Guide to the implementation of the CIPM MRA

CIPM MRA-G-01

VERSION 1

Contents

1. Preface

The present document is meant to be a quick reference guide for those individuals called upon to implement any aspect of the CIPM MRA. By itself, this document does not constitute the final recommendation on any aspect of the CIPM MRA process, rather it is meant to help the users navigate more efficiently through the complexity of the process.

Each chapter is written as a stand-alone reference, in such a way that the user can go directly to any step of the process without the need of going through the whole document.

2. Background

The advent of the global economy demanded an open, transparent and comprehensive scheme to provide information on the equivalence of national measurement services and the technical basis for international trade, commerce and regulatory affairs.

Different regions of the world have created regional agreements trying to achieve this objective. The national metrology institutes (NMI) of these countries have joined in different regional organizations driven by geographical, economic or political affinity. These organizations known as Regional Metrology Organizations (RMO), are also seeking to improve cooperation among the NMIs of their respective regions.

In response to the demand of an international system to establish the equivalence of measurements, the General Conference of Weights and Measures (CGPM) in resolution 2 from the 20th meeting, recommends:

- *that national metrology laboratories, in collaboration with the BIPM, ensure that the necessary comparisons between national standards are carried out in sufficient number to demonstrate international traceability*[1] *of measurement standards;*

[1] Presently, it is considered that comparisons are carried out to demonstrate equivalence of the standards and not traceability.

- *that adequate interconnections are maintained between the comparisons carried out under the auspices of the BIPM and those carried out by the regional groups*[2]*; and*
- *that the results of comparisons carried out by the regional groups be communicated to the BIPM in appropriate form for them to be published by the BIPM and thereby given wide international recognition.*

The International Committee of Weight and Measures (CIPM), responded by implementing a "Mutual Recognition Arrangement of national measurement standards and of calibration and measurement certificates issued by national metrology institutes" (CIPM MRA). The CGPM supported this initiative in resolution 2 from the 21st meeting.

The CIPM MRA was first signed in Paris on the 14th of October of 1999 by the directors of the national metrology institutes (NMIs) from thirty-eight Member States of the Metre Convention and the representatives from two international organizations.

3. The CIPM MRA

The CIPM MRA was drawn up with the following 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; and
- to provide governments and other parties with a secure technical foundation for wider agreements related to international trade, commerce and regulatory affairs.

The process through which the CIPM MRA achieves these objectives involves:

- international comparisons of measurements, known as key comparisons;

[2] Now known as Regional Metrology Organizations, RMOs

- regional comparisons of measurements, known as regional key comparisons;
- other regional or bilateral comparisons of measurements known as supplementary comparisons;
- review of the technical competence of the participants based mainly on the results of comparisons;
- the implementation and review of quality systems and demonstrations of competence by NMIs.

See document CIPM-2005/06(REV), for further details on updates and interpretations made to the original clauses in the CIPM MRA.

The results of this review process are statements of the measurement capabilities of each NMI, known as "Calibration and Measurement Capabilities (CMCs)". These capabilities are published in the BIPM key comparison database (KCDB), maintained by the BIPM and publicly available on the World Wide Web. This database contains four sections corresponding to the four Appendices of the CIPM MRA:

Appendix A: List of NMIs and Designated Institutes participating in the CIPM MRA.

Appendix B: Information on key and supplementary comparisons, including results when they become available.

Appendix C: Calibration and Measurement Capabilities (CMCs).

Appendix D: List of key comparisons.

Appendix E: Terms of reference of the Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB)

4. Coordination of the MRA

Overall coordination of the CIPM MRA is in the hands of the BIPM under the authority of the CIPM. The Consultative Committees (CC) of the CIPM, 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) was established in February 1998 to support implementation of Part 2 of the CIPM MRA. Since its first meeting, the JCRB's main activities have been:

- the coordination and management of reviews of NMI Calibration and Measurement Capabilities (CMCs); and
- the development of policy and guidelines on the operation of the CIPM MRA to assist the RMOs and the CIPM.

5. Participation in the MRA

The CIPM MRA is open to the NMIs of the Member States of the BIPM, to certain international and intergovernmental organizations (IGO) invited by the CIPM, and to the NMIs of Associate States and Economies of the General Conference. This third category results from the decision of the 21st CGPM to create a category of Associate of the CGPM (Resolution 3 of the 21st CGPM) with the specific purpose of providing a way of establishing links to the world's measurement system for those States not yet Members of the Metre Convention. For a list of the services available to Associate States and the rules for their participation in the CIPM MRA see the document CIPM-2005/05.

NMI directors sign the CIPM MRA with the approval of the appropriate authorities in their own country and thereby:

- accept the process specified in the CIPM MRA for establishing the database;
- recognize the results of key and supplementary comparisons as given in the database;
- recognize the CMCs of other participating NMIs as given in the database;
- mutual acceptance of the calibration and measurement certificates.

It should be noted that signing the CIPM MRA engages the signatory NMIs but not necessarily any other agency in their country (or economy). The responsibility for the results

of calibrations and measurements rests wholly with the NMI that makes them and is not, through the CIPM MRA, extended to any other participating NMI.

Only one institute may sign the CIPM MRA on behalf of a Member State, Associate of the CGPM or international organization. Where further institutes have been designated by the appropriate authority to hold national measurement standards, the institution who has signed the arrangement on behalf of the Member State, Associate of the CGPM or international organization with jurisdiction over their activities must notify the BIPM so that they can be identified in Appendix A of the MRA. Document CIPM 2005 -07, describes the procedure for designation of institutes.

All Designated Institutes (DI) must consider it their own responsibility to demonstrate conformity with the requirements of the CIPM MRA. More details and examples of NMIs and their DIs can be found in document CIPM-2005/07. In cases where NMIs or DIs subcontract portions of their calibrations, measurement capabilities, or CRM certification activities covered under the CIPM MRA, the criteria found in document CIPM-2005/09 need also to be fulfilled.

The signatory of the CIPM MRA is the coordinating organization for the country and takes responsibility for establishing an appropriate mechanism so that the CMCs of designated institutes do not overlap with others designated at a national level and that they follow the process of approval established by the JCRB. Only one institute per country can be recognized as holding national responsibility for a specified capability (quantity, measurand, matrix environment, measurement range) and competence, for submitting the related CMCs, and for taking part in the relevant key comparisons.

Finally, NMIs and DIs participating in the CIPM MRA are encouraged to make use of the CIPM MRA logo by featuring it on their calibration and measurement certificates of CMCs contained in the KCDB. The Guidelines for use of the CIPM MRA Logo can be found in document CIPM-2006/04.

6. Calibration and Measurement Capabilities

In order for CMCs to be approved for publication in Appendix C of the CIPM MRA, they must first be reviewed and approved by the appropriate Technical Committee/Working Group[3] of the RMO of origin (intra-RMO review process). As stated in paragraph 13 of the CIPM MRA, NMIs that are not members of an RMO: "Those NMIs that wish to participate in this arrangement but are not members of an RMO, should either form a new RMO, or for the purposes of this arrangement, associate themselves with an existing RMO, whichever is the more appropriate. If neither approach is possible, they should seek to make special provisions."

Once this approval is obtained, CMCs undergo an inter-regional review (inter-RMO review process). The reviews verify the validity of CMCs from the RMOs' points of views thus providing the technical confidence required for publication. TC/WGs play a key role in this process as they conduct the technical review and eventual approval of each CMC submission. The steps TC/WG chairpersons need to follow in order to carry out this process are explained hereafter.

6.1. General rules for accepting CMCs

Technical support for the arrangement, as stated in Section 3 of the CIPM MRA, is achieved mainly through the results of key and supplementary comparisons. Confidence in the supported measurements is further reassured by the implementation of a quality system.

Key comparisons are designed to provide evidence of the proficiency of NMIs in the principal techniques in each field. They are selected, conducted and evaluated by the CIPM Consultative Committees (CCs). Regional key comparisons are conducted by the RMOs TC/WGs and must follow exactly the protocols of the CC key comparisons. Supplementary comparisons are undertaken independently by RMOs when CMCs require additional support not provided by key comparisons.

While the results of key and supplementary comparisons are the ideal supporting evidence for CMCs, it is not the intention of the CIPM MRA to have a **one-to-one correspondence between CMCs and comparisons.** A key or a supplementary comparison may provide enough evidence to underpin the uncertainty claims of a group of related CMCs. How broad this group should be is an issue being considered by the CCs on a continuing basis (see the terms of reference of the CC WG on CMCs, *Terms of References for the CCWG on CMCs*).

In addition to comparison results, the criteria for acceptance of data for Appendix C in chapter 8 of document *CIPM MRA-D-04*, lists a number of different possible sources of information that can be used to support CMC claims, and paragraph 8.1 defines supplementary specific criteria for CRMs.

6.2. Subcontracting of measurements under the CIPM MRA.

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.

The criteria to be fulfilled for subcontracting measurements is described in document CIPM 2005-09, "Subcontracting of measurements under the CIPM MRA".

6.3. Drawing up CMCs

It is required that all CMCs be submitted in a consistent format. Detailed instructions on how to draw up these CMC files can be found in the documents section of the JCRB web page, under chapter 3 of CIPM MRA-D-04 [4]. The up-to-date lists of services or categories can

---

[3] Groups of technical experts in each area are called "Technical Committees" (TCs) in APMP, COOMET and EURAMET, and "Working Groups" (WGs) in SADCMET and SIM.

[4] Please note that upon request the coordinator of the KCDB, BIPM.KCDB@bipm.org, is available to provide advice on the preparation of Excel files.

be found in the search form of the KCDB, under each metrology area at the top of the page. In order to assure compliance with the JCRB rules the BIPM may need to make certain modifications to the CMC files. The allowed BIPM interventions are described in chapter 7 of document CIPM MRA-D-04.

6.4. The CMC Review Process

The CMC Review Process has two stages:

- Intra-regional review: each RMO defines their procedures for conducting the CMC intra-regional review. Once the CMCs are approved at the regional level, it is advisable for the TC/WG Chairperson to send the CMCs to the RMO representative, who in turn submits them to the JCRB for inter-regional review.
- Inter-regional review: the inter-regional review procedure is explained in chapters 4, 5, 6 and 10 of *CIPM MRA-D-04*, and represented in flowchart form in appendix 1 of the same document.

The CMC review process is carried out through the password-protected website of the JCRB (www.bipm.org/JCRB). TC/WG Chairpersons in each RMO can obtain a username and a password from the JCRB Executive Secretary using the contact form, or from their RMO representatives to the JCRB. Other persons can view this process by visiting the JCRB website using the guest username and password:

Username: guest

- Password: guest2001

The ability to download the CMC files from this webpage helps identify the correct version when several are produced after circulation of comments. Once the files are posted for review, the TC/WG Chairpersons in each area contact each other directly to exchange comments or concerns (see CC Working Groups on CMCs below). Contact data for all TC/WG Chairpersons is available in the BIPM web page, under JCRB Directory

At the end of this phase of the review process, reviewing RMOs send their comments to the JCRB Executive Secretary through their JCRB representatives. The JCRB Executive Secretary, in turn, sends them to the representative of the RMO submitting the CMCs under review. These actions are noted in the website with dates.

In response to these comments, the originating RMO sends a revised CMC file which is posted in the JCRB website for final approval. Reviewing RMO representatives and TC/WG chairs may download the file to verify that their comments and concerns have been appropriately addressed, prior to final voting for approval. The voting process works on a consensus basis. The RMOs may abstain from voting, but one negative vote is enough to reject the CMC. It is worth noting that not all RMOs need to participate in the inter-RMO review process for it to be valid as the review process is done on a voluntary basis. The final approval, is done under the votes recorded and consensus of the participating RMOs.

6.5. Publication of the CMCs in KCDB

When all reviewing RMOs have indicated their approval of the posted files, they are published in the open section of the KCDB by the KCDB Manager.

6.6. Review of already published CMCs

From time to time, CMCs may need to be modified either because of editorial improvements or due to changes in the uncertainty, scope or method of measurement. This process is described in chapter 12 of *CIPM MRA-D-04*.

6.7. CC. Working Groups on CMCs

In October 2003, the CIPM approved the creation of "Working Groups on CMCs" in each Consultative Committee, with the following objectives:

- to establish and maintain lists of service categories, and where necessary rules for the preparation of CMC entries;
- to agree on detailed technical review criteria;

- to coordinate and where possible conduct inter-regional reviews of CMCs submitted by RMOs for posting in Appendix C of CIPM MRA;
- to provide guidance on the range of CMCs supported by particular key and supplementary comparisons;
- to identify areas where additional key and supplementary comparisons are needed; and
- to coordinate the review of existing CMCs in the context of new results of key and supplementary comparisons.

These WGs should include representation from all RMOs that have NMIs active in the relevant technical area. WG membership is expected to come from the relevant RMO committees involved in CMC reviews; appropriate experts being chosen depending upon the particular field under review.

TC/WG Chairs who require information on these Working Groups should contact the Executive Secretary of the relevant Consultative Committee, using the contact form in http://www.bipm.org/en/committees/.

7. Measurement Comparisons

The technical basis of the CIPM MRA is the set of results which compare the performance of participating NMIs obtained in the course of time through key comparisons. These are carried out by the Consultative Committees of the CIPM, the BIPM and the Regional Metrology Organizations (RMOs), and published by the BIPM and maintained in the Key Comparison Database. The Technical Supplement to the CIPM MRA specifies conventions and responsibilities relating to the key comparisons.

All the comparisons performed, are meant to support the CIPM MRA and have to be published to keep the whole process transparent; unlike normal comparisons carried out the PT providers or Accreditation Bodies, the results of the comparisons are not anonymous. The

link between each participant and its result must be explicitly stated in the final report and this information is publicly available.

The NMIs that are signatories to the CIPM MRA undertake to put in place appropriate structures within their RMOs so that the RMOs may:

- make proposals to the Consultative Committees on the choice of key comparisons;
- carry out the RMO key comparisons corresponding to the CIPM key comparisons;
- participate in the JCRB; and
- carry out supplementary comparisons and other actions designed to support mutual confidence in the validity of calibration and measurement certificates issued by participating institutes.

7.1. Key comparisons

Key comparisons carried out by Consultative Committees or the BIPM are referred to as CIPM key comparisons; key comparisons carried out by regional metrology organizations are referred to as RMO key comparisons; RMO key comparisons should be linked to the corresponding CIPM key comparisons by means of joint participants.

The details for the operation of Key Comparisons can be found in the *Guidelines for CIPM Key Comparisons*

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. Each reference value is referred to as a key comparison reference value and, in most cases, it can be considered to be a close, but not necessarily the best, approximation to the SI value. 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. The degree of

equivalence derived from an RMO key comparison has the same status as that derived from a CIPM key comparison.

Participation from NMIs and DIs from Associates in CC comparisons or other activities should be carefully considered by the relevant Committee or Working group on a case by case basis, and they may take part where this adds scientific or other value and effectiveness or efficiency to the relevant activity.

Information about these key comparisons can be found at the BIPM homepage: Ongoing comparisons conducted by the BIPM.

The flowchart describing the key comparison process can be found in document *The Key Comparisons Process*.

An institute that considers its result unrepresentative of its standards may request a subsequent bilateral comparison with the pilot institute or one of the participants. For the details of the process for subsequent bilateral key comparisons see document *Process for Subsequent Bilateral Key Comparisons*.

7.2. Supplementary comparisons

A supplementary comparison is a comparison conducted to meet specific needs not covered by key comparisons, including comparisons to support confidence in CMCs. The note on supplementary comparisons, document *A Note on Supplementary comparisons*, the definition of supplementary comparisons in resolution 11 from the 10th JCRB and the flowchart of the supplementary comparison process in document *RMO Supplementary Comparison Process* are part of the guidelines to be followed in conducting these comparisons.

7.3. Monitoring the impact of comparison results on CMC claims

The NMI making the CMC claim has primary and principal responsibility to ensure consistency with the comparison results. RMOs should also monitor the impact of the key and supplementary comparison results on the CMC claims for its members. If there are concerns about particular claims the resolution should follow the description of the chain of

responsibilities as found in document *Monitoring the Impact of Key and Supplementary Comparison Results on CMC Claims*.

8. Quality Systems

In a quality system (QS) the everyday work of an institute or company is described in a standardized way to ensure not only the maintenance of a certain level of quality but its continuous improvement. A functioning quality system makes the work transparent. The working procedures and the needed competent personnel and required equipment are described.

In addition to participation in the key and supplementary comparisons, recognition of calibration and measurement certificates requires one of the following procedures in order to establish the necessary mutual confidence (subject to other RMO rules):

a) an NMI that chooses for its calibration and measurement services a quality system that meets the requirements of ISO/IEC 17025 or equivalent for an NMI, assessed by an accreditation body fulfilling the requirements of ISO/IEC 17011, declares its CMCs and submits them to the local RMO for intra-regional review and then forwards them to the JCRB for inter-regional review and inclusion in Appendix C of the CIPM MRA; and

b) an NMI that chooses to use a different way of assuring quality or chooses a different quality system, or ISO 17025 without third-party assessment, for its calibration and measurement services declares its CMCs and submits them to the local RMO for intra-regional review and then forwards them to the JCRB for inter-regional review and inclusion in Appendix C of the CIPM MRA.

Other standards may be applicable for particular cases, such as ISO Guide 34 for those CMCs that disseminate traceability through Certified Reference Materials.

The review of the QS, is done according to the document *The JCRB Guidelines for the monitoring and reporting of the operation of Quality Systems by RMOs*, and by the annual reports submitted by the NMIs to the RMOs QS review committee and in turn, the RMOs to the JCRB. It is worth noting that demonstration of competence and capability may require

visits and examination of procedures by an NMI and/or by peers selected by the local RMO. For the recommendations for on-site visits by peers and selection criteria for on-site visit peer reviewers see the CIPM MRA policy document CIPM-2006/05.

9. Conclusions

The participation of the NMIs in the CIPM MRA, provide governments and other parties with a secure technical foundation for wider agreements related to international trade, commerce and regulatory affairs. As a result, the CIPM MRA is an important tool for helping all NMIs in the development of its home countries quality of the measurements related to industry, health, environment and science.

For these reasons, it is important to open the participation to all the NMIs in the world and it continues to be the policy of the CIPM and the BIPM, to promote the participation of the widest possible spectrum of NMIs, from the largest to the smaller ones.

The CIPM MRA itself and the rules that operate the agreement, assure that the process is open, transparent and the information available to all the parties, the NMIs, their user's, accreditors and regulators.

10.List of acronyms

APMP	Asia Pacific Metrology Programme
BIPM	Bureau International des Poids et Mesures (International Bureau of Weights and Measures)
CC	Consultative Committee of the CIPM
CGPM	Conference General des Poids et Mesures (International Conference on Weights and Measures)
CIPM	Comité International des Poids et Mesures (International Committee for Weights and Measures)
CIPM MRA	Mutual Recognition Arrangement
CMC	Calibration and Measurement Capability

COOMET	Euro-Asian Cooperation of National Metrological Institutions
CRM	Certified Reference Material
EURAMET	European Association of National Metrology Institutes
JCRB	Joint Committee of the RMOs and the BIPM
KCDB	BIPM key comparison database
NMI	National Metrology Institute
QS	Quality System
RMO	Regional Metrology Organization
SADCMET	Southern African Development Community Cooperation in Metrology
SIM	Sistema Interamericano de Metrologia
TC	Technical Committee
WG	Working Group

11. Documents related to the MRA

11.1. General information on the JCRB

- JCRB terms of reference
- Activities of the JCRB: 1999–2003
- JCRB directory
- Uncertainty contributions of the device under calibration or measurement
- CIPM MRA-D-04 Calibration and Measurement Capabilities in the context of the CIPM MRA
- Recommendations for on-site visits by peers and selection criteria for on-site visit peer reviewers

11.2. Guidance on CMC reviews

- Terms of reference for CC Working Groups on CMCs
- Monitoring the impact of key and supplementary comparison results on CMC claims
- JCRB guidelines for the monitoring and reporting of the operation of quality systems by RMOs

11.3. Guidance on comparisons

- Flowchart of the key comparison process
- Flowchart of the supplementary comparison process
- Flowchart of the process for subsequent bilateral key comparisons
- Key and supplementary comparison registration form
- Supplementary comparisons – definition
- A note on supplementary comparisons

12.Revision History

Version number	Author	Date of Issue/Review	Summary of change
1	L. Seehausen-P. Espina-L. Mussio	2008-05-01	Original draft JCRB 20/08 Approved by JCRB 21/08(1)
		2008-10-17	Approved by CIPM