

**SIM MWG 7- MASS AND RELATED QUANTITIES**

18th meeting, on-line

“Consultative Committee for Mass and Related Quantities”

**Thursday 20 – Friday 21 May de 2021**

**SIM MWG 7. Mass and Related quantities Internal structure and co-chairs (2021)**

Chairman		Aldo Quiroga	INACAL (Perú)	aquiroga@inacal.gob.pe
Co-chairs	Density	Luis Omar Becerra	CENAM (Mexico)	becerra@cenam.mx
	Force and Torque	Juan Alberto Arias Prieto	INM (Colombia)	jarias@inm.gov.co
	Pressure and Vacuum	Mayckol Morales Castro	INM (Colombia)	mmorales@inm.gov.co
	Mass	Luis Manuel Peña	CENAM (Mexico)	lpena@cenam.mx

## Comparison

### Density Comparisons registered in the KCDB (CCM and SIM Comparisons)

Comparison Identifier	Description	Mesurand or Instrument	Low limit	Upper limit	Pilot institute	Start	End	Time elapsed	
CCM.D-K1	Solid density	silicon sphere	2 300 kg/m <sup>3</sup>	2 300 kg/m <sup>3</sup>	NMIJ AIST	2001	2003	20	18
CCM.D-K2	Liquid density	Pentadecane, water, tetrachloroethylene and high-viscosity oil samples	700 kg/m <sup>3</sup>	1 700 kg/m <sup>3</sup>	PTB	2004	2004	17	17
CCM.D-K3	Solid density	Stainless steel weights	8 000 kg/m <sup>3</sup>	8 000 kg/m <sup>3</sup>	NMIJ AIST	2016		5	
CCM.D-K4	Hydrometers	Hydrometers	600 kg/m <sup>3</sup>	2 000 kg/m <sup>3</sup>	INRIM	2011	2012	10	9
CCM.D-K5	Liquid density	three liquids	753 kg/m <sup>3</sup>	1 866 kg/m <sup>3</sup>	BEV	2018		3	
CCM.D-K6	Refractive Index	Liquids			NMIJ AIST				
SIM.M.D-K3	Solid density	Stainless steel weights	8 000 kg/m <sup>3</sup>	8 000 kg/m <sup>3</sup>	INTI	2009	2012	12	9
SIM.M.D-K4	Hydrometers	Hydrometers	600 kg/m <sup>3</sup>	1 300 kg/m <sup>3</sup>	CENAM	2007	2008	14	13
SIM.M.D-S1	Hydrometers	Hydrometers	800 kg/m <sup>3</sup>	1 200 kg/m <sup>3</sup>	CENAM	2007	2007	14	14
SIM.M.D-S2	Hydrometers	Hydrometers	800 kg/m <sup>3</sup>	1 000 kg/m <sup>3</sup>	INMETRO	2009	2010	12	11
SIM.M.D-S3	Solid density	Two spheres, one of glass, one of stainless steel	2 200 kg/m <sup>3</sup>	8 000 kg/m <sup>3</sup>	CENAM	2006	2006	15	15
SIM.M.D-S4	Hydrometers	Hydrometers	600 kg/m <sup>3</sup>	2000 kg/m <sup>3</sup>	INDECOPI	2012	2012	9	9
SIM.M.D-S5	Solid density	Stainless steel weights	8 000 kg/m <sup>3</sup>	8 000 kg/m <sup>3</sup>	INM (CO)	2012	2013	9	8
SIM.M.D-S6	Hydrometers	Hydrometers	600 kg/m <sup>3</sup>	1 300 kg/m <sup>3</sup>	CENAM	2017		4	

## Comparison

### Mass comparisons registered

Comparison Identifier	Metrology Area	Sub-field	Description	Parameters	Measurement period	Pilot institute	Status
SIM.M.M-K4	Mass and related quantities	Mass Standards	Comparison of mass standards		2009 - 2013	INTI	Approved for equivalence
SIM.M.M-K5	Mass and related quantities	Mass Standards	Comparison of mass standards		2009 - 2013	INTI	Approved for equivalence
SIM.M.M-K6	Mass and related quantities	Mass Standards	Comparison of mass standards		2015 - 2017	CENAM	Measurements completed

Comparison Identifier	Metrology Area	Sub-field	Description	Parameters	Measurement period	Pilot institute	Status
SIM.M.M-S1	Mass and related quantities	Mass Standards	Comparison of mass standards		2004 - 2005	CEM	Approved
SIM.M.M-S10	Mass and related quantities	Mass Standards	Comparison of mass standards		2012	INDECOPI	Approved
SIM.M.M-S11	Mass and related quantities	Mass Standards	Determination of mass of weights		2012 - 2013	INM (CO)	Approved
SIM.M.M-S12	Mass and related quantities	Mass Standards	Comparison of mass standards		2012 - 2015	CESMEC	Report in progress, draft A
SIM.M.M-S13	Mass and related quantities	Mass Standards	Comparison of mass standards		2012	INDECOPI	Approved
SIM.M.M-S14	Mass and related quantities	Mass Standards	Comparison of mass standards		2013 - 2014	CEM	Approved
SIM.M.M-S15	Mass and related quantities	Mass Standards	Comparison of mass standards of accuracy F1	Nominal density: 7950 kg/m <sup>3</sup>	2015 - 2016	INTI	Approved
SIM.M.M-S16	Mass and related quantities	Mass Standards	Comparison of mass standards		2016	CENAM	Approved
SIM.M.M-S17	Mass and related quantities	Mass Standards	Comparison of mass standards		2017	CENAM	Measurements completed
SIM.M.M-S18	Mass and related quantities	Mass Standards	Comparison of mass standards		2018	CENAM	Measurements completed
SIM.M.M-S2	Mass and related quantities	Mass Standards	Comparison of mass standards		2005	CENAM	Approved
SIM.M.M-S3	Mass and related quantities	Mass Standards	Comparison of mass standards		2007 - 2008	CESMEC	Approved
SIM.M.M-S4	Mass and related quantities	Mass Standards	Comparison of mass standards		2009	CENAM	Approved
SIM.M.M-S5	Mass and related quantities	Mass Standards	Comparison of mass standards		2005	CENAM	Approved
SIM.M.M-S6	Mass and related quantities	Mass Standards	Comparison of mass standards		2009	CESMEC	Report in progress, draft B
SIM.M.M-S7	Mass and related quantities	Mass Standards	Comparison of mass standards		2009 - 2010	BSJ	Approved
SIM.M.M-S8	Mass and related quantities	Mass Standards	Comparison of mass standards		2006	CESMEC	Approved
SIM.M.M-S9	Mass and related quantities	Mass Standards	Determination of the susceptibility and magnetic polarization of weights by means of the susceptometer method		2011 - 2012	INDECOPI	Approved



## Comparison

### Pressure comparison registered

Comparison	Status	Last update	Pilot
SIM.M.P-K6 SIM Key Comparison in Pneumatic Gauge Pressure for High Accuracy Pressure Balances up to 120 kPa	Approved	2021	CENAM
SIM.M.P-K1 SIM Key Comparison in Pneumatic Gauge Pressure for High Accuracy Pressure Balances up to 7 MPa	Approved	2021	CENAM
SIM.M.P-S10 Pneumatic Gauge Pressure Comparison from 700 kPa to 7 000 kPa	Approved	2020	Inacal-CENAM

### Comparison in process

- 1 Positive Gauge Pressure Comparison**                      10 kPa to 100 kPa  
SIM.M.P-K6.1              Reference NIST, Pilot CENAM
  
- 2 Absolute Pressure Comparison**                              10 kPa to 121 kPa  
SIM.M.P-K2              Reference NIST, Pilot CENAM

## Comparison Pressure comparison registered

Comparison	Status	Latest year for measurements	Pilot	Institute
SIM.M.P-S9 (pressure)	CANCELED	2021	José Palma (Fernando Garcia)	LCPN-P
SIM.M.P-S3 (pressure)	CANCELED	2021	José Palma (Fernando Garcia)	LCPN-P
SIM.M.P-S4 (pressure)	CANCELED	2021	José Palma (Fernando Garcia)	LCPN-P
SIM.M.P-S2 (pressure)	Draft report B in review	2011 ...	<i>Paulo Couto</i> (Victor Loayza) <b>Jackson Oliveira</b>	INMETRO
(Vacuum)	Abandoned	2018	Jackson Oliveira	INMETRO
SIM.M.P-K7 (Pressure)	Draft report B Finished, published at an international Conference but pending approval. Change to S7?		Jorge Torres	CENAM

## Comparison

### Force and Torque comparison registered

Code	Aim	Capacity	Pilot	Year	State
SIM.M.F-S1	Testing Machines	10 kN to 100 kN	IDIC	2010	Approved
SIM.M.F-S4	Transducer in compression	50 kN & 100 kN	IDIC-INTI	2012-2013	Approved
SIM.M.F-S5	Testing Machines	50 kN to 200 kN	CENAM	2013	Approved
SIM.M.T-S2	Torque Wrench	50 N·m, 100 N·m, 300 N·m & 500 N·m	CENAM	2017	Approved
SIM.M.F-S2	Testing Machines	10 kN to 100 kN	IDIC	2012	Draft A *
SIM.M.F-S3	Charpy Test	20 J & 100 J	NIST	2012-2013	Draft B *
SIM.M.T-S1	Torque Transducer	10 N·m, 20 N·m & 50 N·m	CENAM	2016	Draft A
SIM.M.F-S6	Testing Machines	10 kN to 100 kN	IDIC	2017	Draft A
SIM.M.F-S7	Transducer in compression	500 kN & 1000 kN	IDIC	2018-2019	Completed
SIM.M.F-S8	Testing Machines	20 kN to 200 kN	IDIC	2018	Completed
SIM.M.F-S9	Transducer in compression	20 kN to 200 kN	IDIC	2019	Planned
SIM.M.F-S10	Testing Machines	300 kN to 3000 kN	IDIC	2020	Draft A

### SIM Activities

Pilot comparison methods for micro-balances calibration (November 2017 – INTI)

## SIM Activities

<b>KCDB 2.0 at the service of the SIM region in Mass and Related Quantities</b>	<b>March 21-26, 2021</b>
Virtual meeting (MWG - Pressure).	September 25, 2020
6th International CCM Conference on Pressure and Vacuum Metrology in Pereira, Colombia (MWG - Pressure).	May 7-10, 2017
Dynamic Measurements (from Industry to Primary Standard) –IADB-SIM Research Engagement Opportunity.	December, 2018 and September ,2019
“Análisis y Revisión de la Guía de Calibración de Instrumentos de Pesaje microbalanzas” – “Calibration of weighing instruments microbalances” INM Colombia.	March 11-13, 2020
“Análisis y Validación del método alternativo en Calibración de microbalanzas y pesas menores al miligramo” – “Calibration of weighing instruments microbalances” CENAM – México.	September 04-06, 2019



## Report of SIM MWG 7

Quantities	Author
Mass	Luis Manuel Peña
Density	Luis Omar Becerra
Pressure and Vacuum	Jorge Torres Guzman
Force and Torque	Alejandro Savarin

# **SIM MWG7**

## **Sub-Group of Mass Meeting**

**M. Sc. & T. Luis Manuel Peña Pérez**

**[lpena@cenam.mx](mailto:lpena@cenam.mx)**

**Co-Chair**

**KCDB 2.0 at the service of the SIM region in Mass and Related Quantity**

**March 25<sup>th</sup>, 2021**

# Outline

1. Guidelines on CMCs submission process for mass.
2. CMCs review process.
3. Guidelines on Key and Supplementary comparisons in mass.
4. Matters Pending (CMCs, comparisons).
5. Agreements.

## 1. Guidelines on CMCs submission process for mass.

- The three fundamental elements leading to **approval** of an institute's CMCs are:
- ✓ **participation** by the institute **in reviewed and approved scientific comparisons**;
  - ✓ operation by the institute of an **appropriate and approved quality management system**;
  - ✓ **international peer-review** (regional and inter-regional) of claimed CMCs.

## 1. Guidelines on CMCs submission process for mass.

### ➤ Scientific comparisons

- ✓ The technical basis of the CIPM MRA is the set of results obtained over the course of time through scientific key comparisons carried out by the Consultative Committees of the CIPM, the BIPM and the regional metrology organizations (RMOs) and published by the BIPM and maintained in the KCDB.
- ✓ The key comparisons are essentially of two types:
  - **CIPM key comparisons**, of international scope, are carried out by those participants having the highest level of skills in the measurement involved and are restricted to laboratories of Member States. The CIPM key comparisons deliver "the reference value" for the chosen key quantity;
  - **RMO key comparisons**, of regional scope, are organized at the scale of a region (though they may include additional participants from other regions) and are open to laboratories of Associates as well as Member States. These key comparisons deliver complementary information without changing the reference value.
- ✓ The comparisons underpin the development of the CMCs which are stated in terms of a measurand and its uncertainty and may include advice about the instrumentation used.



## 1. Guidelines on CMCs submission process for mass.

### ➤ Quality management system

- ✓ The participating institutes are required to operate an appropriate quality management system which is subject to an approval process run by the relevant regional metrology organization.
  
- ✓ The accepted standards are ISO/IEC 17025 and ISO Guide 34 (for those institutes producing or assigning values to reference materials).

## 1. Guidelines on CMCs submission process for mass.

### ➤ Review of CMCs

- ✓ Claimed CMCs are developed by the participating institutes and submitted for **first-stage review by their regional metrology organization**. Once this review process has been completed, the regional metrology organization submits the CMCs to a **second-stage inter-regional peer-review process**.
- ✓ Having successfully completed both peer-review processes the **CMCs are published** in the **KCDB**.

## 1. Guidelines on CMCs submission process for mass.

### ➤ Reference documents for CMCs submission and review

#### Calibration and measurement capabilities in the context of the CIPM MRA

Guidelines for their review, acceptance and maintenance

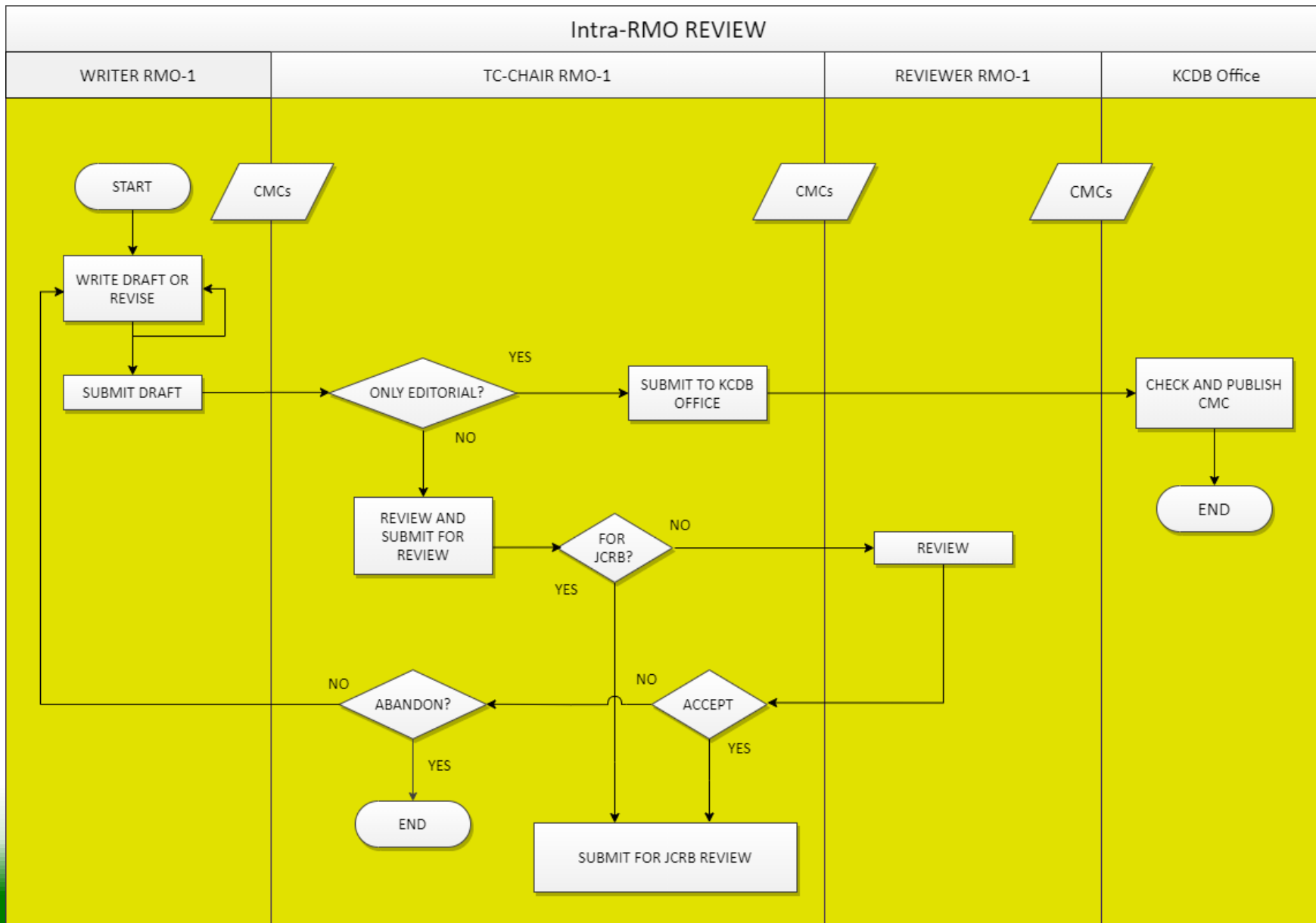
CIPM MRA-G-13

Version 1.0  
11/01/2021



SIM-D-05 3.5

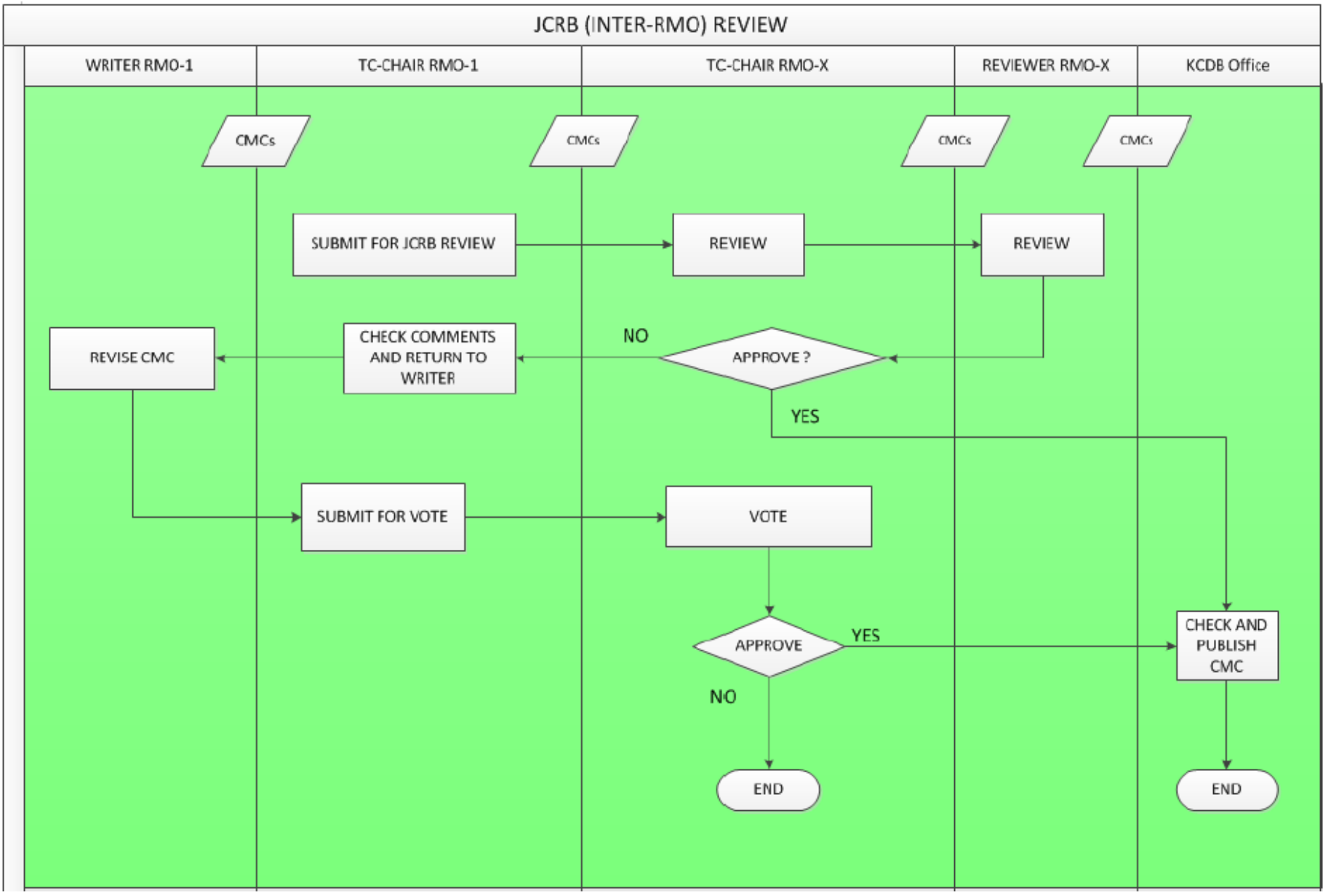
SIM REFERENCE DOCUMENT Nº 05  
SIM Procedure for Review of Calibration and Measurement Capabilities  
Submitted on the KCDB 2.0 Platform of the CIPM MRA



Flowchart for  
intra-regional review

\*Reference SIM-D-05-3.5

# SIM MWG7 Sub-Group of Mass Meeting



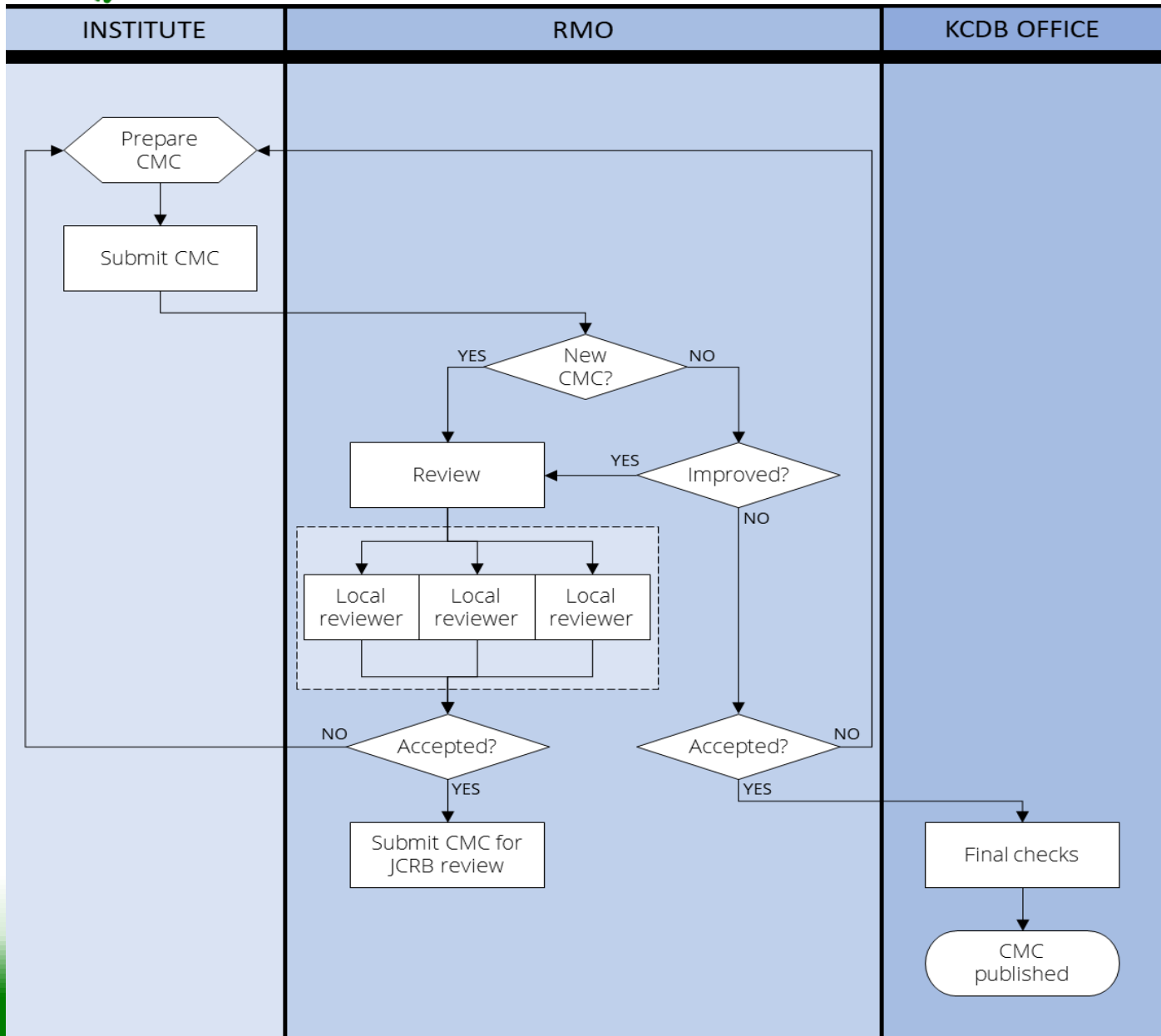
Flowchart for JCRB Review Process (SIM and other regions)

*[inter-regional review]*

\*Reference SIM-D-05-3.5



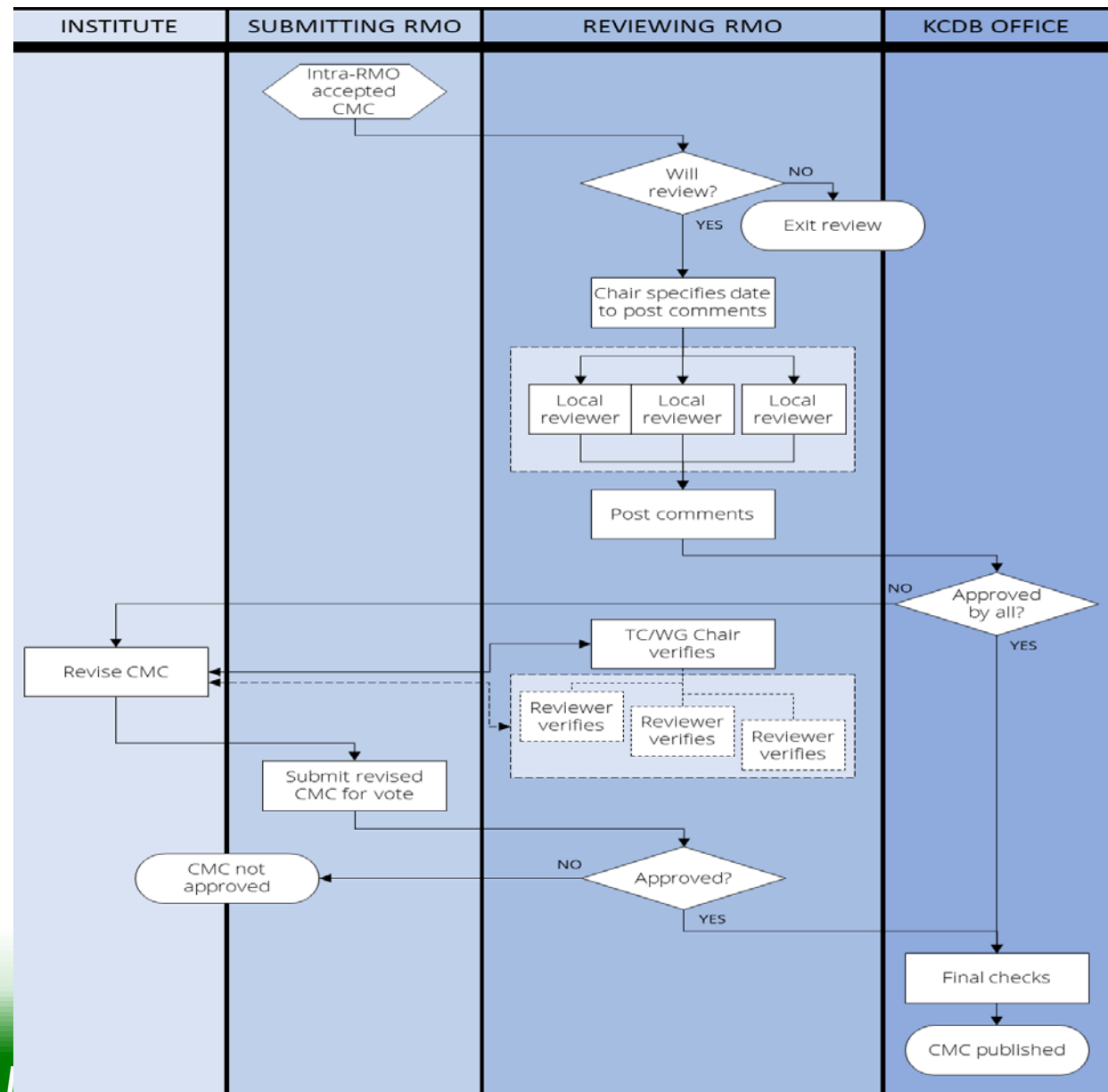
# SIM MWG7 Sub-Group of Mass Meeting



Flowchart for Intra regional review of CMCs organized through the KCDB platform.

\*Reference: CIPM MRA-G-13

# SIM MWG7 Sub-Group of Mass Meeting



Flowchart for JCRB review of CMCs organized through the KCDB platform

\*Reference: CIPM MRA-G-13

## 1. Guidelines on CMCs submission process for mass.

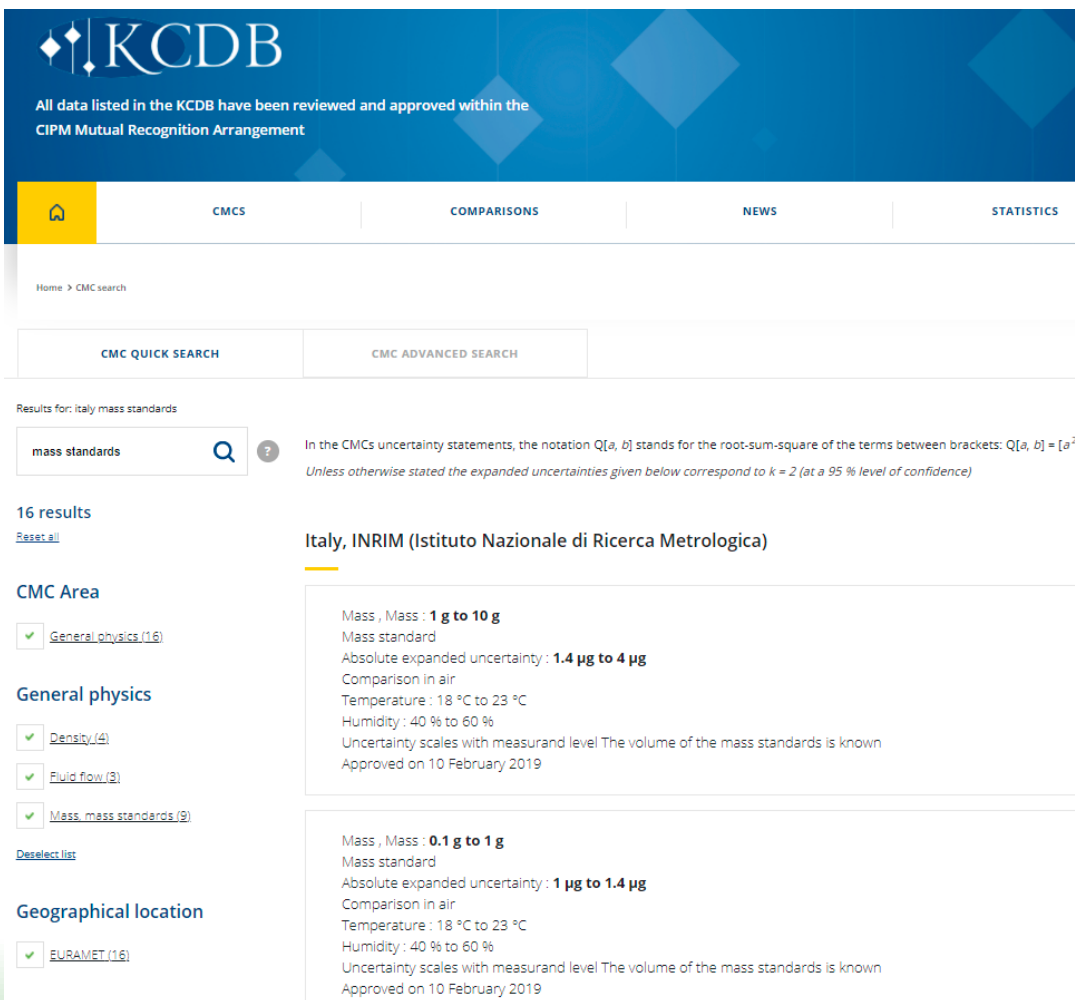
### ➤ SPECIFIC CRITERIA FOR CMCs SUBMISSION IN MASS:

- The measurand in each CMC entry should be group as far as possible by decades. The uncertainty should be reported also as an interval of the corresponding group.

Examples:

Measurand	Uncertainty		Measurand	Uncertainty	
1 mg - 100 mg	0.4 mg	✓	1 mg	0.4 mg	✗
			2 mg	0.4 mg	
			5 mg	0.4 mg	
			10 mg	0.4 mg	
			20 mg	0.4 mg	
			50 mg	0.4 mg	
			100 mg	0.4 mg	
0.1 g - 1 g	0.4 mg	✓	0.1 g	0.4 mg	✗
			0.2 g	0.4 mg	
			0.5 g	0.4 mg	
			1 g	0.4 mg	
0.1 kg - 1 kg	4.6 mg - 30 mg	✓	0.1 kg	4.6 mg	✗
			0.2 kg	7.3 mg	
			0.5 kg	15 mg	
			1 kg	30 mg	

## Examples of published mass CMCs



**KCDB**  
All data listed in the KCDB have been reviewed and approved within the CIPM Mutual Recognition Arrangement

Home > CMC search

CMC QUICK SEARCH    CMC ADVANCED SEARCH

Results for: italy mass standards

mass standards

In the CMCs uncertainty statements, the notation  $Q[a, b]$  stands for the root-sum-square of the terms between brackets:  $Q[a, b] = [a^2 + b^2]^{1/2}$ . Unless otherwise stated the expanded uncertainties given below correspond to  $k = 2$  (at a 95 % level of confidence)

16 results  
[Reset all](#)

**CMC Area**

- [General physics \(16\)](#)

**General physics**

- [Density \(4\)](#)
- [Fluid flow \(3\)](#)
- [Mass, mass standards \(9\)](#)

[Deselect list](#)

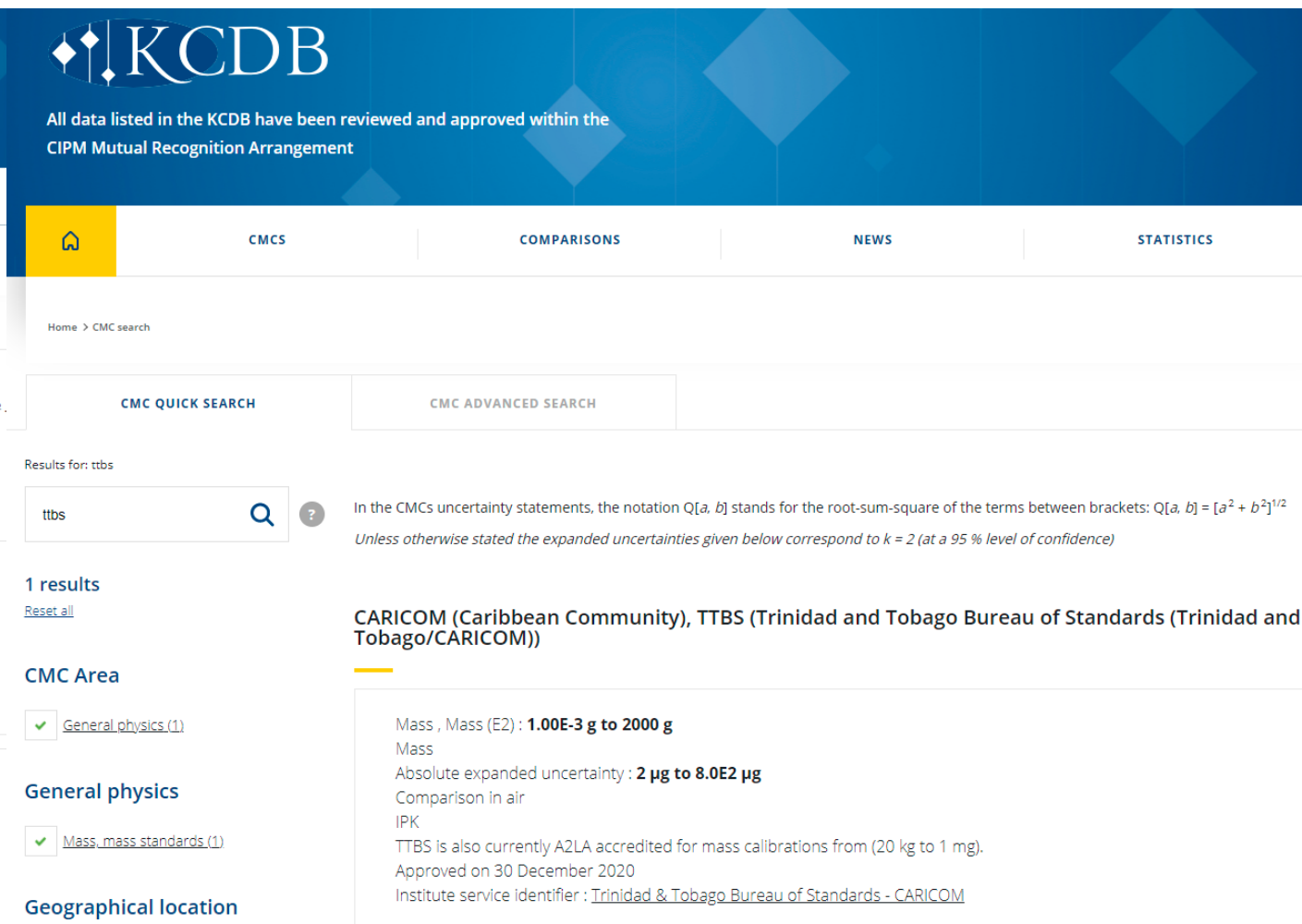
**Geographical location**

- [EURAMET \(16\)](#)

**Italy, INRIM (Istituto Nazionale di Ricerca Metrologica)**

Mass, Mass : **1 g to 10 g**  
Mass standard  
Absolute expanded uncertainty : **1.4 µg to 4 µg**  
Comparison in air  
Temperature : 18 °C to 23 °C  
Humidity : 40 % to 60 %  
Uncertainty scales with measurand level The volume of the mass standards is known  
Approved on 10 February 2019

Mass, Mass : **0.1 g to 1 g**  
Mass standard  
Absolute expanded uncertainty : **1 µg to 1.4 µg**  
Comparison in air  
Temperature : 18 °C to 23 °C  
Humidity : 40 % to 60 %  
Uncertainty scales with measurand level The volume of the mass standards is known  
Approved on 10 February 2019



**KCDB**  
All data listed in the KCDB have been reviewed and approved within the CIPM Mutual Recognition Arrangement

Home > CMC search

CMC QUICK SEARCH    CMC ADVANCED SEARCH

Results for: ttbs

ttbs

In the CMCs uncertainty statements, the notation  $Q[a, b]$  stands for the root-sum-square of the terms between brackets:  $Q[a, b] = [a^2 + b^2]^{1/2}$ . Unless otherwise stated the expanded uncertainties given below correspond to  $k = 2$  (at a 95 % level of confidence)

1 results  
[Reset all](#)

**CMC Area**

- [General physics \(1\)](#)

**General physics**

- [Mass, mass standards \(1\)](#)

**Geographical location**

**CARICOM (Caribbean Community), TTBS (Trinidad and Tobago Bureau of Standards (Trinidad and Tobago/CARICOM))**

Mass, Mass (E2) : **1.00E-3 g to 2000 g**  
Mass  
Absolute expanded uncertainty : **2 µg to 8.0E2 µg**  
Comparison in air  
IPK  
TTBS is also currently A2LA accredited for mass calibrations from (20 kg to 1 mg).  
Approved on 30 December 2020  
Institute service identifier : [Trinidad & Tobago Bureau of Standards - CARICOM](#)

## 1. Guidelines on CMCs submission process for mass.

### 8. Modification of published CMCs

Institutes may modify published CMCs in the KCDB. The modification categories are:

- 8.1. material or editorial errors and improvements to the explanatory text for a quantity, instrument, method etc. This does not change the essence of the CMC (instrument, range of the quantity and of the parameters, method, measurement uncertainty, traceability), but improves the content for the KCDB users. Intra-regional and JCRB reviews are not required, but changes need to be confirmed by the local RMO TC/WG Chair.
- 8.2. voluntary updating of a CMC by reducing its range and/or increasing its measurement uncertainty when an institute wants to reduce their engagement in a particular measurement activity. Intra-regional and JCRB reviews are not required, but changes need to be confirmed by the local RMO TC/WG Chair.
- 8.3. significant unresolved deviation from a comparison result with respect to a CMC, in which case a reduced range or an increase of the measurement uncertainty may be required. In such cases, the RMO TC/WG Chair shall verify that the reduced range or increased measurement uncertainty is sufficient to assure the equivalence of the measurements.
- 8.4. change of the method of measurement, reduction of the measurement uncertainty or increase in scope. In this case, modifications shall follow the full procedure of intra-regional and JCRB review as if they were new CMCs.



## 2. CMCs review process.

### ➤ **PROPOSAL** for CMCs review process in Mass (for a SIM NMI)

#### I. SIM RMO review process (Intra-regional review)

- a) NMI writes claimed CMCs in KCDB 2.0 (with all the evidence to support them).
- b) Co-Chair and TC Chair are notified for the new Submission (through e-mail).

#### **Co-Chair:**

- c) asks for SIM NMIs reviewers (by email to all technical contacts).
- d) receives comments (if any) or the approval of claimed CMCs and notifies to the NMI.
- e) receives the reply to the comments (if any) from NMI and sends to reviewers.
- f) If all discrepancies are solved and CMCs are approved, Co-Chair notifies to TC Chair that claimed CMCs are approved by SIM RMO.
- g) TC Chair starts JCRB review process (Inter-regional review) of NMI claimed CMCs.

Details and timelines are specified in **SIM-D-05-3.5**.

Whole process should be completed in **50 calendar days**.

This process applies to the review of mass CMCs of other RMOs.

## 2. CMCs review process.

➤ **PROPOSAL** for CMCs review process in **Mass** (for a SIM NMI)

II. SIM RMO review process (Inter-regional review)

**Follow the procedure established in CIPM MRA-G-13**  
**Pay attention to timelines and deadlines!!!**

## 2. CMCs review process.

The reviewers will then check the **range** and **uncertainty** of the **submitted CMCs** for consistency with information from some or all of the following sources as described in Section 3.3 of CIPM MRA-G-13:

- Results of key and supplementary comparisons
- Publicly available information on technical activities including publications
- On-site peer-assessment reports, including those from accreditation assessment with appropriate technical peers
- Active participation in RMO projects
- Other evidence of knowledge and experience, as agreed by the appropriate Consultative Committee

**While the results of key and supplementary comparisons are the ideal supporting evidence, all other sources listed above may be considered to underpin CMCs.**

## 2. CMCs review process.

Appendix 3: Example of Format for reporting intraRMO review of CMCs

### Questionnaire Which May Be Used for the Review of CMCs

<b>NMI/DI:</b>	
<b>Person responsible:</b>	
<b>Metrology area</b> <b>Branch:</b> <b>Service:</b> <b>Sub-service:</b>  (Consistent with items in KCDB)	(Please specify area, branch and service to which the information reported below applies)

## 2. CMCs review process.

Appendix 3: Example of Format for reporting intraRMO review of CMCs

### Questionnaire Which May Be Used for the Review of CMCs

Review Process			
	Yes	No	Comments
<b>Participation in comparisons</b>			
<b>CC or RMO KCs?</b>			(Please name comparison identifier)
<b>Supplementary Comparisons?</b>			(Please name comparison identifier)
<b>Past comparisons?</b>			(CIPM, RMO or others, please specify)
<b>Bilateral comparisons?</b>			(Please specify)

## 2. CMCs review process.

Appendix 3: Example of Format for reporting intraRMO review of CMCs

### Questionnaire Which May Be Used for the Review of CMCs

Technical activities			
<b>Measurement methods</b>			(Brief description of method used)
<b>Traceability of standards</b>			(Name NMIs/DIs which provide traceability)
<b>Written measurement instructions</b>			(Written procedures available? Language?)
<b>Uncertainty budgets</b>			(Are they already available? If yes, are they calculated following the ISO Guide to the Expression of Uncertainty in Measurement?)
<b>Key publications</b>			(Please specify)



## 1. Guidelines on CMCs submission process for mass.

### Appendix 3: Example of Format for reporting intraRMO review of CMCs

#### Questionnaire Which May Be Used for the Review of CMCs

Quality management system			
<b>Status of implementation of QMS?</b>			(ISO/IEC 17025 and/or 17034 fully implemented?)
<b>Self-declared or accredited QM system?</b>			(If accredited, please name accreditation body)
<b>Which CMCs are covered by the accreditation?</b>			(Are all CMCs covered by the accreditation? If no, please specify the corresponding areas of measurement)
<b>Which CMCs are covered by self-declaration?</b>			(List here all areas of measurement which are not covered by accreditation)
<b>Engagement in TC-Quality</b>			. (Participation in meetings and other activities)
<b>QM system reviewed by TC-Quality?</b>			(Meeting when the QMS was presented, status of review)

## 2. CMCs review process.

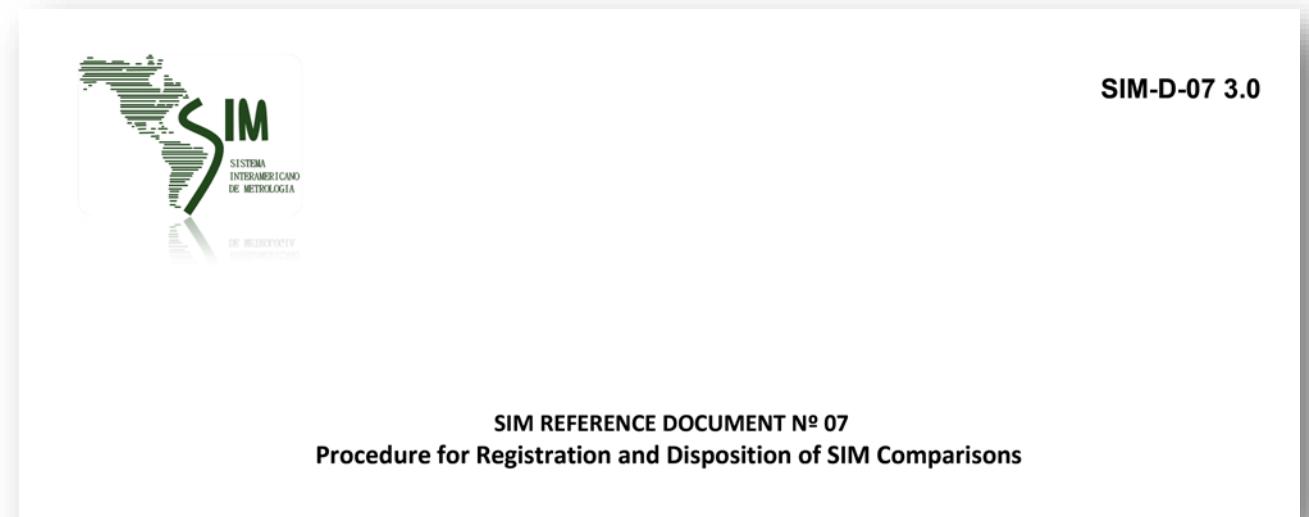
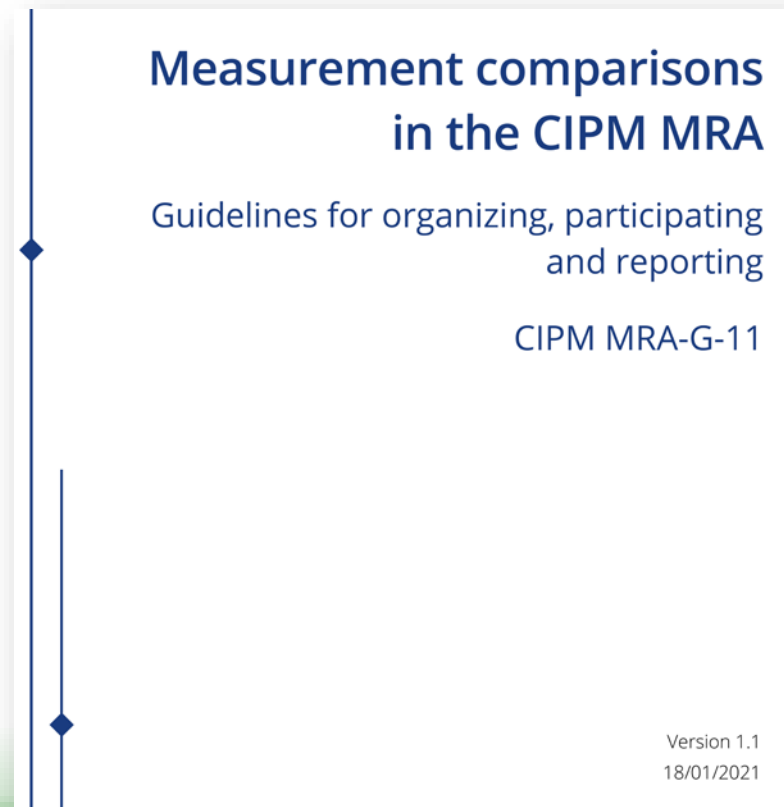
Appendix 3: Example of Format for reporting intraRMO review of CMCs

### Questionnaire Which May Be Used for the Review of CMCs

Additional information			
<b>Participation in RMO technical activities?</b>			(Projects, meetings, etc.; please specify)
<b>Visits of technical experts?</b>			(Please specify name and date of visit)
<b>On-site visits by peers?</b>			(Please specify name and date of visit)
<b>Any other information?</b>			(i.e. publications, etc.)

## 3. Key and Supplementary Comparisons in mass.

➤ Reference documents for KC, SC and PS.



### 3. Key and Supplementary Comparisons in mass.

#### ➤ Types of Comparisons:

#### ➤ Key Comparison (KC)

- selected by a Consultative Committee to test the principal techniques and methods in the field.
- may include comparisons of representations of multiples and sub-multiples of SI base and derived units as well as comparisons of artefacts.

## 3. Key and Supplementary Comparisons in mass.

### ➤ The KC are essentially of two types:

#### ➤ CIPM KC:

- of international scope,
- are organized by Consultative Committees or the BIPM,
- are restricted to laboratories of Member States and normally members of the corresponding Consultative Committees.
- CIPM KC deliver a “reference value” for the key quantity chosen.

#### ➤ RMO KC:

- of regional scope,
- are organized at the scale of a region (though they may include additional participants from other regions)
- are open to laboratories of Associates as well as Member States.
- RMO KC are intended to provide RMO members **with the means to link to the reference value established by the corresponding CIPM KC.**
- The RMO key comparisons deliver complementary information without changing the reference value derived from the CIPM KC.
- A degree of equivalence derived from an RMO key comparison has the same status as one derived from a CIPM KC.

### ➤ KC may be extended by subsequent key comparisons.

## 3. Key and Supplementary Comparisons in mass.

### ➤ Supplementary comparison (SC)

- is intended to cover areas or techniques not addressed by key comparisons.
- are complementary to KC and are not intended as second-level comparisons.
- Their final reports are published in the KCDB, but degrees of equivalence are not necessarily computed.

### ➤ Pilot Studies (PS)

- are a third category of comparison
- normally undertaken to establish measurement parameters for a “new” field or instrument, or as a training exercise.
- alone are not normally considered sufficient support for calibration and measurement capabilities (CMCs)
- are not registered nor published in the KCDB.

## 3. Key and Supplementary Comparisons in mass.

### ➤ Subsequent comparisons

- are organized for one or several participants.
- should follow the same procedure as a forerunning comparison
- are normally carried out for one of the following reasons:
  - after completing a comparison, an institute considers its result unrepresentative of its standards/capabilities;
  - an institute was not ready to participate at the time a comparison was conducted.

**Example:            Bilateral comparisons**



### 3. Key and Supplementary Comparisons in mass.

#### ➤ Subsequent comparisons... bilateral comparison information:

#### 9. Disagreements

An institute that considers its result unrepresentative of its standards may request a subsequent separate bilateral comparison with the pilot institute or one of the participants. This should take place as soon as possible after the completion of the comparison in progress. The subsequent bilateral comparison is considered as a new and distinct comparison.

In the event of disagreement about the comparison results, or over the interpretation of results, which cannot be resolved by the participants themselves, the corresponding RMO TC/WG, the key comparison working group, or the Consultative Committee, the matter will be referred to the CIPM for a decision.

### 3. Key and Supplementary Comparisons in mass.

#### ➤ Criteria for SIM Mass KC and SC

- Organize KC / SC with the largest number of participants possible.
- Avoid bilateral comparison as far as possible.
- Select nominal values similar to CCM KC for linking SIM KC/SC.
  - SIM KC shall be linked to CCM KC (2 linking NMIs are preferable)
  - SIM SC are recommended to be linked to CCM KC
- NMIs are encourage to pilot KC/SC [couched by experienced SIM NMIs]

### 3. Key and Supplementary Comparisons in mass.

**Bureau**  
↑ **International des**  
| **Poids et**  
| ↓ **Mesures**

Consultative Committee for Mass and  
related quantities

**CCM WG Strategy** 14.01.2013 (latest revision: 22.07.2019)

---

#### **Strategy 2017-2027**

Consultative Committee for Mass and Related  
Quantities (CCM)

---

### 3. Key and Supplementary Comparisons in mass.

#### 7 Required key comparisons and pilot studies with indicative repeat frequency

The CCM general philosophy when deciding to make a comparison is to be close to industry and to the customer needs. Where travelling standards are used sequentially, participation in CIPM KCs should be limited to the minimum number of institutes necessary to provide effective linkage in each region (no more than three institutes per RMO).

A short description and a timetable of the required KCs in each WG are given here. The list of ongoing and planned KCs is presented under section 8. Without further indication, the repeat frequency for a KC is 10 years.

## 7.7 Mass standards (realization and dissemination)

- On-going key comparisons of realisation experiments (the first to be completed in Q2, 2020 and then approximately every 2 years),
- Traditional comparisons of mass standards should continue following the current plan,
- Comparisons below 100 mg have been considered and are not deemed necessary since:
  - calibration of a weight in the range 100 mg to 500 mg is sufficient to demonstrate capability down to 1 mg
  - Smaller fractional weights are less robust and therefore not good transfer standards
- However, Comparisons of sub-mg mass standards have taken place within EURAM-ET (and including COOMET members) and could be extended to the CCM,
- Separate KCs for the validation of realisation experiments operating at values other than 1 kg may need to be considered or could be accommodated via the existing KC schedule (values of sub-multiples would need to be appropriate).

# SIM MWG7 Sub-Group of Mass Meeting

year 20XX KC identifier	17	18	19	20	21	22	23	24	25	26	27	28	29	30
CCM.M-K1 CCM.M-K4 (1 kg)						X								
CCM.M-K2 CCM.M-K5 CCM.M-K7 (sub-multiples)								X						
CCM.M-K3 CCM.M-K6 (50 kg)							X							
CCM.M-K8			X		X		X		X		X		X	

*Table 7: Timetable of the required KCs in mass standards.*

# SIM MWG7 Sub-Group of Mass Meeting

Elapsed time between CCM KC in Mass Standars			
Measurand	CCM.M-XX		Elapsed time (years)
1 kg	K1 1995-1998	K4 2011-2012	14
	K2 1998-1999	K5 2000-2003	
(Sub-)multiples kg	K5 2000-2003	K7 2014-2015	12
	K3 2001-2002	K6 2011-2013	

CCM KC Identifier	Year 20XX																		
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
CCM.M-K1 CCM.M-K4 (1 kg)	X	SIM.M.M-K4 linked to CCM.M-K4									X		SIM KC (1 kg) linked to new CCM KC						
CCM.M-K2 CCM.M-K5 CCM.M-K7 ((Sub-)multiples kg)		SIM.M.M-K5 linked to CCM.M-K5		X								SIM KC (sub-)multiples linked to CCM.M-K7	X						
CCM.M-K3 CCM.M-K6 (50 kg)		X				SIM.M.M-K6 linked to CCM.M-K6						X							SIM KC (50 kg) linked to new CCM KC
CCM.M-K8 (1 kg) realization of kg under vacuum								X		X		X		X		X		X	



## 4. Matters Pending (CMCs, comparisons).

### ➤ SIM KC

Comparison Identifier	Metrology Area	Sub-field	Description	Parameters	Measurement period	Pilot institute	Status
SIM.M.M-K4	Mass and related quantities	Mass Standards	Comparison of mass standards		2009 - 2013	INTI	Approved for equivalence
SIM.M.M-K5	Mass and related quantities	Mass Standards	Comparison of mass standards		2009 - 2013	INTI	Approved for equivalence
SIM.M.M-K6	Mass and related quantities	Mass Standards	Comparison of mass standards		2015 - 2017	CENAM	Measurements completed

**Draft A of SIM.M.M-K6 will be circulate among participants by end of april., 2021**


## 4. Matters Pending (CMCs, comparisons).



Comparison Identifier	Metrology Area	Sub-field	Description	Parameters	Measurement period	Pilot institute	Status
SIM.M.M-S1	Mass and related quantities	Mass Standards	Comparison of mass standards		2004 - 2005	CEM	Approved
SIM.M.M-S10	Mass and related quantities	Mass Standards	Comparison of mass standards		2012	INDECOPI	Approved
SIM.M.M-S11	Mass and related quantities	Mass Standards	Determination of mass of weights		2012 - 2013	INM (CO)	Approved
SIM.M.M-S12	Mass and related quantities	Mass Standards	Comparison of mass standards		2012 - 2015	CESMEC	Report in progress, draft A
SIM.M.M-S13	Mass and related quantities	Mass Standards	Comparison of mass standards		2012	INDECOPI	Approved
SIM.M.M-S14	Mass and related quantities	Mass Standards	Comparison of mass standards		2013 - 2014	CEM	Approved
SIM.M.M-S15	Mass and related quantities	Mass Standards	Comparison of mass standards of accuracy F1	Nominal density: 7950 kg/m <sup>3</sup>	2015 - 2016	INTI	Approved
SIM.M.M-S16	Mass and related quantities	Mass Standards	Comparison of mass standards		2016	CENAM	Approved
SIM.M.M-S17	Mass and related quantities	Mass Standards	Comparison of mass standards		2017	CENAM	Measurements completed
SIM.M.M-S18	Mass and related quantities	Mass Standards	Comparison of mass standards		2018	CENAM	Measurements completed
SIM.M.M-S2	Mass and related quantities	Mass Standards	Comparison of mass standards		2005	CENAM	Approved
SIM.M.M-S3	Mass and related quantities	Mass Standards	Comparison of mass standards		2007 - 2008	CESMEC	Approved
SIM.M.M-S4	Mass and related quantities	Mass Standards	Comparison of mass standards		2009	CENAM	Approved
SIM.M.M-S5	Mass and related quantities	Mass Standards	Comparison of mass standards		2005	CENAM	Approved
SIM.M.M-S6	Mass and related quantities	Mass Standards	Comparison of mass standards		2009	CESMEC	Report in progress, draft B
SIM.M.M-S7	Mass and related quantities	Mass Standards	Comparison of mass standards		2009 - 2010	BSJ	Approved
SIM.M.M-S8	Mass and related quantities	Mass Standards	Comparison of mass standards		2006	CESMEC	Approved
SIM.M.M-S9	Mass and related quantities	Mass Standards	Determination of the susceptibility and magnetic polarization of weights by means of the susceptometer method		2011 - 2012	INDECOPI	Approved

## 4. Matters Pending (CMCs, comparisons).



**SIM.M.M-S12**
 PRINT OUT

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INFORMATION & CONTACT
PARTICIPANTS

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Metrology area, Sub-field	Mass and related quantities, Mass Standards
Description	Comparison of mass standards
Time of measurements	2012 - 2015
Status	Report in progress, draft A

Measurand	Mass: 50 kg
Transfer device	A stainless steel weight of 50 kg

Comparison type	Supplementary Comparison
Consultative Committee	CCM (Consultative Committee for Mass and Related Quantities)
Conducted by	SIM (Inter-American Metrology System)
Comments	

Pilot Institute	<a href="#">CESMEC</a> Centro de Estudios, Medición y Certificación de Calidad Chile
Contact person	Francisco GARCIA ✉ <a href="mailto:fgarcia@cesmec.cl">fgarcia@cesmec.cl</a> +56 2 3502 185

Participants		Role
CESMEC	Chile	Pilot Laboratory
INACAL (former INDECOPI)	Peru	Participant
CENAM	Mexico	Participant (shall be included)

## 4. Matters Pending (CMCs, comparisons).



PRINT OUT

**SIM.M.M-S17**

**INFORMATION & CONTACT**    PARTICIPANTS

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Metrology area, Sub-field: Mass and related quantities, Mass Standards  
 Description: Comparison of mass standards  
 Time of measurements: 2017  
 Status: Measurements completed

References: [SIM.M.M-S17 Registration and progress form](#)  
[SIM.M.M-S17 Technical Protocol](#)

Measurand: Mass at 200 mg, 1 g, 50 g, 200 g, 1 kg and 2 kg  
 Transfer device: Mass standards in stainless steel

Comparison type: Supplementary Comparison  
 Consultative Committee: CCM (Consultative Committee for Mass and Related Quantities)  
 Conducted by: SIM (Inter-American Metrology System)

Comments:

Pilot institute: [CENAM](#)  
 Centro Nacional de Metrologia  
 Mexico

Contact person: Luis Omar BECERRA  
 ✉ [lbecerra@cenam.mx](mailto:lbecerra@cenam.mx)  
 +52 442 211 05 73

Participants		Role
CENAM	Mexico	Pilot Laboratory
LCM (former LACOMET)	Costa Rica	Participant

## 4. Matters Pending (CMCs, comparisons).



**SIM.M.M-S18** PRINT OUT

**INFORMATION & CONTACT**    PARTICIPANTS

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Metrology area, Sub-field: Mass and related quantities, Mass Standards  
 Description: Comparison of mass standards  
 Time of measurements: 2018  
 Status: Measurements completed

---

References: [SIM.M.M-S18 Registration and progress form](#)  
 Measurand: Mass of 20 kg  
 Transfer device: Mass standard of 20 kg

---

Comparison type: Supplementary Comparison  
 Consultative Committee: CCM (Consultative Committee for Mass and Related Quantities)  
 Conducted by: SIM (Inter-American Metrology System)  
 Comments:

Pilot institute: [CENAM](#)  
 Centro Nacional de Metrología  
 Mexico

Contact person: L. M. Pena  
 ✉ [lpna@cenam.mx](mailto:lpna@cenam.mx)  
 52 442 2 11 05 00 to 04

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Additional: [Xavier Navas, Centro Nacional de Metrología de Panama AIP](#)

Participants		Role
CENAM	Mexico	Pilot Laboratory
CENAMEP AIP	Panama	Participant

## 4. Matters Pending (CMCs, comparisons).



**SIM.M.M-S6** PRINT OUT

**INFORMATION & CONTACT**    PARTICIPANTS

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Metrology area, Sub-field	Mass and related quantities, Mass Standards
Description	Comparison of mass standards
Time of measurements	2009
Status	Report in progress, draft B

---

Measurand	Mass: 10 kg, 2 kg, 1 kg, 200 g, 50 g, 1 g, 200 mg
Transfer device	Set of standard weights

---

Comparison type	Supplementary Comparison
Consultative Committee	CCM (Consultative Committee for Mass and Related Quantities)
Conducted by	SIM (Inter-American Metrology System)
RMO Internal Identifier	SIM.7.46
Comments	

Pilot institute	<a href="#">CESMEC</a> Centro de Estudios, Medición y Certificación de Calidad Chile
Contact person	Francisco GARCIA ✉ <a href="mailto:fgarcia@cesmec.cl">fgarcia@cesmec.cl</a> +56 2 3502 185

Participants		Role
CESMEC	Chile	Pilot Laboratory
CENAMEP AIP	Panama	Participant

### 4. Matters Pending (CMCs, comparisons).

#### ➤ Future comparison or pilot studies

##### ➤ Calibration of sub-milligram weights.

➤ NIST participating with E.F.B. (and Subdivision method?)

➤ SIM NMIs with Subdivision method

##### ➤ Others?



### 4. Matters Pending (CMCs, comparisons).

#### ➤ Calibration guidelines

##### ➤ Calibration of microbalances.

- In April 2021 will be circulated the Spanish version to SIM Mass technical contacts for review and comments.
- After reviewing and approval of SIM Mass MWG7:
  - SIM has budget for translation to English and for printed versions.
  - Electronic versions will be available in SIM webpage

##### ➤ Calibration of NAWI

- In middle May 2021 the SIM Guidelines on calibration of NAWI cg-01/v.01 based on EURAMET CG-18 4.0 will be available in SIM webpage (English and Spanish versions).

## 4. Agreements

### CMCs

- Each NMI is responsible for submitting their mass CMCs in KCDB 2.0
  - A representative of the NMI should ask for a writer account.
  - Former excel sheets forms are not longer required.
  - Fill the Check List of Annex 3 in SIM-D-05.
  - Minutes of QSTF meeting with the approval of the NMI QS is required (?)
  - SIM MWG7 will ask Sally Bruce (Chair) and Cristopher Cortés (Co-chair) from QSTF for a document with all the relevant information certifying that the NMI QS has been approved by SIM-QSTF.
- Read and follow the updated versions of SIM-D-05 and CIPM MRA-G-13.
- Keep contact with TC Chair, Secretary(\*) and Co-chair in case of questions.
- Review process will be submitted by Co-chair, Secretary or TC Chair based on information.

(\*) *This new function in the Sub-Group of Mass was created in this meeting. See Agreements -> Other topics*

## 4. Agreements

### Comparisons

- The registration and continuity of comparisons is through KCDB 2.0
  - A representative of the pilot NMI should ask for a pilot account.
  - PDF forms are no longer necessary to fill.
- Pilot laboratories are encouraged to follow up the status of comparisons.
- Read and follow the updated versions of SIM-D-07 and CIPM MRA-G-11.
- **Future comparisons (planned for 2021-2024):**
  - **SIM.M.M-K4 (1 kg) and SIM.M.M-K7 ([sub]multiples of 1 kg).**
  - **A questionnaire will be sent to SIM mass technical contacts so they can express their interest in participating.**
  - **INM - Colombia offered to be the Pilot Laboratory of both comparisons.**
  - **NIST - USA and CENAM - Mexico agreed to participate as linking laboratories to CCM KC.**
  - **Due to pandemic and travel restrictions, transportation of travelling standards among participants will be by door-to-door courier service (no hand-carried).**

## 4. Agreements

### Other topics

#### ➤ SIM KILOGRAM DISSEMINATION PROJECT (SKDP)

- Each SIM laboratory should plan on returning their kilogram to the laboratory (NRC or NIST) that issued the original calibration report. This is clearly indicated on the reports.
- Each SIM laboratory should plan on sending their kilogram to the appropriate laboratory (NRC or NIST). No hand-carrying of weights due to the pandemic.
- Each SIM laboratory should determine the best way for them to send the kilograms and then confirm this with the calibrating laboratory (NRC or NIST). Any difficulties can be dealt with on a case-by-case basis.

#### ➤ SECRETARY OF SUB-GROUP OF MASS OF SIM-MWG7

- Our appreciation to **Edward Mulhern, M. Sc. from NIST** for taking the responsibility as Secretary of the Sub-Group of Mass. Congratulations!

# THANK YOU FOR YOUR ATTENTION

**M. Sc. & T. Luis Manuel Peña Pérez**

[lpena@cenam.mx](mailto:lpena@cenam.mx)

Co-Chair Sub-Group of Mass

SIM MWG7



## MWG 7- MASS AND RELATED QUANTITIES

“KCDB 2.0 at the service of the SIM region in Mass and Related Magnitudes”



## **CMCs, Key and Supplementary Comparisons on Density**

**M.Sc. Luis Omar Becerra (CENAM – México)**

**Co-Chair Density sub working group of the SIM MWG-7**

[Lbecerra@cenam.mx](mailto:Lbecerra@cenam.mx)

**2021-03-26**

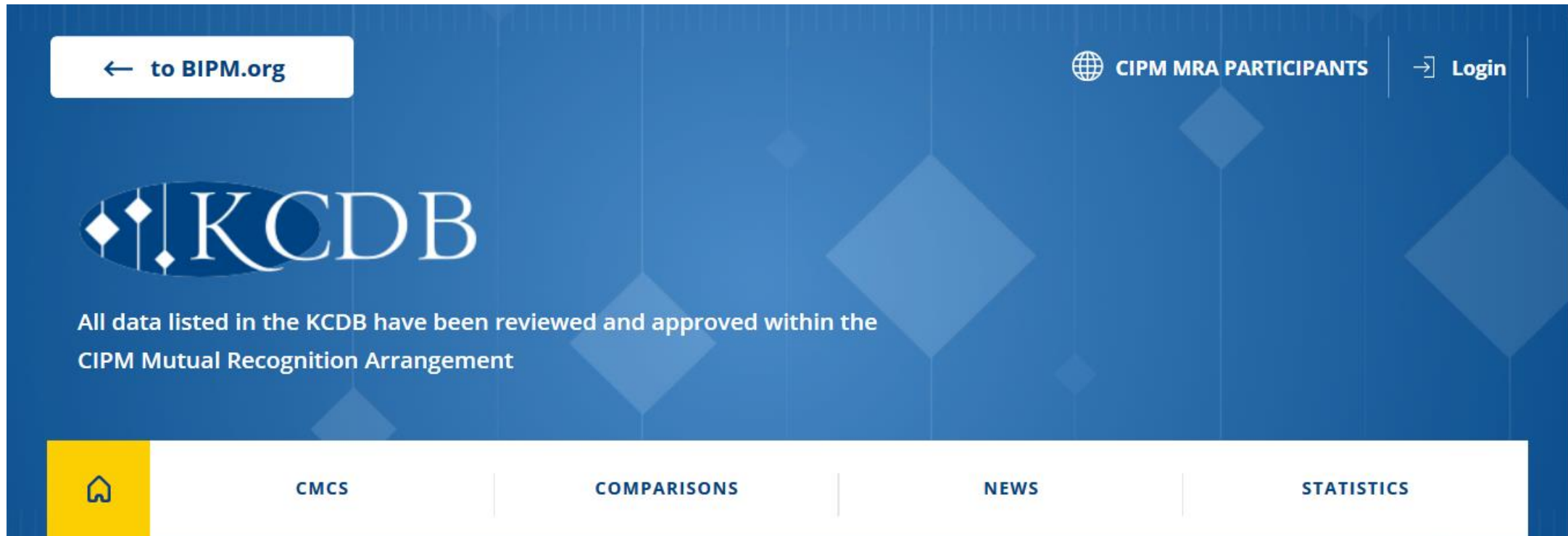


## Topics

- 1. Particularities in the magnitude of the presentation of Density CMCs.**
- 2. Review and Approval of CMCs on Density**
- 3. Particularities of Key Comparisons, Supplementary Comparisons and Pilot Studies on Density measurements**
- 4. Other topics**

## 1. Particularities in the magnitude of the presentation of Density CMCs

¿Which Density services can be published at the KCDB?



← to BIPM.org

🌐 CIPM MRA PARTICIPANTS | → Login

# KCDB

All data listed in the KCDB have been reviewed and approved within the CIPM Mutual Recognition Arrangement

🏠 CMCS | COMPARISONS | NEWS | STATISTICS



# Classification of services

2019-08-02

**METROLOGY AREA: MASS AND RELATED QUANTITIES**

**BRANCH: MASS**

## 2. Density

### 2.1 Density of solid

2.1.1 Density of solid: solid density artefact

2.1.2 Volume of solid: solid artefact

### 2.2 Density of liquid

2.2.1 Density measuring device

2.2.2 Density of liquid

### 2.3 Refractive index of liquid

2.3.1 Refractive index of liquid

## Examples of expression of CMCs in density

Quantity	Instrument or Artifact	Method of Measurement	Parameters	Measurand	Uncertainty	Uncertainty Equation
Volume of solid	Solid density standard	Hydrostatic weighing	Reference temperature : 20 °C Mass : less than 1030 g	[ 50.0 , 440.0 ] cm <sup>3</sup>	mm <sup>3</sup> (Absolute)	0.15 + 0.0015V (V volume in cm <sup>3</sup> The uncertainty is expressed in mm <sup>3</sup> )
Volume of solid	Mass standard: 20 kg to 50 kg	Hydrostatic weighing	Reference temperature : 20 °C	[ 2400.0 , 6500.0 ] cm <sup>3</sup>	[ 600.0 , 1600.0 ] mm <sup>3</sup> (Absolute)	
Density of liquid	Liquid	Hydrostatic weighing	Liquid temperature : 20 °C Pressure : 101325 Pa Viscosity : max. 1000 mPa s	[ 1000.0 , 2000.0 ] kg/m <sup>3</sup>	[ 0.004 , 0.018 ] kg/m <sup>3</sup> (Absolute)	
Density of liquid	Liquid	Hydrostatic weighing	Liquid temperature : 20 °C Pressure : 101325 Pa Viscosity : max. 1000 mPa s	[ 1000.0 , 2000.0 ] kg/m <sup>3</sup>	1 x 10 <sup>-5</sup> (Relative)	

- It is preferable to express capabilities in intervals instead of discrete values
- The uncertainty interval should cover all the individual values
- The claimed uncertainty should agree with the results on comparisons (Key or supplementary)

## 2. Review and Approval of CMCs on Density

The three fundamental elements leading to approval of an institute's CMCs are:

- participation by the institute in reviewed and approved scientific comparisons;
- operation by the institute of an appropriate and approved quality management system;
- international peer-review (regional and inter-regional) of claimed calibration and measurement capabilities.



## **SIM REFERENCE DOCUMENT N° 05 (SIM-D-05 3.5)**

### **SIM Procedure for Review of Calibration and Measurement Capabilities**

### **Submitted on the KCDB 2.0 Platform of the CIPM MRA**

*Calibration and Measurement Capability (CMC)* For the purpose of this reference document, the definition of a CMC and associated notes are as provided in Section 1 of the CIPM MRA-G-13 (<https://www.bipm.org/en/cipm-mra/cipm-mra-documents/>):

***“A CMC is a calibration and measurement capability available to customers under normal conditions:***

***(a) as published in the BIPM key comparison database (KCDB) of the CIPM MRA; or***

***(b) as described in the laboratory’s scope of accreditation granted by a signatory to the ILAC Arrangement.”***

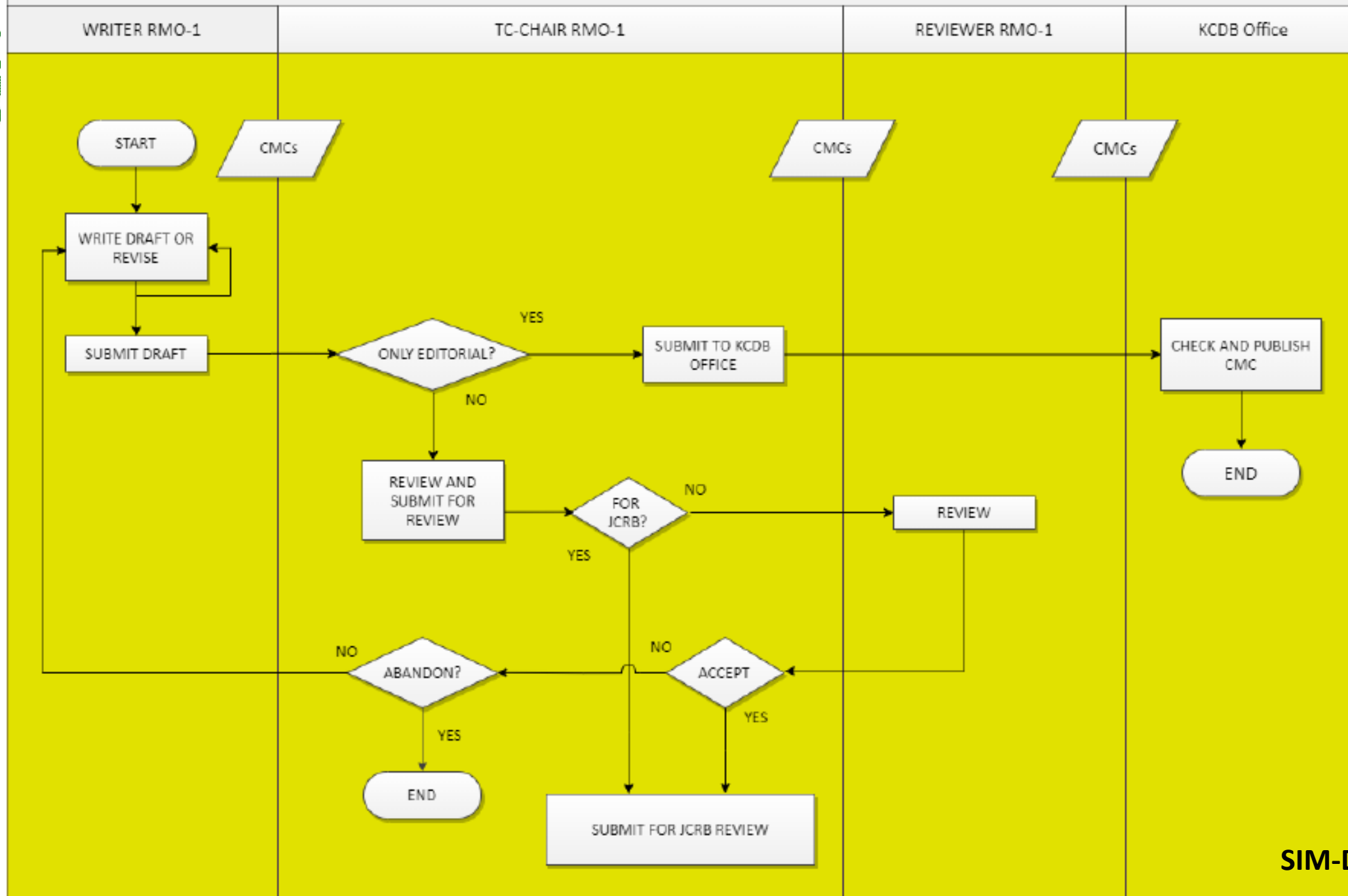
## The Process of Reviewing CMCs for Acceptability

- **IntraRMO Review process (SIM)**
- **JCRB Review Process (SIM and other regions)**

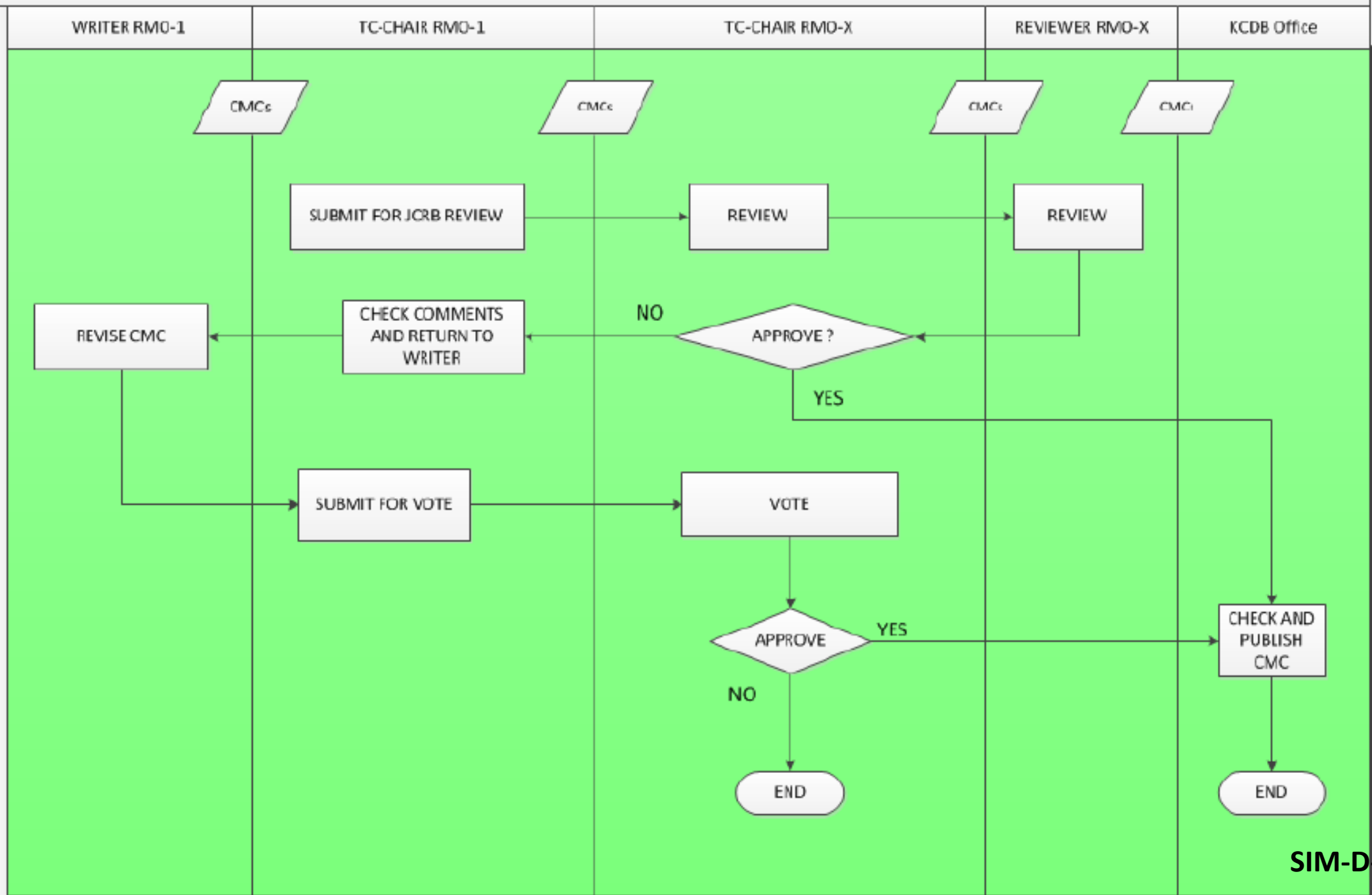




# Intra-RMO REVIEW



# JCRB (INTER-RMO) REVIEW

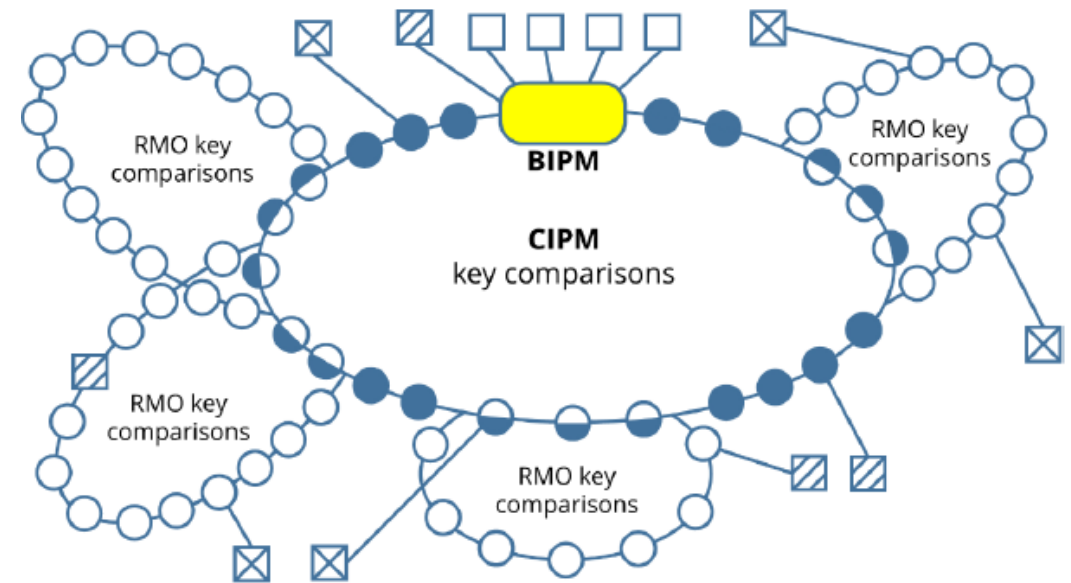


### 3. Particularities of Key Comparisons, Supplementary Comparisons and Pilot Studies on Density measurements

#### Measurement comparisons in the CIPM MRA

Guidelines for organizing, participating and reporting  
CIPM MRA-G-11

<https://www.bipm.org/utils/common/documents/CIPM-MRA/CIPM-MRA-G-11.pdf>



- NMI/DI participating in CC key comparisons
- NMI/DI linking RMO key comparisons to CIPM key comparisons
- NMI/DI participating in RMO key comparisons
- NMI/DI participating in ongoing BIPM key comparisons
- ⊠ NMI/DI participating in a bilateral key comparison
- ▨ International organization signatory to the CIPM MRA



Table 1. An overview of the comparisons organized within the frame of the CIPM MRA.

Activity	CIPM comparisons		RMO comparisons		Pilot studies
	Key	Supplementary	Key	Supplementary	
Objective (Section 2)	To test the principal techniques and methods in the field	To meet specific needs not covered by key comparisons	To extend the coverage of the CIPM key comparisons regionally	To meet specific needs not covered by RMO key comparisons	To establish measurement parameters for a “new” field or instrument, or as a training exercise
Organization (Section 3)	CCs and BIPM		RMO TCs/WGs		BIPM, CCs and RMOs
Technical protocol (Section 4)	Includes the proposal for the method of determination of the key comparison reference value	According to common requirements	Follows the CIPM key comparison and any relevant CC guidelines. Includes the way in which the results will be linked to the CIPM key comparison	According to common requirements	Depends on CCs and RMOs

Type	CIPM comparisons		RMO comparisons		Pilot studies
Activity	Key	Supplementary	Key	Supplementary	
Registration (Section 5)	Registered in the KCDB				Not registered in the KCDB
Participation (Section 6)	Open to laboratories having the highest technical competence and experience (CC members). Participation may be restricted (see “2.Type of comparisons” for details) Associates may participate in special cases		Open to all RMO members and other institutes (including from other RMOs), subject to decision by the organizing RMO		CCs and RMOs
Outcomes (Section 7)	Measured values and measurement uncertainties				Measured values and measurement uncertainties
	Key comparison reference values and degrees of equivalence	May include degrees of equivalence	Degrees of equivalence	May include degrees of equivalence	



# KCDB 2.0 at the service of the SIM region in Mass and Related Magnitudes



Type	CIPM comparisons		RMO comparisons		Pilot studies
Activity	Key	Supplementary	Key	Supplementary	
Approval of reports (Section 8)	Withdrawal is generally not allowed				According to practice of CCs and RMOs
	Approved by CCs	Approved by CCs	Approved by CCs	Approved by RMOs	
CMC support (Section 8.2)	Draft B may be used to underpin CMCs	Final report needed to underpin CMCs	Draft B may be used to underpin CMCs	Final report needed to underpin CMCs (overseen by CC)	Generally not used to support CMCs
Publication (Section 10)	<p>Published in the KCDB. For up-to-date information, the pilot institute shall report the status of comparisons.</p> <p>Recommended to publish in the Technical supplement of <i>Metrologia</i> or other scientific publications.</p>				<p>Not published in the KCDB. Pilot studies run by the BIPM are available on the BIPM website. Pilot studies by CC or RMO may be available</p>

## Density Comparisons registered in the KCDB (CCM and SIM Comparisons)

Comparison Identifier	Description	Mesurand or Instrument	Low limit	Upper limit	Pilot institute	Start	End	Time elapsed	
CCM.D-K1	Solid density	silicon sphere	2 300 kg/m <sup>3</sup>	2 300 kg/m <sup>3</sup>	NMIJ AIST	2001	2003	20	18
CCM.D-K2	Liquid density	Pentadecane, water, tetrachloroethylene and high-viscosity oil samples	700 kg/m <sup>3</sup>	1 700 kg/m <sup>3</sup>	PTB	2004	2004	17	17
<b>CCM.D-K3</b>	<b>Solid density</b>	<b>Stainless steel weights</b>	<b>8 000 kg/m<sup>3</sup></b>	<b>8 000 kg/m<sup>3</sup></b>	<b>NMIJ AIST</b>	<b>2016</b>		<b>5</b>	
<b>CCM.D-K4</b>	<b>Hydrometers</b>	<b>Hydrometers</b>	<b>600 kg/m<sup>3</sup></b>	<b>2 000 kg/m<sup>3</sup></b>	<b>INRIM</b>	<b>2011</b>	<b>2012</b>	<b>10</b>	<b>9</b>
CCM.D-K5	Liquid density	three liquids	753 kg/m <sup>3</sup>	1 866 kg/m <sup>3</sup>	BEV	2018		3	
CCM.D-K6	Refractive Index	Liquids			NMIJ AIST				
<b>SIM.M.D-K3</b>	<b>Solid density</b>	<b>Stainless steel weights</b>	<b>8 000 kg/m<sup>3</sup></b>	<b>8 000 kg/m<sup>3</sup></b>	<b>INTI</b>	<b>2009</b>	<b>2012</b>	<b>12</b>	<b>9</b>
<b>SIM.M.D-K4</b>	<b>Hydrometers</b>	<b>Hydrometers</b>	<b>600 kg/m<sup>3</sup></b>	<b>1 300 kg/m<sup>3</sup></b>	<b>CENAM</b>	<b>2007</b>	<b>2008</b>	<b>14</b>	<b>13</b>
SIM.M.D-S1	Hydrometers	Hydrometers	800 kg/m <sup>3</sup>	1 200 kg/m <sup>3</sup>	CENAM	2007	2007	14	14
SIM.M.D-S2	Hydrometers	Hydrometers	800 kg/m <sup>3</sup>	1 000 kg/m <sup>3</sup>	INMETRO	2009	2010	12	11
SIM.M.D-S3	Solid density	Two spheres, one of glass, one of stainless steel	2 200 kg/m <sup>3</sup>	8 000 kg/m <sup>3</sup>	CENAM	2006	2006	15	15
SIM.M.D-S4	Hydrometers	Hydrometers	600 kg/m <sup>3</sup>	2000 kg/m <sup>3</sup>	INDECOPI	2012	2012	9	9
SIM.M.D-S5	Solid density	Stainless steel weights	8 000 kg/m <sup>3</sup>	8 000 kg/m <sup>3</sup>	INM (CO)	2012	2013	9	8
SIM.M.D-S6	Hydrometers	Hydrometers	600 kg/m <sup>3</sup>	1 300 kg/m <sup>3</sup>	CENAM	2017		4	



## KCDB 2.0 at the service of the SIM region in Mass and Related Magnitudes



**Bureau**  
↑ **International des**  
| **Poids et**  
| ↓ **Mesures**

Consultative Committee for Mass and  
related quantities

CCM WG Strategy 14.01.2013 (latest revision: 22.07.2019)

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### **Strategy 2017-2027**

## Consultative Committee for Mass and Related Quantities (CCM)

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The audience for this strategy is mainly the CCM, the NMI Directors, the government representatives, the BIPM director and the CIPM.

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## 5 Future Scan

### 5.2.1 Density and Viscosity

On density standards, the strategic planning to serve industry and society has been discussed at its meetings on the following subjects:

- comparison of the capabilities in calibrating vibrating-tube density meters,
- refractive index of liquids for food industry and agriculture,
- density measurements under high pressures and high temperatures ( $p\rho T$  properties) for energy saving and environment technology,
- increasing industrial/research requirement for density determination on porous materials, powders and particulates (which involves techniques such as gas pycnometry).

## 7 Required key comparisons and pilot studies with indicative repeat frequency

The CCM general philosophy when deciding to make a comparison is to be close to industry and to the customer needs. Where travelling standards are used sequentially, participation in CIPM KCs should be limited to the minimum number of institutes necessary to provide effective linkage in each region (no more than three institutes per RMO).

### 7.1 Density and viscosity

- In general, completed and planned KCs covers almost all of the CMCs on density. No frequent KCs are necessary. **A period of 10 to 15 years is considered to be adequate for density,**
- As the **gas density** measurements will be of importance for energy savings and energy transportations, such a CMC may be covered by a new KC on the  $p\rho T$  properties of fluids,
- As the food industry and agriculture need a traceable standard of the **refractive index of liquids** for sugar content measurements, supplying the refractive index standard liquids, which are similar to the density standard liquids, are necessary. Such a comparison is covered by CCM.D-K6.



year 20XX KC identifier	17	18	19	20	21	22	23	24	25	26	27	28	29	30
CCM.D-K1					X									
CCM.D-K2							X							
CCM.D-K3			X											
CCM.D-K4											X			
CCM.D-K5			X											
CCM.D-K6					X									

*Table 1: Timetable of the required KCs in density*



## Future density comparisons within the SIM region

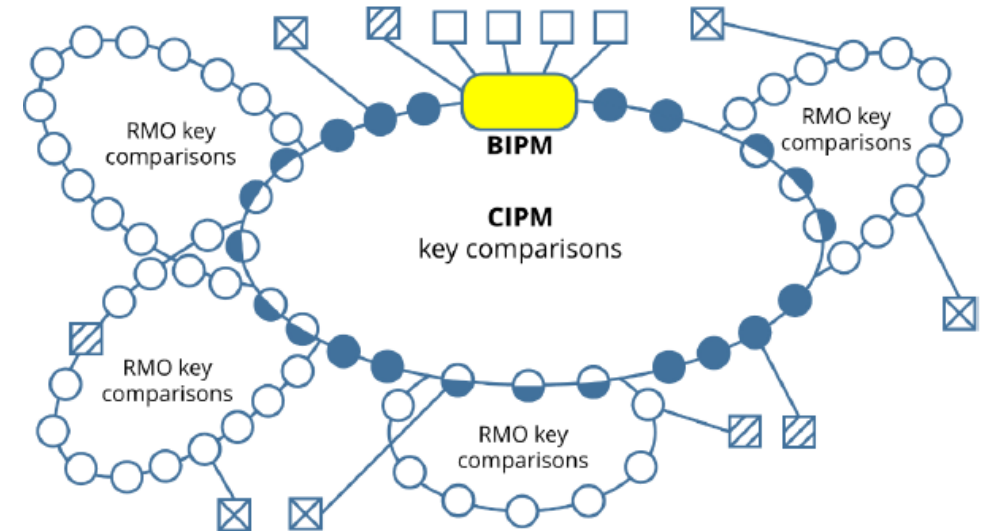
- SIM Key comparisons**

To extend the coverage of the CIPM key comparisons regionally

CCM.D-K1	Solid density	silicon sphere
CCM.D-K2	Liquid density	Pentadecane, water, tetrachloroethylene and high-viscosity oil samples
<b>CCM.D-K3</b>	<b>Solid density</b>	<b>Stainless steel weights</b>
<b>CCM.D-K4</b>	<b>Hydrometers</b>	<b>Hydrometers</b>
CCM.D-K5	Liquid density	three liquids
CCM.D-K6	Refractive Index	Liquids

- SIM Supplementary comparisons**

To meet specific needs not covered by RMO key comparisons



- Is there any proposal for a new SIM Density Comparison?
  - Measurand / Instruments (traveling standards)
  - Nominal values / Uncertainty
  - Pilot laboratory and coordinating group
  - Defining participant laboratories
  - Timetable of the comparison (Protocol / Measurements / Report)
  - Budget (acquiring instruments, or materials, e.g. liquids, shipping, meetings, etc.)



## 4. Other topics

- Update of the directory of SIM Technical contacts on Density
- Defining a Secretary of this sub-working group
- Others ...



## KCDB 2.0 at the service of the SIM region in Mass and Related Magnitudes



**Thanks for your attention ...**






# Pressure and Vacuum at SIM

Dr. Jorge C. Torres-Guzman, Chair  
CENAM, Mexico  
Mayckol Morales, Deputy  
INM, Colombia

April 2021

# Interamerican Metrology System, SIM



-  **Noramet**
-  **Camet**
-  **Andimet**
-  **Suramet**
-  **Carimet**

n.	Region	Country	NMI	DI if relevant	REPRESENTATIVE	E-MAIL	TELEPHONE	ADDITIONAL CONTACT
1	N O R T A	Canada	NRC		Matthew Brown	Matthew.Brown@nrc-cnrc.gc.ca		
2		Mexico	CENAM		Jorge Torres-Guzman	jorge.torres@cenam.mx	52 442 211 0572	Jesus Aranzolo Suarez <JARANZOL@cenam.mx>
3		USA	NIST		Julia Scherschligt	julia.scherschligt@nist.gov		Hendricks, Jay H. <jay.hendricks@nist.gov>
	C I A M T R E	Caribbean Community	CARICOM					
12		Jamaica		BSJ				
17		Trinidad and Tobago		TTBS				
18	C A M E T	Belize	BBS					
19		Costa Rica	LACOMET		Fernando José Andrés Monge	fandres@lacomet.go.cr		
20		El Salvador	CIM		Jorge Adalberto Medrano	jorge.medrano@cim.gob.sv		
21		Guatemala	CENAME		Fernando A. Rodríguez Coronado	frodriguez@mineco.gob.gt		
22		Honduras	CEHM					
23		Nicaragua	LANAMET		Juan Gabriel Pérez Olivas	presion.lanamet@mific.gob.ni		
24	Panama	CENAMEP		José Kuruc	<a href="mailto:jkuruc@cenamep.org.pa">jkuruc@cenamep.org.pa</a>		Saul García <a href="mailto:sgarcia@cenamep.org.pa">sgarcia@cenamep.org.pa</a>	
25	A N D I M E	Bolivia	IBMETRO		Henry Paco Mariño	<a href="mailto:hpaco@ibmetro.gob.bo">hpaco@ibmetro.gob.bo</a>		<a href="mailto:gchacon@ibmetro.gob.bo">gchacon@ibmetro.gob.bo</a>
26		Colombia	INM		Mayckol Morales	mmorales@inm.gov.co		
27		Ecuador	INEN		Sebastian Vicente	svicente@normalizacion.gob.ec		
28		Peru	INACAL		Leonardo de la Cruz	<a href="mailto:ldelacruz@inacal.gob.pe">ldelacruz@inacal.gob.pe</a>		
29		Venezuela	SENCAMER					
30	S U R E T A M	Argentina	INTI		Juan Forastieri	<a href="mailto:jaforast@inti.gob.ar">jaforast@inti.gob.ar</a>		victorm@inti.gob.ar
31		Brazil	INMETRO		Jackson S Oliveira	<jsoliveira@inmetro.gov.br>		
32		Chile	INN		Marcial Espinoza	marcial.espinoza@enaer.cl		Angel Flores, G.Calidad <angel.flores@enaer.cl>
33		Paraguay	INTN		Roque Arnaldo Baez Genes	rbaez@intn.gov.py		
34		Uruguay	LATU		Pablo Constantino	pconstan@latu.org.uy		

- Last two meetings of the SIM P&V Subgroup.

25 March 2021, virtual meeting.

25 September 2020, virtual meeting.

- Last workshop of the SIM P&V Subgroup.

**March 21-26, 2021** KCDB 2.0 at the service of the SIM region in Mass and Related Quantities.



6<sup>th</sup> CCM International  
Conference on Pressure and  
Vacuum Metrology

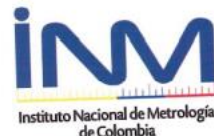
in conjunction with the

5<sup>th</sup> International Conference  
IMEKO TC 16

Pereira-Colombia, May 7-10, 2017

**Programme & Abstracts**

Bureau  
International des  
Poids et  
Mesures



6<sup>th</sup> International CCM Conference on Pressure and Vacuum Metrology in **Pereira, Colombia** was successfully organised. There were 60 papers presented and 85 participants registered.

## Issues discussed

- Terms of reference. Agreed.
- Membership. Agreed.
- Selection of participants at KC. Agreed.
  
- New CMCs.
- Comparisons published or approved.
- Comparisons in process.
- Comparisons pending, not complete.
- Change of chairmanship.

- New CMCs.
  1. Costa Rica
  2. Colombia
  3. Uruguay

- Comparisons published or approved.

<b>Comparison</b>	<b>Status</b>	<b>Last update</b>	<b>Pilot</b>
<p>SIM.M.P-K6</p> <p>SIM Key Comparison in Pneumatic Gauge Pressure for High Accuracy Pressure Balances up to 120 kPa</p>	Approved	2021	CENAM
<p>SIM.M.P-K1</p> <p>SIM Key Comparison in Pneumatic Gauge Pressure for High Accuracy Pressure Balances up to 7 MPa</p>	Approved	2021	CENAM
<p>SIM.M.P-S10</p> <p>Pneumatic Gauge Pressure Comparison from 700 kPa to 7 000 kPa</p>	Approved	2020	Inacal-CENAM



- Comparisons in process.

## 1 Positive Gauge Pressure Comparison

10 kPa to 100 kPa

SIM.M.P-K6.1

Reference NIST, Pilot CENAM

## 2 Absolute Pressure Comparison

10 kPa to 121 kPa

SIM.M.P-K2

Reference NIST, Pilot CENAM

Comparison	Status	Latest year for measurements	Pilot	Institute
SIM.M.P-S9 (pressure)	CANCELED	2021	José Palma (Fernando Garcia)	LCPN-P
SIM.M.P-S3 (pressure)	CANCELED	2021	José Palma (Fernando Garcia)	LCPN-P
SIM.M.P-S4 (pressure)	CANCELED	2021	José Palma (Fernando Garcia)	LCPN-P
SIM.M.P-S2 (pressure)	Draft report B in review	2011 ...	<i>Paulo Couto</i> (Victor Loayza) <b>Jackson Oliveira</b>	INMETRO
(Vacuum)	Abandoned	2018	Jackson Oliveira	INMETRO
SIM.M.P-K7 (Pressure)	Draft report B Finished, published at an international Conference but pending approval. Change to S7?		Jorge Torres	CENAM

**Others**

DIRECCIÓN DE FUERZA Y PRESIÓN

Comparison in Vacuum  $1 \times 10^{-4}$  Pa to 133 kPa Range of Pneumatic Absolute Pressure, INMETRO. **Abandoned**

- New chairman, as per June 2021 Mayckol Morales, INM, Colombia.
- Election of the Co-Chair and Technical Secretary in progress.

### Advisors

Juan Forastieri (INTI, Argentina)

Jorge Torres (CENAM, Mexico)

**Thanks!**



# Force and Torque at SIM

*2017-2021 Recent activities*

*2021-2025 Planned activities*



Alejandro Savarin - April 20, 2021



Instituto  
Nacional  
de Tecnología  
Industrial

**INTI**



Ministerio de  
Desarrollo Productivo  
Argentina

# Force & Torque Members and CMCs

Out of 34 countries that are part of the SIM, only 13 have Force and / or Torque capabilities.

Country	NMI / DI	FORCE			TORQUE		
		Deadweight or Lever Machine	Reference Machine	Testing Machines	Deadweight Machine	Reference Machine	Torque Wrenches
Argentina	INTI	Yes	Yes	Not declared			Not yet
Bolivia	IBMETRO			Yes			
Brasil	INMETRO	Yes	Yes		Yes		Yes
Colombia	INM	Yes	Yes	Not declared		Yes	
Ecuador	INEN			Yes			
Perú	INACAL			Yes			
Costa Rica	LCM			Yes			
Panamá	CENAMEP			Yes			
México	CENAM	Yes	Yes	Not declared	Yes	Yes	
USA	NIST	Yes					
Chile	IDIC (DI)	Yes	Yes	Not declared		Yes	Yes
Paraguay	INTN			Yes			
Uruguay	LATU			Yes			

Contact Information:

<https://drive.google.com/drive/folders/1H6au3v9iJDMxwI5XD160EV1w35MTT3GU?usp=sharing>

# Approved and pending Intercomparisons

Code	Aim	Capacity	Pilot	Year	State
SIM.M.F-S1	Testing Machines	10 kN to 100 kN	IDIC	2010	Approved
SIM.M.F-S4	Transducer in compression	50 kN & 100 kN	IDIC-INTI	2012-2013	Approved
SIM.M.F-S5	Testing Machines	50 kN to 200 kN	CENAM	2013	Approved
SIM.M.T-S2	Torque Wrench	50 N·m, 100 N·m, 300 N·m & 500 N·m	CENAM	2017	Approved
SIM.M.F-S2	Testing Machines	10 kN to 100 kN	IDIC	2012	Draft A *
SIM.M.F-S3	Charpy Test	20 J & 100 J	NIST	2012-2013	Draft B *
SIM.M.T-S1	Torque Transducer	10 N·m, 20 N·m & 50 N·m	CENAM	2016	Draft A
SIM.M.F-S6	Testing Machines	10 kN to 100 kN	IDIC	2017	Draft A
SIM.M.F-S7	Transducer in compression	500 kN & 1000 kN	IDIC	2018-2019	Completed
SIM.M.F-S8	Testing Machines	20 kN to 200 kN	IDIC	2018	Completed
SIM.M.F-S9	Transducer in compression	20 kN to 200 kN	IDIC	2019	Planned
SIM.M.F-S10	Testing Machines	300 kN to 3000 kN	IDIC	2020	Draft A

*Legend: Orange can be considered a great delay. Yellow can be considered a reasonable delay. SIM.M.F-S2 and SIM.M.F-S3 will have news very soon.*

# Outstanding Activity



Title:

Dynamic Measurements (from Industry to Primary Standard) – IADB-SIM Research Engagement Opportunity

NMIs:

CENAM, INM, INMETRO, INTI, NIST

Duration:

July 2017 – March 2020

Summary:

- NIST worked on reducing the influence quantities of their 1kN sinusoidal force standard machine,
- INMETRO worked on the calibration of fatigue machines and step accelerated torque benches, and
- INTI worked on force continuous measurements.

Outcome:

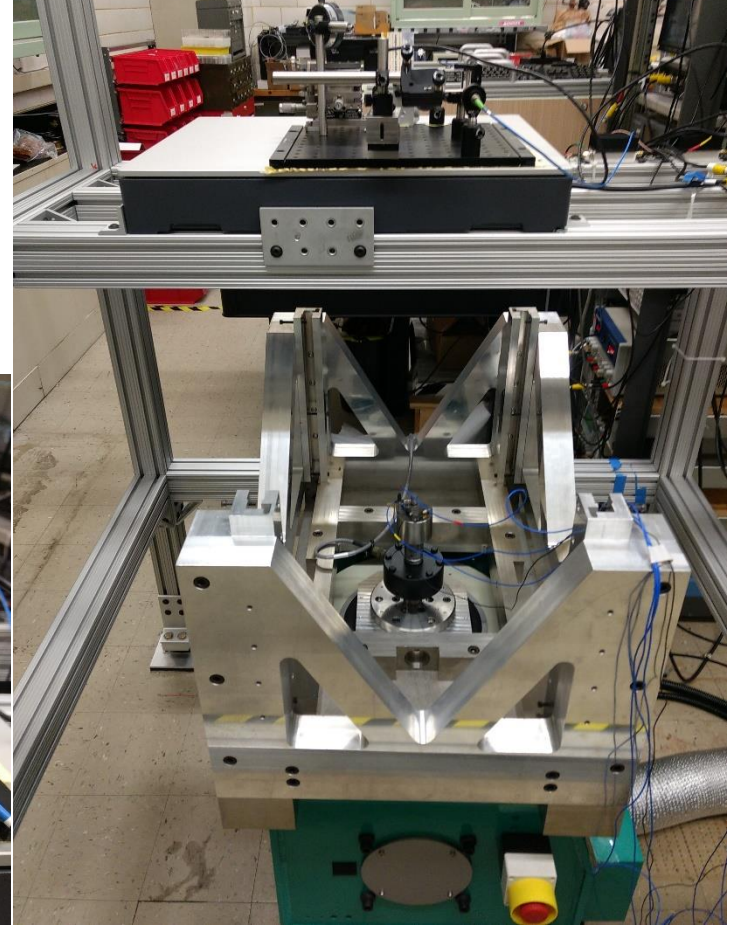
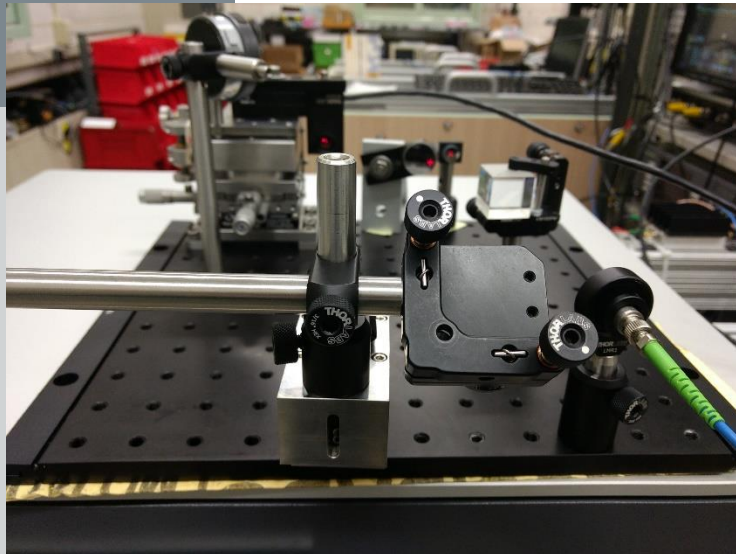
Two congresses/seminars (NIST-USA, CIMMEC-Brazil)

Two measurement workshops (NIST-USA, INMETRO-Brazil)

□ 2017-2021 Recent Activities

# Dynamic Measurements (from Industry to Primary Standard) – IADB-SIM Research Engagement Opportunity

2018-12. 1kN NIST sinusoidal force standard machine.  
Real time rocking motion measurement by mean of a  
quadrant photodetector.

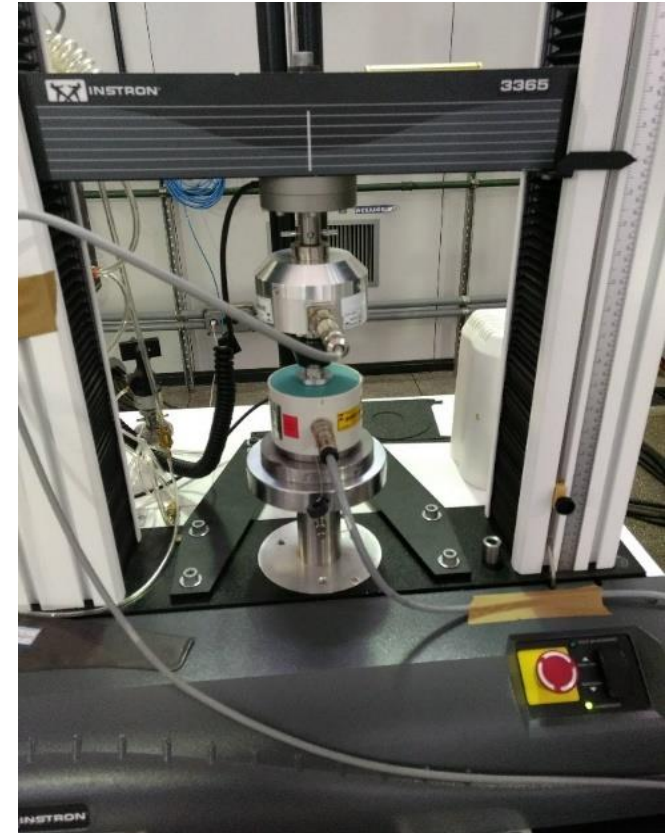
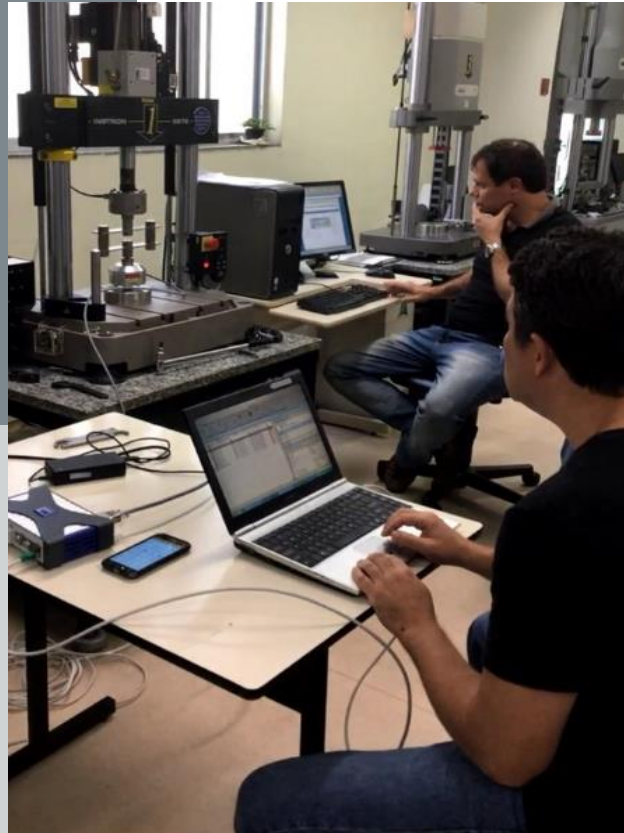




▣ 2017-2021 Recent Activities

Dynamic Measurements (from Industry to Primary Standard) –  
IADB-SIM Research Engagement Opportunity

2019-09. Fatigue machine measurements (left), and continuous force measurement on a testing machine (right).



## Latest activities



**March 21-26, 2021**

KCDB 2.0 at the service of the SIM region in Mass and Related Quantities.

**April 15, 2021**

Force and Torque meeting

- Membership
- Selection of participants at KC and SC.
- Comparisons pending, in progress, etc
- Projects
- Publications
- Change of representative members.

# New Force & Torque as per July 2021

## Representative members

Chairman: Juan Arias, INM, Colombia.  
Co-chairman: Christian Villarroel, IDIC, Chile.  
Technical Secretary: Kevin Chesnutwood, NIST, USA.

## Advisors

Jorge Torres (CENAM, Mexico)  
Rafael Oliveira (INMETRO, Brazil)  
Alejandro Savarin (INTI, Argentina)



# Planned Intercomparisons

Code	Aim	Capacity	Year	Observations
SIM.M.T-K# SIM.M.T-S#	Torque Measurements	500 N·m & 1000 N·m	2023/2024	INMETRO or CENAM RV and Pilot Could be a KC or a SC
SIM.M.F-K# SIM.M.F-S#	Force Measurements	5 kN & 10 kN	2023	INMETRO or CENAM RV and Pilot Could be a KC or SC
SIM.M.F-K#	Force Measurements	500 kN & 1000 kN	2022	NIST - RV - INTI-INMETRO Pilot
SIM.M.F-S#	Testing Machines	200 kN to 1000 kN	2023/2024	INTI - RV and Pilot
SIM.M.F-S#	Testing Machines	20 kN to 100 kN	2023/2024	INTI - RV and Pilot

*The reference value (RV) and the pilot will be in relation to the SIM countries that participate in the analog comparisons of the CCM.*

- *SIM is continuing working on the Non-static Force Traceability.*
- *INMETRO and INTI are collaborating on the ComTraForce EMPIR project.*
- *Will be a webinar and a group meeting bimonthly.*
- *Pilot studies will be added to the intercomparisons in order to analyze other parameters, including non-static regimes.*
- *Torque metrology is under nice development in the region.*
- *A group database will be created (CMC, IC, training, etc.).*
- *A broader interaction between countries is demanded.*

# Many thanks!



*Alejandro Savarin - April 2021  
asavarin@inti.gov.ar*