description of the Travelling Standards

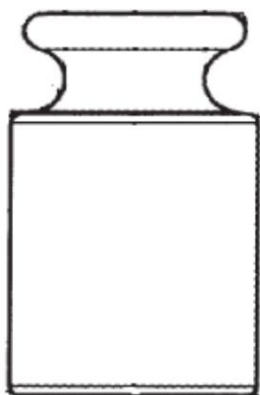
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2 kg

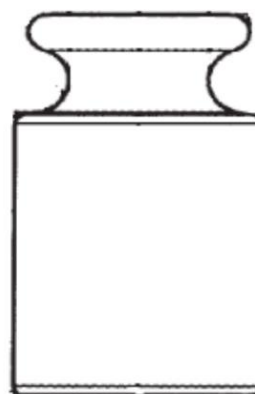
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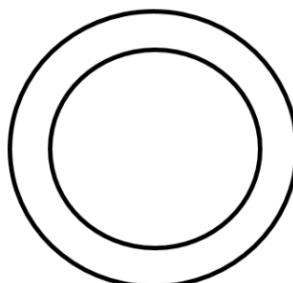
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Back



Bottom



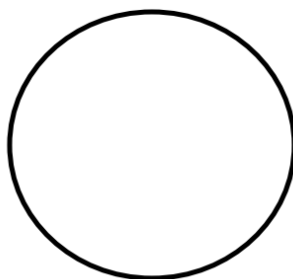
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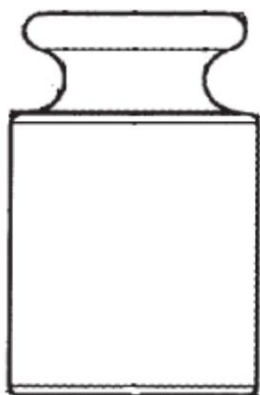
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1 kg

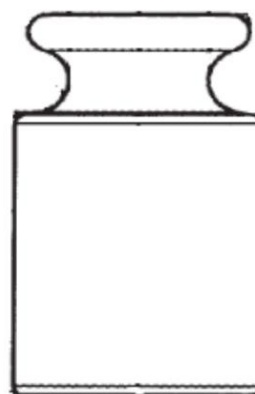
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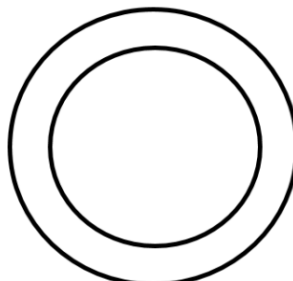
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Back



Bottom



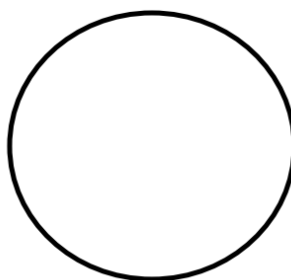
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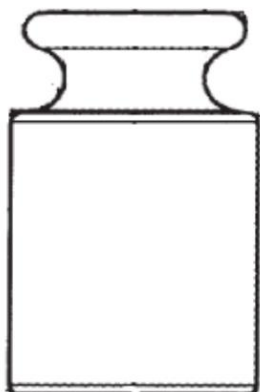
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200 g

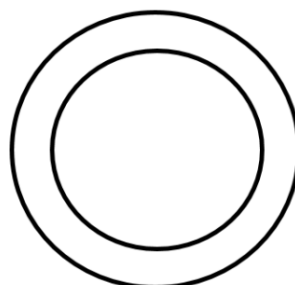
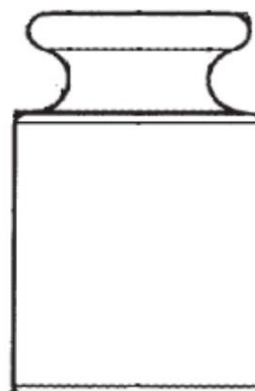
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Front



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Bottom

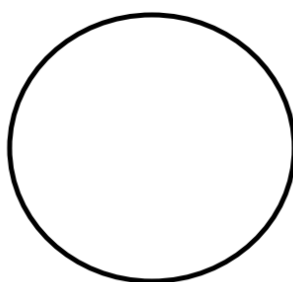
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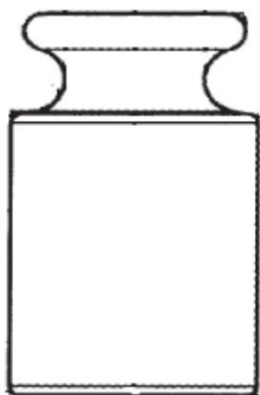
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50 g

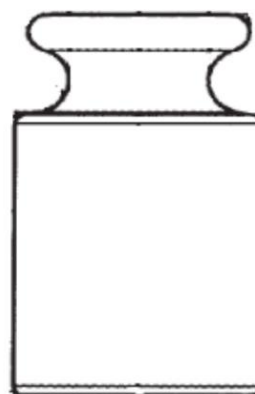
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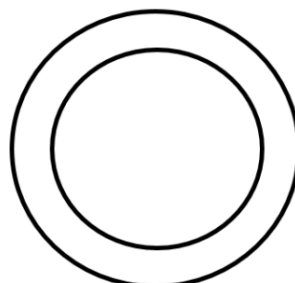
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Bottom



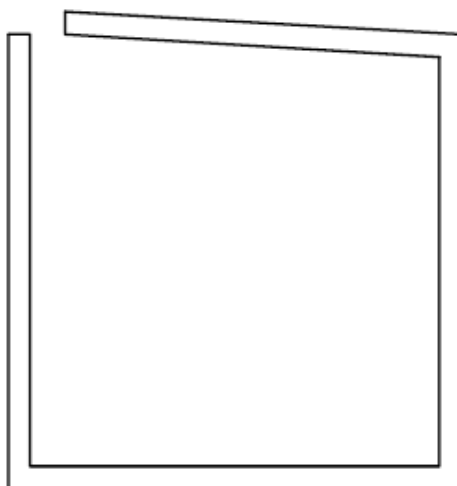
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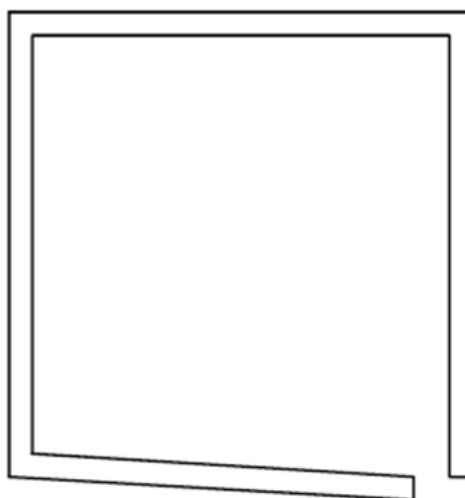
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200 mg (Wire)

Side A



Side B





Protocol of Mass Comparison among SIM CARIMET NMIs



Annex E

Surface Description of the Travelling Standards

Weight (ID)	FRONT	REAR	TOP	BOTTOM
5 kg				
2 kg				
1 kg				
200 g				
50 g				
Weight (ID)	Side A		Side B	
200 mg				

Defect Identification Table

Description of Damage	Defect ID number
Depression	1
Slight Scratches	2
Scratch	3
No Defects	4

Inspection done by:		Date inspected:	
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