



SIM.L-S7.2019
Supplementary Comparison
**Calibration of Gauge Blocks by
Mechanical Comparison**

Technical Protocol
(Final- Rev1 – March 2022)

INSTITUTO NACIONAL DE TECNOLOGÍA INDUSTRIAL
ARGENTINA
CENTRO NACIONAL DE METROLOGÍA
MÉXICO

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Highlighted modifications respect to Final version November 2019

1. Introduction.

The metrological equivalence of national measurement standards and calibration certificates issued by national metrology institutes is established by a set of key and supplementary comparisons chosen and organized by the Consultative Committees of the *Conférence Internationale des Poids et Mesures*, (CIPM) or by the regional metrology organizations in collaboration with the Consultative Committees, (CC).

Additionally, the CC as well as the regions may also identify other important comparisons called supplementary and identified with a S. The SIM region has identified the Calibration of Gauges Blocks (GB) by Mechanical Comparison as one of these comparisons, mainly because this service is at the highest level in the traceability chain of length for most countries in the Americas.

During the latest meeting of SIM Length Working Group, it was decided to run a supplementary comparison of GB calibration by Mechanical Comparison, SIM.L-S7:2019, with INTI, the National Metrology Institute (NMI) of Argentina as pilot of the comparison.

INTI will provide the GB, will register the participants, will process the results and will emit the report in its different subsequent versions.

The comparison will be conducted in accordance with the rules and procedures for SIM comparison and the guideline CIPM MRA-D05 of BIPM.

The participants are requested to strictly follow the instructions included in this protocol.

Due to the large number of participants anticipated, it is very important that participating NMIs perform their measurements during assigned dates. Participants should keep in mind that the allocated time period is not only for measurements, but also for transportation and customs clearance as well.

By their declared intention to participate in this comparison, the participating NMI accept the general instructions.

2. Organization.

The organization will be coordinated by the pilot laboratory, particularly by Eng. Diego Bellelli from INTI (bellelli@inti.gob.ar).

The technical protocol has been drafted by the pilot laboratory with assistance from CENAM, based on similar documents. The technical protocol was sent to all participants before circulating of the artifacts.

2.1 Requirements for participation.

The participating laboratories should offer this calibration service regularly to their clients.

2.2 Participants: Participation in the comparison was opened to all members of the SIM TC-L group. The participating NMIs are listed on next table. In March 2022 PAI asked to be part of this comparison

Contact	NMI	Information
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Carola Garcia	CENAME, Centro nacional de Metrología Calzada Atanasio Tzul 27-32, GUATEMALA	Tel. 502 2247 2600 e-mail: cbgarcia@mineco.gob.gt
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Wellington S. Barros	INMETRO, Instituto Nacional de Metrologia, Normalização e Qualidade Industrial. Av. N.Sra. das Graças, 50 – Villa Operária – Xerém – Duque de Caixas – RJ. CEP 25250-020, BRASIL	Tel. +55 21 2679-9271 Fax +55 21 2679-9207 e-mail: wsbarros@inmetro.go.br
Leonardo Rojas	LACOMET, Laboratorio Costarricense de Metrología. Ciudad de la Investigación de la UCR, San Pedro, San José, Costa Rica. (De la Muñoz y Nanne en San Pedro, 500 m hacia el Norte).	Tel. +506 4060-1020 Fax +506 2283-5133 e-mail: lrojas@lacomet.go.cr
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2.3 Time Schedule.

The comparison is organized in a single loop. Each laboratory will have one month to make its measurements and to prepare for transportation for the next participant. The schedule was designed to fit with the preferences of the laboratories for scheduling the measurements and any changes to the schedule, after the start of the circulation, will be discuss and agree among the participants and the TC-L chairman. The pilot laboratory, INTI, made several measurements to check the stability of the artifacts. **Due to COVID-19 the schedule has some modifications respect to the original one**

Participating NMI should respect strictly the allocated time for their participation.

Laboratory	Country	Date
CENAM (initial fo y fu)	México	January 2020
CENAM (mechanical)	México	January 2020
LATU	Uruguay	February 2020
DICTUC	Chile	March 2020
LACOMET	Costa Rica	September 2020
NIST (interferometric)	USA	October 2020
NIST (mechanical)	USA	November 2020
CENAMEP	Panamá	January 2021
CENAM (chequeo fo y fu)	México	February 2021
INTI (mechanical)	Argentina	July 2021
INTI (intermediate check)	Argentina	August 2021
INEN	Ecuador	February 2022
INM	Colombia	March 2022
BSJ	Jamaica	April 2022
TTBS	Trinidad & Tobago	May 2022
INMETRO	Brasil	June 2022
CENAME	Guatemala	July 2022
IBMETRO	Bolivia	August 2022
INACAL	Perú	September 2022
CENAM (fo y fu final check)	México	October 2022
PAI	Kuwait	November 2022
INTI (final measurement)	Argentina	December 2022

Date of measurement.

2.4 Transportation.

Transportation to the following participant according to the program of section 2.3 of this document, is the responsibility of each participant including associated shipping costs and insurance.

Once a participant NMI completes the measurements, the pack has to be sent to the following participant and an e-mail to the following laboratory with copy to the pilot must be sent indicating date of shipment, parcel service company and tracking number.

The gauge blocks are stored in a carton box identified as TESA M122-400, ID 102C001928
The standards are packed in a carton box (dimensions 26 cm x 16 cm x 10 cm) ready to be shipped.

Do not touch the gagues blocks with bare hands, please use gloves. For transportation and customs there are a pair of latex gloves in the box, please if they become damaged, replace them.

The package contains the following items:

- 6 steel short gauge blocks



The steel gauge blocks need to be protected against oxidation by means of oil, pure petrolatum or some protective agent. **Please do not touch with bare hands, use gloves.**

The gauges should be de-greased. Please use soft cleaning paper or similar. The gauge blocks must be handled with care!

The package should be sent with a reliable transportation method, preferably with a well-known carrier.

Please inform the pilot laboratory by email immediately after receiving the standards, using the attached form from the Annex A of this document.

Immediately after having completed the measurements, the package should be sent to the next laboratory. Preferably, all administrative formalities should be prepared before finishing measurements. Please inform again the pilot laboratory and the next laboratory when the package has left your installations (using the same form from Annex A), indicating shipping date, transportation company, identification number of the shipment (tracking number), and any useful detail.

2.5 Financial aspects and insurance.

Each participating laboratory covers the costs for the measurements, transportation, custom formalities and the insurance for the shipment against loss or damage as well. **The pilot laboratory has no insurance for any loss or damage of the standards during transportation.**

3. Description of the Standards.

The package contains 6 short gauge blocks made of steel. The GBs have a rectangular cross section according to the International Standard ISO 3650. The thermal expansion coefficient supplied by the manufacturer will be used and their technical description is found in the next tables.

Nominal Length (mm)	Identification Number	Thermal Expansion Coefficient ($10^{-6} K^{-1}$)	Manufacturer
0.5	725292	11.5	Tesa
2.5	525083	11.5	Tesa
10	180342	11.5	Tesa
25	3225200	11.5	Tesa
60	1425127	11.5	Tesa
100	1425351	11.5	Tesa

Table 3. Steel Short Gauge Blocks.

4. Measurement instructions.

The GBs will be measured based on the procedure the laboratory normally uses offering this calibration service. Before making the measurements, the GBs need to be checked to verify that the surface is not damaged, has severe scratches and/or rust that may affect the measurement result. The condition in which the blocks are received will be reported in the form in the annex B. "Face A" surface is the marked one with nominal length, identification number and manufacturer for GBs with nominal length < 6 mm and the surface on the right side for gauge blocks with a nominal length ≥ 6 mm, looking on the front side of the marked lateral surface (see Figures 1 and 2). The remaining surface will be called "Face B".

For measurement, the gauge blocks should be positioned as indicated in figures 1 and 2:

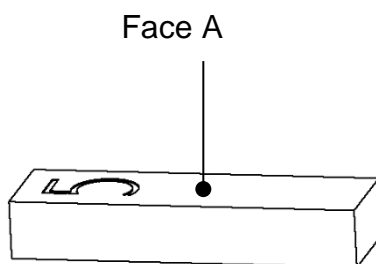


Figure 1. Gauge Block with nominal length < 6 mm

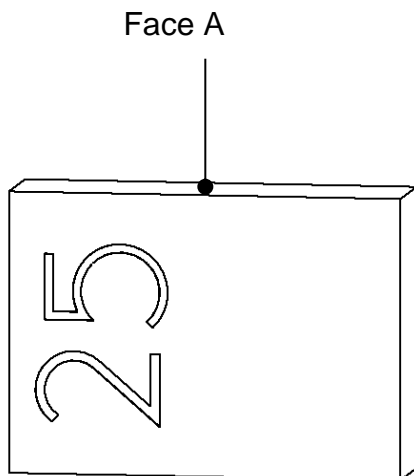


Figure 2. Gauge block with nominal length ≥ 6 mm

4.1 Gauge blocks calibration.

The measurand is the deviation of the central length of the GB with respect to its nominal length, as defined in ISO 3650. The central length is determined by mechanical comparison against the laboratory reference gauge blocks using an appropriate comparator. Where possible, the participants also have to determine the variation in length across the surface of each gauge by undertaking measurements at five points on the surface of each

The gauge blocks should be measured by mechanical comparison with the laboratory's reference gauge blocks, using the normal calibration procedure.

The following are the measurands for each gauge block:

1) Deviation of the central length d (at P1 in figure 3) is the difference between the measured central length l_c and the nominal length l_n , calculated as:

$$d = l_c - l_n$$

2) Where possible, points P2 to P5 (figure 3) must be measured. These values will be used by each participant to calculate f_o and f_u , for each gauge, according to ISO 3650.

f_o is calculated as follows:

$$f_o = l_{\max} - l_c$$

f_u is calculated as follows:

$$f_u = l_c - l_{\min}$$

where l_{\max} and l_{\min} are the maximum measured length and the minimum measured length respectively. Figure 4

The results should be recorded in Annex C (please send the Excel form also to avoid transcription errors).

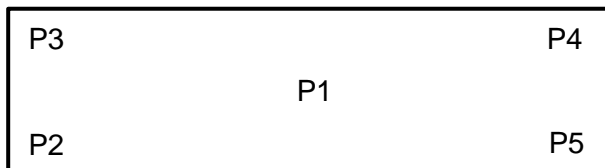


Figure 3. Measuring points

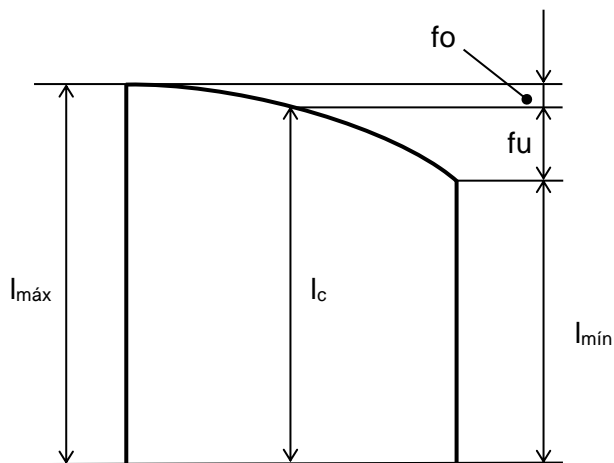


Figure 4. Definitions according to ISO 3650

4.2 Measurement uncertainty.

The uncertainty of measurement shall be estimated and reported as would be normal for mechanical comparison according to the ISO Guide for the Expression of Uncertainty in Measurement. Detailed uncertainty estimation must be reported in Annex D.

5. Result report.

The forms for the report of the measurement results are in the annex C of this document and should be properly sent filled out and signed by the metrologist and the responsible person for revision, **within the four weeks following the completion of the measurements**. It is also asked to send the results in the excel form to avoid transcription errors. The excel form must be protected to avoid any involuntary modification, but the cells must be left free to be selected to copy and paste.

The dimensional and optical department of INTI will calibrate the deviation of the central length from the nominal length by interferometry method.

The dimensional metrology direction of CENAM, will calibrate the deviations f_o and f_u by interferometry method.

In order to give transparency to the comparison, all the reports shall be sent to NRC within four weeks after completing the measurements. Contact person Mr. Brian Eves (brian.eves@nrc-cnrc.gc.ca).

This is because the reference value for central length is going to be given by interferometry by the dimensional and optical department of INTI (placed in the city of Buenos Aires) and another laboratory of INTI (placed in the city of Córdoba) will take part as participant by mechanical comparison and pilot.

The same happens with CENAM: the reference value of f_0 and f_u is going to be given by interferometry and also CENAM is going to participate with mechanical comparison.

NRC will receive the values and after the completion of all the measurements will ask each laboratory separately if the received values are correct, and once all the participants have finished the measurements, NRC will send all the results to the pilot for data analysis.

The uncertainty estimation will be reported in the form in the annex D.

In the form of the annex E, the technical features of the used instrument should be indicated.

Once the results are collected, the pilot laboratories will prepare a preliminary report to be analyzed and commented on by the participants.

Annex A: Reception form and shipment of gauge blocks.

To: Instituto Nacional de Tecnología Industrial INTI
Diego Bellelli
Av. Vélez Sársfield 1561
X5000JKC
Córdoba ARGENTINA
Fax +54 351 468 1021

e-mail: bellelli@inti.gob.ar

From: (Participating laboratory)

Mark the option with an X:

- We confirm having received the gauge blocks for the SIM comparison of Gauge Blocks by mechanical comparison on** *(indicate reception date)*

- We confirm having sent the gauge blocks to** *(name of the laboratory)* **the** *(indicate date of shipment)* **having used the following transport method** *(please indicate carrier, identification number and other details you consider important)*

After a visual inspection:

- There are no considerable damages; their general state will be reported in the form from the annex B, together with the measurement results.**
- There are severe damages putting at risk the measurement result.** *Please indicate the damages, specifying every detail and if it is possible sending photos. If it is necessary use additional sheets for your report.*




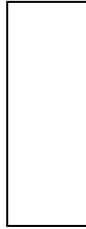

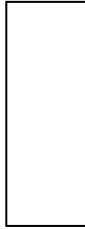



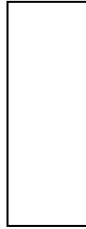
Date:



Name:

Signature:

Annex B. Form for reception conditions of the gauge blocks.
After a detailed inspection of the measurement surfaces of the gauge blocks, these are the results:

STEEL SHORT GAUGE BLOCKS

Face A	Face B	Face A	Face B	Face A	Face B	Face A	Face B	Face A	Face B
									
0.5 mm		2.5 mm		10 mm		25 mm		60 mm	
Id.		Id.		Id.		Id.		Id.	

Face A	Face B
	
100 mm	
Id.	

Observations:

Laboratory: _____
Date: _____ **Name and Signature** _____

Annex C: Result Report Forms.

Laboratory: _____

Nominal length	Deviation of the central length from the nominal length ($l_c - l_n$)	Uncertainty of central length	Deviation from central length f_o ($l_{max} - l_c$)	Deviation from central length f_u ($l_c - l_{min}$)	Uncertainty ($k=1$) for f_o and f_u	Identification number
[mm]	[nm]	[nm]	[nm]	[nm]	[nm]	
0.5						
2.5						
10						
25						
60						
100						

Date:

Name:

Signature:

Annex E. Form of technical characteristics of the used instrument.

Type.	Model.	Serial number.	Measurement range mm	Date of last calibration

Instrument description.

Type of instrument:

Traceability:

Calibration method of your reference:

Interval of temperature during measurements:

Laboratory: _____

Date: _____ Name and Signature _____