Capacity Building & Knowledge Transfer

CIPM MRA and its role in the QI

Andy Henson

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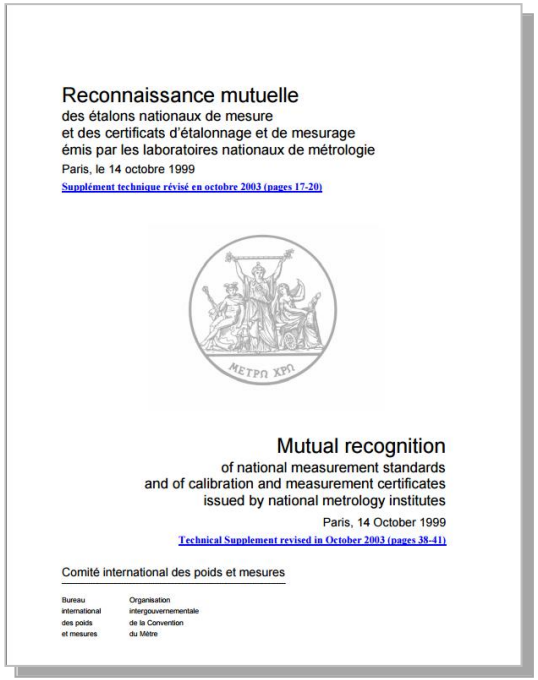
BIPM

Bureau International des Poids et Mesures

Focuses on the importance of the CIPM MRA. Requirements will be covered during later presentations.



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)

ΜΕΤΡΩ ΧΡΩ

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.

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Capacity Building & Knowledge Transfer

01 - The origins of the CIPM MRA

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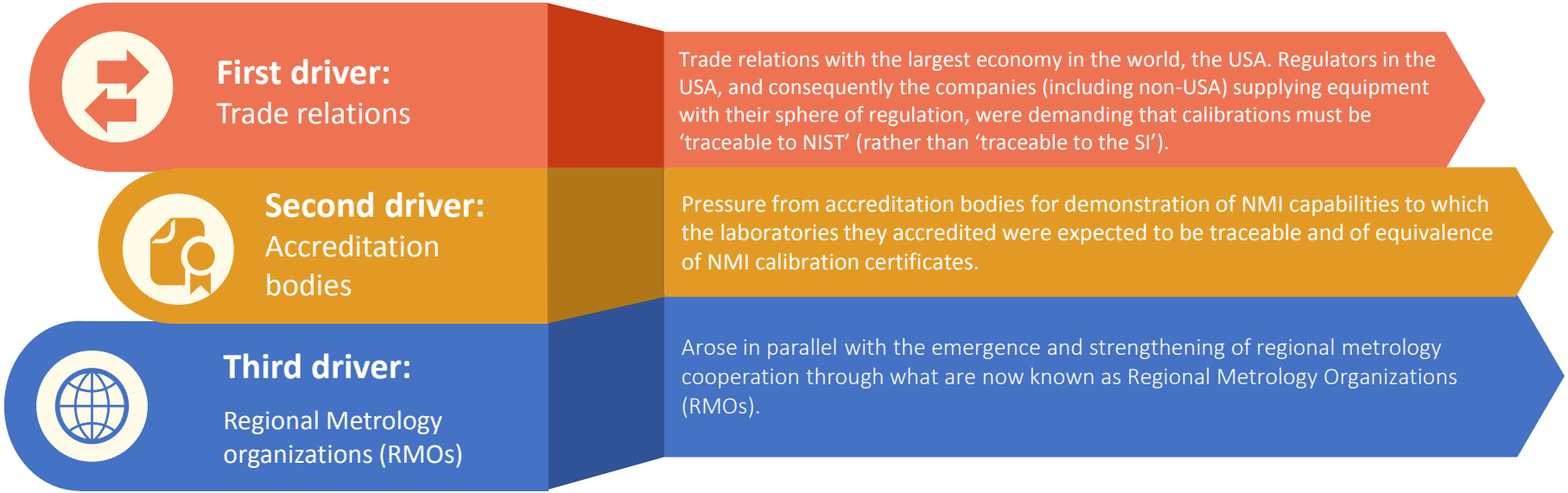
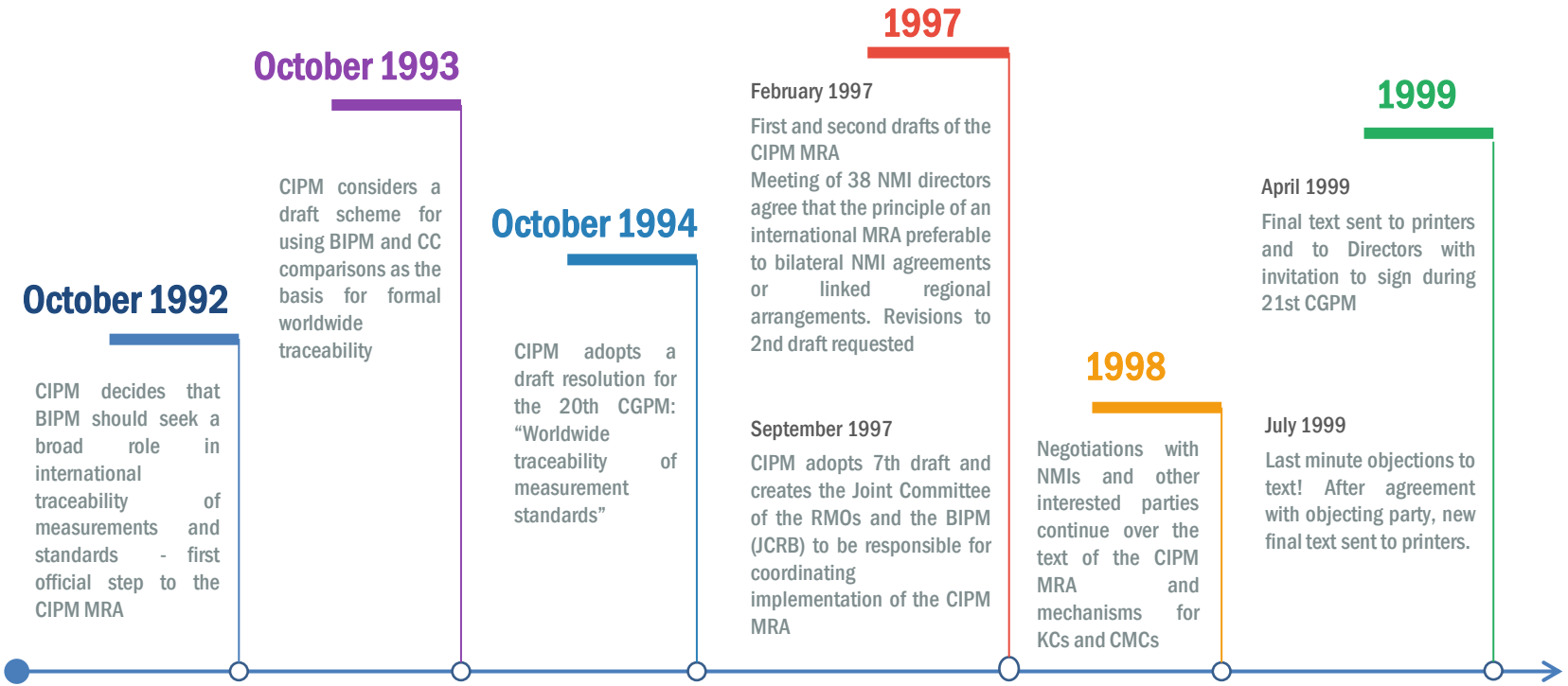
The origins of the CIPM MRA

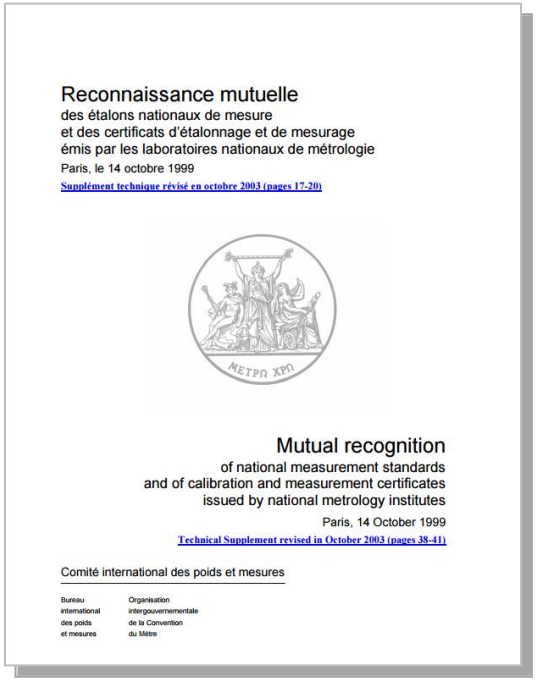
The backdrop to the CIPM MRA was the major increase in world trade triggered by the General Agreement on Tariffs and Trade. The Uruguay Round — 1986-1994— led to the creation of the World Trade Organization (WTO). As fiscal barriers to trade were reduced, non-tariff barriers, and the need to address 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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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.

*In some cases, a NMI or other designated institute, either for unexpected reasons or on a continuing basis, may sometimes **subcontract** a small part of its calibration, measurement or CRM certification activities under the CIPM MRA to another competent laboratory with which it collaborates and which acts as a subcontractor.*

Recognition…

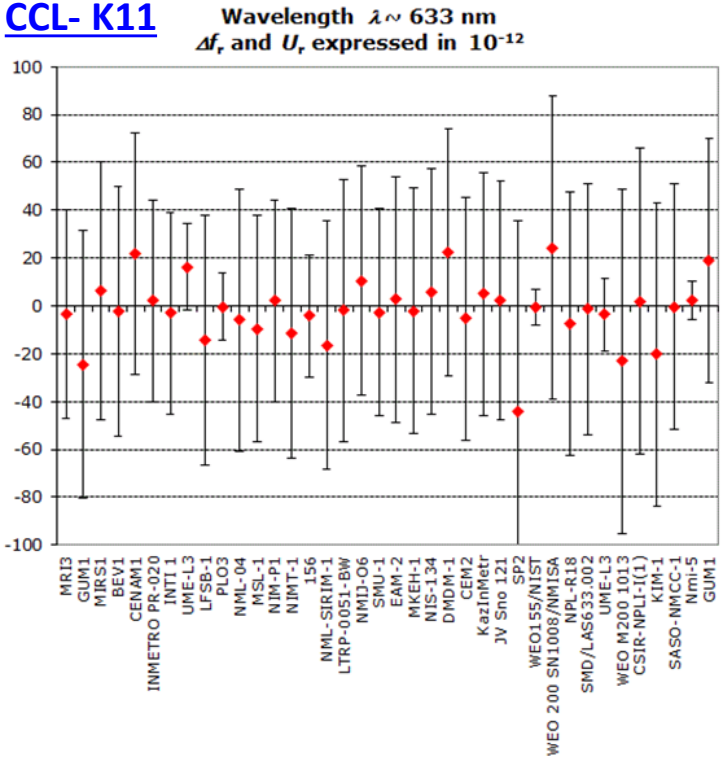
Participating NMI/DI agrees to:

- **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

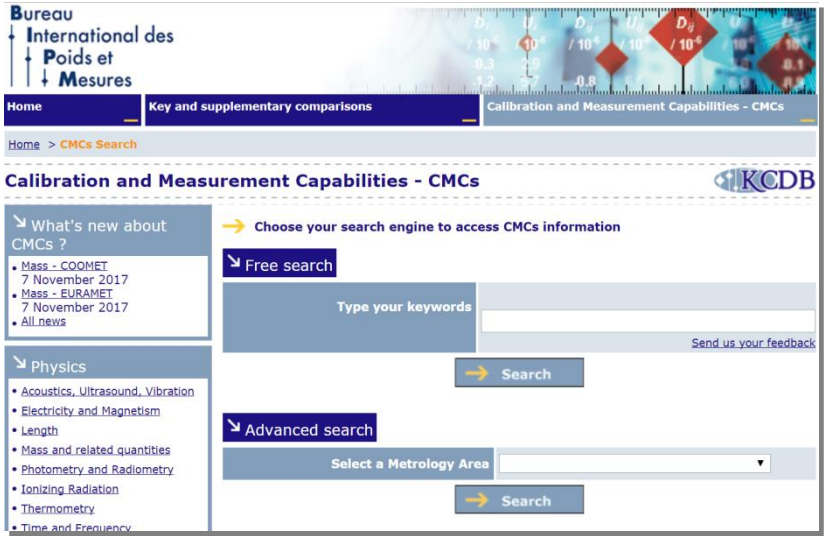
Degree of equivalence of national standards

- 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.



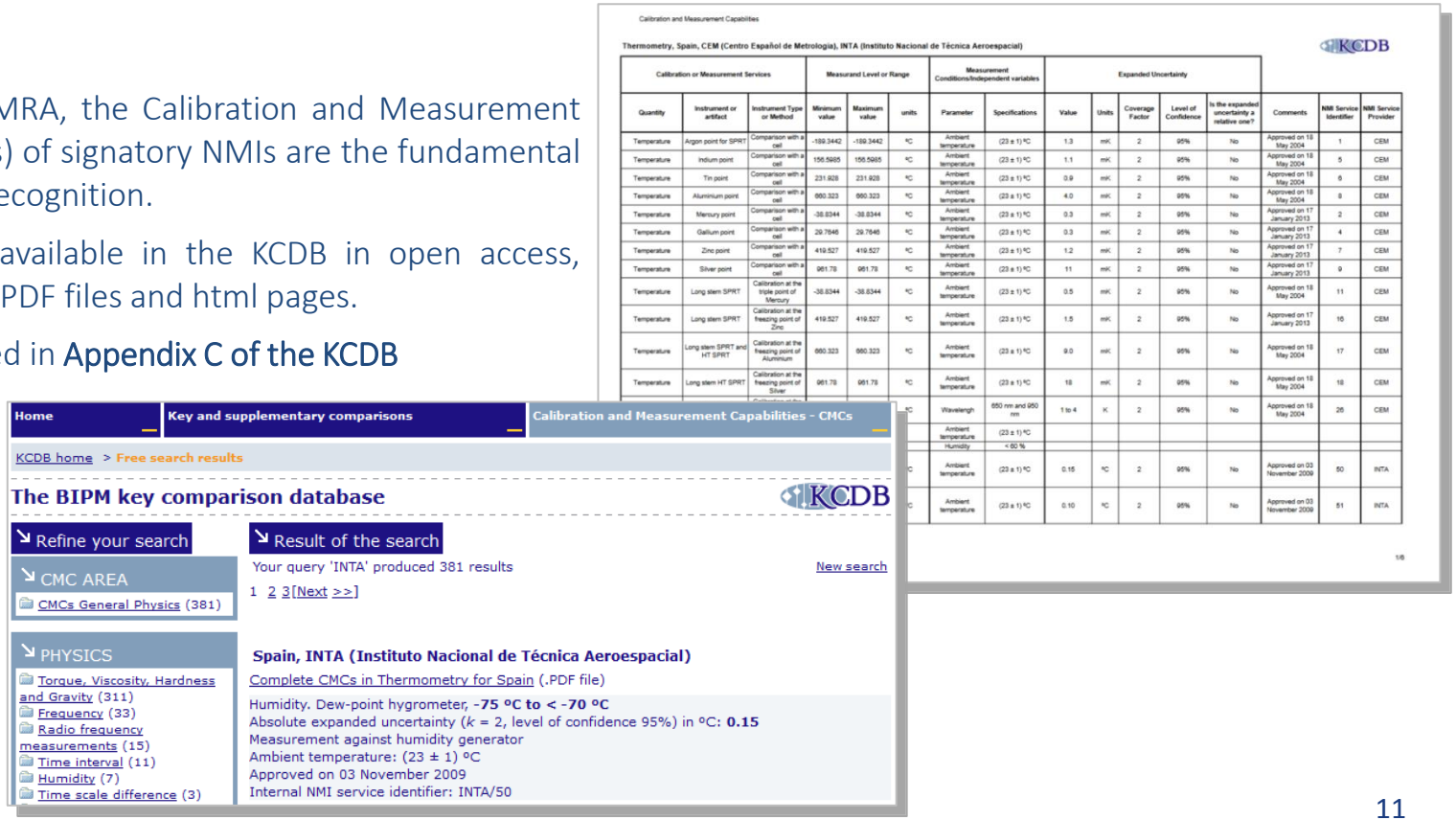
Validity of calibration and measurement certificates

- 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, the Calibration and Measurement Capabilities (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
					°C	Wavelengh	650 nm and 950 nm	1 to 4	K	2	95%	No	Approved on 18 May 2004	26	CEM
						Ambient temperature	(23 ± 1) °C								
						Humidity	< 60 %								
					°C	Ambient temperature	(23 ± 1) °C	0.15	°C	2	95%	No	Approved on 03 November 2009	50	INTA
					°C	Ambient temperature	(23 ± 1) °C	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
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Mutual recognition
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issued by national metrology institutes

Paris, 14 October 1999

Comité international des poids et mesures

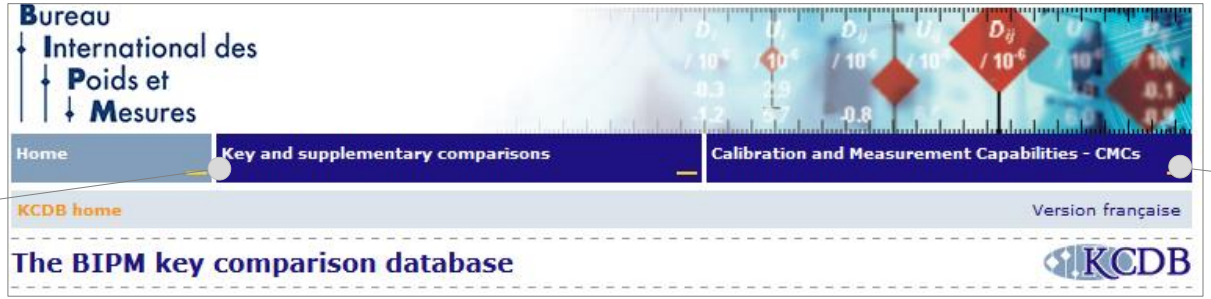
2 Scope of the arrangement

2.1 Participating national metrology institutes, listed in Appendix A, recognize the degree of equivalence of national measurement standards, derived from the results of key comparisons, for the quantities and values specified in Appendix B. This constitutes part one of the arrangement.

2.2 Participating institutes recognize the validity of calibration and measurement certificates issued by other participating institutes for the quantities and ranges specified in Appendix C. This constitutes part two of the arrangement.

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

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



EQUIVALENCE OF NATIONAL STANDARDS

ACCEPTANCE OF CERTIFICATES

Capacity Building & Knowledge Transfer

02 - Structure of the CIPM MRA

Key players

- *NMIs (& DIs)*
- *CIPM*
- *BIPM*
- *Consultative Committees of the CIPM (CCs), Working groups*
- *Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB)*
- *Regional Metrology Organizations (RMOs)*

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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

Chairman of the JCRB: Dr Martin Milton, the BIPM Director
Executive Secretary: *Mr Nikita Zviagin*
CIPM Secretary: *Dr James W. McLaren*

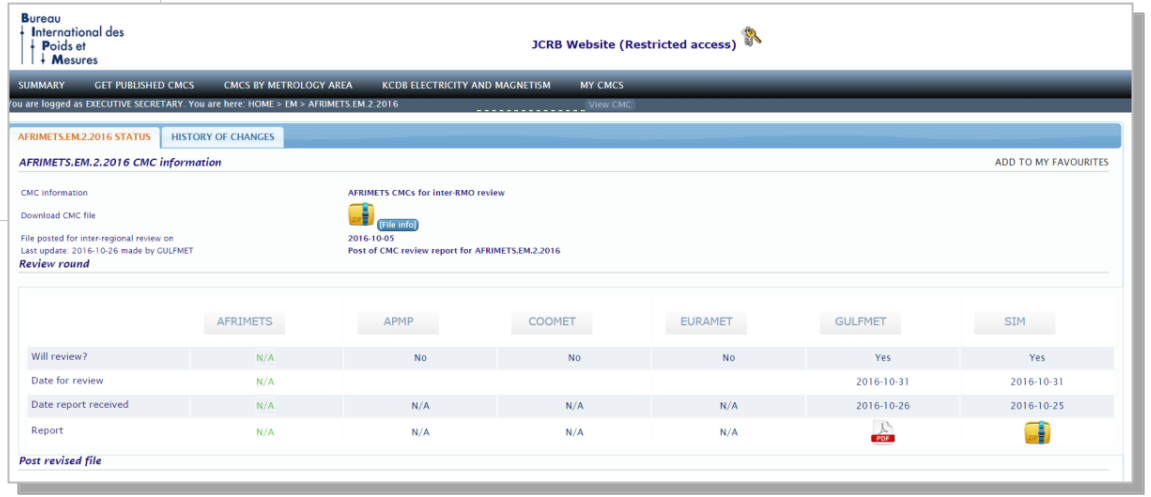
Current RMO representatives to the JCRB:
AFRIMETS - Dr Wynand Louw
APMP - Dr Toshiyuki Takatsuji
COOMET - Dr Pavel Neyezhmakov
EURAMET - Dr Beat Jeckelmann
GULFMET - Mr Saleh Al-Rumaih
SIM - Ing. Quim. Claudia Santo

- Representatives may bring up to 4 advisers

- 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 inter-regional 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.



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.

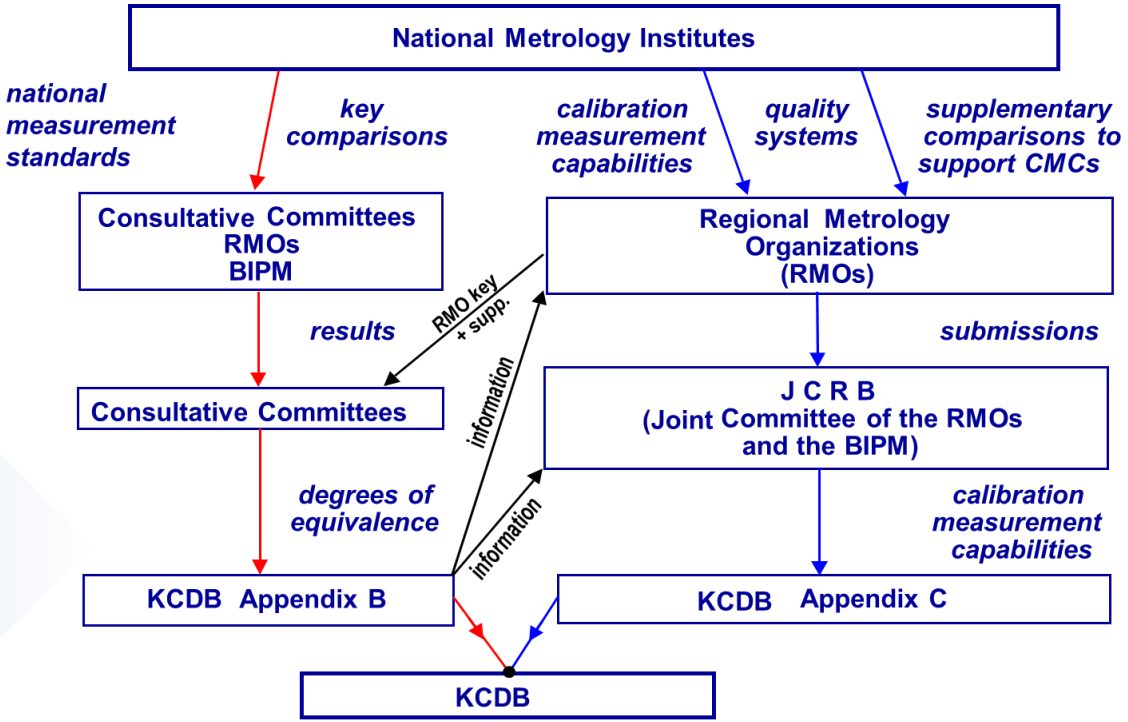
In particular, they:

- 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

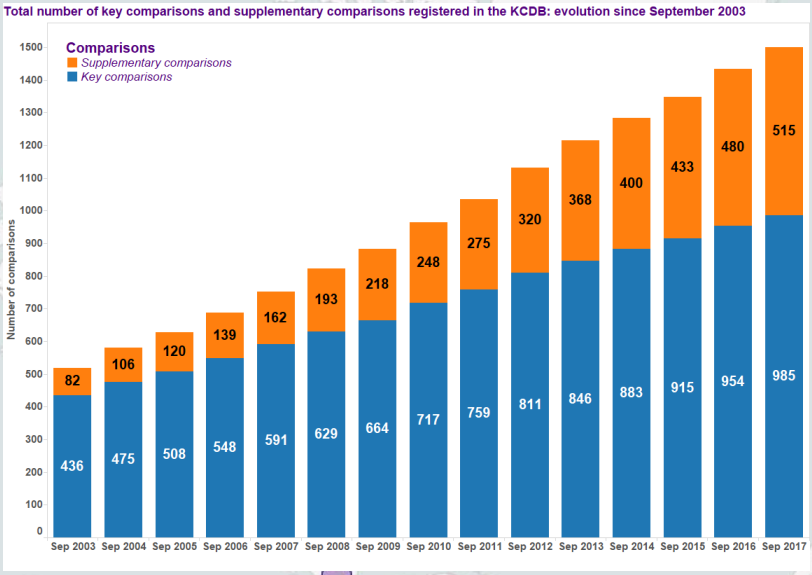
In recent years CC Presidents meet to share experience – in 2017 JCRB and CIPM agreed that each RMO should also send a representative(s) to that meeting.

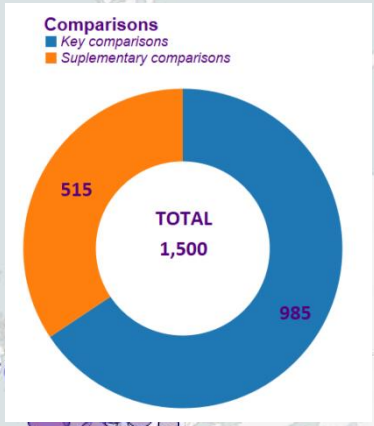


Capacity Building & Knowledge Transfer

03 – Global impact of the CIPM MRA

Bureau International des Poids et Mesures





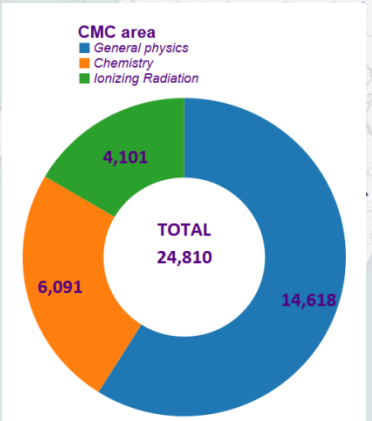
CIPM MRA today

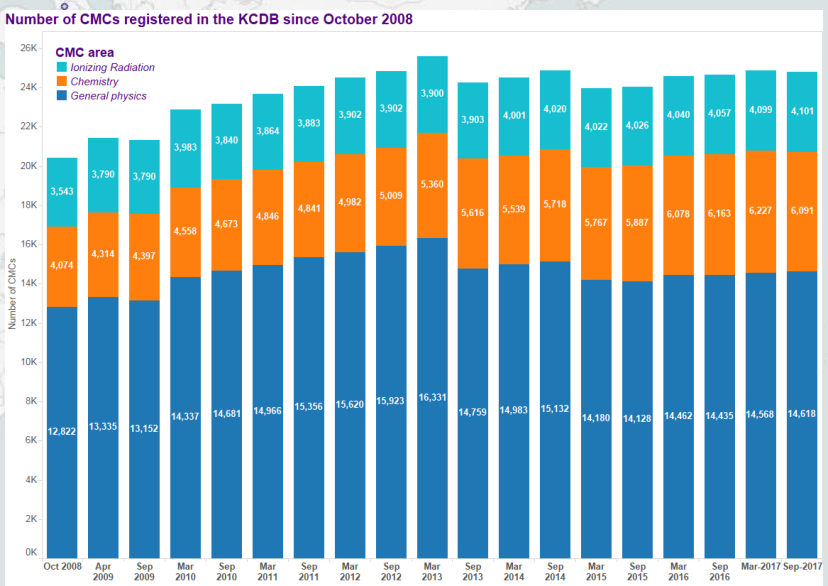
98 National Metrology Institutes
- *57 Member States*
- *41 Associates*

4 International organizations
(ESA, IAEA, JRC, WMO)

plus 156 Designated Institutes

Total: 258 Institutes





CIPM MRA *today* - 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

Mutual recognition
of national measurement standards
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issued by national metrology institutes

Paris, 14 October 1999

Comité international des poids et mesures

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***

*Today, the CIPM MRA provides **a primary source to identify internationally recognized national capabilities** within the NMI and wider metrology community. The underpinning science and the outcomes are openly available to all interested parties…*

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.

Bureau International des Poids et Mesures

ILAC P10:01/2013

laboratories that can demonstrate competence, measurement capability and traceability". For equipment and reference standards that must be calibrated, the ILAC policy is that they shall be calibrated by:

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.

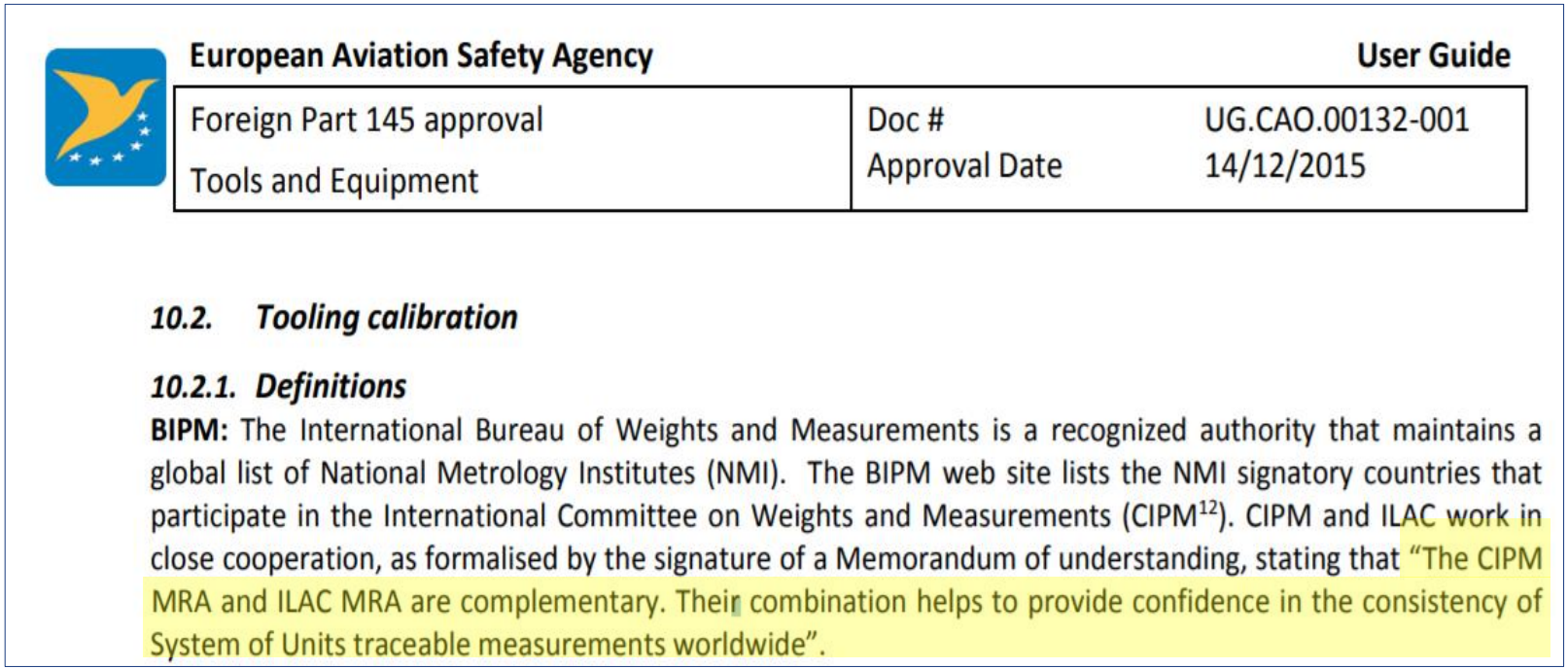
Note 1: Some NMIs may also indicate that their service is covered by the CIPM MRA by including the CIPM MRA logo on their calibration certificates, however the fixing of the logo is not mandatory and the BIPM KCDB remains the authoritative source of verification.

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

European Aviation Safety Agency



European Aviation Safety Agency **User Guide**

Foreign Part 145 approval Tools and Equipment	Doc # Approval Date	UG.CAO.00132-001 14/12/2015

10.2. Tooling calibration

10.2.1. Definitions

BIPM: The International Bureau of Weights and Measurements 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 on Weights and Measurements (CIPM[12]). CIPM and ILAC work in close cooperation, as formalised by the signature of a Memorandum of understanding, stating that "The CIPM MRA and ILAC MRA are complementary. Their combination helps to provide confidence in the consistency of System of Units traceable measurements worldwide".

ISO/IEC FDIS 17025:2017

Annex A

A.3 Demonstrating metrological traceability

A.3.1 Laboratories are responsible for establishing metrological traceability in accordance with this document. Calibration results from laboratories conforming to this document provide metrological traceability. Certified values of certified reference materials from reference material producers conforming to ISO 17034 provide metrological traceability. There are various ways to demonstrate conformity with this document, i.e. third party recognition (such as an accreditation body), external assessment by customers or self-assessment. Internationally accepted paths include, but are not limited to the following.

a) Calibration and measurement capabilities provided by national metrology institutes and designated institutes that have been subject to suitable peer-review processes. Such peer-review is conducted under the CIPM MRA (International Committee for Weights and Measures Mutual Recognition Arrangement). Services covered by the CIPM MRA can be viewed in Appendix C of the BIPM KCDB (International Bureau of Weights and Measures Key Comparison Database) which details the range and measurement uncertainty for each listed service.

b) Calibration and measurement capabilities that have been accredited by an accreditation body subject to the ILAC (International Laboratory Accreditation Cooperation) Arrangement or to Regional Arrangements recognized by ILAC have demonstrated metrological traceability. Scopes of accredited laboratories are publicly available from their respective accreditation bodies.

A.3.2 The Joint BIPM, OIML (International Organization of Legal Metrology), ILAC and ISO Declaration on Metrological Traceability provides specific guidance when there is a need to demonstrate international acceptability of the metrological traceability chain.

Joint BIPM, OIML, ILAC and ISO declaration

BUREAU INTERNATIONAL DES POIDS ET MESURES

ORGANISATION INTERNATIONALE DE METROLOGIE LEGALE

INTERNATIONAL LABORATORY ACCREDITATION COOPERATION

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

JOINT

BIPM, OIML, ILAC AND ISO

DECLARATION ON

METROLOGICAL TRACEABILITY

9th November 2011

Michael Kühne
Director of the BIPM

Stephen Patoray
BIML Director

Peter Unger
ILAC Chair

Robert Steele
ISO Secretary General

2. The importance of metrological traceability

We assert that international consistency and comparability of measurements are required if the missions of our Organizations are to be achieved. In particular, measurement comparability is an essential characteristic of an international r
be universally accepted. This internationa
measurement results are traceable to interna
are the International System of Units (SI),
results should be traceable to other intern
and reference standards established by the

The BIPM, OIML, ILAC, and ISO endorse the following recommendations:

- in order to be able to rely on their international acceptability, calibrations should be performed
  - in National Metrology Institutes who should normally be signatories to the CIPM MRA[3] and have CMCs published in the relevant areas of the KCDB[4] or
  - in laboratories accredited by accreditation bodies which are signatories to the ILAC Arrangement[5];
- measurement uncertainty should follow the principles established in the GUM;
- the results of the measurements made in accredited laboratories should be traceable to the SI[2];
- NMIs providing traceability for accredited laboratories should normally be signatories to the CIPM MRA and have CMCs published in the relevant areas of the KCDB;
- within the OIML's MAA, accreditation should be provided by bodies which are signatories to the ILAC Arrangement and the above policies on traceability to the SI should be followed;

The above principles should be used whenever there is a need to demonstrate metrological traceability for international acceptability.

3. Use of this Declaration

These principles underpin a world measurement system which provides a robust, internationally accepted framework within which users can have confidence in the validity and acceptability of measurements results. BIPM, OIML, ILAC and ISO strongly urge legislators and regulators to refer to the Arrangements described earlier in this Declaration and also to accept measurement results made within this system, thereby helping avoid technical barriers to trade. We also invite interested parties to endorse these principles and to make use of them in their own work.

https://www.bipm.org/utils/common/pdf/BIPM-OIML-ILAC-ISO_joint_declaration_2011.pdf

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 BP,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

Who benefits from the CIPM MRA?

Participating NMIs and Designated Institutes

- *Benefit from coordination, greater rigour and increased acceptance of capabilities*

Those NMIs wanting to hold a national standard that is not primary

- *able to identify which NMIs can provide the traceability to the SI*

The accredited laboratory community

- *able to identify which NMIs can provide the traceability to the SI*
- *easily able to demonstrate valid traceability route to accreditors*

Industry

- *able to source top level measurement capability*

Regulators

- *who need a technical basis to underpin acceptance of non national calibrations*

Increased *collaboration*

In the words of the RMOs

- "NMIs are deeply engaged in international activities: comparisons, meetings, training, technical visits, peer reviews, resulting in a tightly knit community of peers with heightened awareness of common issues and practices, and leading to a truly globalized metrology system."

Improved *capabilities*

In the words of the RMOs

- “The agreement has, without doubt, driven up the quality of the measurement services offered by the NMIs, as evidenced by the improving performance in key comparisons over the years.”
- “Scientific metrology can and should be held to the highest standards of excellence and transparency. “

Enhanced *awareness*

In the words of the RMOs

- "The KCDB provides a crucial resource for the accredited calibration and testing laboratories who must demonstrate internationally accepted traceability."

- "The MRA has enhanced the relationship and recognition of metrology with the other pillars of Quality Infrastructure at national, regional and international levels."

Conclusion

The main achievements of the CIPM MRA are:

- The potential removal of technical barriers to trade
- The mutual acceptance of calibration certificates issued by NMIs and DIs
- The mutual confidence through a peer reviewed system, underpinned by measurement comparisons
- Worldwide harmonized realisations of the SI units and measurement standards
- Provision of traceability routes
- Improved measurement capabilities of many NMIs and DIs (incl. the establishment of the tools to monitor and to quantify these capabilities).

Capacity Building & Knowledge Transfer

Thank you

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