



## TOWARDS MUTUAL RECOGNITION OF METROLOGICAL COMPETENCE

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## Imprint

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This guide is intended to give an insight into the steps necessary when a national metrology institute wishes to gain mutual recognition of its national measurement standards and of calibration and measurement certificates under the Mutual Recognition Arrangement of National Measurement Standards and of Calibration and Measurement Certificates issued by National Metrology Institutes (CIPM MRA). The formal, up to date and authoritative guidance is that issued by the CIPM and/or the Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB) available from the BIPM on its website <http://www.bipm.org>, specifically those pages addressing the CIPM MRA, at <http://www.bipm.org/en/cipm-mra/>

# 1. Why have internationally recognized measurement capabilities?

The expansion of international trade in the late 1800s created the need and will to establish internationally consistent measurements. The signing of the Metre Convention in 1875 established the International Bureau of Weights and Measures (BIPM), and signalled the beginning of an internationally unified system of measurements. The BIPM and its Member States continue to promote and develop what is now the International System of Units (SI), which has been widely adopted throughout the world. Continual improvements to standards of living have led to increased demand for high quality products, safer food and environmentally sound technologies. This in turn has led to higher expectations and requirements for products and services and the associated technical regulations have become an increasing obstacle to free trade.

Technical barriers to trade (TBTs) are the result of different technical regulations and conformity assessment procedures in different markets. An exporter of fruit and vegetables, for example, can only deliver products which conform to threshold concentrations for pesticides allowed in the import market. A motor vehicle can only be introduced into the market if the admissible level of emissions is not exceeded, while many products such as electronic devices must meet specific technical requirements to ensure the safety of the user.

An important step towards the reduction of technical barriers to trade is mutual recognition of the procedures and certificates that are used in conformity assessments to prove compliance with various technical regulations and standards. However, mutual recognition of conformity assessment procedures and certificates is impossible without a reliable technical basis, i.e. reliable and accepted measurements and analyses to demonstrate compliance. Internationally recognized metrological competence in a country is fundamental to guarantee reliable testing and analyses, and lays the foundation for international acceptance of the results.

The inability to comply with market requirements and a lack of internationally accepted local proof of compliance restricts the ability of developing countries to attract inward investment. There is little point in establishing a factory if the goods it produces do not meet, or cannot demonstrate that they meet, the expectations of the global market. Thus the existence of internationally recognized metrological competence within a country can positively influence investment decisions.

However, not all countries need the same level of metrological services. The required competence depends crucially on economic demands and on the goods and services produced. It is reasonable and wise to focus on those competencies best serving a country's economic needs. Independent of the level of accuracy, international recognition of metrological competence is indispensable to participation in free trade.

This document describes how mutual recognition of metrological competence can be achieved and the conditions which must be met by an economy for it to be recognized by others as a reliable trading partner.

## 2. Building mutual recognition of measurement capabilities

In 1999, the International Committee for Weights and Measures (CIPM) addressed the need for a mechanism to allow international recognition of technical competence in calibrations and measurements by establishing the CIPM Mutual Recognition Arrangement (CIPM MRA): An arrangement for mutual recognition of national measurement standards and of calibration and measurement certificates issued by national metrology institutes (NMIs). In March 2011, directors of the national metrology institutes from 48 Member States, 32 Associates and 3 international organizations had signed the CIPM MRA. The BIPM and the "Joint Committee of the Regional Metrology Organizations and BIPM" (JCRB) coordinates the implementation of the CIPM MRA.

The objectives of the CIPM MRA are:

- To provide international recognition of national standards.
- To provide confidence in the measurement capabilities of participating laboratories for all users, including the regulatory and accreditation bodies.
- To provide the technical basis for acceptance of measurements used to support the trade of goods and services.

The core element in the implementation of the CIPM MRA is the recognition of a national metrology institute's calibration and measurement capabilities (CMCs). The recognition of these capabilities is based on a detailed and rigorous review process. The data on the capabilities is then published in a single, world-wide publicly available database maintained by the BIPM, known as the "key comparison database" (KCDB). For each specific calibration or measurement service the entries in the key comparison database show the measurand, the range, the method and the measurement uncertainty that the national metrology institute provides to its customers.

Only those calibration and measurement certificates for which the technical competence is attested through an entry of a calibration and measurement capability in the key comparison database are recognized within the scope of the CIPM MRA. The recognition of the calibration and measurement capability is not tied to achieving a specific level of measurement uncertainty: Each national metrology institute (and designated laboratory) declares the calibration and measurement capabilities – including the uncertainty – corresponding to its particular competence and equipment.

### 3. The steps to mutual recognition

Within the CIPM MRA, certain requirements have to be met by the applicant to obtain approval of calibration and measurement capabilities:

- a) The institute's home country is a Member of the BIPM or a State Associate to the General Conference on Weights and Measures (CGPM).
- b) The national metrology institute is a signatory of the CIPM MRA.
- c) The national metrology institute (and any additional designated institutes in countries with a dispersed national measurement system) can prove traceability to the International System of Units (SI).
- d) The national metrology institute has proven technical expertise in the field of the submitted calibration and measurement capabilities.
- e) The quality system of the national metrology institute is reviewed and approved by the responsible region metrology organization (RMO).

#### *a.1) Becoming a Member of the International Bureau of Weights and Measures (BIPM)*

The procedure to become a party to the Metre Convention (Member of the BIPM) reflects the fact that the Metre Convention is a diplomatic treaty. The government of the State wishing to accede the Metre Convention formally notifies the Minister of Foreign and European Affairs of the French Republic of its intent by letter delivered through its embassy in Paris. It is not sufficient for the national metrology institute or sponsoring Ministry alone to make the approach directly, although contact beforehand by the national metrology institute with the BIPM helps ensure that the process runs smoothly. The BIPM can advise on the drafting of such letters and the practical aspects of application. Details describing how to become a Member State are available on the BIPM's website.

Amongst various advantages and prerogatives conferred on them, Members of the BIPM benefit from scientific exchanges and transfer of knowledge through participation in the activities of the consultative committees. The BIPM's laboratories provide free calibration services exclusively to its members.

#### *a.2) Becoming an Associate of the General Conference on Weights and Measures (CGPM)*

The category of Associate of the CGPM was created to facilitate participation in the CIPM MRA for States that are not yet in a position to benefit from full membership of the BIPM. Associate status is a transitional arrangement, with Associates becoming full Members when their metrological capability is sufficiently developed. The annual subscription fee for Associates is significantly lower than the contribution for Members, however, participation in the consultative committees and access to BIPM calibration services is exclusively for Member States. Associates may be invited as observers to meetings of the General Conference on Weights and Measures.

Application to become an Associate should be notified to the BIPM via the applicant State's embassy in Paris. Details describing how to become an Associate can be found on the BIPM website, and the BIPM can, on request, provide one-to-one guidance.

#### *b) Signing the CIPM MRA*

Signing of the CIPM MRA is open to the national metrology institute from those States that have acceded to the Metre Convention (Members of the BIPM) and Associates of the General Conference on Weights and Measures. Unlike membership of the BIPM, the CIPM MRA is not a treaty, it is an arrangement between national metrology institutes and they are the signatories. In some countries, there may be more than one institution holding national standards for different units. In this case the CIPM MRA is signed by a single institute, which is granted signatory status by the appropriate authority in the country. The other institutes, known as designated institutes (DIs) participate through the signatory and their names are attached to the CIPM MRA document. The signatory is usually the national metrology institute.

### ***c) Establishing traceability to the International System of Units (SI)***

A national metrology institute or a designated institute has two choices for establishing the traceability of its national standards to the International System of Units (SI):

- via a primary realization or representation of the unit concerned.
- via another national metrology institute or designated institute having relevant calibration and measurement capabilities with appropriate uncertainty published in the key comparison database.

Establishing traceability to the International System of Units via any accredited calibration laboratory that is not a national metrology institute or a designated institute is not sufficient within the CIPM MRA. There are some cases where traceability to the International System of Units is not possible, e.g. in some areas of chemistry and biology. In these cases, it is the decision of the appropriate consultative committee to establish which paths of traceability are acceptable. For laboratory medicine the BIPM maintain a database of higher order reference materials and reference measurement procedures on behalf of the Joint Committee for Traceability in Laboratory Medicine <http://www.bipm.org/en/committees/jc/jctlm/http://www.bipm.org/en/committees/jc/jctlm/JCTLM>.

### ***d) Proven technical expertise in the field of the submitted calibration and measurement capabilities (CMCs)***

Technical underpinning of the calibration and measurement capabilities concerned is achieved mainly through participation in comparisons. Comparisons are a series of measurements of the same artefact, performed by different institutes to compare the performance of the participating institutes. In exceptional cases, for example where comparison results are not yet available or comparisons are not possible, other evidence demonstrating technical competence can be accepted. Typically such evidence includes scientific publications, active participation in research projects of the respective regional metrology organisation, or on-site peer-assessment reports.

Calibration and measurement capabilities can be underpinned by key or supplementary comparisons, initiated either by the BIPM, a consultative committee, a responsible regional metrology organisation or a national metrology institute. In all cases, registration of the comparison in the key comparison database is essential. Participation is generally limited to national metrology institutes and designated institutes and depends on the type of comparison.

Unlike proficiency testing schemes, which are used to underpin accreditation, the results of a comparison to prove calibration and measurement capabilities in the context of the CIPM MRA are published in the key comparison database and are available to the public. More details on the procedures for comparisons can be found on the BIPM website.

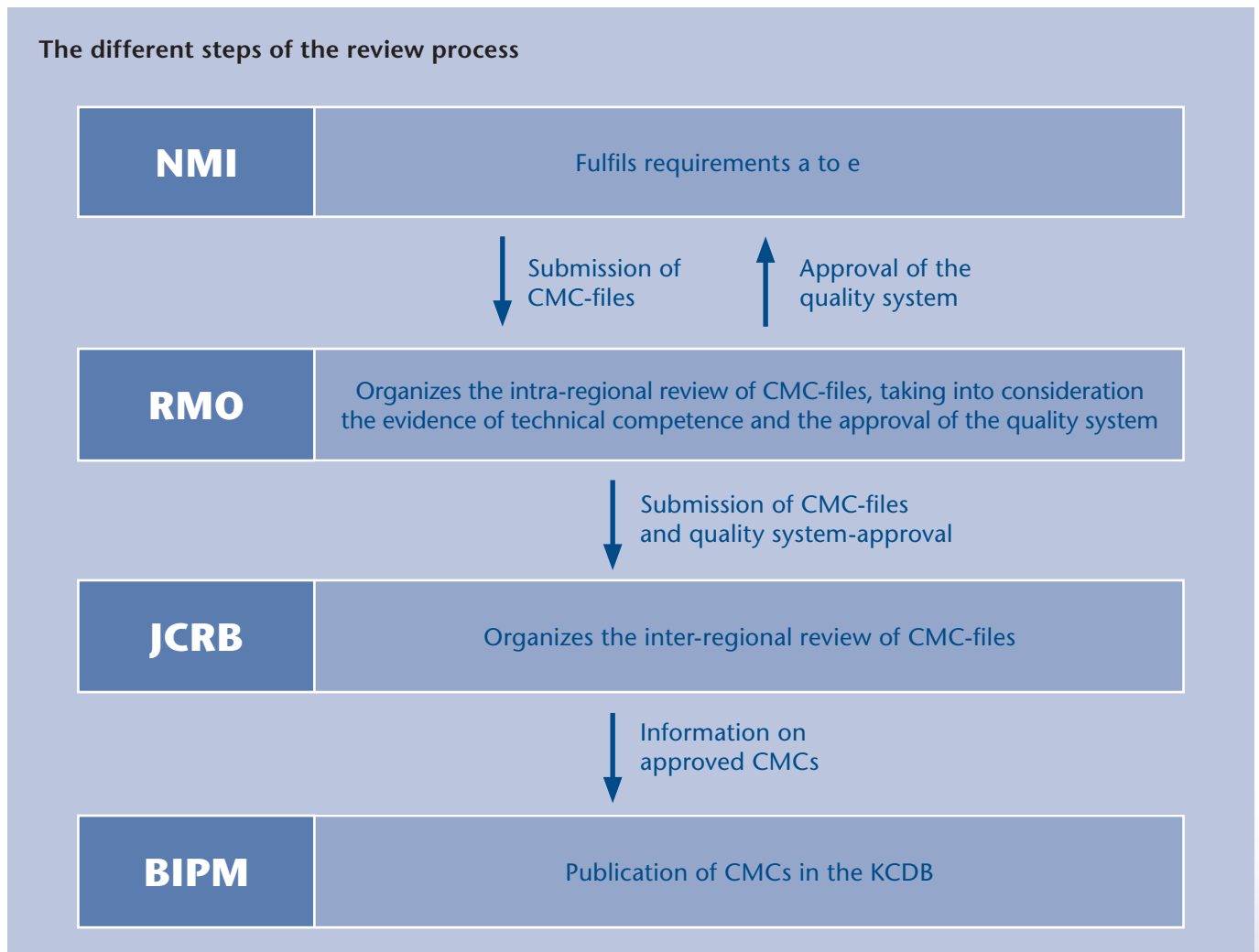
### ***e) Review and approval of the quality system***

The CIPM MRA requires the participating national metrology institute and designated institute to establish and maintain a quality system. The quality system of a national metrology institute or designated institute should comply with ISO/IEC 17025 (ISO guide 34 for national metrology institutes that produce certified reference materials). All laboratories with declared calibration and measurement capabilities must demonstrate operation of an appropriate quality system.

It is the role of the responsible regional metrology organisation to review and approve the quality system operated by their members and to report on their acceptance to the Joint Committee of the Regional Metrology Organizations and the International Bureau of Weights and Measures (JCRB).

Detailed procedures for the review of quality systems vary slightly in detail between the different responsible regional metrology organisations. However, all the procedures follow general guidelines established by the International Committee for Weights and Measures and are considered equivalent.

When all five requirements (a to e) are fulfilled, the calibration and measurement capabilities are submitted and the review process starts. This process involves the following:



### 1. Submission of calibration and measurement capabilities (CMCs)

When mutual recognition is requested, the results of comparisons and other technical information are used to fill in a BIPM excel template (CMC-file) for each metrology area. The scope of a submitted calibration and measurement capability does not have to correspond exactly to the comparison. A broad group of calibration and measurement capabilities can be underpinned by the same comparison if approved by the respective consultative committee. The calibration and measurement capabilities-file is submitted to the chairperson of the responsible regional metrology organisation technical committee for the area concerned.

### 2. Intra-regional review of calibration and measurement capabilities (CMCs)

The claimed calibration and measurement capabilities undergo an intra-regional review, that is a review within the regional metrology organization to which the national metrology institute is affiliated. The procedure for intra-regional review is established by each responsible regional metrology organisation following the guidelines of the Joint Committee of the Regional Metrology Organizations and the BIPM. Thus the practices may vary in the detail but all achieve the same outcome. The objective is to ensure that the claimed calibration and measurement capabilities are justified and correspond to the technical expertise of the laboratory prior to their onward submission for review by the other regions.

### ***3. Inter-regional review of calibration and measurement capabilities (CMCs)***

When the calibration and measurement capabilities have been approved at a regional level, the chairperson of the respective technical committee of the responsible regional metrology organisation submits a request for the inter-regional review to the Joint Committee of the Regional Metrology Organizations and the BIPM. The submission, including the excel-files, must be accompanied by a declaration by the chair of the responsible regional metrology organisation's quality systems working group indicating that the quality system meets the requirements of ISO/IEC17025 and ISO guide 34 if appropriate.

The inter-regional review is conducted by technical committees (TC) or working groups (WG) of another regional metrology organisation in the metrological area where mutual recognition is requested. The chairpersons of the technical committee/working group responsible for the review may involve representatives of other national metrology institutes if they are members of the technical committees/working groups. Participation in the review process is optional but at least one other regional metrology organisation has to take part.

Following submission, the technical committee/working group chairs from the different regional metrology organisations may comment on the submitted data. Based on the comments received a revision is submitted for approval by all regional metrology organisations participating in the review process.

The entire review process is coordinated via an interactive website maintained by the BIPM and all information on the process is available to all participants in the CIPM MRA. This transparent process ensures that all national metrology institutes participating in the CIPM MRA have the opportunity to review the data before approval and publication.

### ***4. Publication of the calibration and measurement capabilities (CMCs) in the key comparison database (KCDB)***

Following successful inter-regional review and approval, the calibration and measurement capabilities are published by the BIPM in the key comparison database. This database is maintained by the key comparison database office at the BIPM and is available on the BIPM website (<http://kcdb.bipm.org/>). The database is freely available for public access. It provides information on the calibration and measurement capabilities of national metrology institutes which are available to customers, thereby maximizing transparency concerning the capabilities of national metrology institutes.

In cases where any requirements cease to be fulfilled, calibration and measurement capabilities entries are removed from the key comparison database.

The transparent and participative review process for any calibration and measurement capability entry in the key comparison database is a reliable and mutually recognized technical foundation on which economic activity can be built. Trading partners are able to fulfil the requirements of import markets and investors can rely on a proven level of technical infrastructure for their products. Participation in the CIPM MRA and achieving recognized calibration and measurement capabilities at whatever level facilitates integration into the world economy.

### Overview: Stages to mutual recognition of calibration and measurement capabilities

	Stage	conditions	advantages
1a*	<b>Associate of the CGPM</b>	<ul style="list-style-type: none"> <li>• Payment of annual subscription</li> <li>• Member of a RMO</li> </ul>	<ul style="list-style-type: none"> <li>• Participation in the CIPM-MRA is possible</li> <li>• Participation in regional comparisons is possible (and required for participation in CIPM MRA)</li> </ul>
1b	<b>Member of the BIPM</b>	<ul style="list-style-type: none"> <li>• Payment of full contribution (plus a "one off" entry fee equal to the first year contribution)</li> </ul>	<ul style="list-style-type: none"> <li>• Participation in the CIPM-MRA is possible</li> <li>• participations in consultative committees (subject to appropriate expertise)</li> <li>• Participation and vote in CGPM</li> <li>• Free BIPM-calibration services</li> <li>• Participation in BIPM/CC key comparisons (subject to appropriate expertise)</li> <li>• Right to purchase prototype kilogram</li> </ul>
2	<b>Participant in the CIPM-MRA</b>	<ul style="list-style-type: none"> <li>• NMI is defined</li> <li>• Member or Associate</li> <li>• Intention to develop and declare CMCs</li> </ul>	<ul style="list-style-type: none"> <li>• Possibility to publish CMCs recognized by the other NMIs</li> <li>• Possibility to designate additional institutions who hold national measurement standards</li> <li>• Participation in the NMI directors meetings</li> <li>• Trade facilitation by recognition of other NMIs measurement capabilities</li> </ul>
3	<b>Registration of CMC entries in the KCDB</b>	<ul style="list-style-type: none"> <li>• Member or Associate</li> <li>• Signing of CIPM-MRA</li> <li>• Traceability to the International System of Units (SI)</li> <li>• Prove of technical competence</li> <li>• Maintenance of a quality system</li> </ul>	<ul style="list-style-type: none"> <li>• Political independence (independence from other countries; independence from accreditation bodies)</li> <li>• Contact to best NMIs, facilitations of transfer of know how</li> <li>• Own realization of SI-units possible</li> <li>• Trade facilitation by mutual recognition of measurement capabilities</li> <li>• Gives the basis for international recognition of measurements made by accredited calibration and testing laboratories</li> </ul>

\*A country can either become Associate of the CGPM first or become Member of BIPM directly without being Associate before.

# Glossary

## **BIPM, International Bureau of Weights and Measures**

The International Bureau of Weights and Measures (BIPM), was established in 1875 by the Metre Convention as an inter-governmental organization. The mission of the BIPM is to provide a basis for a single, coherent system of measurements throughout the world, traceable to the International System of Units (SI). As of March 2011, there were 55 Member States of the BIPM, and 32 Associate States and Economies of the General Conference.

## **CGPM, General Conference on Weights and Measures**

The General Conference on Weights and Measures (CGPM) is the plenary organ of the BIPM and comprises representatives of the Member States of the BIPM. Every four years it meets to approve the work programme and budget for the BIPM, and to deliberate and decide on issues of major metrological importance.

## **CIPM, International Committee for Weights and Measures**

The International Committee for Weights and Measures (CIPM) comprises 18 members, appointed on an individual basis, each of a different nationality who meet annually. The CIPM's task is to supervise the activities of the BIPM. The chairpersons of the consultative committees are drawn from the CIPM.

## **CC, Consultative Committees**

The work of the BIPM is supported by a number of consultative committees (CCs), comprised of international experts of the highest level in specific fields who act as advisers on scientific and technical matters, and are responsible for the initiation of comparisons.

## **NMI, National metrology institute**

A national metrology institute, NMI, is an institute designated by national decision to develop and maintain national measurement standards for one or more quantities. An NMI represents the views of its home country to the NMIs of other countries, as they relate to the regional metrology organizations and to the BIPM.

## **DI, Designated Institute**

Apart from an national metrology institute, other institutes can be appointed by the national metrology institute or the national government to hold specific national standards. In the context of the CIPM MRA these other institutes are referred to as designated institutes (DIs). Depending on national metrology policy, the number of DIs varies from country to country.

## **RMO, Regional Metrology Organization**

A Regional Metrology Organization is an association of national metrology institutes from one region that is created to facilitate collaboration between the national metrology institutes. Activities of RMOs vary somewhat but typically include:

- coordination of regional comparisons
- cooperation in metrology research and development
- facilitating traceability to primary realization of the SI
- developing metrological infrastructure in member countries
- joint training and consultation
- sharing of technical capabilities and facilities

RMOs play a prominent role within the CIPM MRA as they are responsible for carrying out the calibration and measurement capabilities review process.

At the present time, there are five RMOs:

- Intra-Africa Metrology System (AFRIMETS)
- Asia Pacific Metrology Programme (APMP)
- Euro-Asian Cooperation of National Metrological Institutions (COOMET)
- European Association of Metrology Institutes (EURAMET)
- Inter American Metrology System (SIM)

Both AFRIMETS and SIM operate through sub regional structures.

## **JCRB, Joint Committee of the Regional Metrology Organizations and the BIPM**

The JCRB is the joint committee of the regional metrology organizations and the BIPM, established to coordinate regional metrology organization's activities in the process of mutual recognition of calibration and measurement capabilities. The JCRB plays an important role in the implementation of the CIPM MRA.

## **KCDB, key comparison database**

The key comparison database (KCDB) is a publicly available database maintained by the BIPM. It contains:

- a list of the participants of the CIPM MRA (Appendix A)
- information and results of key and supplementary comparisons (Appendix B)
- calibration and measurement capabilities – CMCs (Appendix C)
- a list of key comparisons (Appendix D)

