



Metrological traceability to the SI

The primary tool for “getting measurements right”

Metrological traceability is the underlying concept that connects measurement results to the international system of units and defines how those results agree with national standards.

What is metrological traceability?

The International Vocabulary of Basic and General Terms in Metrology (VIM) defines metrological traceability as:

“property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty”.

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In the context of the CIPM MRA, the “reference” is the primary realization of the SI unit by a National Metrology Institute (NMI), often referred to as the National Standard. Metrological traceability embodies the concepts of measurement uncertainty and calibrations against a hierarchy of reference standards. For calibration and measurement capabilities (CMCs) claimed by participants in the CIPM MRA, the simplest traceability path is direct calibration against the national standard, with an evaluation of the measurement uncertainty. However, multiple intermediate calibrations between the national standard and the delivered CMC are also valid, as long as the uncertainty is evaluated for each calibration in the hierarchy.

Why is metrological traceability important?

Metrological traceability gives you confidence and assurance that your measurements results are right. Measurements made in the context of the CIPM MRA are part of the broader international quality infrastructure, which also includes accreditation (ILAC¹), legal metrology (OIML²), and standardization (ISO³). For measurement results to be universally accepted, there must be comparability across all aspects of the international system.

How can metrological traceability be achieved?

An institute participating in the CIPM MRA has two options for establishing metrological traceability to the SI:

- By a primary realization of the unit of measurement concerned. In this case, traceability shall be declared to its own demonstrable realization of the SI. Methods of realization are approved by the relevant Consultative Committees of the CIPM.⁴
- Through another CIPM MRA participant having relevant CMCs with appropriate measurement uncertainty published in the KCDB, or through calibration and measurement services provided by the BIPM. In this case, traceability is declared through the laboratory providing the service, which itself will have a primary realization of the unit.

In exceptional cases where these two options are not possible, alternative paths for achieving traceability to recognized standards are proposed to the CIPM through the Consultative Committees.

CMCs often involve auxiliary influence quantities in the measurement (such as temperature when performing mass calibrations) that are not part of the main traceability path to the SI and which can be shown to make only a minor contribution to the measurement uncertainty of the CMC. Traceability of those influence quantities can either be to an institute with CMCs in the KCDB or to a laboratory accredited by a signatory to the ILAC Arrangement.⁵

¹ International Laboratory Accreditation Cooperation

² International Organization of Legal Metrology

³ International Organization for Standardization

⁴ <https://www.bipm.org/en/publications/mises-en-pratique>

⁵ The ILAC Mutual Recognition Arrangement (ILAC MRA)

For further information:

CIPM MRA Documents: <https://www.bipm.org/en/cipm-mra/cipm-mra-documents>

Joint BIPM, OIML, ILAC, and ISO Declaration on Metrological Traceability <https://www.bipm.org/en/liaison-partners/ilac>

JCGM 200:2012 VIM, International vocabulary of metrology – Basic and general concepts and associated terms (VIM) <https://www.bipm.org/en/committees/jc/jcgm/publications>