

FINAL REPORT OF SIM KEY COMPARISON ON 50 kg STAINLESS STEEL MASS STANDARD SIM.M.M-K6 PILOTEED BY CENAM – MEXICO

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ABSTRACT

In order to show equivalence in the calibration of 50 kg stainless steel mass standards, this key comparison was organized among eight National Metrology Institutes (NMI) of the Sistema Interamericano de Metrología (SIM).

The aims of this key comparison were to compare the results obtained by NMIs in calibration of 50 kg stainless steel weights and to link the participant results to the key comparison identified as CCM.M-K6, organized by Consultative Committee for Mass and Related Quantities (CCM).

For this key comparison CENAM – Mexico acted as pilot laboratory. CENAM – Mexico and NRC – Canada act as linking laboratories between this comparison and the CCM.M-K6.

1. INTRODUCTION

The SIM.M.M.-K6 comparison was organized among eight SIM NMIs in order to link the participant results to the CCM.M-K6.

CENAM provided and characterized a 50 kg OIML weight as travelling standard.

The participant laboratories measured the travelling standard from October 2015 to August 2017 according to the initial and modified schedule.

The results of the participant laboratories are linked directly to the Key Comparison Reference Value (KCRV) of CCM.M-K6 through the results obtained by the two linking laboratories, CENAM – Mexico and NRC – Canada who participated in both SIM.M.M-K6 and CCM.M-K6.

2. PARTICIPANTS

Seven National Metrology Institutes (NMI) and one Designated Institute (DI) took part in this key comparison. LACOMET is the NMI of Costa Rica and has CMCs on the calibration of weights up to 50 kg; RECOPE is the DI of Costa Rica for large mass and with this comparison, they intend to support their CMCs on the calibration of weights within the range from 50 kg to 1 000 kg. Both institutes, LACOMET and RECOPE, are signatories of the CIPM-MRA. The participating laboratories are listed in table 1.

Table 1.1. Participant laboratories of the comparison

National Institute of Metrology	Acronym	Country
Centro Nacional de Metrología	CENAM	Mexico
Refinería Costarricense del Petróleo	RECOPE	Costa Rica
Laboratorio Costarricense de Metrología	LACOMET	Costa Rica
Instituto Nacional de Tecnología Industrial	INTI	Argentina
Servicio Ecuatoriano de Normalización	INEN	Ecuador
Instituto Nacional de Metrología de Colombia	INM(CO)	Colombia
Laboratorio Tecnológico del Uruguay	LATU	Uruguay
National Research Council Canada	NRC	Canada

For the purposes of linking with the key comparison, the results of the Costa Rican National Metrology Laboratory (LACOMET) will not be included in the linking analysis to KCRV of CCM.M-K6. Instead RECOPE, as Costa Rica Designated Institute for the calibration of large weights, will be the institute using this comparison as supporting evidence to underpin CMCs in the range from 50 kg to 1000 kg.as indicated by the email sent on 04 June 2025 by LACOMET Director to the Pilot Laboratory Technical Contact of this comparison, in response to the JCRB in its letter dated May 13, 2025 (see the Appendix at the end of this report). Consequently, Table 2 includes only the participants whose results will be considered in the KCRV evaluation.

Table 1.2. Participating laboratories in the comparison considered for the KCRV evaluation

National Institute of Metrology	Acronym	Country
Centro Nacional de Metrología	CENAM	Mexico
Refinería Costarricense del Petróleo	RECOPE	Costa Rica
Instituto Nacional de Tecnología Industrial	INTI	Argentina

Servicio Ecuatoriano de Normalización	INEN	Ecuador
Instituto Nacional de Metrología de Colombia	INM(CO)	Colombia
Laboratorio Tecnológico del Uruguay	LATU	Uruguay
National Research Council Canada	NRC	Canada

3. MASS COMPARATOR USED BY PARTICIPANTS

The weighing instruments used by participating laboratories are listed in table 2.

Table 2. Weighing Instruments used by participant laboratories.

Acronym	Manufacturer	Type	Range	Resolution
CENAM	Mettler-Toledo	AX64004	64 kg	0.1 mg
RECOPE	Mettler-Toledo	XP 64003 L	64 kg	5 mg
LACOMET	Sartorius	CCE60K3	60 kg	2 mg
INTI	Mettler Toledo	XPE64003LC	64.1 kg	5 mg
INEN	Mettler-Toledo	XP64002L	64.1 kg	10 mg
INM(CO)	Mettler-Toledo	XP64003L	60 kg	5 mg
LATU	Sartorius	Comparator	50 kg	10 mg
NRC	Mettler-Toledo	AX64004	64 kg	0.1 mg

Note: Certain commercial equipment, instruments, or materials are identified in this paper to foster understanding. Such identification does not imply recommendation or endorsement by any of the participating organizations nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

4. TRAVELLING STANDARDS

The travelling standards for this comparison was a 50 kg weight, made in one piece of stainless steel, OIML shaped (Fig. 1).



Fig. 1. Travelling standard

4.1 Carrying case for the transportation of the travelling standards

The travelling standard was sent to the participant laboratories in a heavy-duty plastic box as an outer container and inside was placed an inner container made in aluminium, where the travelling standard was allocated, including all the accessories needed for its handling.



Fig. 2. Heavy duty outer container for the travelling standard

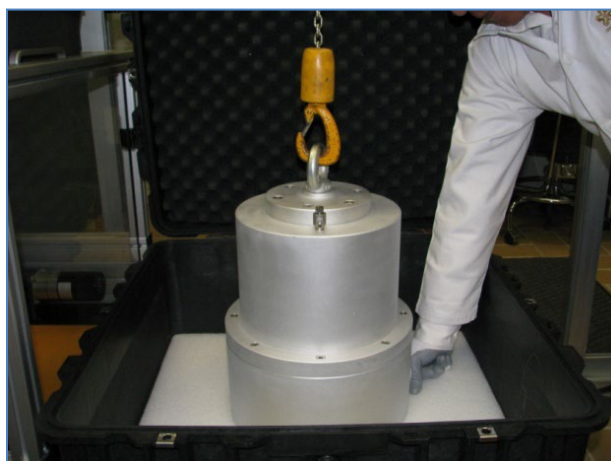


Fig. 3. Inner container made in aluminium

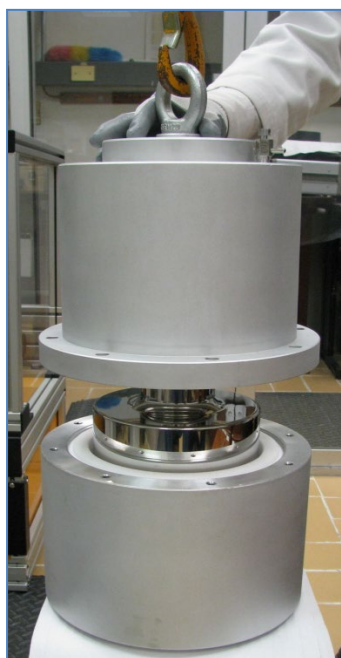


Fig. 4. Aluminium case containing the travelling standard



Fig. 5. Travelling standard

4.2 Characterization of the travelling standards

Values of density, volume, and magnetic properties of the weight were measured at CENAM before its circulation among participant laboratories. The data of the travelling standard is listed in table 3.

Table 3. Data of the travelling standards

Identification	LPM.00.10
Nominal Value	50 kg
Density at 20 °C *	8 009.48 kg/m ³
Standard uncertainty of the density	0.64 kg/m ³
Volume at 20 °C *	6 242.6 cm ³
Standard uncertainty of the volume	0.5 cm ³
Magnetic susceptibility (χ) *	< 0.02
Magnetization *	< 2.5 μ T
Height	289 mm
Diameter	183 mm
Height of centre of gravity above base	162.6 mm

* Values measured by the pilot laboratory.

5. TRANSPORTATION OF THE TRAVELLING STANDARDS

For this comparison, the weight was initially planned to be circulated among participants in one petal according to dates listed in table 4.

CENAM measured the mass of the travelling standard at the beginning and at the end of the circulation to evaluate its possible drift.

Table 4. Circulation of the travelling standard

Acronym	Arrival date	Departure date
CENAM	–	2015-11-16
RECOPE	2015-11-23	2015-12-14
LACOMET	2015-12-21	2016-01-25
INTI	2016-02-01	2016-02-22
LATU	2016-02-29	2016-03-28
INM(CO)	2016-04-04	2016-04-25
INEN	2016-05-02	2016-05-23
CENAM	2016-05-30	–

Due to transportation and customs issues, some NMIs did not measure the travelling standard according to Table 4. After LATU finished his measurements, the traveling standard was sent to CENAM who made an intermediate measurement. NRC – Canada was included later in this key comparison in order to have a second linking laboratory to the CCM.M-K6 key comparison. The updated schedule is shown in table 5.

Table 5. Updated circulation of the travelling standard

Acronym	Arrival date	Departure date
CENAM	–	2017-03-08
INEN	2017-03-20	2017-04-17
INM(CO)	2017-04-26	2017-08-18
NRC	2017-05-29	2017-06-19
CENAM	2017-06-28	–

6. SUMMARY OF RESULTS REPORTED BY PARTICIPANTS

Table 6 shows the results m_i and combined standard uncertainties $u(m_i)$ provided by the participants. The results are listed in table 6 as follows:

$$x_i = m_i - m_0 \quad (1)$$

Where:

- x_i is the mass correction to the travelling standard reported by participant i
- m_i is the mass of the travelling standard as reported by participant i
- m_0 is the nominal mass of the travelling standard, 50 kg

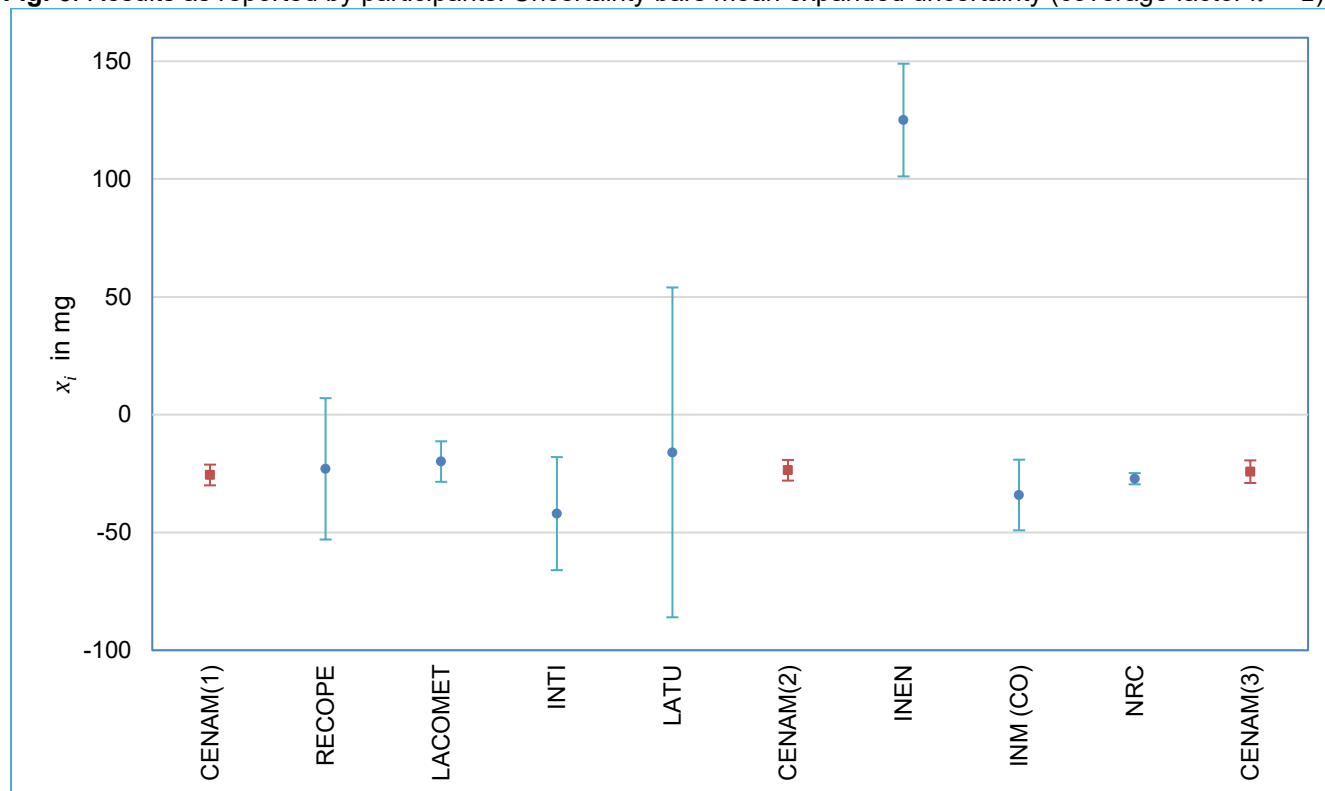
Table 6. Results as reported by participants

Acronym	x_i / mg	$u(x_i)$ / mg $k = 1$
CENAM ₍₁₎	-25.6	2.2
RECOPE	-23	15
LACOMET	-19.9	4.3
INTI	-42	12
LATU	-16	35
CENAM ₍₂₎	-23.6	2.2
INEN	125.049	11.96
INM(CO)	-34.1	7.5
NRC	-27.17	1.19
CENAM ₍₃₎	-24.2	2.4

Note: The subscript shows different measurements.

After the first analysis, some outliers were found on the results. The pilot laboratory asked some of the participant laboratories to verify or confirm their results, some of them made corrections and others confirmed their results. The values in Table 6 are also shown graphically in Figure 6.

Fig. 6. Results as reported by participants. Uncertainty bars mean expanded uncertainty (coverage factor $k = 2$).



The error associated to the instability of the travelling standard was evaluated taking into account the measurements made by the Pilot Laboratory, i.e., CENAM₍₁₎, CENAM₍₂₎ and CENAM₍₃₎ as follows:

$$\varepsilon_{\text{inst}(1)} = \text{CENAM}_{(1)} - \text{CENAM}_{(2)} \quad (2)$$

$$\varepsilon_{\text{inst}(2)} = \text{CENAM}_{(2)} - \text{CENAM}_{(3)} \quad (3)$$

The standard uncertainty of $u(\varepsilon_{\text{inst}(1)})$ and $u(\varepsilon_{\text{inst}(2)})$ was evaluated considering that each error corresponds to a half interval of a uniform probability distribution with mean value equal to zero, then:

$$u(\varepsilon_{\text{inst}(1)}) = \frac{|\varepsilon_{\text{inst}(1)}|}{\sqrt{3}} = \frac{|\text{CENAM}_{(1)} - \text{CENAM}_{(2)}|}{\sqrt{3}} = \frac{|(-25.6 \text{ mg}) - (-23.6 \text{ mg})|}{\sqrt{3}} = 1.15 \text{ mg} \quad (4)$$

$$u(\varepsilon_{\text{inst}(2)}) = \frac{|\varepsilon_{\text{inst}(2)}|}{\sqrt{3}} = \frac{|\text{CENAM}_{(2)} - \text{CENAM}_{(3)}|}{\sqrt{3}} = \frac{|(-23.6 \text{ mg}) - (-24.2 \text{ mg})|}{\sqrt{3}} = 0.35 \text{ mg} \quad (5)$$

The mean values of $\varepsilon_{\text{inst}(1)}$ and $\varepsilon_{\text{inst}(2)}$ were assumed equal to zero.

The value of $u(\varepsilon_{\text{inst}(1)})$ was included in the calculation of the uncertainty (variance-covariance matrix) for the participants laboratories that measured the travelling standard between CENAM₍₁₎ and CENAM₍₂₎, i.e.: RECOPE, LACOMET, INTI and LATU. The value of $u(\varepsilon_{\text{inst}(2)})$ was included in the calculation of the uncertainty (variance-covariance matrix) for the participants laboratories that measured the travelling standard between CENAM₍₂₎ and CENAM₍₃₎, i.e.: INEN, INM (CO) and NRC.

7. ANALYSIS OF RESULTS AND LINKING TO CCM.M-K6

The results of this comparison were analysed using the generalised least squares method, to linked to the key comparison CCM.M-K6, as described in [7, 8]. Similarly, this analysis directly combines the SIM comparison results with the CCM.M-K6 results of the SIM link laboratories (CENAM and NRC), to estimate the degree of equivalence for each laboratory relative to the CCM.M-K6 key comparison reference value – KCRV, and the degree of equivalence between pairs of laboratories.

The method of generalised least squares starts with the equation:

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{e} \quad (6)$$

where $\mathbf{y}$ is a vector of the measurement results, $\mathbf{X}$ is a matrix design, $\boldsymbol{\beta}$ is a vector of unknowns and $\mathbf{e}$ is a vector of errors.

The results are included from the deviations of the two link laboratories from the KCRV, according to the Final Report of the key comparison CCM.M-K6:

$$\text{CENAM} - \text{KCRV} = (0.90 \pm 2.28) \text{ mg} \quad (7a)$$

$$\text{NRC} - \text{KCRV} = (1.27 \pm 3.38) \text{ mg} \quad (7b)$$

where the number following the symbol $\pm$ is the expanded uncertainty with a coverage factor $k = 2$. For better understanding, equation 7a is interpreted as the mass value assigned by CENAM to the average mass of the traveling standard is 0.90 mg greater than the KCRV, the same criteria are used for equation 7b. The KCRV for CCM.M-K6 is calculated as the median of the mass differences between results reported by participant and results reported by pilot laboratory. For SIM.M.M-K6 comparison, nine measurement results are included for the traveling standard, as shown in table 6.

The equation describing each SIM comparison measurement for the traveling standard can be written as:

$$m(\text{Lab}_i)_p - 50 \text{ kg} = \Delta_i - (50 \text{ kg} - m) + e_{i,p} \quad (8)$$

where $m(\text{Lab}_i)_p$ is the p^{th} value assigned to the traveling standard by laboratory i ; m is the mass of the traveling standard; Δ_i is the bias of laboratory i ; and $e_{i,p}$ is a random error associated with the measurement.

Similarly, the equation for CCM.M-K6 results of the link laboratories is:

$$m_c(\text{Lab}_i) - K = \Delta_i - (K - m_c) + e_i \quad (9)$$

where m_c is the average mass of the 50 kg weight of CCM.M-K6 comparison, K is the key comparison reference value, and $m_c(\text{Lab}_i) - K$ is the measured deviation between the link laboratory i and the KCRV, as shown in equations (7a) or (7b).

The known values are $m(\text{Lab}_i)_p - 50 \text{ kg}$, and $m_c(\text{Lab}_i) - K$. The unknown values are Δ_1 to Δ_7 , $50 \text{ kg} - m$ and $K - m_c$. Solving the twelve equations defined by equations (8) and (9) requires a constraint, and we choose $K - m_c = 0$ so that the values obtained for Δ_1 to Δ_7 from the solution are the expected deviations of each laboratory's result from the KCRV. The constraint is in row 12 of the matrix design X .

Results vector $\hat{\beta}$ is given by:

$$\hat{\beta} = CX^T\Phi^{-1}y \quad (10)$$

with uncertainty matrix C

$$\mathbf{C} = (\mathbf{X}^T \mathbf{\Phi}^{-1} \mathbf{X})^{-1} \quad (11)$$

Hence, $\hat{\beta}_1$ (the first element of $\hat{\beta}$), is an estimate of the unknown Δ_1 .

Matrix $\mathbf{\Phi}$ is an input uncertainty (variance-covariance) matrix. The diagonal terms of $\mathbf{\Phi}$ are the variances associated with each measurement plus the variance associated with the instability of the travelling standard, equations (4) or (5) depending on the participant laboratory. In each case, the standard uncertainty was calculated from the reported expanded uncertainty using $k = 2$. Off-diagonal terms in $\mathbf{\Phi}$ allow known correlations to be included. Matrix $\mathbf{C}$ is the calculated variance-covariance matrix from which the uncertainties in the results of the analysis are obtained.

With the restriction $K - m_c = 0$, the first 7 terms of $\hat{\beta}$ ($\hat{\beta}_1$ to $\hat{\beta}_8$) and the corresponding diagonal terms of $\mathbf{C}$ directly give the expected deviation for each laboratory's result from the KCRV and the variance associated with this deviation. For pairs of laboratories i y j , $\hat{\beta}_i - \hat{\beta}_j$ is the difference of their deviations from the KCRV and $C_{ii} + C_{jj} - 2C_{ij}$ is the variance associated with this difference.

Table 7 summarizes the correlated uncertainties. The dominant correlation in this comparison is between CENAM measurements. This correlation is mainly due to the standard weight uncertainty used as reference for instability measurements. Other less significant correlations arise for the link laboratories (because they used a common reference standard for CCM and SIM comparison), and for the laboratories with a common source of traceability (for example, the standard reference of INEN is traceable to CENAM); nevertheless, these correlations were considered as negligible due to the long chain of traceability from 1 kg to 50 kg.

Table 7. Correlated standard uncertainties in milligrams

	Intra-laboratory	Intra-laboratory: CCM-SIM	Inter-laboratory: traceable to another SIM laboratory
CENAM	4.754	1.251	-
RECOPE	-	-	-
INTI	-	-	-
LATU	-	-	-
INEN	-	-	0.001
INM (CO)	-	-	-
NRC	-	2.469	-

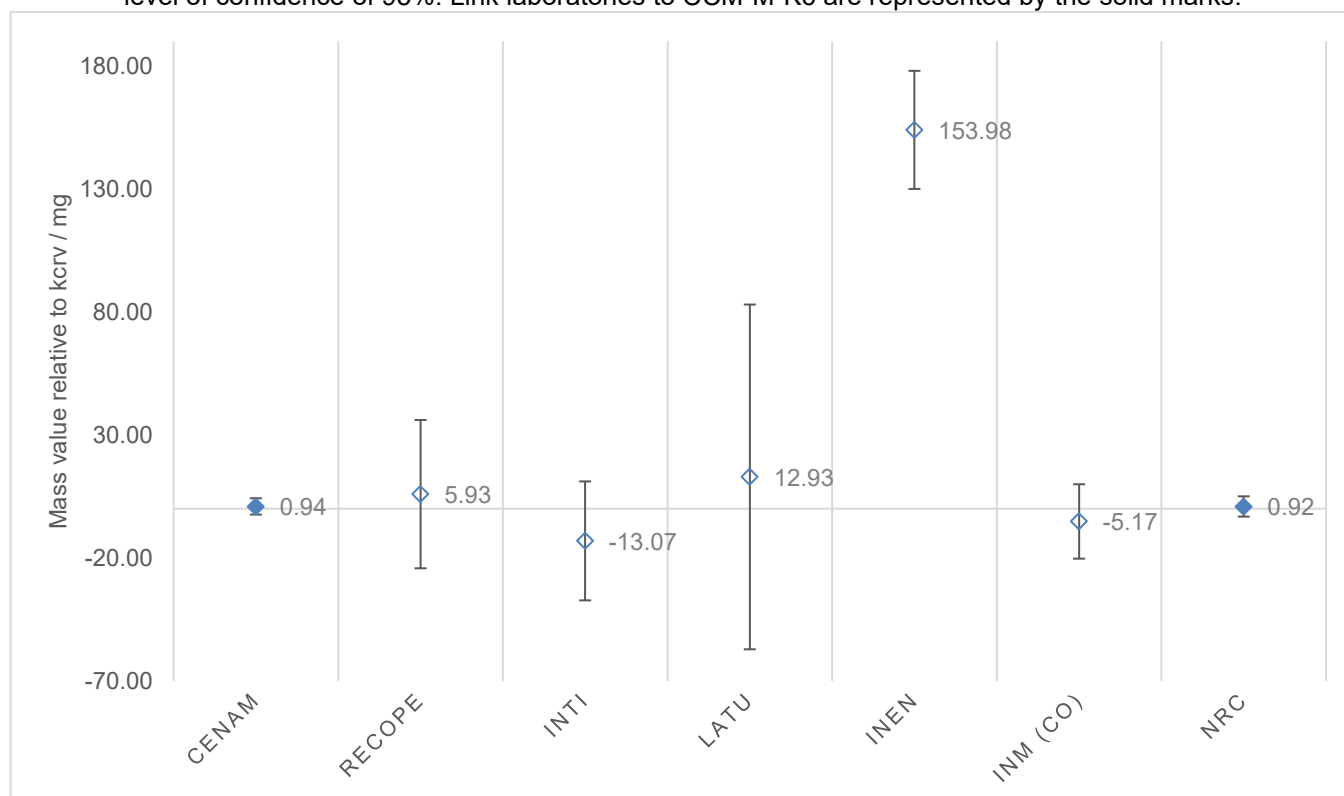
The results of the deviation from the KCRV for each laboratory, together with the associated uncertainty (calculated using $k = 2$) are shown in Table 8 and Figure 7. Zero mass value in Figure 7 corresponds to the KCRV of comparison CCM.M-K6; this figure shows that most results

of the participating laboratories are consistent with each other and with the KCRV, except for one laboratory.

Table 8. Deviation from the KCRV (key comparison value of CCM.M-K6) and associated expanded uncertainty for each participating laboratory

	Difference from KCRV / mg	Expanded uncertainty / mg
CENAM	0.94	3.31
RECOPE	5.93	30.1
INTI	-13.07	24.2
LATU	12.93	70.1
INEN	153.98	24.0
INM (CO)	-5.17	15.1
NRC	0.92	4.12

Fig. 7 Mass values deviation from the KCRV of CCM.M-K6 for the participating laboratories. The bars represent a level of confidence of 95%. Link laboratories to CCM-M-K6 are represented by the solid marks.



More detailed results of the analysis are given in Tables 9 to 11. Table 9 gives the differences in mass values between pairs of laboratories, Table 10 gives the uncertainty of these differences, and Table 11 gives the ratio of these values.

Table 9. Differences in mass value (A-B, in milligrams) between the A laboratory (left column) and B laboratory (top row).

	CENAM	RECOPE	INTI	LATU	INEN	INM (CO)	NRC
CENAM		-4.99	14.01	-11.99	-153.03	6.11	0.02
RECOPE	4.99		19.00	-7.00	-148.05	11.10	5.01
INTI	-14.01	-19.00		-26.00	-167.05	-7.90	-13.99
LATU	11.99	7.00	26.00		-141.05	18.10	12.01
INEN	153.03	148.05	167.05	141.05		159.15	153.06
INM (CO)	-6.11	-11.10	7.90	-18.10	-159.15		-6.09
NRC	-0.02	-5.01	13.99	-12.01	-153.06	6.09	

Table 10. Expanded uncertainty (in milligrams with $k = 2$) for the corresponding values in Table 9.

	CENAM	RECOPE	INTI	LATU	INEN	INM (CO)	NRC
CENAM		30.13	24.17	70.06	23.99	15.11	4.05
RECOPE	30.13		38.56	76.23	38.44	33.63	30.17
INTI	24.17	38.56		74.07	33.97	28.40	24.22
LATU	70.06	76.23	74.07		74.01	71.63	70.07
INEN	23.99	38.44	33.97	74.01		28.25	24.04
INM (CO)	15.11	33.63	28.40	71.63	28.25		15.19
NRC	4.05	30.17	24.22	70.07	24.04	15.19	

Table 11. Ratio of the laboratory-to-laboratory difference from Table 9 to the expanded uncertainty in this difference from Table 10 for each pair-wise combination of laboratories. Values with a magnitude that exceeds 1.0 or 2.0 are shown with different shading respectively.

	CENAM	RECOPE	INTI	LATU	INEN	INM (CO)	NRC
CENAM		-0.17	0.58	-0.17	-6.38	0.40	0.01
RECOPE	0.17		0.49	-0.09	3.85	0.33	0.17
INTI	-0.58	-0.49		-0.35	-4.92	-0.28	-0.58
LATU	0.17	0.09	0.35		-1.91	0.25	0.17
INEN	6.38	3.85	4.92	1.91		5.63	6.37
INM (CO)	-0.40	-0.33	0.28	-0.25	-5.63		-0.40
NRC	-0.01	-0.17	0.58	-0.17	-6.37	0.40	

8. SUMMARY AND CONCLUSIONS

This report summarizes the procedure and results of SIM.M.M-K6, a key comparison of 50 kg weights. These results are linked to the Key Comparison Reference Value (KCRV) of the CCM.M-K6 comparison, supporting the calibration and measurement capabilities (CMCs) of the participating laboratories.

From October 2015 to August 2017, one mass standard made of stainless steel and characterized by the pilot laboratory was circulated among participants.

Seven National Metrology Institutes (NMIs) and one Designated Institute (DI) from the SIM region participated in this key comparison. RECOPE is the Designated Institute of Costa Rica in the calibration of weights from 50 kg up to 1 000 kg. The results reported by participants are shown in Table 6.

It was decided that the results from RECOPE (the DI of Costa Rica) would be used to link to the KCRV of CCM.M-K6. However, the annex of this report includes a data analysis that links the results of all participants, including LACOMET (NMI) and RECOPE (DI) from Costa Rica.

CENAM – Mexico and NRC – Canada acted as linking laboratories between the results reported by participants of SIM.M.M-K6 and the KCRV of CCM.M-K6. CENAM was also the Pilot Laboratory of this key comparison. The reproducibility of the values reported by both linking laboratories in both comparisons is in good statistical agreement.

Due to delays during the transportation of the weight among participants, it was necessary for the Pilot Laboratory to perform an intermediate control measurement of the traveling standard. The travelling standard showed no significant drift.

The differences between the results of each participant laboratory and the KCRV of the CCM.M-K6 comparison was calculated using the method of generalized least squares [7] with equation (10) and the results are reported in Table 8. The results of one participant laboratory, INEN – Ecuador, is not in agreement with the KCRV or with the results of other participant laboratories. Therefore, INEN should take corrective actions to minimize random or systematic errors in order to support CMCs at this level.

The ratio of laboratory-to-laboratory between each pair-wise combination of laboratories is reported in Table 11, showing a good agreement between most of the laboratories.

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- Paola Ochoa, INM(CO) - Colombia
- Jhon Barreto, INM(CO) – Colombia

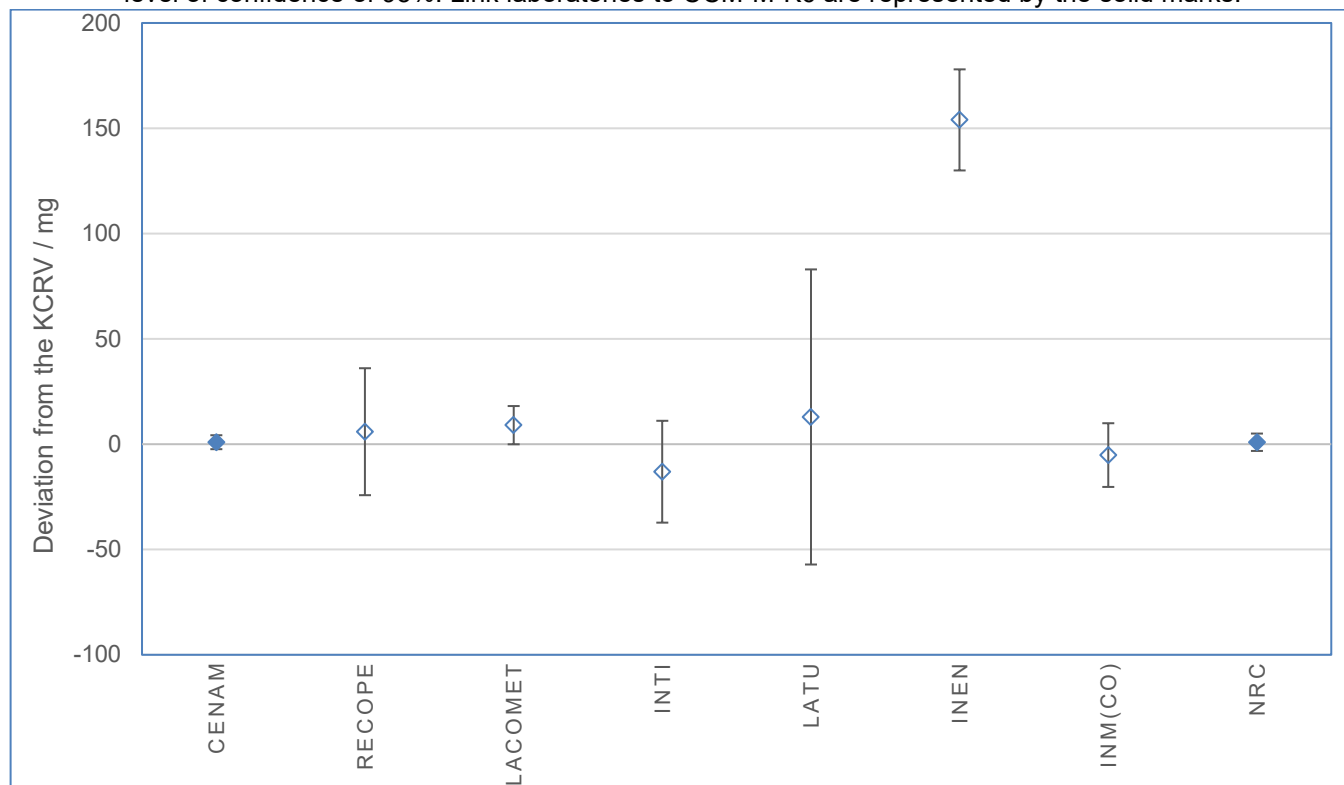
Special acknowledgement to Donny Taípe from INACAL – Peru, for performing the data analysis and calculations involved for linking the SIM.M-M-K6 to CCM.M-K6 according to the procedure described in [7].

ANNEX. Results incorporating measurement data from LACOMET

Table 12. Deviation from the KCRV (key comparison value of CCM.M-K6) and associated expanded uncertainty for each participating laboratory

	Difference from KCRV / mg	Expanded uncertainty / mg
CENAM	0.94	3.31
RECOPE	5.93	30.1
LACOMET	9.03	9.1
INTI	-13.07	24.2
LATU	12.93	70.1
INEN	153.98	24.0
INM (CO)	-5.17	15.1
NRC	0.92	4.12

Fig. 8 Mass values deviation from the KCRV of CCM.M-K6 for the participating laboratories. The bars represent a level of confidence of 95%. Link laboratories to CCM-M-K6 are represented by the solid marks.



More detailed results of the analysis are given in Tables 9 to 11. Table 9 gives the differences in mass values between pairs of laboratories, Table 10 gives the uncertainty of these differences, and Table 11 gives the ratio of these values.

Table 13. Differences in mass value (A-B, in milligrams) between the A laboratory (left column) and B laboratory (top row).

	CENAM	RECOPE	LACOMET	INTI	LATU	INEN	INM (CO)	NRC
CENAM		-4.99	-8.09	14.01	-11.99	-153.03	6.11	0.02
RECOPE	4.99		-3.10	19.00	-7.00	-148.05	11.10	5.01
LACOMET	8.09	3,10		22.10	-3.90	-144.95	14.20	8.11
INTI	-14.01	-19,00	-22,10		-26.00	-167.05	-7.90	-13.99
LATU	11.99	7,00	3,90	26,00		-141.05	18.10	12.01
INEN	153.03	148,05	144,95	167,05	141,05		159.15	153.06
INM (CO)	-6.11	-11,10	-14,20	7,90	-18,10	-159,15		-6.09
NRC	-0.02	-5.01	-8.11	13.99	-12.01	-153.06	6.09	

Table 14. Expanded uncertainty (in milligrams with $k = 2$) for the corresponding values in Table 9.

	CENAM	RECOPE	LACOMET	INTI	LATU	INEN	INM (CO)	NRC
CENAM		30.13	9.05	24.17	70.06	23.99	15.11	4.05
RECOPE	30.13		31.38	38.56	76.23	38.44	33.63	30.17
LACOMET	9.05	31.38		25.70	70.60	25.53	17.46	9.19
INTI	24.17	38.56	25.70		74.07	33.97	28.40	24.22
LATU	70.06	76.23	70.60	74.07		74.01	71.63	70.07
INEN	23.99	38.44	25.53	33.97	74.01		28.25	24.04
INM (CO)	15.11	33.63	17.46	28.40	71.63	28.25		15.19
NRC	4.05	30.17	9.19	24.22	70.07	24.04	15.19	

Table 15. Ratio of the laboratory-to-laboratory difference from Table 9 to the expanded uncertainty in this difference from Table 10 for each pair-wise combination of laboratories. Values with a magnitude that exceeds 1.0 or 2.0 are shown with different shading respectively.

	CENAM	RECOPE	LACOMET	INTI	LATU	INEN	INM (CO)	NRC
CENAM		-0.17	-0.89	0.58	-0.17	-6.38	0.40	0.01
RECOPE	0.17		-0.10	0.49	-0.09	3.85	0.33	0.17
LACOMET	0.89	0.10		0.86	-0.06	-5.68	0.81	0.88
INTI	-0.58	-0.49	-0.86		-0.35	-4.92	-0.28	-0.58
LATU	0.17	0.09	0.06	0.35		-1.91	0.25	0.17
INEN	6.38	3.85	5.68	4.92	1.91		5.63	6.37
INM (CO)	-0.40	-0.33	-0.81	0.28	-0.25	-5.63		-0.40
NRC	-0.01	-0.17	-0.88	0.58	-0.17	-6.37	0.40	

APPENDIX – Letter from JCRB to LACOMET (NMI of Costa Rica) and email from LACOMET to Pilot Laboratory indicating to consider RECOPE (DI of Costa Rica) results for the link to KCRV of CCM.M-K6.



O/Ref: MM-CFA-2025-1225

Dr Fernando Jose Andres Monge
Director General
Laboratorio Costarricense de
Metrologia
Costa Rica

Sèvres, 13 May 2025

Dear Dr Andres Monge,

We received a copy of your letter addressed to Dr Wynand Louw, the CIPM President. I am responding in the capacity of the JCRB Chairman since your queries touch on the implementation of the CIPM MRA activities in accordance with the guideline and policy documents.

First, we need to keep in mind that different requirements apply for CMCs published on the KCDB and for the participation in RMO comparisons.

- For CMCs to be published, Chapter 3 of CIPM MRA-P-13 is strict on overlapping of CMCs.
- For RMO comparisons, participation in RMO comparisons is open to all RMO members and is decided by the appropriate committee of the RMO. As far as the RMO has agreed the participation in the planning stage, all the results should be published in the report according to Chapter 8 of CIPM-MRA-G-11.

Upon this prerequisite, below is our response to three queries posed at the end of your letter:

1. According to clause 3.3 of the CIPM MRA-G-13, the “ideal” technical evidence to underpin CMCs are the results of key and supplementary comparisons. Other sources listed may be considered to underpin CMCs, however it is the CCs that are responsible for providing specific guidance on their use, for your case the CCM

For the specific case in issue, the results of the comparison SIM.M.M-K6 serve as ideal supporting evidence for the CMC claim of 50 kg mass standard. Both LACOMET and RECOPE participated in this comparison, and their results should be included in the comparison report as per the CIPM-MRA-G-11 document (section 8.2 Comparison results: *Measurement comparison reports should be written to reflect the experiment that was actually performed, including summary results from all participants.*). Although the participation of two institutes (an NMI and a DI) from the same country in a single comparison under the CIPM MRA is not a common practice, there are some examples recorded in the KCDB, mainly from the CCQM. Such arrangements are typically made based on agreements by the relevant CC and RMO levels. As communicated by the CCM Executive Secretary, we understood that the pilot institute and the CCM-WGM Chair had agreed both LACOMET and RECOPE results can be included in the final report, but only LACOMET to be included within the calculation of the degree of equivalences from the KCRV. Including the results of both institutes in the comparison report can at least serve as supporting evidence for the CMC claims on the 50 kg mass standard.

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2. According to CIPM-MRA-G-11, it is recommended that the Technical Protocol of a comparison include a statement indicating which service categories/CMCs can be supported by the comparison, or criteria to identify such categories/CMCs (i.e., a statement of 'how far the light shines'). Whether the results of the comparison SIM.M.M-K6 at 50 kg are sufficient to underpin CMCs up to 1000 kg should be decided by the local RMO TC Chair, in consultation with the CCM if necessary.

In addition, according to communication from the CCM Executive Secretary, a guidance document on the review of CMCs for mass standards is currently being finalized by the CCM-WGM. The topic of 'how far the light shines' is planned to be discussed at the next WGM meeting, scheduled for 24 June 2025. The outcomes of these discussions will clarify this issue.

3. For the CMC to be published on the KCDB, we advise you to avoid the CMC overlap by distinguishing the two institutions at the 50 kg point in respect to the CIPM MRA-P-13. As for the comparison report, the results of both institutes should be published and to be accepted as valid evidence. Regarding further evidence required to support the range up to 1000 kg, please keep in touch with the CCM and the RMO reviewers to obtain additional details.

I remain at your disposal in case you have any further queries.

Yours sincerely,



Dr Martin J.T. Milton
JCRB Chairman

Luis Manuel Peña Perez

De: Fernando Andres <fandres@lacomet.go.cr>
Enviado el: miércoles, 4 de junio de 2025 05:31 p. m.
Para: Luis Manuel Peña Perez
CC: Olman Ramos; Marcela Prendas; Sheila Preste Perez; Roberto Coto Rojas
Asunto: Re: Situación sobre comparación clave SIM.M.M-K6
Datos adjuntos: 2025-04-22-Letter-DI- RECOPE KY2-ck-KY-IA rev-signed.pdf; Respuesta de Hao Fang sobre CIPM-MRA-G-13.pdf

No suele recibir correo electrónico de fandres@lacomet.go.cr. [Por qué es esto importante](#)

Estimado Luis Manuel,

Luego de revisar la situación en la que nos encontramos a nivel nacional y realizar las consultas de aclaración tanto al CCM como al CIPM/BIPM; he decidido que para la comparación SIM.M.M-K6 se proceda de la siguiente forma:

- Que se considere el resultado de medida del laboratorio de RECOPE para la estimación del KCRV.
- Que el resultado de medida del Lacommet sea evaluado según los criterios estadísticos definidos en el protocolo y dicho análisis sea parte del reporte final según consideren apropiado (posiblemente un anexo).

Agradezco la paciencia con este tema y el apoyo a nuestro país en el reconocimiento de sus Capacidades de Medición y Calibración (CMC) en la magnitud de masas. Sobre este tema, adjunto las respuestas brindadas por el CCM y el CIPM/BIPM para su consideración.

Saludos cordiales,



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COSTARRICENSE
DE METROLOGÍA

GOBIERNO
DE COSTA RICA

**Fernando José Andrés
Monge**

DIRECTOR

DIRECCIÓN

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----- END OF THE SIM.M.M-K6 REPORT -----