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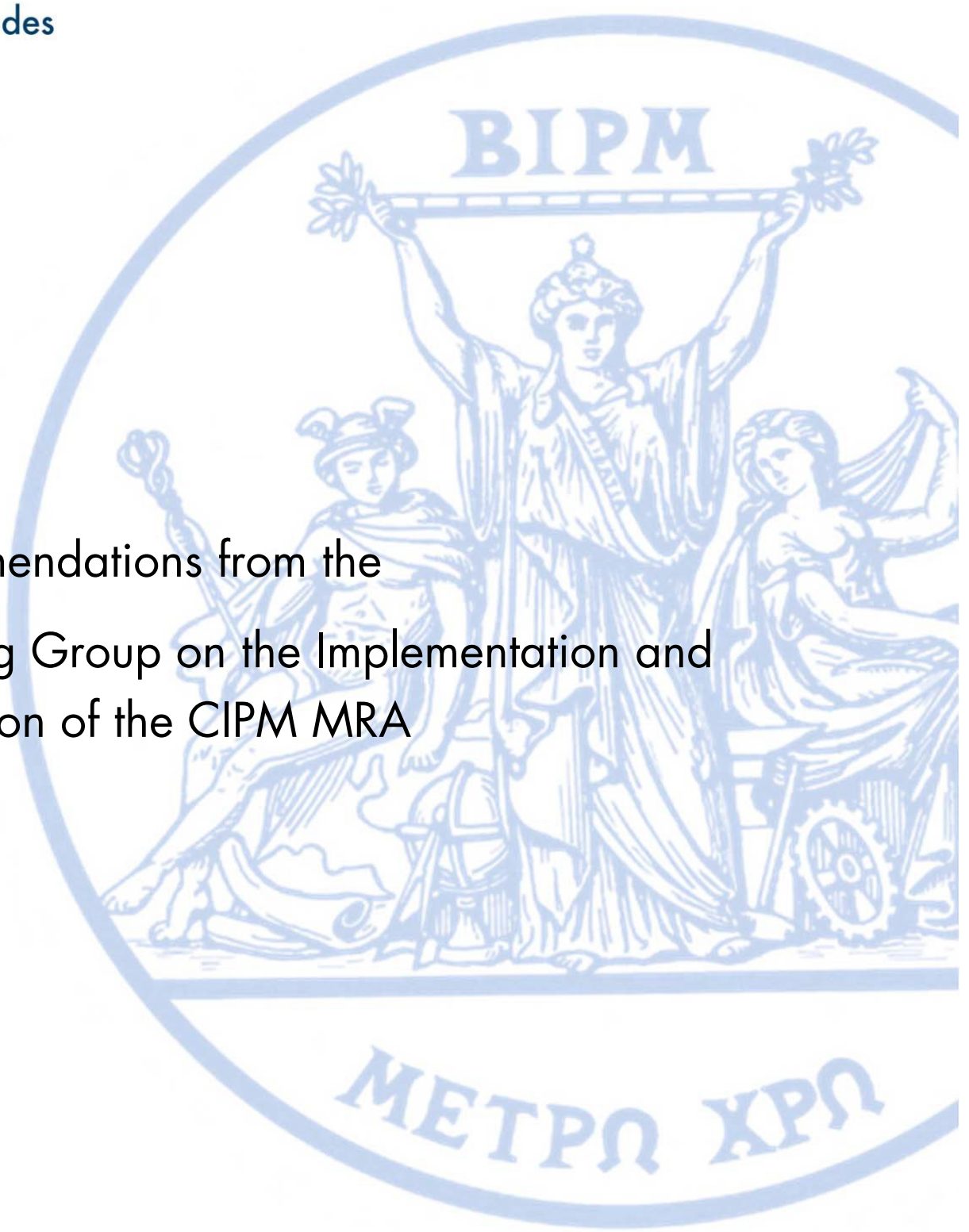

Recommendations from the Working Group on the Implementation and Operation of the CIPM MRA

Final Version – 23 August 2016

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Recommendations from the Working Group on the Implementation and Operation of the CIPM MRA

1. Background

The arrangement for the "Mutual recognition of national measurement standards and of calibration and measurement certificates issued by national metrology institutes" (the MRA) was established by the International Committee for Weights and Measures on 14 October 1999. Since its inception the arrangement has grown continuously; there are now almost 1400 Key and Supplementary Comparisons registered in the KCDB together with over 24 000 CMC entries. By any measure the MRA has been a great success. However, the comparison programme, the evaluation of CMC claims and the maintenance of the database has required and continues to require significant resources from the NMIs, the Regional Metrology Organizations (RMOs) and the BIPM.

After 15 years of operation a number of NMI Directors proposed that the implementation and operation of the MRA should be reviewed with a view to improving its efficiency and effectiveness. To this end, the CIPM proposed to the 25th CGPM that a review of the implementation and operation of the MRA should be conducted. This led to Resolution 5 which, *inter alia* noted:

- *that after 15 years of successful operation of the CIPM MRA, there is a need to review its implementation and operation,*
- *the improvements being made within the existing framework including the strategic planning of comparisons and ongoing streamlining of processes,*
- *a workshop planned for 2015 to engage in a broad discussion of the CIPM MRA, involving: Directors of National Metrology Institutes, Member States representatives, representatives of RMOs and other relevant stakeholders concerning the benefits of the CIPM MRA, as well as establishing views on what works well, and what needs to be improved regarding its implementation,*

and invited

- *the CIPM to establish a working group under the chairmanship of its President, with membership to be determined at the 2015 workshop, to conduct a review of the implementation and operation of the CIPM MRA.*

The MRA Review Workshop met on 13 and 14 October 2015 and discussed many issues of concern. It appointed a Working Group on the Implementation and Operation of the CIPM MRA (the "Working Group") to conduct the review and to consider the issues of concern identified by the Workshop in further detail.

2. Key points identified by the workshop

The discussions at the workshop confirmed that the processes involved in the MRA have evolved, they have not been static. The JCRB and the CCs have progressively addressed shortcomings and many improvements have already been implemented over the years.

All points raised at the workshop were considered by the Working Group, following the workshop and a series of key points were agreed:

General

1. The MRA should continue to maintain its high levels of quality and integrity so as not to undermine the effort invested over 15 years.

2. The MRA should continue to be inclusive and be built on the appropriately demonstrated and documented assessment of capabilities between the NMIs.

3. The MRA is an arrangement between NMIs; it is a tool to support them in:

   – *"establishing the degree of equivalence of national measurement standards maintained by NMIs and DIs;*

   – *providing for the mutual recognition of calibration and measurement certificates issued by NMIs and DIs;"*

   thereby providing governments and other parties with secure technical foundations for wider agreements related to international trade, commerce and regulatory affairs.

4. The total effort required to operate all aspects of the MRA should not rise above the present levels and should be reduced where possible. Steps should be taken to spread the load more widely.

5. The KC/CMC processes should be tailored according to the risk and complexity of the issues being handled.

6. There is a need to upgrade the KCDB and the JCRB databases using new modern IT tools.

Key Comparisons (KCs)

7. The planning of KCs should be strategic (e.g., part of the strategic plan of each CC).

8. As stated in the text of the MRA, key comparisons test the principal techniques and methods in the field[1]. Not all NMI services can be directly underpinned by a KC. Also, participation in key comparisons should not be used as an alternative to comprehensive in-house procedures for monitoring the stability of standards.

[1] Note applicable to chemistry and biology, "In addition, Key Comparisons validate NMIs ability to develop and use higher-order methods for delivering SI-traceable services to customers".

9. Reducing the numbers of CIPM key, RMO key and supplementary comparisons should not be objectives in their own right; they should be planned and used more efficiently to achieve the goal articulated in #2 above.

10. The progress of CIPM key, RMO key and supplementary comparisons at each stage through to completion should be monitored actively, with appropriate interventions when necessary.

Calibration and Measurement Capabilities (CMCs)

11. The different user experiences and expectations for the KCDB and CMCs in different fields of metrology should be recognized. Whilst the definition of a CMC is universal, the technical implementation may be different in fields such as chemistry and ionizing radiation.

12. Steps should be taken to increase the efficiency of the CMC review process.

13. The relationship between CMCs and services should be reviewed.

14. Unnecessary duplication in the process of reviewing CMCs should be eliminated.

The Key Comparison Database (KCDB)

15. The KCDB provides quality assured information concerning the comparability of the measurement capabilities that NMIs/DIs maintain to underpin the services they provide to their customers.

16. It is not practical or affordable for the KCDB to provide all information needed by all customers in all sectors of world metrology.

17. Mechanisms should be considered to improve specific access to NMI services (e.g. by providing web links in the KCDB).

3. Questions raised by the workshop for the Working Group to address

In addition to the key points listed in the previous section, the Workshop also posed a series of questions that it considered to be central to the future implementation and operation of the MRA.

1. How can the level of participation in KCs be managed more effectively?

2. How can the KCDB provide better visibility of the services supported by the CMCs?

3. How can the proliferation of CMCs be constrained?

4. How can the processes of CMC review be made more efficient?

5. Are new and different mechanisms needed to support States with developing metrology systems to participate in the MRA? How can they become more pro-active in addressing their needs?

6. Are improvements in the governance of the MRA by the JCRB and the CIPM needed to ensure more effective and timely operation of the MRA?

7. Are changes in the governance of the MRA by the JCRB and the CIPM needed to ensure effective and timely implementation of improvements from the review?

8. Should new scopes and processes be developed for CMCs in chemistry? Should new areas such as biology and emerging technologies also be considered?

9. Should a new strategy be developed for KCs and CMCs in ionizing radiation?

4. Meeting of the Working Group

The 'Working Group on the Implementation and Operation of the CIPM MRA' (the Working Group) met formally at the BIPM on 14 and 15 March 2016. Members of the Working Group together with other attendees at the meeting are listed in Appendix 1.

In advance of the formal meeting of the Working Group, four sub-groups were identified to consider the questions posed by the Workshop. The sub-groups were asked to consider particular questions and conveners were appointed to report back to the whole Working Group. The reports from the sub-groups formed the basis for much of the discussion that took place at the Working Group meeting and also the development of the Recommendations in this report. The membership of the sub-groups and the questions they addressed are listed below:

Sub-Group on the Management of the KC and CMC processes (Questions 1 - 4)

1. How can the level of participation in KCs be managed more effectively?
2. How can the KCDB provide better visibility of the services supported by the CMCs?
3. How can the proliferation of CMCs be constrained?
4. How can the processes of CMC review be made more efficient?

Members: Gert Rietveld (Convener), Yuning Duan, Hector Laiz, Philippe Richard, Jörn Stenger

Sub-Group on Mechanisms to support States with developing metrology systems (Question 5).

5. Are new and different mechanisms needed to support States with developing metrology systems participate in the MRA? How can they become more pro-active in addressing their needs?

Members: Martyn Sené (Convener), Nino Mikanadze, Dennis Moturi, Claudia Santo, Prayoon Shiowattana

Sub-Group on Governance (Questions 6 and 7)

6. Are improvements in the governance of the MRA by the JCRB and the CIPM needed to ensure more effective and timely operation of the MRA?
7. Are changes in the governance of the MRA by the JCRB and the CIPM needed to ensure effective and timely implementation of improvements from the review?

Members: Peter Fisk (convener), Jim Olthoff, Beat Jeckelmann, Vladimir Krutikov

Sub-Group on Specific issues relating to CMCs for chemistry and ionizing radiation (Questions 8 and 9)

8. Should new scopes and processes be developed for CMCs in chemistry? Should new areas such as biology and emerging technologies also be considered?
9. Should a new strategy be developed for KCs and CMCs in ionizing radiation?

Members: Willie May (Convener), Luc Erard, Takashi Usuda, Wynand Louw, Robert Edelmaier

5. Recommendations from the Working Group

Recommendation 1 - (On managing the level of participation in KCs more effectively)

a. The strategy documents of the CCs must clearly define the long-term timetable for KCs (including the repeat cycle). The RMO TCs should also plan regional KCs and SCs strategically, to reflect the needs of the RMO.

   Action: CCs, RMOs, JCRB

b. Where travelling standards are used sequentially, participation in CIPM KCs should typically be limited to the minimum number of institutes necessary to provide effective linkage in each region, (typically no more than three institutes per RMO). Criteria for participation should include: measurement uncertainty, geographical spread and willingness to coordinate in the subsequent RMO KC.

   Action: CCs

c. The NMIs should be encouraged to share the roles involved in coordinating KCs (e.g. through mentorship, sharing toolkits and best practice).

   Action: NMIs, CCs, RMOs

Recommendation 2 - (On providing better visibility of the services supported by the CMCs in the KCDB)

a. The BIPM should work with the JCRB and the CCs to develop the scope for KCDB 2.0

   Action: BIPM, JCRB, CCs

b. The BIPM should implement KCDB 2.0 with (for example) an improved web interface and an improved search facility.

   Action: BIPM

c. The CCs should work towards better consistency in the expression of CMCs (e.g. units, uncertainty ranges)

   Action: CCs

Recommendation 3 - (On constraining the proliferation of CMCs)

a. The results of KCs and SCs should be interpreted as widely as reasonably applicable to indicate coverage of CMCs.

   Action: CCs

b. The use of CMCs to cover as many services as is technically justified should be encouraged, so that CMCs become representative rather than comprehensive. It should be emphasized that the goal is for NMIs to develop services and that CMCs are tools for describing the capabilities maintained to underpin the delivery of those services. The NMI QSs should document the relationship between services and CMCs.

Action: RMOs, JCRB, NMIs

c. The CCs and NMIs are encouraged to use uncertainty equations and matrices to reduce the number of CMCs where possible.

Action: CCs, NMIs

d. CMCs shall reflect the services available to customers under normal conditions, in accord with the MRA, and shall not be artificially subdivided.

Action: NMIs, RMOs, JCRB

e. NMIs should be advised to use the percentage of coverage of their services by CMCs as a metric of success rather than the number of CMCs (The number of CMCs alone should not be considered a metric of the success of an NMI).

Action: CIPM, RMOs, NMIs

Recommendation 4 - (On improving the efficiency of the CMC review processes)

a. The CCs should develop a "risk-based" approach[2] to CMC review procedures, that defines the need for intra- and inter-RMO reviews, with *inter alia* the aim to minimize, or even avoid, the inter-RMO review where justified[3].

Action: CCs, RMOs, JCRB

b. The CCs and the JCRB should harmonize the use of evidence to support CMCs that does not arise from KC and SC participation.

Action: CCs, JCRB, RMOs

c. The JCRB should ensure greater consistency in the implementation of the intra-RMO review.

Action: JCRB, RMOs

d. More training should be provided, together with improved guidance material to help ensure 'right first time' CMCs and common understanding of expectations when reviewing.

Action: RMOs, BIPM

[2] The type of risk-based approach foreseen would balance the risk to the integrity of the MRA resulting from incorrect information in the KCDB against the cost and time required to review all submissions with the current degree of rigour.

[3] The CCQM at its meeting in April 2016 discussed this matter and agreed that the interregional review as currently conducted in chemistry should continue. The expertise for review (for chemistry and particularly for biology) and harmonization of expectations does not yet exist in all regions.

e. The BIPM should investigate the feasibility of a web-based tool for the complete CMC submission and review giving full tracking of the CMC review process, for example as part of the KCDB 2.0.

Action: BIPM

f. Training should be provided at both RMO and CC levels to ensure that those with operational responsibility within the CIPM MRA understand the relevant processes and specifically their obligations within them.

Action: JCRB, RMOs, CCs, BIPM

Recommendation 5 - (On encouraging and enabling states with developing metrology systems to become signatories and fully participate in the MRA)

a. The JCRB should work with the CCs to collate and develop, as far as possible, a small number of consistent methodologies for carrying out comparisons, including evaluation tools, templates (including reporting) and supporting training materials; noting the key role the BIPM Capacity Building and Knowledge Transfer Programme can play, particularly in dissemination of these and in training.

Action: JCRB, CCs, BIPM

b. The BIPM, JCRB and the RMOs should encourage and assist developing Metrology institutes to both participate in, and then when sufficiently experienced, to pilot inter-laboratory comparisons for the purposes of demonstrating competence as needed for service provision.

Action: BIPM, JCRB, RMOs

c. The RMOs should encourage developed NMIs to act as mentors by sharing experience, by assisting in coordination and by participating in bi-lateral comparisons which are a valuable and cost-effective means of gathering evidence of competence for a CMC.

Action: RMOs, NMIs

d. The RMOs and the BIPM should provide promotional materials to help NMIs that are developing metrology systems to explain the value of the MRA to their funding bodies and Governments.

Action: BIPM and RMOs

Recommendation 6 - (On the governance of the MRA by the JCRB and the CIPM)

a. The JCRB should exercise its authority more fully as defined in its terms of reference in the implementation of the MRA.

    Action: JCRB

b. Noting that several recommendations of the WG charge the JCRB with additional responsibilities, the CIPM should review the document '*Rules of procedure for the JCRB'* (CIPM MRA-D-01).

    Action: CIPM

c. A designated member of CIPM should attend all JCRB meetings.

    Action: CIPM

Recommendation 7 - (On the effective and timely implementation of improvements from this review through the JCRB and the CIPM)

a. The CIPM should, as far as possible, use the JCRB to implement the agreed improvements in the operation/implementation of the CIPM MRA.

    Action: CIPM, JCRB

b. The JCRB/RMO Chairs and members of CIPM should improve communication to ensure CIPM/CC/JCRB interfaces are clear.

    Action: CIPM, CCs, JCRB, RMOs

Recommendation 8 - (On the scopes and processes used for developing CMCs in chemistry)

a. The CCQM and the CCRI should review and revise the templates, if needed, for Chemistry, Biology and Ionizing Radiation CMCs to ensure they are appropriate.

    Action: CCQM, CCRI

Recommendation 9 - (On the development of a new strategy for KCs and CMCs in Ionizing Radiation)

a. The CCRI should finalize and implement strategies to rationalize the suite of KCs and optimize the number of CMCs.

> Note: For both KCs and CMCs, the grouping of species in radioactivity and energies in neutron fluence (e.g. by measurement technique) is considered logical in view of the current transition of radioactivity measurements towards mass spectrometry based metrology.
>
> Action: CCRI

6. Conclusion

The review of the implementation and operation of the CIPM MRA has been an inclusive process with the Review Working Group appointed by a workshop involving NMI Directors, and representatives from: the RMOs, user groups, the CIPM, CCs and the BIPM. The Working Group was chaired by the CIPM President and its membership included representatives from all metrology regions and from large, medium and small NMIs.

The Working Group has formulated a list of some nine recommendations with 28 sub-recommendations and has proposed the key parties to act on each recommendation.

7. Glossary of Acronyms used in this report

BIPM	International Bureau of Weights and Measures/*Bureau International des Poids et Mesures*
CCQM	Consultative Committee for Amount of Substance: Metrology in Chemistry and Biology/*Comité consultatif pour la quantité de matière : métrologie en chimie et biologie*
CCRI	Consultative Committee for Ionizing Radiation/*Comité consultatif des rayonnements ionisants*
CCs	Consultative Committee
CGPM	General Conference on Weights and Measures/*Conférence Générale des Poids et Mesures*
CIPM	International Committee for Weights and Measures/*Comité International des Poids et Mesures*
CIPM MRA	CIPM Mutual Recognition Arrangement
CMC	Calibration and Measurement Capability
DI	Designated institute
IT	Information technology
JCRB	Joint Committee of the Regional Metrology Organizations and the BIPM
KCDB	The BIPM key comparison database
KCs	Key comparisons
NMI	National Metrology Institute
QSs	Quality systems
RMO	Regional Metrology Organization
SCs	Supplementary comparisons
TCs	Technical committees

APPENDIX 1

Membership of the Working Group on the CIPM MRA Review

BIPM, Sèvres – 14 and 15 March 2016

Chair: Dr Barry Inglis, CIPM President

Attendees:

Dr James Olthoff	Physical Measurement Laboratory Director, NIST (USA).	**[SIM]**
Dr Jörn Stenger	Member of the Presidential Board, PTB (Germany).	**[EURAMET]**
Dr Yuning Duan	Vice-Director, NIM (China); CIPM member; CCT President.	**[APMP]**
Dr Martyn Sené	Deputy Director and Director of Operations, NPL (UK).	**[EURAMET]**
Dr Takashi Usuda	Assistant Director General, NMIJ (Japan); CIPM Member; CCPR & CCAUV President.	**[APMP]**
Mr Luc Erard	Scientific Advisor, LNE (France); CIPM Member; CCTF President.	**[EURAMET]**
Dr Peter Fisk	Chief Executive and Chief Metrologist, NMIA (Australia); APMP Chair.	**[APMP]**
Mr Dennis Moturi	Head of Department, Metrology, KEBS (Kenya); AFRIMETS President.	**[AFRIMETS]**
Dr Vladimir Krutikov	Director, VNIIOFI (Russian Federation), COOMET President.	**[COOMET]**
Dr Beat Jeckelmann	EURAMET Chairperson, Chief Science Officer, METAS (Switzerland).	**[EURAMET]**
Dr Héctor Laiz	Director of Metrology, INTI (Argentina); SIM President.	**[SIM]**
Dr Wynand Louw	Director Research & International, NMISA (South Africa); CCRI President.	**[AFRIMETS]**
Dr Gert Rietveld	Chief Metrologist, VSL (Netherlands); CIPM member; CCEM President.	**[EURAMET]**
Mr Robert Edelmaier	Director of Metrology Service, BEV (Austria).	**[EURAMET]**
Ms Nino Mikanadze*	Director of Metrology Institute, GEOSTM (Georgia).	**[COOMET]**
Ms Claudia Santo	Metrology Director, LATU (Uruguay).	**[SIM]**
Dr Barry Inglis	CIPM President (WG Chair).	
Dr Martin Milton	BIPM Director.	
Mr Prayoon Shiowattana*	Director, NIMT (Thailand), Invited by the Chairman to represent interests in chemistry in developing countries.	**[APMP]**

Also attending:

Dr Yury Kustikov*	Deputy Director, VNIIM (Russian Federation).	**[COOMET]**
Mr Andy Henson	Director, BIPM International Liaison and Communication Department.	
Dr Douglas Olson	JCRB Executive Secretary (2015-2016).	

Supporting the meeting:

Mr José Maria Los Arcos	Director, BIPM Ionizing Radiation Department.
Dr Susanne Picard	KCDB Coordinator, Executive Secretary of the CCT.
Dr Michael Stock	Director, BIPM Physical Metrology Department.
Dr Robert Wielgosz	Director, BIPM Chemistry Department.

Apologies for absence:

Dr Willie May*	Director, NIST (USA); Vice-President CIPM: CCQM President.	**[SIM]**
Dr Philippe Richard	Deputy Director, METAS (Switzerland); CIPM Member; CCM President.	**[EURAMET]**

Note - The names of the attendees were agreed at the MRA Review Workshop on 13 and 14 October 2015.

Four additional attendees are indicated with an asterisk. They were invited by the Chairman in order to provide fairer representation for their metrology field, region or size of NMI.

Appendix 2 – Timeline

14 – 15 March 2016 – Meeting of the WG.

27 May 2016 – Final comments on draft report received from WG.

June 2016 - Report completed and sent to CIPM and NMI Directors for comment (deadline of 29 July 2016).

August 2016 - Final Report published and sent to CIPM and NMI Directors.

24 – 25 October 2016 - Report presented and actions prioritized at meeting with NMI Directors.

26 – 28 October 2016 - CIPM confirm action plan.

1 January 2017 – Actions under way by BIPM, RMOs, NMIs, CCs and JCRB.

November 2018 - CIPM report on outcomes to 26th CGPM.