Global traceability

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BIPM

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Bureau
International des
Poids et
Mesures

Why is Metrological Traceability Important?

- Metrological traceability is important because it gives you confidence and assurance that your measurement results are '*right*' - that is they agree with national standards within the statement of uncertainty in measurement.

- The results you report to your customers can be used to provide calibrations, perform tests, manufacture products, drive innovation, or make decisions which could affect health, safety, and even court proceedings.

The *only* way we have of knowing we are getting it '*right*' is to have metrological traceability back to the SI (or other agreed reference)

If you provide unreliable results to a manufacture that makes or services aircraft, you could be putting other people's lives at risk. Would you put your family on that plane?

Another customer of yours could be using equipment to make medical decisions that affect someone's health. What is the patient was your spouse or child?

Maybe your results will be used in court as evidence which can affect the outcome of a case. Would you be confident if you were on trial for murder?

The work that you perform in the laboratory can significantly impact society.

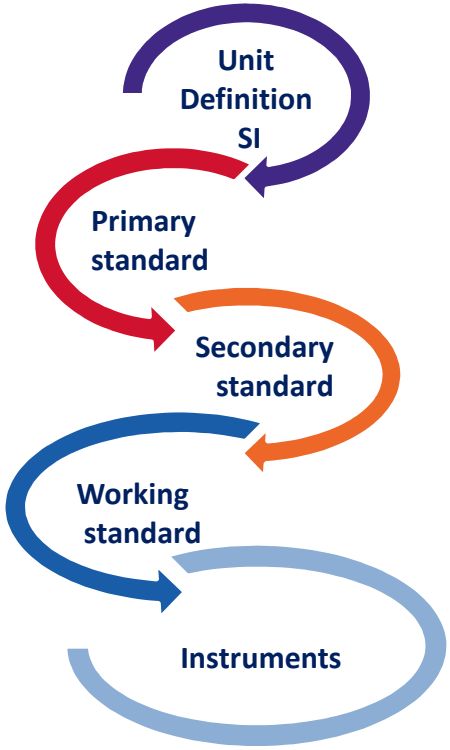
Components must be compatible and interoperable in the modern global world!!!

What is Metrological Traceability?

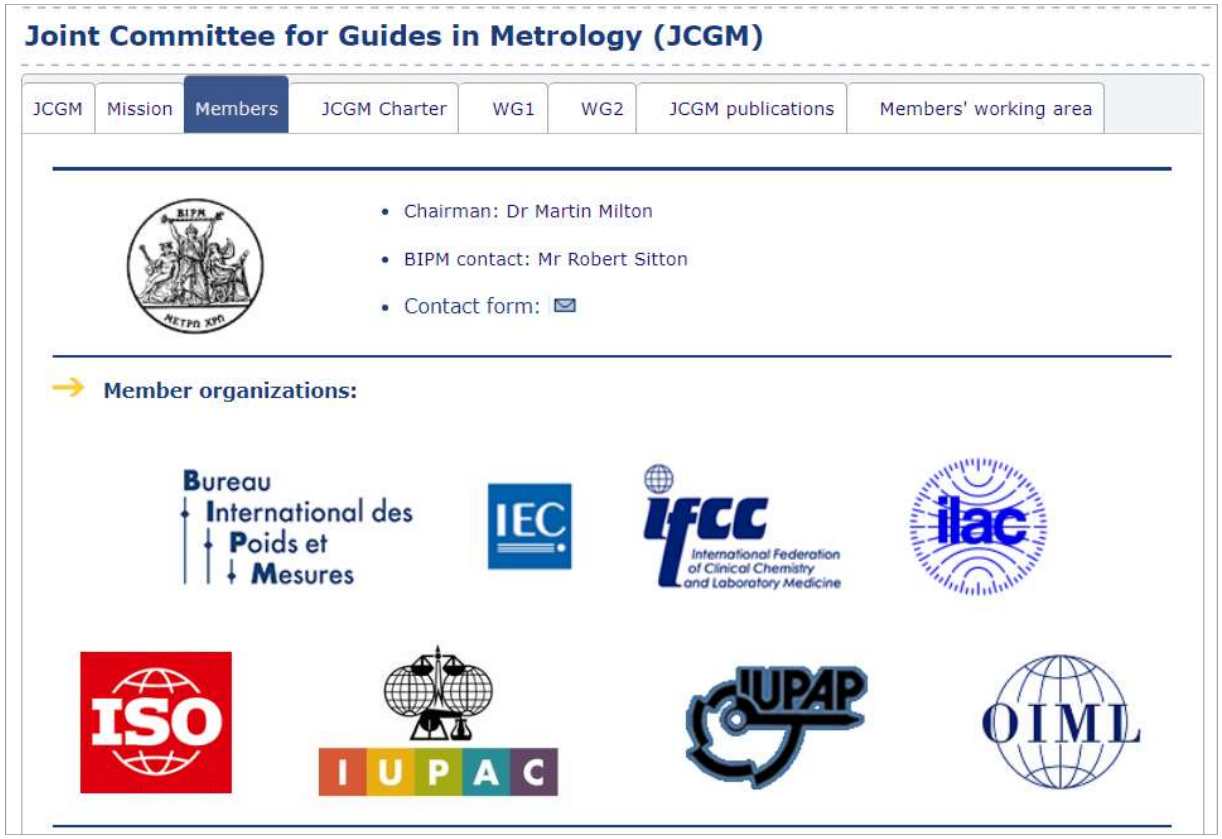
The objectives of metrology are achieved through providing the framework for traceable measurements.

> ***"Metrological Traceability"*** *- the 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*
>
> From the International Vocabulary of Basic and General Terms in Metrology; VIM, 3rd edition, JCGM 200:2012

Note: traceability is the property of the result of a measurement, not of an instrument or calibration report or laboratory



International Vocabulary of Basic and General Terms in Metrology; VIM, 3rd edition, JCGM 200:2012



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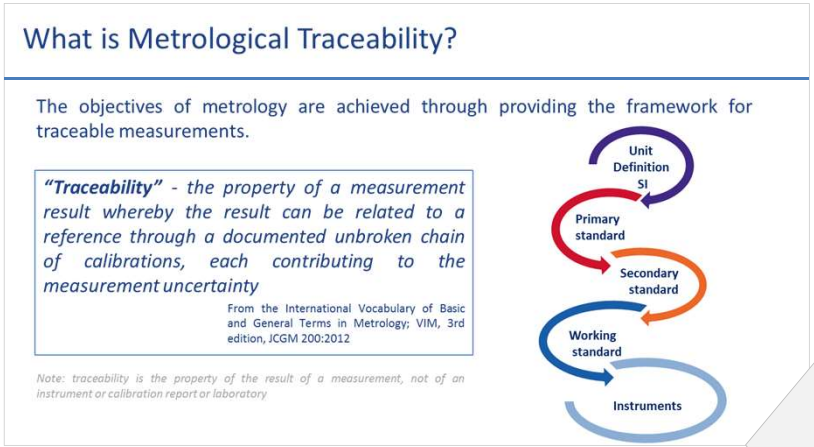
https://www.bipm.org/en/publications/guides/#vim

Metrological Traceability



For this definition, **a 'reference' can be** a definition of a measurement unit through its **practical realization** or a **measurement standard**, or a **certified reference material** or **reference measurement procedure, specified method or consensus standard**

What is Metrological Traceability?

The abbreviated term "traceability" is often used to as shorthand for 'metrological traceability' … *'it's a traceable measurement'*

…however, in the wider context that term is used for other concepts too, such as 'sample traceability' or 'document traceability' or or 'material traceability' or 'origin of goods'…

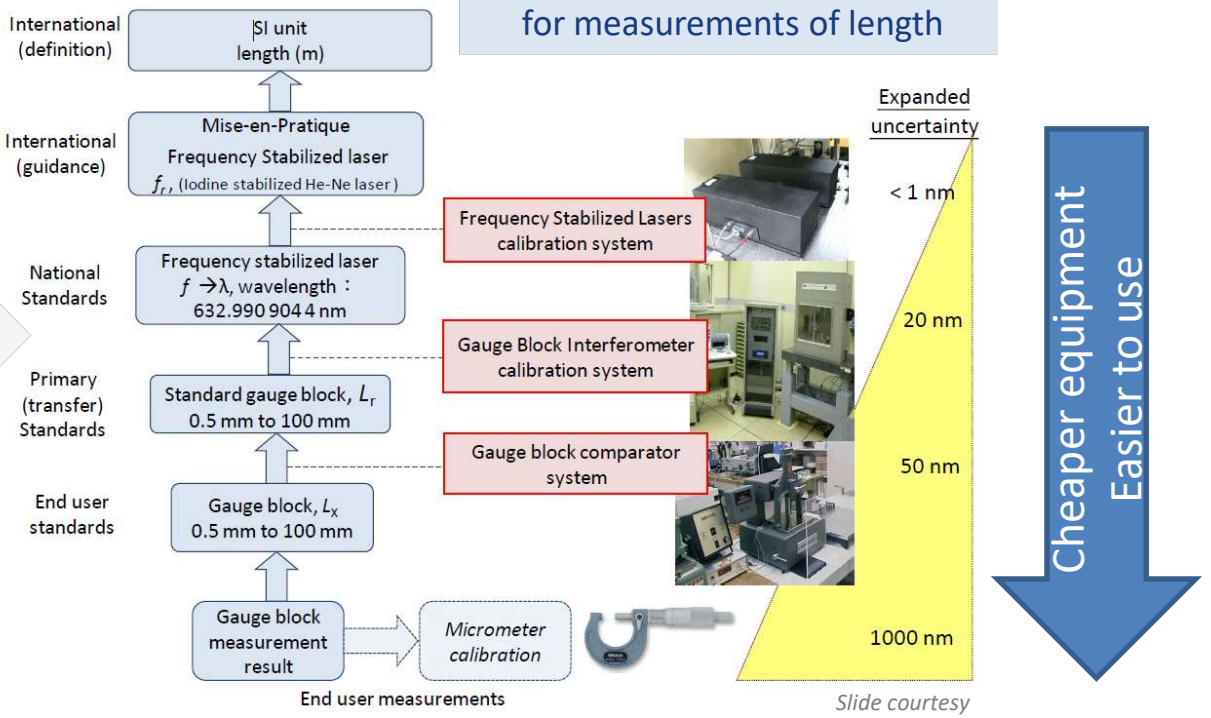
Therefore, the full term of **"metrological traceability"** is preferred if there is any risk of confusion.

Metrological traceability requires an established calibration hierarchy.

Calibration should be documented - including information on metrological traceability.

Reports can be issued as hard copies or by electronic means.

A metrological traceability chain for measurements of length



Slide courtesy
Dr S Davidson, NPL, UK

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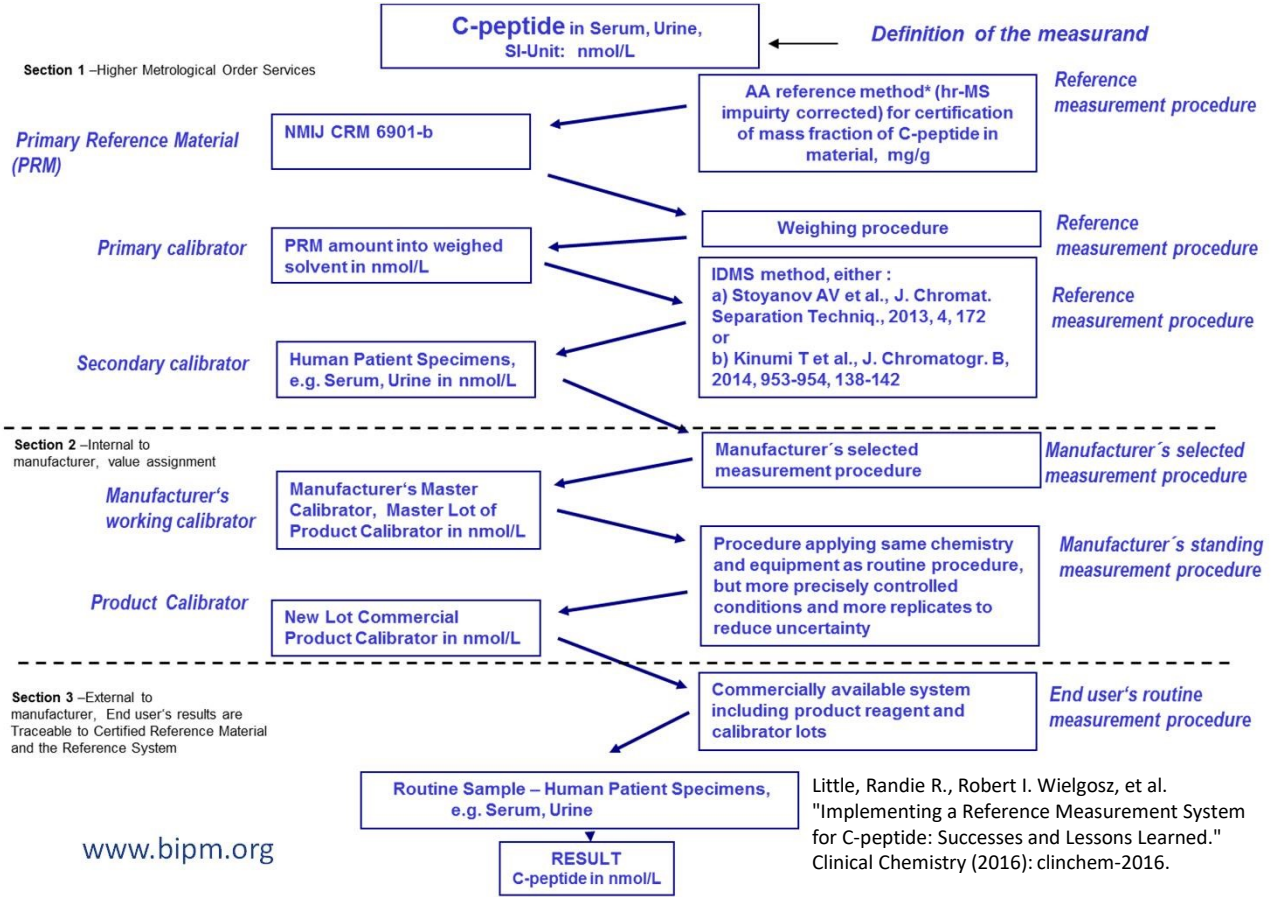
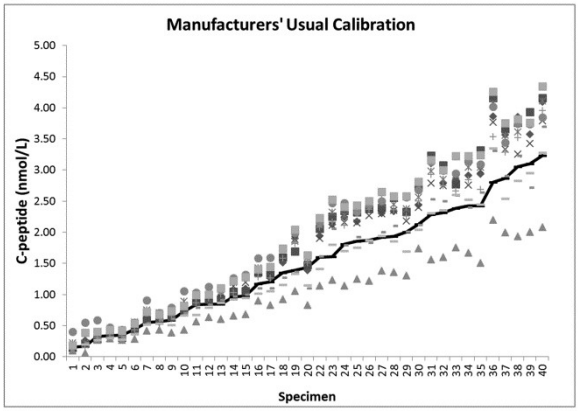
Calibration hierarchies in Chemical and Biochemical Measurements

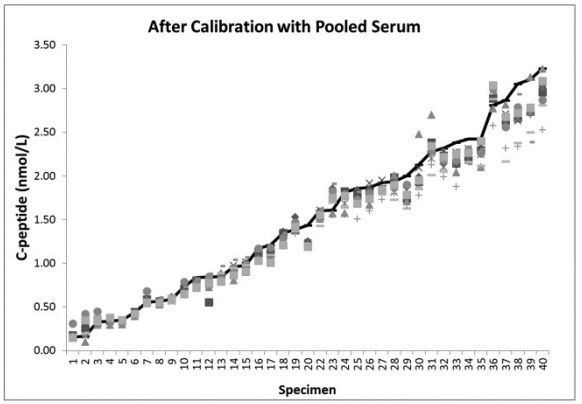


Little, Randie R., Robert I. Wielgosz, et al. "Implementing a Reference Measurement System for C-peptide: Successes and Lessons Learned." Clinical Chemistry (2016): clinchem-2016.

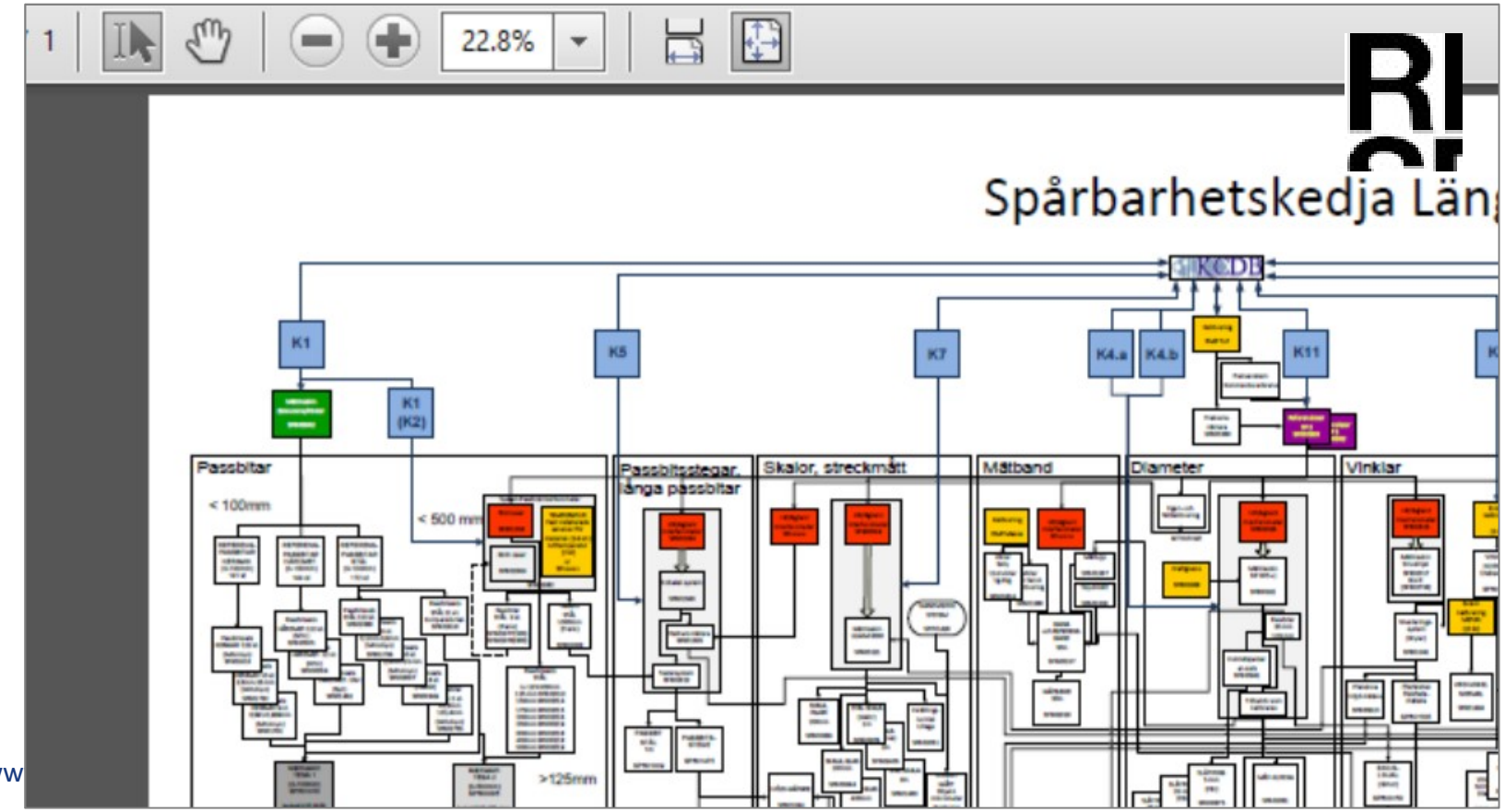
A.



B.



Traceability chain of length – Sweden NMI



N° 77 6 November 2017

CERTIFICATE

for the study and calibration of a 100 pF capacitance standard,
Andeen-Hagerling model AH11A, serial number <s/n>, belonging to the
<NAME OF NMI> (<ACRONYMS>), <City>, <Country>.
(Previous BIPM Certificate number 3, 5 February 2015)

The capacitor, enclosed in an Andeen-Hagerling frame AH1100, serial number 00200213, was received on 29 September 2017. It was measured six times during the period from 6 October to 26 October 2017. The measurements were carried out by R. Chayramy and this certificate was checked by P. Gournay and approved by M. Stock.

Study

Measurement method: comparison with a reference group of four 10 pF capacitors, using a coaxial bridge for two terminal-pair impedances. The capacitance of the reference group is known in terms of the recommended value of the von Klitzing constant, $R_{K\text{-}90}$ = 25 812.807 Ω, by means of a chain of impedance bridges.

Nominal ambient temperature of laboratory: 23 °C
Mean reading of the front panel meter "CHASSIS TEMP (°C)": 31.6
Mean reading of the front panel meter "DRIFT (PPM)": 0.004
Nominal voltage applied to the capacitor (root-mean-square value): 10 V
Nominal frequency of the measurements: 1592 Hz

BIPM evaluation of the voltage coefficient of capacitance: 0.4×10^{-7} pF/V, with a standard uncertainty of 2×10^{-7} pF/V.

BIPM evaluation of the relative capacitance change with frequency from 1000 Hz to 1592 Hz: $(C_{1592} - C_{1000}) / C_{1000} = -18.5\times10^{-8}$ with a standard uncertainty of 6×10^{-8}.

Results

Value of the capacitance of standard 01645 at 1592 Hz and 10 V on the mean date, 14 October 2017:

$$C = 99.999\ 400\ 3\ \text{pF}$$

Relative combined standard uncertainty:

$$U = 4.0\times10^{-8}$$

This uncertainty can be divided into two components: a component of 0.6×10^{-8} arising from the observed stability of the standard over the measurement period, and a component of 4×10^{-8} for the BIPM measurements and traceability.

All of the uncertainties given in this certificate are estimated standard uncertainties, without the application of a coverage factor, k; the standard uncertainty associated with the use of the recommended value $R_{K\text{-}90}$, which has a relative value of 1×10^{-7}, has not been included.

M. Stock
Director of the Physical Metrology Department

Metrological traceability routes - ISO/IEC 17025:2017

6.5 Metrological traceability

6.5.1 The laboratory shall establish and maintain metrological traceability of its measurement results by means of a documented unbroken chain of calibrations, each contributing to the measurement uncertainty, linking them to an appropriate reference.

6.5.2 The laboratory shall ensure that measurement results are traceable to the International System of Units (SI) through:

a) calibration provided by a competent laboratory; or

NOTE 1 Laboratories fulfilling the requirements of this document are considered to be competent.

b) certified values of certified reference materials provided by a competent producer with stated metrological traceability to the SI; or

NOTE 2 Reference material producers fulfilling the requirements of ISO 17034 are considered to be competent.

c) direct realization of the SI units ensured by comparison, directly or indirectly, with national or international standards.

6.5.3 When metrological traceability to the SI units is not technically possible, the laboratory shall demonstrate metrological traceability to an appropriate reference, e.g.:

a) certified values of certified reference materials provided by a competent producer;

b) results of reference measurement procedures, specified methods or consensus standards that are clearly described and accepted as providing measurement results fit for their intended use and ensured by suitable comparison.

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CIPM MRA specific requirements on metrological traceability

CIPM MRA Requirements on metrological traceability

All CMCs must include information on traceability of the measurements to the SI.

According to the CIPM MRA, there are two routes to establish traceability:

1. via a **primary realization** of the unit of measurement concerned, in which traceability is declared to its own demonstrable realization of the SI.
2. via another **NMI or DI having relevant CMCs** with appropriate uncertainty published **in the KCDB**, or through calibration and measurement services offered by the BIPM

CIPM MRA-D-04

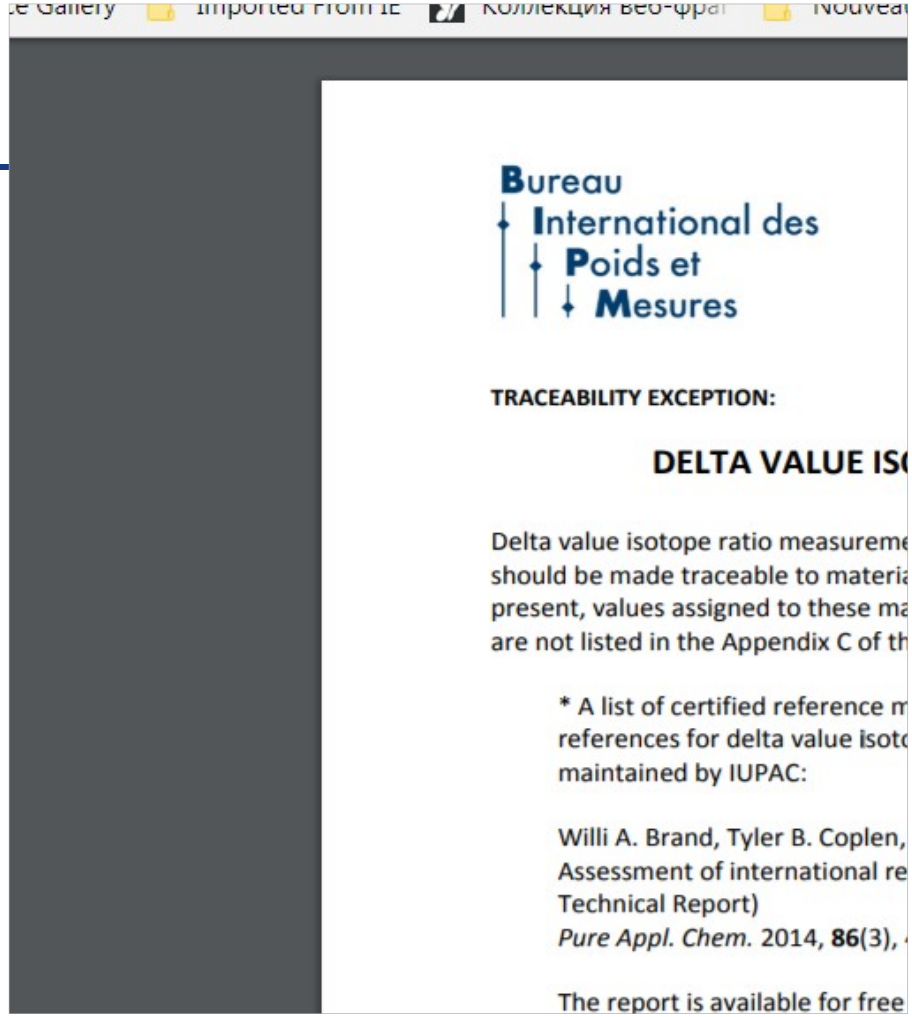
In order for a primary realization or representation of the unit of measurement to be considered valid, **it requires the approval of the relevant Consultative Committee.**

The NMI or DI must make available a full assessment of the uncertainty budget and the traceability route for its measurement activity when submitting CMCs for intra- and inter-Regional review.

Traceability exceptions…

- In exceptional cases, where neither of these two routes can be strictly applied, alternative paths for establishing the traceability to recognized standards may be proposed to the CIPM through the corresponding Consultative Committee.

Any such exceptions, once approved by the CIPM, will be available in the CIPM MRA documents part of the BIPM website.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TRACEABILITY EXCEPTION:

DELTA VALUE IS

Delta value isotope ratio measureme
should be made traceable to materi
present, values assigned to these ma
are not listed in the Appendix C of th

* A list of certified reference m
references for delta value isot
maintained by IUPAC:

Willi A. Brand, Tyler B. Coplen,
Assessment of international re
Technical Report)
Pure Appl. Chem. 2014, **86**(3),

The report is available for free

Primary realization

SI Brochure – 9th edition (2019) – Appendix 2 20 May 2019

Primary realization

Mise en pratique for the definition of the metre in the SI

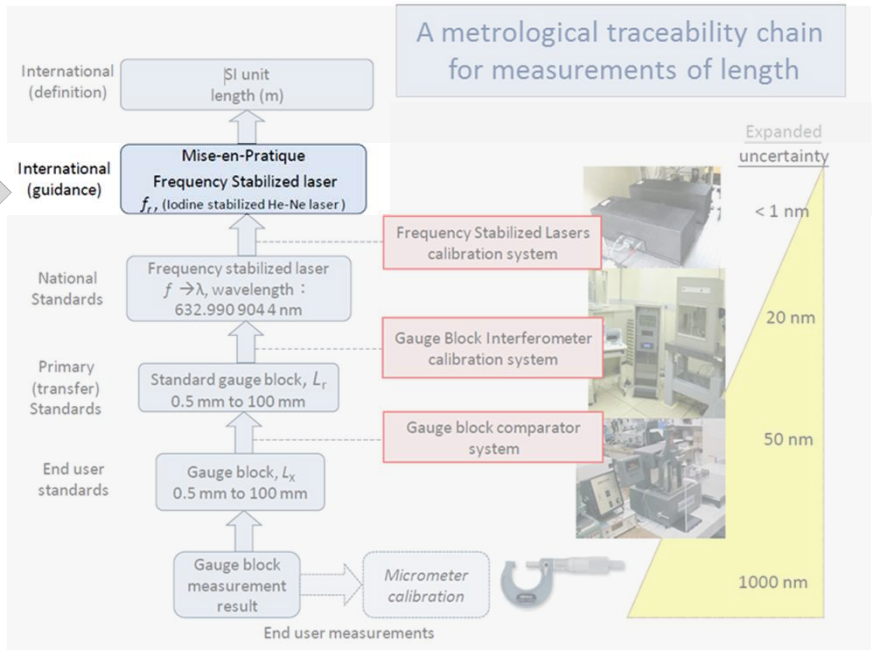
Consultative Committee for Length

1. Introduction

The purpose of this *Mise en Pratique*, prepared by the Consultative Committee for Length (CCL) of the International Committee for Weights and Measures (CIPM), is to indicate how the definition of the SI base unit, the metre, symbol m, may be realized in practice.

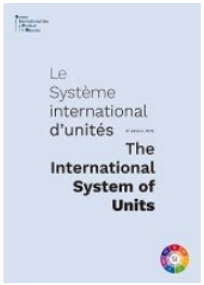
In general, the term 'to realize a unit' is interpreted to mean the establishment of the value and associated uncertainty of a quantity of the same kind as the unit that is consistent with the definition of the unit. A primary method of realizing a unit is a method having the highest metrological properties; whose operation can be completely described and understood; for which a complete uncertainty statement can be written down in terms of SI units; and which does not require a reference standard of the same quantity.

This document starts with the definition of the metre as agreed at the 26th meeting of the Conférence Générale des poids et Mesures (CGPM) in November 2018. This is followed by a description of the



Real example of practical realization

Primary realization



Base units

Base quanti

Name

length
mass
time, durati
electric cur
thermodyna
amount of s
luminous in

Derived units

Derived quantity
plane angle
solid angle
frequency
force
pressure, stress
energy, work, amount of heat
power, radiant flux
electric charge, amount of elect
electric potential dif

Prefixes

Factor	Name	Symbol	Factor	Name	Symbol
10^{1}	deca	da	10^{-1}	deci	d
10^{2}	hecto	h	10^{-2}	centi	c
10^{3}	kilo	k	10^{-3}	milli	m
10^{6}	mega	M	10^{-6}	micro	μ
10^{9}	giga	G	10^{-9}	nano	n
10^{12}	tera	T	10^{-12}	pico	p
10^{15}	pet				
10^{18}	ex				
10^{21}	zet				
10^{24}	yo				

Practical realizations of the definitions of some important units

Appendix 2: *Mises en pratique* | SI Brochure (9th edition)

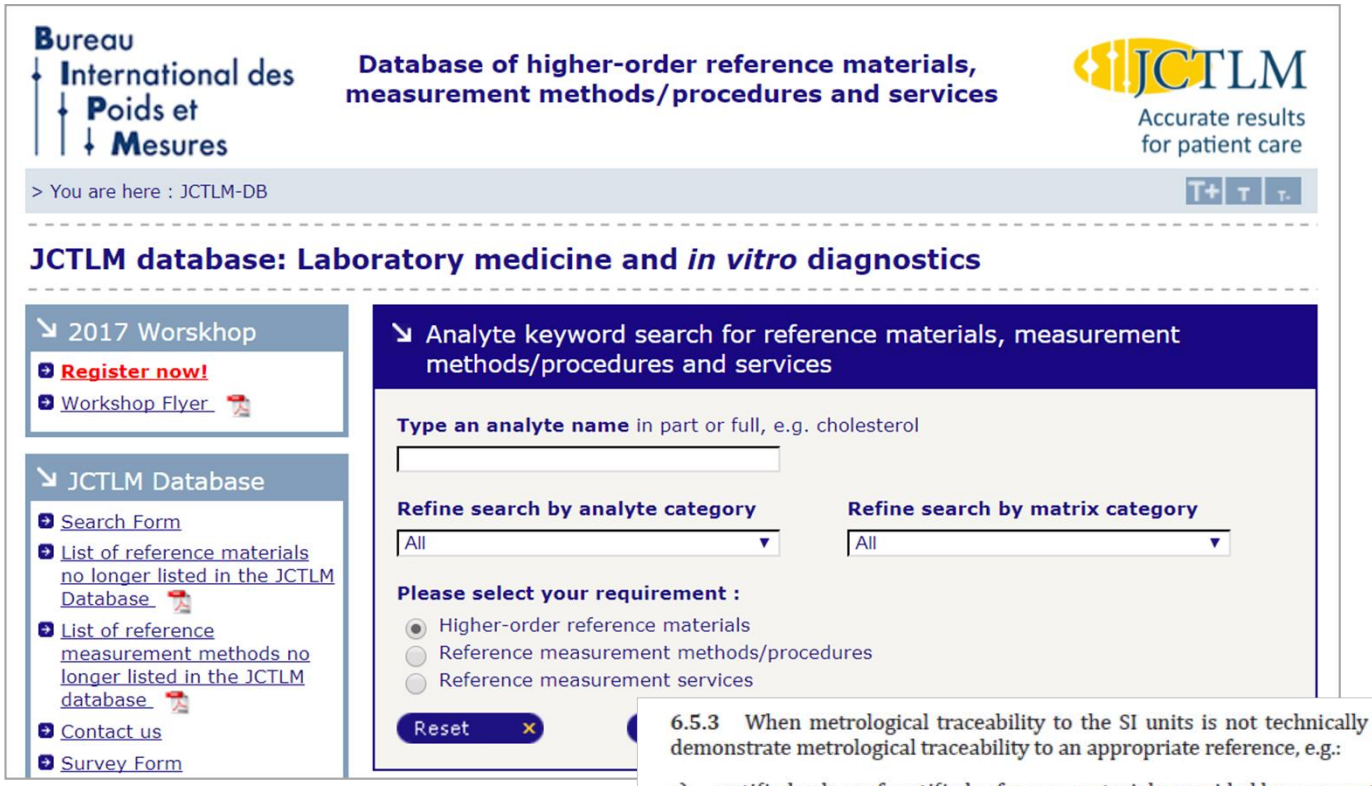
→ **Appendix 2 of the SI Brochure**

The *mises en pratique* are prepared by the relevant Consultative Committees and are then published in electronic form here on the BIPM website, where they may be revised more frequently than if they were printed in the SI Brochure.

- **second**
  - *Mise en pratique* for the definition of the second in the SI (20 May 2019)
  - Recommended values of standard frequencies (last updated 30 November 2018)
- **metre**
  - *Mise en pratique* for the definition of the metre in the SI (20 May 2019)
  - Guidance document CCL-GD-MeP-1
  - Guidance document CCL-GD-MeP-2
  - Guidance document CCL-GD-MeP-3
  - Recommended values of standard frequencies (last updated 30 November 2018)

Appendix 2 is published in electronic form only and available on the BIPM website:
https://www.bipm.org/en/publications/mises-en-pratique/

When it is technically not possible…



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www.bipm.org

Joint BIPM, OIML, ILAC and ISO declaration

https://www.bipm.org/utils/common/pdf/BIPM-OIML-ILAC-ISO_joint_declaration_2018.pdf

Bureau International des Poids et Mesures

INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES

INTERNATIONAL ORGANISATION OF LEGAL METROLOGY

INTERNATIONAL LABORATORY ACCREDITATION COOPERATION

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

JOINT

BIPM, OIML, ILAC, and ISO

DECLARATION ON

METROLOGICAL TRACEABILITY

This document was originally signed
9th November 2011, then

updated and reaffirmed
13th November 2018

Martin Milton
Director of the BIPM

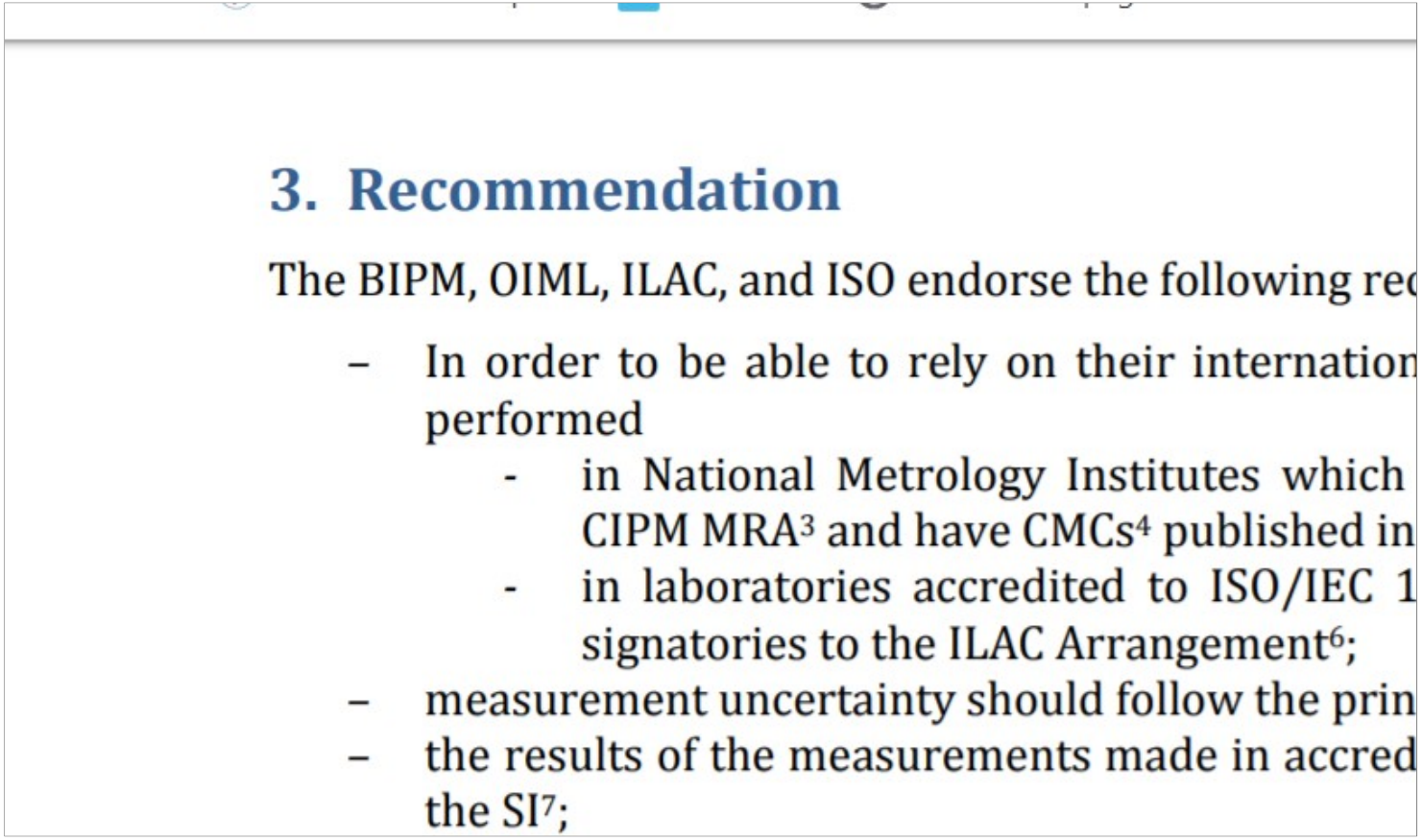
Stephen Patoray
BIML Director

Merih Malmqvist Nilsson
ILAC Chair

Sergio Mujica
ISO Secretary General

Bureau International des Poids et Mesures

Joint BIPM, OIML, ILAC and ISO declaration



3. Recommendation

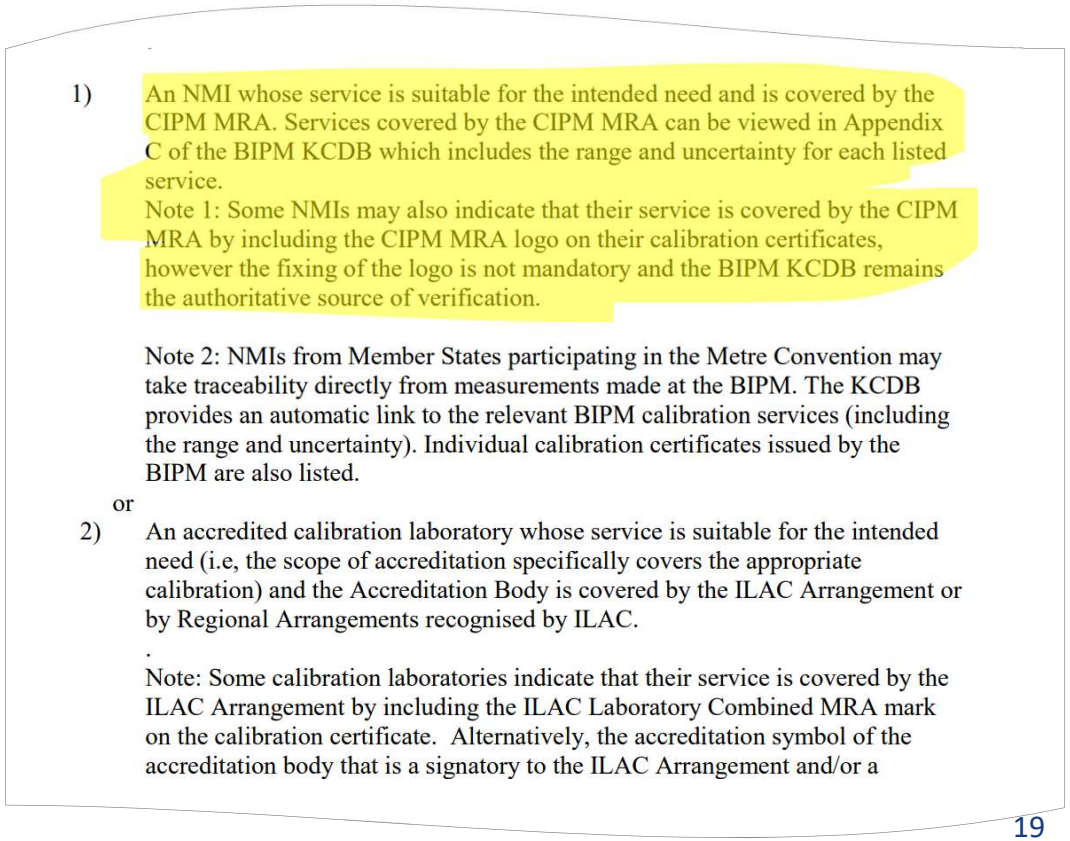
The BIPM, OIML, ILAC, and ISO endorse the following rec

- In order to be able to rely on their internation performed
  - in National Metrology Institutes which CIPM MRA[3] and have CMCs[4] published in
  - in laboratories accredited to ISO/IEC 1 signatories to the ILAC Arrangement[6];
- measurement uncertainty should follow the prin
- the results of the measurements made in accred the SI[7];

ILAC policy for accreditation community

- **ILAC P10:01/2013** "ILAC Policy on Traceability of Measurement Results"

This document describes the ILAC policy on metrological traceability of measurement results.



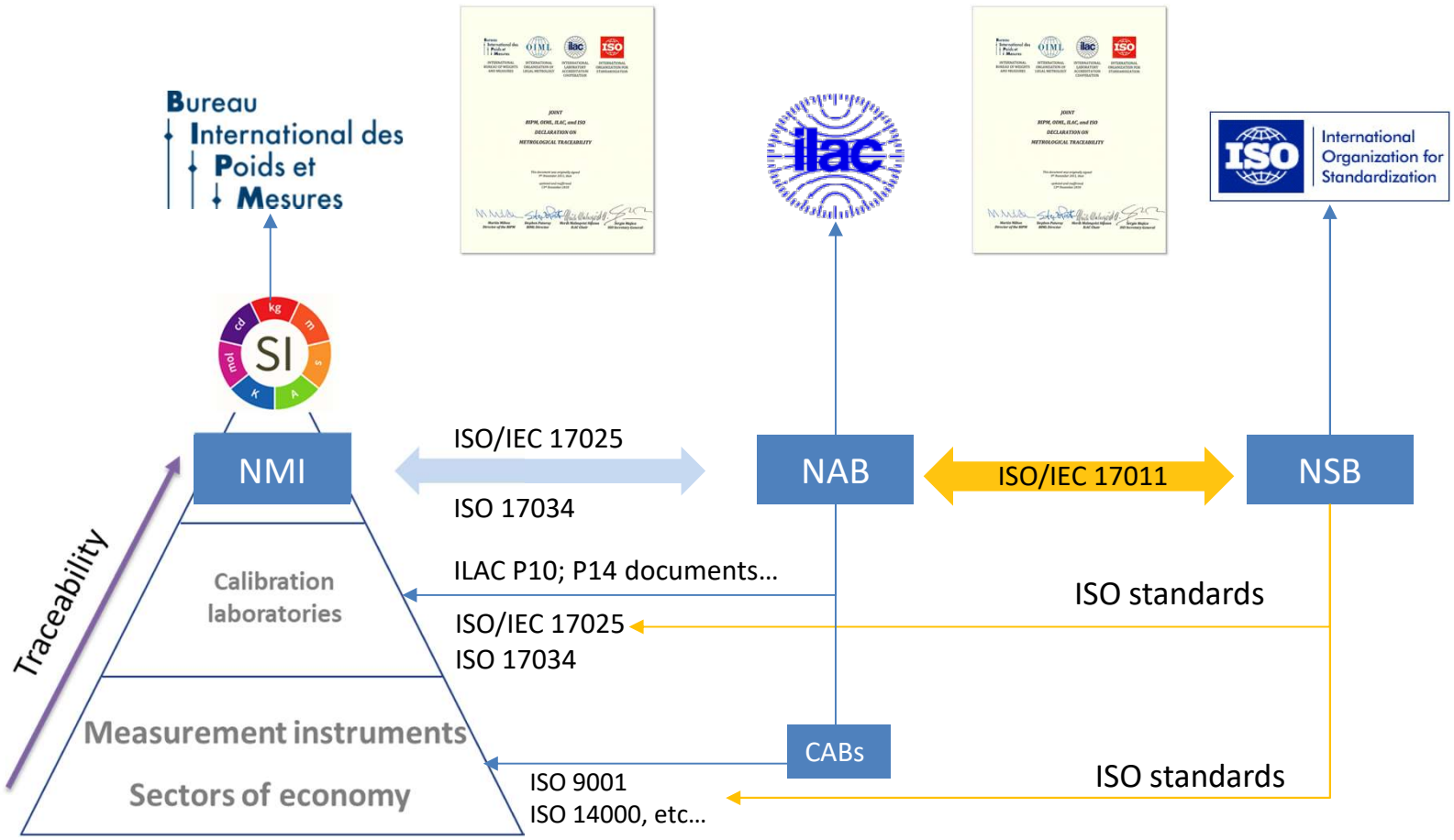
1) An NMI whose service is suitable for the intended need and is covered by the CIPM MRA. Services covered by the CIPM MRA can be viewed in Appendix C of the BIPM KCDB which includes the range and uncertainty for each listed service.
Note 1: Some NMIs may also indicate that their service is covered by the CIPM MRA by including the CIPM MRA logo on their calibration certificates, however the fixing of the logo is not mandatory and the BIPM KCDB remains the authoritative source of verification.

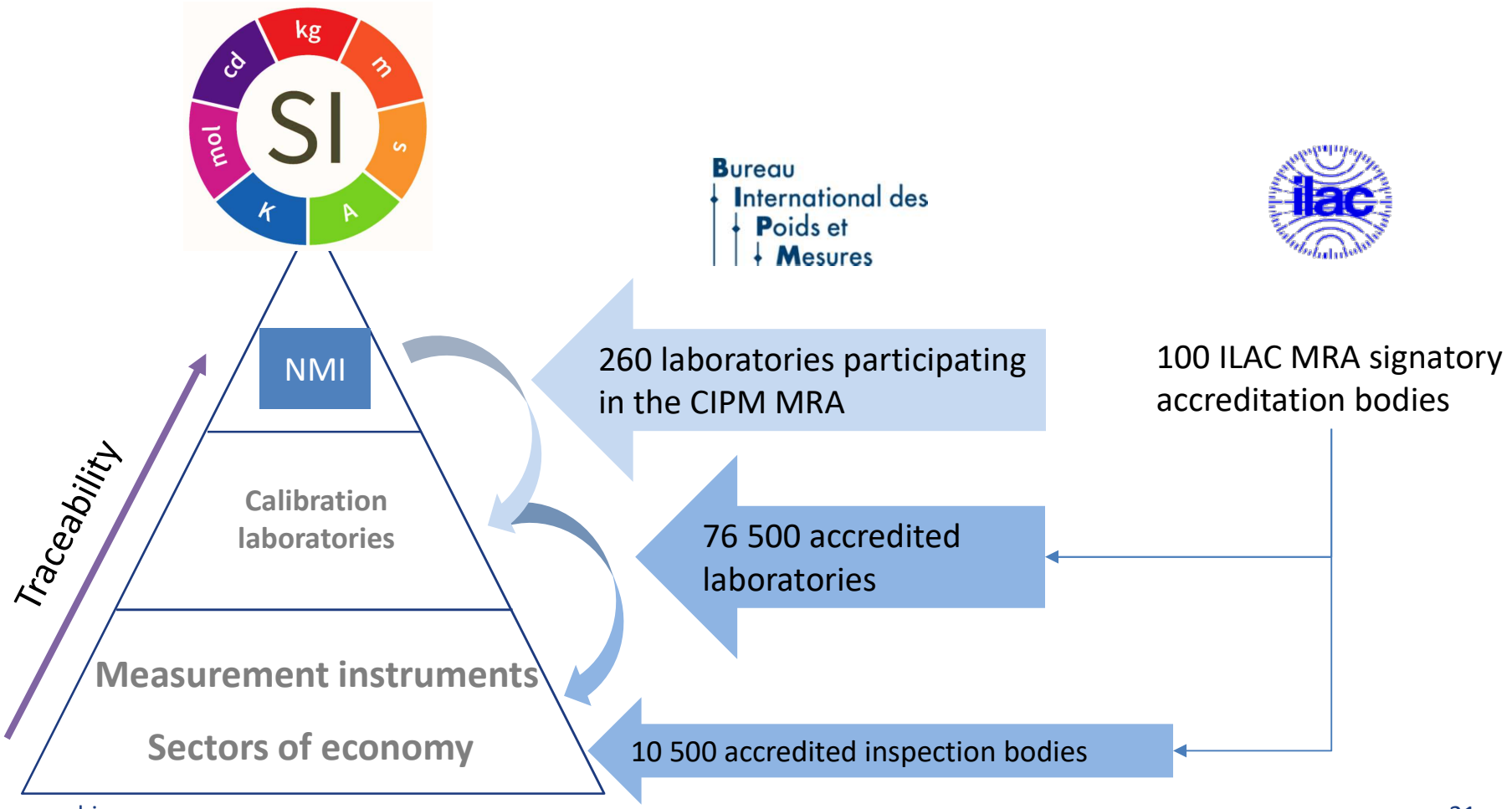
Note 2: NMIs from Member States participating in the Metre Convention may take traceability directly from measurements made at the BIPM. The KCDB provides an automatic link to the relevant BIPM calibration services (including the range and uncertainty). Individual calibration certificates issued by the BIPM are also listed.

or

2) An accredited calibration laboratory whose service is suitable for the intended need (i.e, the scope of accreditation specifically covers the appropriate calibration) and the Accreditation Body is covered by the ILAC Arrangement or by Regional Arrangements recognised by ILAC.

Note: Some calibration laboratories indicate that their service is covered by the ILAC Arrangement by including the ILAC Laboratory Combined MRA mark on the calibration certificate. Alternatively, the accreditation symbol of the accreditation body that is a signatory to the ILAC Arrangement and/or a


Bureau International des Poids et Mesures
ilac
International Organization for Standardization
SI
NMI
NAB
NSB
ISO/IEC 17025
ISO 17034
ISO/IEC 17011
Traceability
Calibration laboratories
Measurement instruments
Sectors of economy
ILAC P10; P14 documents…
ISO/IEC 17025
ISO 17034
ISO standards
CABs
ISO 9001
ISO 14000, etc…
ISO standards


kg
m
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SI
Bureau International des Poids et Mesures
ilac
NMI
Calibration laboratories
Measurement instruments
Sectors of economy
Traceability
260 laboratories participating in the CIPM MRA
100 ILAC MRA signatory accreditation bodies
76 500 accredited laboratories
10 500 accredited inspection bodies

Unbroken chain of calibrations through the CIPM MRA

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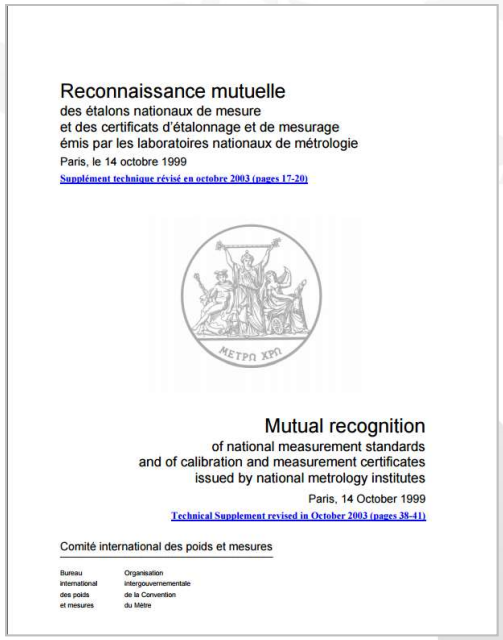
CIPM MRA

- a secure technical foundation for wider agreements



Reconnaissance mutuelle
des étalons nationaux de mesure
et des certificats d'étalonnage et de mesurage
émis par les laboratoires nationaux de métrologie
Paris, le 14 octobre 1999
Supplément technique révisé en octobre 2003 (pages 17-20)

Mutual recognition
of national measurement standards
and of calibration and measurement certificates
issued by national metrology institutes
Paris, 14 October 1999
Technical Supplement revised in October 2003 (pages 38-41)

Comité international des poids et mesures

Bureau international des poids et mesures
Organisation intergouvernementale de la Convention du Mètre

The CIPM Mutual Recognition Arrangement (CIPM MRA) is the framework through which **NMIs demonstrate**

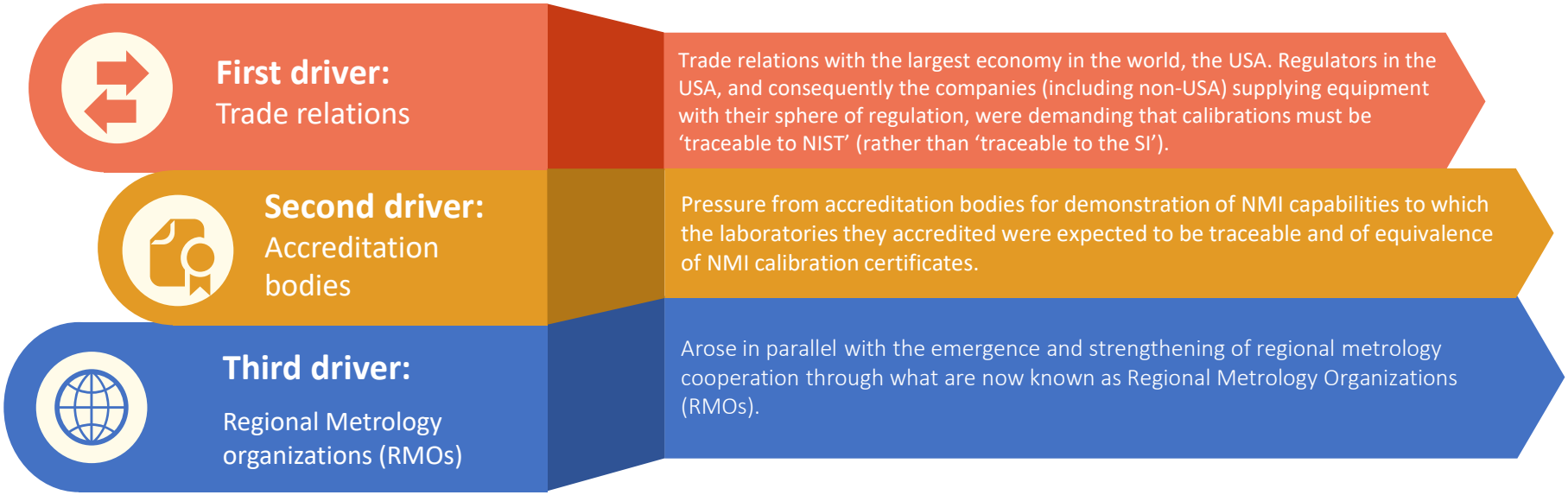
- the international equivalence of their measurement standards and
- the calibration and measurement certificates they issue.

The work of the CIPM MRA now goes far beyond matters of trade to cover climate change, healthcare etc.

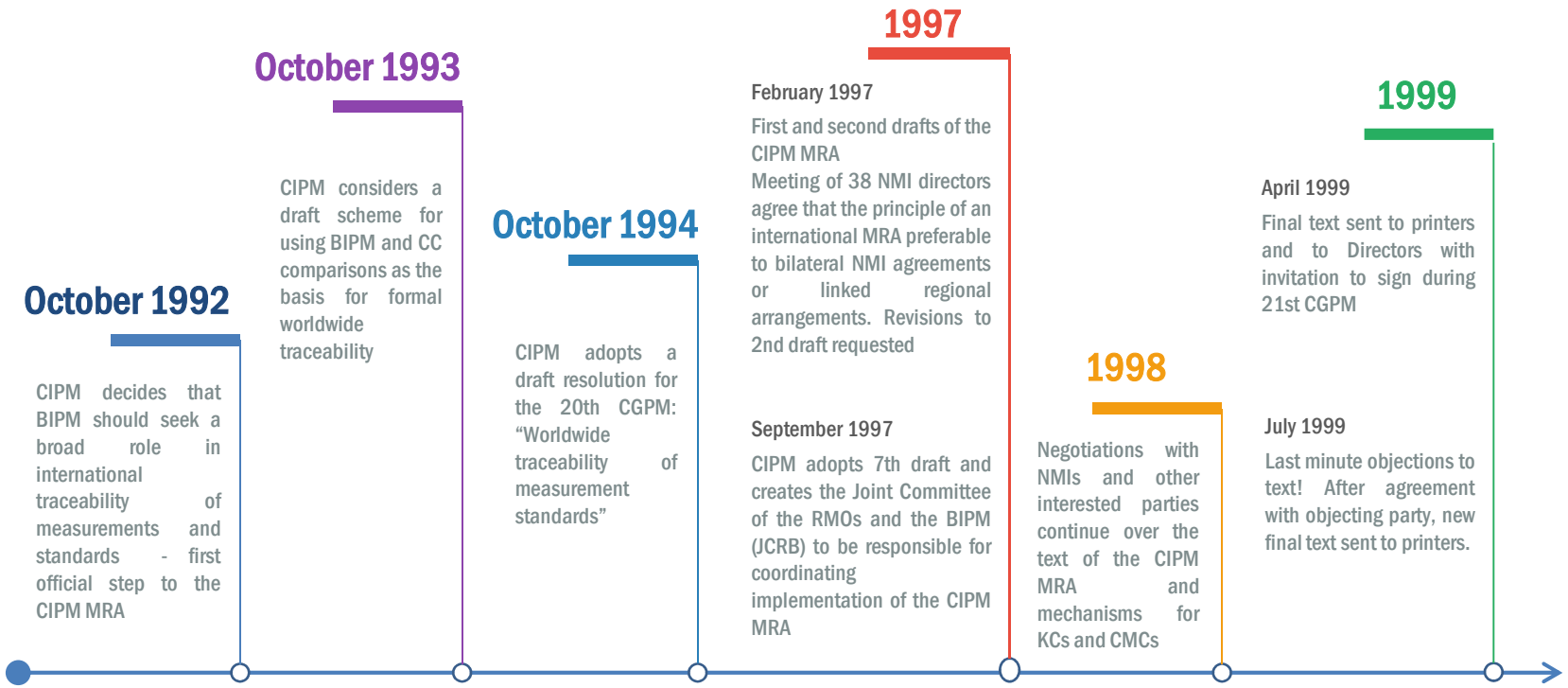
Bureau International des Poids et Mesures

The origin of the CIPM MRA

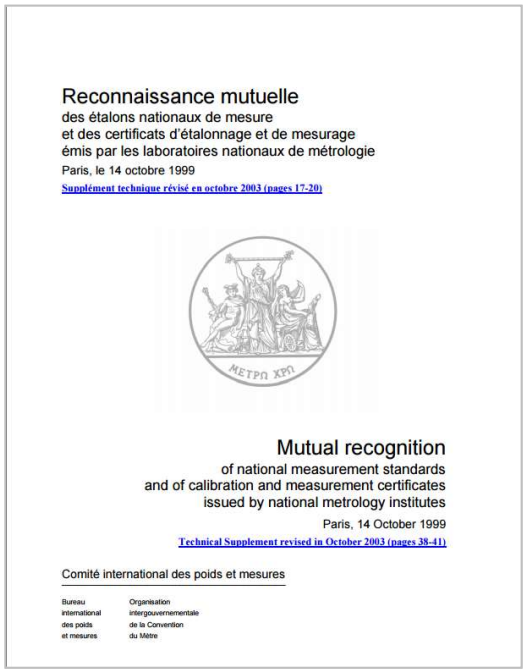
The backdrop to the CIPM MRA was the major increase in world trade triggered by the General Agreement on Tariffs and Trade. The Uruguay Round — 1986-1994— led to the creation of the World Trade Organization (WTO). As fiscal barriers to trade were reduced, non-tariff barriers, and the need to address them, were brought into far sharper focus, leading to the Technical Barriers to Trade (TBT) Agreement which first came into force alongside the WTO in 1995. The need to measure consistently, and to have those measurements accepted across trading partners, was fundamental to an increasingly globalized world.



Timeline of the CIPM MRA



Launch of the CIPM MRA



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ΜΕΤΡΩ ΧΡΗ

Mutual recognition
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Paris, 14 October 1999
Technical Supplement revised in October 2003 (pages 38-41)

Comité international des poids et mesures

Bureau international des poids et mesures
Organisation intergouvernementale de la Convention du Mètre

The CIPM Mutual Recognition of national measurement standards and of calibration and measurement certificates issued by national metrology institutes (CIPM MRA) was signed in Paris on 14 October 1999 by the Directors of

- **38 National Metrology Institutes (NMIs)** and
- **two international organizations.**

Objectives:

- *to establish the **degree of equivalence** of national measurement standards maintained by NMIs*
- *to provide for the **mutual recognition of calibration and measurement certificates** issued by NMIs*
- *thereby to provide governments and other parties with a secure technical foundation **for wider agreements related to international trade, commerce and regulatory affairs**.*

The essence of the CIPM MRA is that it provides the institutional and technical framework (the "what", "who" and "how") for NMIs to recognize each others' measurement standards and calibration certificates.

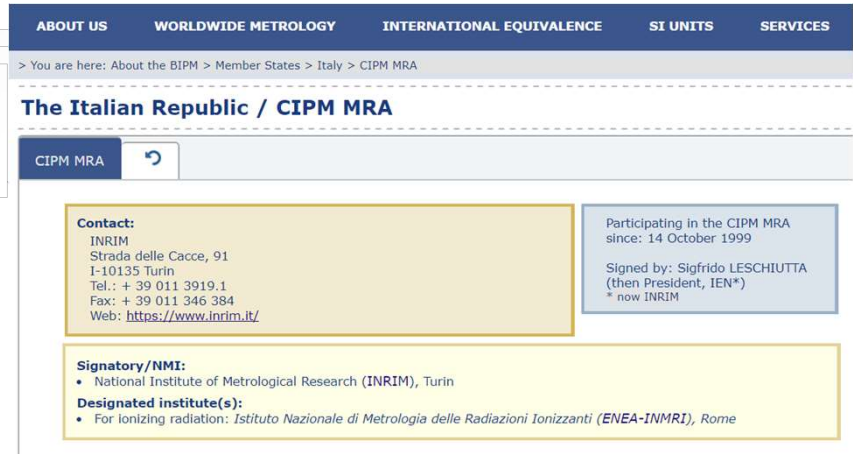
Participation

The CIPM MRA is open to:

- NMIs of the Member States of the BIPM
- certain international and intergovernmental organizations (IGO) invited by the CIPM
- NMIs of Associate States and Economies of the General Conference

- *Designated institutes (DIs)*

The CIPM MRA also introduced the concept of "designated institutes" as responsible for certain national standards and associated services that are not covered by the activities of the "traditional" NMI.



Essential requirements: Engagement

By signing the CIPM MRA, an NMI agrees to:

- **accept the** process specified in the CIPM MRA for establishing the database
- **recognize the results of key and supplementary comparisons** as stated in the database
- **recognize the calibration and measurement capabilities** of other participating NMIs as stated in the database

Essential requirements: Exclusions

The ‘recognition’ offered by the CIPM MRA is not unlimited:

- signature of the CIPM MRA engages NMIs but **not necessarily any other agency in their country**

- **responsibility for the results of calibrations and measurements rests wholly with the NMIs that makes them** and is not, through the CIPM MRA, extended to any other participating NMI

Recognition…

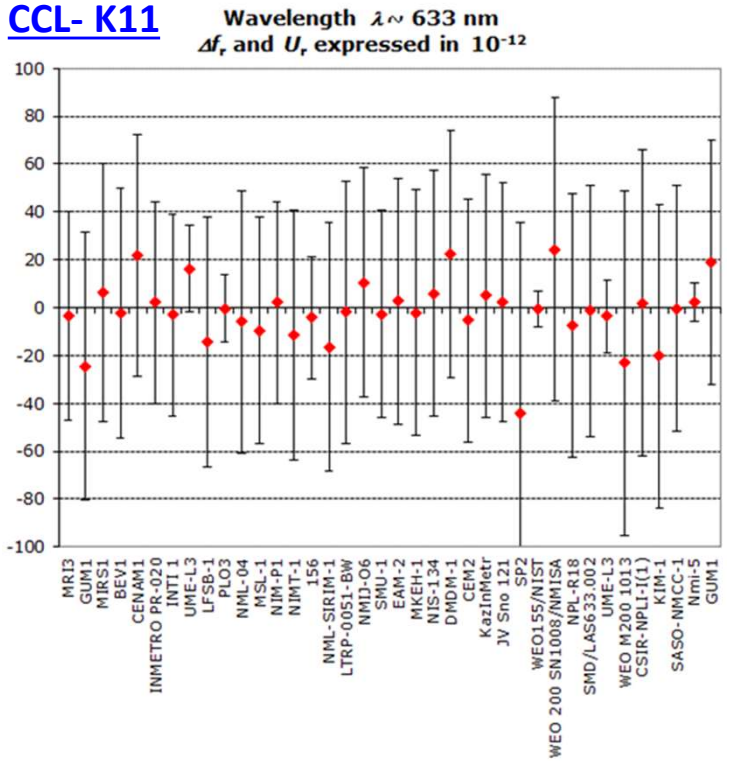
Participating NMI/DI agrees to:

- **recognize the degree of equivalence** of national measurement standards, derived from the results of key comparisons

- **recognize the validity of calibration and measurement certificates** issued by other participating NMIs/DIs

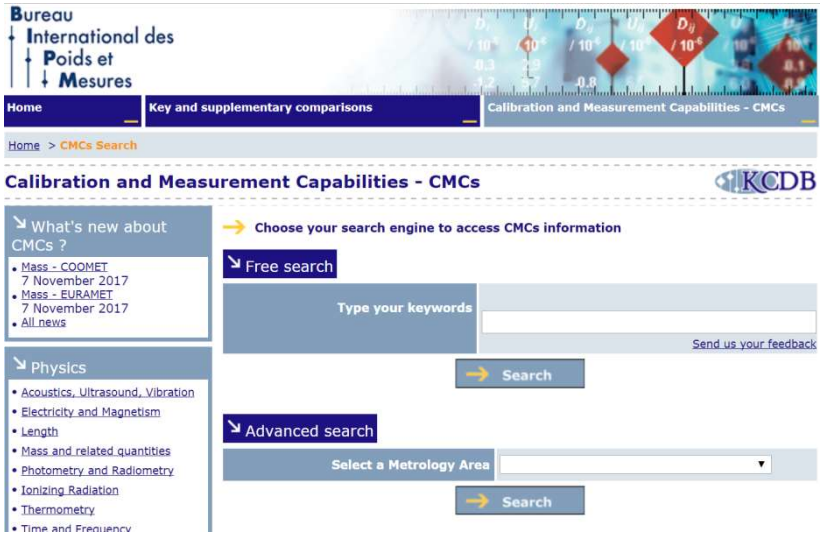
Degree of equivalence *of national standards*

- The degree of equivalence of measurement standards is taken to mean the degree to which these standards are consistent with reference values determined from the key comparisons and hence are consistent with one another.
- The degree of equivalence of a national measurement standard is expressed quantitatively in terms of its deviation from the key comparison reference value and the uncertainty of this deviation.



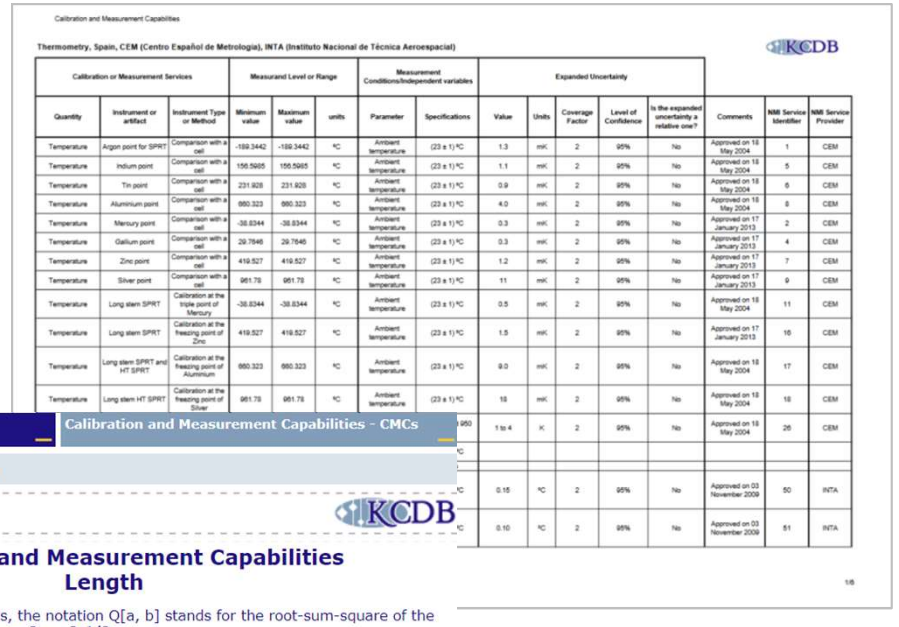
Validity of calibration and measurement certificates

- By placing the logo on a calibration certificate and the statement, NMI/DI is indicating that the calibration falls within NMI/DI's calibration and measurement capabilities (CMCs) published in the KCDB under the CIPM MRA.



CMCs in the KCDB

- Under the CIPM MRA, **CMCs** of signatory NMIs are the fundamental object of mutual recognition.
- CMCs are made available in the KCDB in open access, under the form of PDF files and html pages.
- CMCs are published in **Appendix C of the KCDB**


Calibration and Measurement Capabilities

Thermometry, Spain, CEM (Centro Español de Metrología), INTA (Instituto Nacional de Técnica Aeroespacial)

KCDB

Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty						
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Comments	NMI Service Identifier	NMI Service Provider
Temperature	Argon point for SPRT	Comparison with a cell	-189.3442	-189.3442	°C	Ambient temperature	(23 ± 1) °C	1.3	mK	2	95%	No	Approved on 18 May 2004	1	CEM
Temperature	Indium point	Comparison with a cell	156.5985	156.5985	°C	Ambient temperature	(23 ± 1) °C	1.1	mK	2	95%	No	Approved on 18 May 2004	5	CEM
Temperature	Tin point	Comparison with a cell	231.928	231.928	°C	Ambient temperature	(23 ± 1) °C	0.9	mK	2	95%	No	Approved on 18 May 2004	6	CEM
Temperature	Aluminium point	Comparison with a cell	660.323	660.323	°C	Ambient temperature	(23 ± 1) °C	4.0	mK	2	95%	No	Approved on 18 May 2004	8	CEM
Temperature	Mercury point	Comparison with a cell	-38.8344	-38.8344	°C	Ambient temperature	(23 ± 1) °C	0.3	mK	2	95%	No	Approved on 17 January 2013	2	CEM
Temperature	Gallium point	Comparison with a cell	29.7646	29.7646	°C	Ambient temperature	(23 ± 1) °C	0.3	mK	2	95%	No	Approved on 17 January 2013	4	CEM
Temperature	Zinc point	Comparison with a cell	419.527	419.527	°C	Ambient temperature	(23 ± 1) °C	1.2	mK	2	95%	No	Approved on 17 January 2013	7	CEM
Temperature	Silver point	Comparison with a cell	961.78	961.78	°C	Ambient temperature	(23 ± 1) °C	11	mK	2	95%	No	Approved on 17 January 2013	9	CEM
Temperature	Long stem SPRT	Calibration at the triple point of Mercury	-38.8344	-38.8344	°C	Ambient temperature	(23 ± 1) °C	0.5	mK	2	95%	No	Approved on 18 May 2004	11	CEM
Temperature	Long stem SPRT	Calibration at the freezing point of Zinc	419.527	419.527	°C	Ambient temperature	(23 ± 1) °C	1.5	mK	2	95%	No	Approved on 17 January 2013	16	CEM
Temperature	Long stem SPRT and HT SPRT	Calibration at the freezing point of Aluminium	660.323	660.323	°C	Ambient temperature	(23 ± 1) °C	9.0	mK	2	95%	No	Approved on 18 May 2004	17	CEM
Temperature	Long stem HT SPRT	Calibration at the freezing point of Silver	961.78	961.78	°C	Ambient temperature	(23 ± 1) °C	18	mK	2	95%	No	Approved on 18 May 2004	18	CEM
Temperature								1 to 4	K	2	95%	No	Approved on 18 May 2004	26	CEM
								0.15	°C	2	95%	No	Approved on 03 November 2009	50	INTA
								0.10	°C	2	95%	No	Approved on 03 November 2009	51	INTA

1/8

CIPM MRA Logo and the statement

CIPM MRA-D-02

Once an NMI has published CMCs, it can apply to the BIPM Director to use the CIPM MRA logo.

The CIPM MRA logo can be affixed to:

- *calibration certificates**
- *certified reference materials (CRMs)*

** If the calibration certificates include statements of compliance or verification against an identified metrological specification or clauses thereof, the following words should be added:* **"…The "CIPM MRA Logo" and this statement attest only to the measurement component of the certificate"**

"This certificate is consistent with the capabilities that are included in Appendix C of the MRA drawn up by the CIPM. Under the MRA, all participating institutes recognize the validity of each other's calibration and measurement certificates for the quantities, ranges and measurement uncertainties specified in Appendix C (for details see http://www.bipm.org)"

Key Comparison Database (KCDB)


Reconnaissance mutuelle
des étalons nationaux de mesure
et des certificats d'étalonnage et de mesurage
émis par les laboratoires nationaux de métrologie

Mutual recognition
of national measurement standards
and of calibration and measurement certificates
issued by national metrology institutes

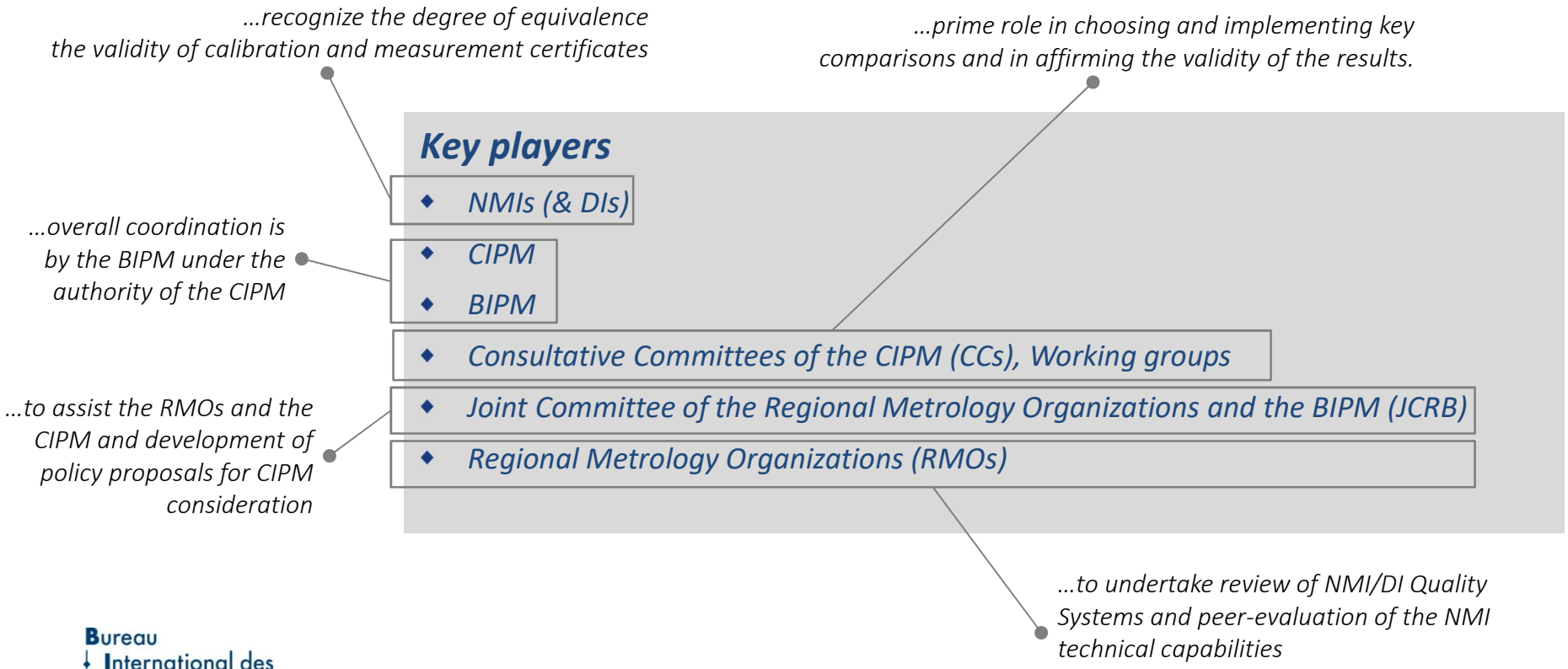
KCDB is a public website containing all results of the participation in the CIPM MRA:

- List of participants *(Appendix A)*
- Peer-reviewed measurement comparisons *(Appendix B)*
- Peer-reviewed CMC declarations*(Appendix C)*

EQUIVALENCE OF NATIONAL STANDARDS

ACCEPTANCE OF CERTIFICATES

Structure of the CIPM MRA



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CIPM MRA Organizations Structure

Roles and responsibilities within the CIPM MRA:

- overall coordination is by the **BIPM** under the authority of the CIPM
- the Consultative Committees of the **CIPM (CCs)**, the Regional Metrology Organizations (**RMOs**) and the BIPM are responsible for carrying out the key and supplementary comparisons
- a Joint Committee of the Regional Metrology Organizations and the BIPM (**JCRB**) coordinating the activities among the RMOs in establishing confidence for the recognition of calibration and measurement certificates, according to the terms of the Mutual Recognition Arrangement

Coordination role of the BIPM and the JCRB

The JCRB is responsible for guidelines on the operation of the CIPM MRA to assist the RMOs and the CIPM and development of policy proposals for CIPM consideration

- Through JCRB, the BIPM operates the CMC review website
- The BIPM chairs the JCRB and provides the Executive Secretary

The Executive Secretary position has always been a secondment position from one of the Member State NMIs to the BIPM, the secondment typically being for a two year period.

- ***Chairman of the JCRB:*** *Dr Martin Milton, BIPM Director*
- ***Executive Secretary:*** *Dr Sten Bergstrand*
- ***CIPM Secretary***
- ***RMO representatives to the JCRB***

- Representatives may bring up to 4 advisers

Technical role of CCs

Consultative Committees have a prime role in choosing and implementing key comparisons and in affirming the validity of the results. In particularly, they are responsible:

a) to identify the KCs in each field

b) to initiate and organize, with the collaboration of the BIPM, the execution of KCs at intervals to be decided individually for each comparison

c) to review the results of CIPM KCs and determine the KCRV and degrees of equivalence

d) to approve the final report of CIPM KCs

e) to examine and confirm the results of RMO KCs and SCs

f) to examine and confirm the results of bilateral key comparisons

Technical role of RMOs

Regional Metrology Organisations (RMOs)

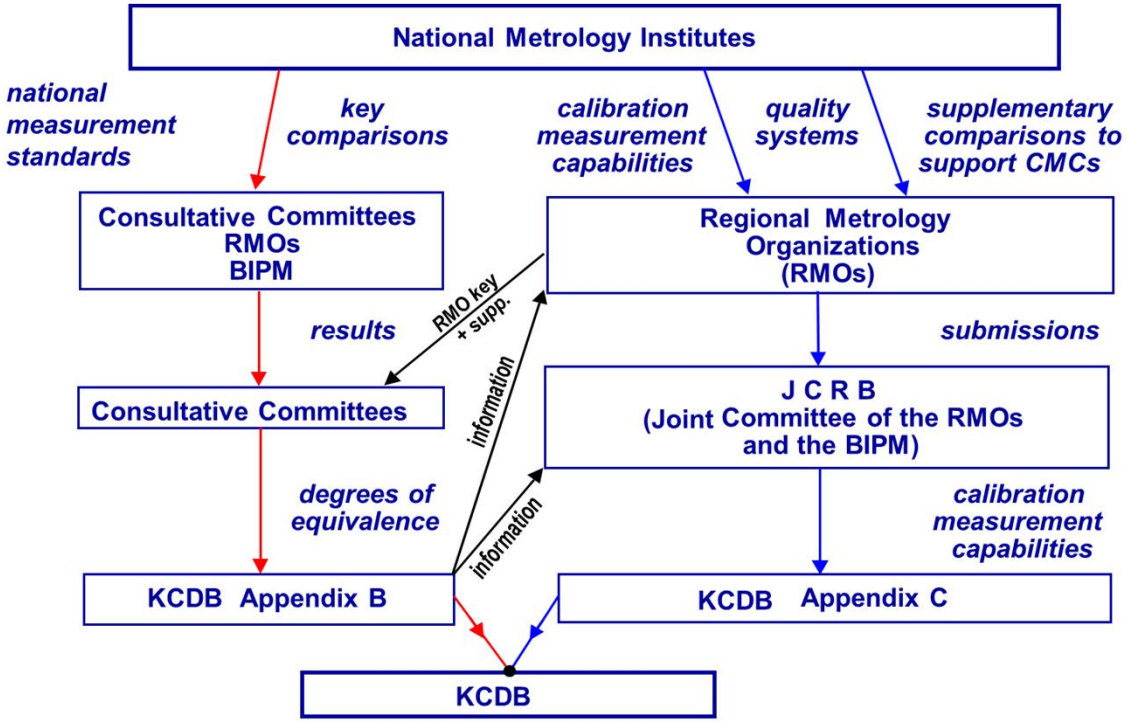
The RMOs play an important role within the CIPM MRA.

In particular, they:

- Undertaking review of NMI/DI Quality Systems
- Carry out the RMO key comparisons,
- Carry out supplementary comparisons ,
- Representative to the JCRB participates in development of policy and guidelines
- TC Chairs responsible for the review of the CMC's.

Diagram of the CIPM MRA

CC RMO WGs play a vital role ensuring consistent and technically valid application



Mechanisms of the CIPM MRA

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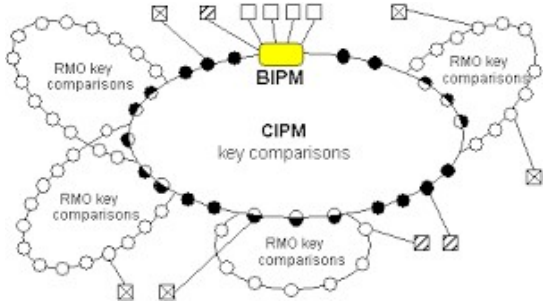
Essential requirements: Process

The objectives of the CIPM MRA are achieved through:

- International comparisons of measurements, to be known as **key comparisons**
- **Supplementary** international comparisons of measurements
- **Quality systems** and demonstrations of competence by NMIs
- International **peer evaluation of CMC claims**

Mechanisms of the CIPM MRA: *comparisons*

- **A fundamental mechanism** of the CIPM MRA
- Primary function is to **establish the degrees of equivalence of national measurement standards** which is the technical basis on which NMIs recognize each others national measurement standards
- Key and Supplemental comparisons are also **demonstrations of NMI measurement capabilities**
- **Registered in Appendix B of the KCDB**



There are 3 basic categories

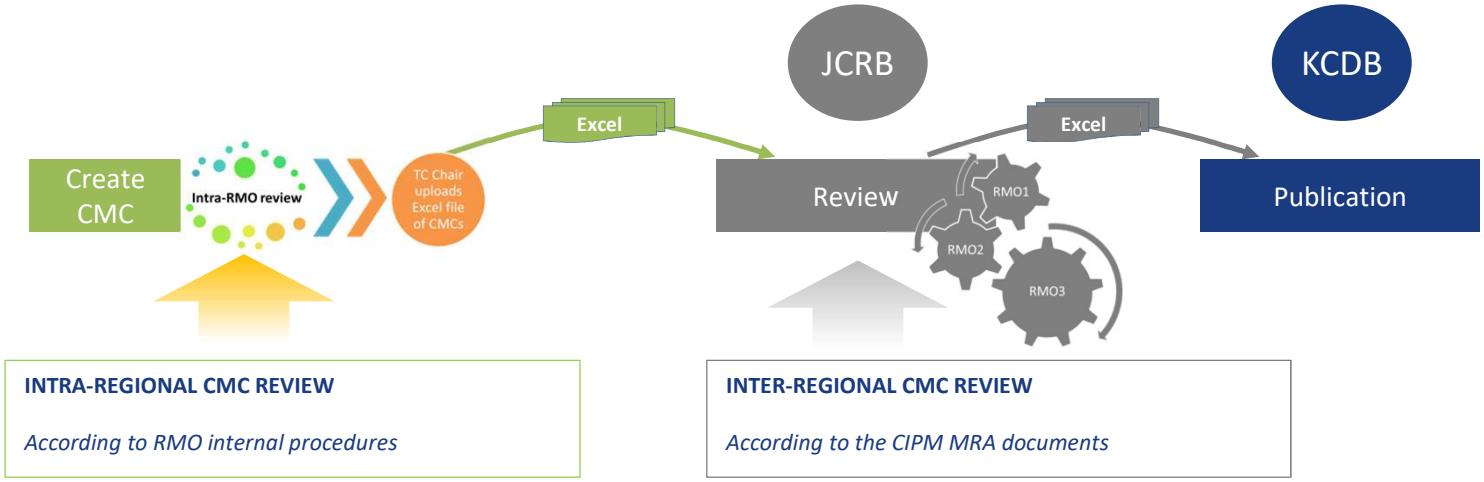
- *CIPM key*
- *RMO key*
- *Supplementary*

Mechanisms of the CIPM MRA: *Quality system*

CIPM MRA requires that all signatory NMIs establish and maintain an appropriate Quality System (QS) as the basis of establishing confidence in each others calibration and measurement activities.

- NMIs have a choice between **accreditation** and **self-declaration** of their QS
- RMOs are responsible for oversight and approval of the QSs of their member NMIs
- RMOs must conduct full review of member NMI QSs at least every five years.

Mechanisms of the CIPM MRA: *Peer evaluation of CMCs*



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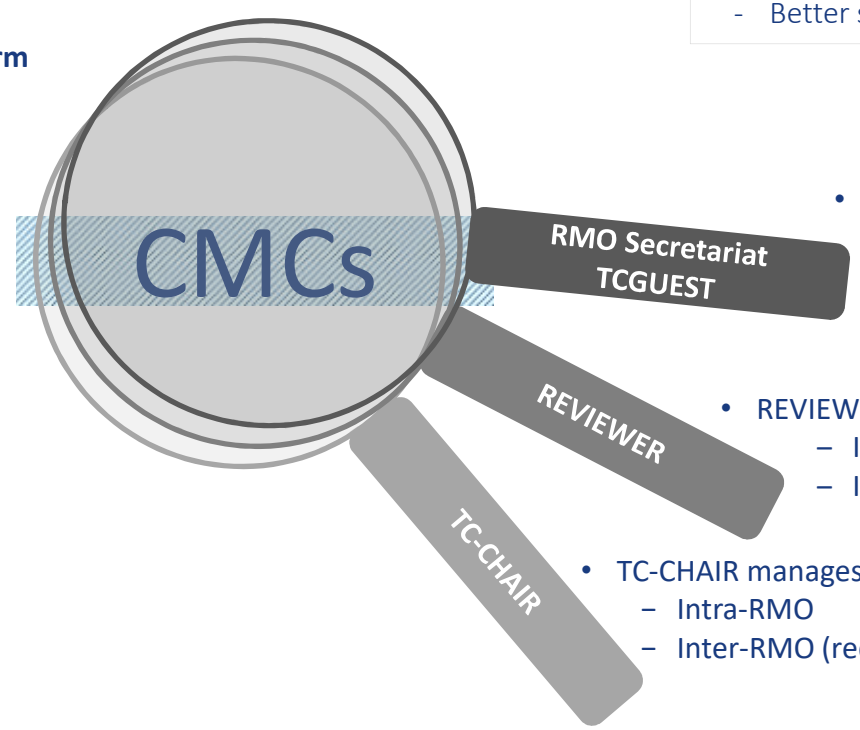
CIPM MRA review
KCDB 2.0 – *General concept*

Improved user experience:
- Faster review
- Tabulated results
- Numerical search
- Greater consistency
- Better statistics

- **Intra-RMO CMC review is integrated into the platform**
- **Review process and publication database combined**

– NMI/DI drafts CMCs directly onto the platform and communicates to TC-CHAIR for review

– No manual transfer of data for review
– No manual transfer of data for publication



- Monitor the CMC review process

- REVIEW of CMCs
  - Intra-RMO
  - Inter-RMO

- TC-CHAIR manages the review process:
  - Intra-RMO
  - Inter-RMO (reduced duplication)

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Global impacts of the CIPM MRA

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There are many benefits provided by metrology that are difficult to account for using a purely quantitative assessment…

It is important to understand that the importance of metrology extends well beyond economic benefits…

https://www.bipm.org/en/bipm/int/impact-studies.html

Impact and case studies related to metrology

KPMG Consulting

PUBLIC SERVICES

POTENTIAL ECONOMIC IMPACT OF THE CIPM MUTUAL RECOGNITION ARRANGEMENT

FINAL REPORT APRIL, 2002

governance. In addition, trade data is presented to highlight the 'order of magnitude' potential impact that reducing technical barriers to trade would have for MRA signatory nations.

The key findings of the Study are as follows:

- Based on information gathered in the NMI Survey, it is reasonable to suggest that the MRA results in a notional saving of approximately 75k € in the cost of establishing and maintaining mutual recognition with one other NMI compared with the cost of the same thing pre-MRA.
- The results also indicate that the total notional saving to the community of NMIs is in the order of 85M € per annum, at present levels of cost and comparison activity. The associated conclusion is that the cost of establishing mutual recognition on the scale currently achieved would have been prohibitively expensive in the absence of the centrally coordinated MRA.
- A conservative order-of-magnitude estimate of the MRA's potential role in reducing technical barriers to trade internationally is presented, suggesting that the MRA might confer significant benefit to signatory nations. It is suggested further that strategies for realizing this potential be pursued by BIPM at the international level and by NMIs at the domestically.

Some FACTS

DSME, Korea – BP, USA

DSME offshore plant

- recalibration at NIST:
  US$ 1 million
- penalty of 2 month delay:
  US$ 10 million

Challenge

- Offshore plant order by an Oil Major, USA.
- Calibration traceable to NIST required.

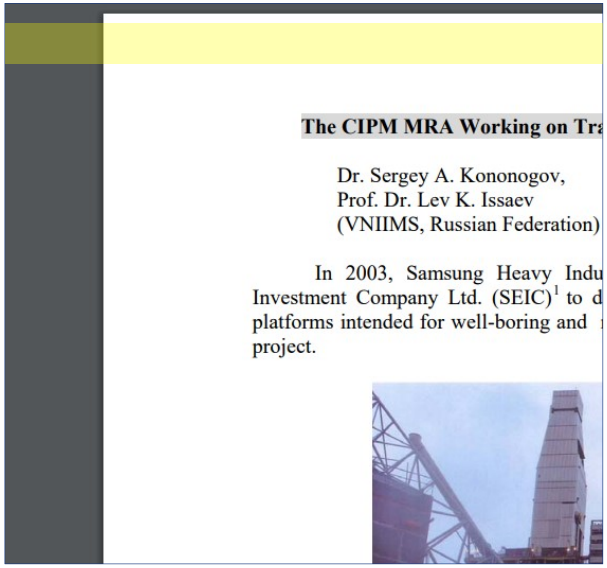
Solution

- DSME, accredited by KOLAS, a member of ILAC MRA.
- DSME keeps traceability of its standards traceable to KRISS.
- KRISS and NIST are all signatory to the CIPM MRA.
- NIST confirmed that "traceability to KRISS is equivalent to traceability to NIST" via the CIPM MRA.

Benefit

- US$ 11 million saved
- US$ 30,000 Invested for calibration

Impact and case studies related to metrology



The CIPM MRA Working on Tra

Dr. Sergey A. Kononogov,
Prof. Dr. Lev K. Issaev
(VNIIMS, Russian Federation)

In 2003, Samsung Heavy Indu
Investment Company Ltd. (SEIC)[1] to d
platforms intended for well-boring and
project.

The Protocol has finally arranged an opportunity for acceptance of calibration results performed on site as the primary verification for the loops (channels), satisfying the requirements of the State metrological control in the Russian Federation and allowing Samsung Heavy Industries to fulfill its duties to deliver the platforms in time. As a result of the collaboration, the company was able to save an estimated US $ 1.1 B in costs.

[Written: June 2008]

The CIPM MRA signatories are acceptable to the Federal Aviation Administration

Safety Assurance System: Inspect a Part 145 Repair Station's Tools and Equipment

B. Review Calibration/Record. Review the part of the RSM or QCM describing the system and the procedures used for calibrating MTE.

1) The ASI should verify:

a) The repair station is calibrating MTE per intervals, procedures, and the system described in the RSM or QCM.

b) All MTE are calibrated and traceable to a standard acceptable to the Federal Aviation Administration (FAA), to include those recommended by the manufacturer, and the National Institute of Standards and Technology (NIST) or other national authority.

NOTE: The part 145 rule states that tooling used to make airworthiness determinations must be calibrated to a standard acceptable to the FAA. Those standards may be derived from the NIST, to a standard provided by the equipment manufacturer, or other recognized standards. The International Bureau of Weights and Measures (BIPM) is a recognized authority that maintains a global list of National Metrology Institutes (NMI). The BIPM Web site lists the NMI signatory countries that participate in the International Committee for Weights and Measures (CIPM). The CIPM Mutual Recognition Arrangement (MRA) signatories are acceptable to the FAA and can be found at http://www.bipm.org. There are many accreditation bodies that provide third-party laboratory accreditation. The International Laboratory Accreditation Cooperation (ILAC) establishes a global network for accreditation of laboratory and testing facilities. Signatories to the ILAC MRA are in full conformance with the standards of International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC) 17011. ILAC MRA signatories are acceptable to the FAA and can be found at http://www.ilac.org. Accredited laboratories have already established traceability through the assessment and accreditation process under ISO/IEC 17025. No further documentation is required once traceability is confirmed to a recognized accredited laboratory. Additionally, for foreign equipment, the standard of the country of manufacture may be used if acceptable to the Administrator.

European Aviation Safety Agency

Conclusion

Metrological traceability is important because it gives confidence and assurance that measurement results are ‘right’

Metrological traceability is realized through a documented unbroken chain of calibrations.

NMIs demonstrate measurement capabilities through participation in the CIPM and RMO Key or Supplementary comparisons

The CIPM MRA provides easy access to transparent, science underpinned, peer reviewed calibration and measurement capabilities of the NMI/DI community (but not the only solution)

Thank you

andy.henson@bipm.org

Bureau International des Poids et Mesures

www.bipm.org