

## CALIBRATION AND MEASUREMENT CAPABILITIES

### A paper by the joint BIPM/ILAC working group

#### Background.

1. After the “Nashville meeting” of the Regional Metrology Organisations and ILAC in 2006, the BIPM/ILAC working group received a number of comments on its proposals for a common terminology for Best Measurement Capability (BMC) and Calibration and Measurement Capability (CMC). It also received comments on its proposal to harmonise on the term “measurement capability” (MC). Some commentators, primarily from the RMO and National Metrology Institute (NMI<sup>1</sup>) community, wished, however, to retain the term CMC. They argued that it had become widely accepted for use in describing, evaluating, promoting, and publishing the capabilities listed in the Calibration and Measurement Capability part of the Key Comparison Data Base of the CIPM MRA. Other commentators from both communities considered that the two terms were applied and interpreted differently according either to established practice or to poor or inconsistent interpretation. They considered that this was itself an adequate justification for a harmonized definition. All, however, agreed that there should be further work to follow up the “Nashville statement” (NS).
2. A further proposal was discussed between the BIPM and the ILAC in a bilateral meeting on 8 March 2007 when ILAC representatives volunteered to move away from the term BMC and to harmonise on CMC. The issue was presented to a meeting between the Regional Metrology Organisations (RMO) and the Regional Accreditation Bodies (RAB) on 9 March 2007. The RMO/RAB meeting welcomed the text. Small modifications were made at the Joint Committee of the Regional Metrology Organisations and the BIPM (the JCRB) on 3 May 2007 in Johannesburg. A presentation was then made on 10 May 2007 to the

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<sup>1</sup> Where the term NMI is used it is intended to include Designated Institutes (DIs) within the framework of the CIPM MRA

Accreditation Issues Committee of ILAC which accepted the document. This text was circulated to the members of the working group on 1 June, in advance of its planned meeting during the NCSLI conference in St Paul, USA, on 1 August 2007 so that there could be further regional consultations. During that period, a small working group developed "Notes 5a and b" aimed at the reference material community.

3. The BIPM/ILAC working group finalised the text during the St Paul meeting and now presents it for approval by the ILAC General Assembly in October 2007 and by the International Committee for Weights and Measures (CIPM) in November 2007. The working group suggested that, after approval, BIPM and ILAC should draft a joint statement on the subject. It also recommended that ILAC should adapt its current draft policy on estimation of uncertainty in calibration so as to take account of the recommendations and the outcome of the working group. The working group will continue to collaborate on other joint documents, which might include additional guidance to laboratories or bodies which produce reference materials. Other documents could include any agreed actions as a result of the ILAC survey of Accreditation Bodies on their experience of accrediting NMIs and a similar survey of the NMIs' experiences. These documents will be discussed in the RMO/RAB meeting in March 2008.
4. The Definition.

**"In the context of the CIPM MRA and ILAC Arrangement, and in relation to the CIPM-ILAC Common Statement, the following shared definition is agreed upon:**

**a CMC is a calibration and measurement capability available to customers under normal conditions:**

**(a) as published in the BIPM key comparison database (KCDB) of the CIPM MRA; or**

**(b) as described in the laboratory's scope of accreditation granted by a signatory to the ILAC Arrangement. "**

5. The Notes to accompany the definition are of crucial importance, and aim to clarify issues of immediate relevance to the definition. They do not claim to cover every implication, or to address related issues. They may, however, be developed further, either in the current draft ILAC policy document on the estimation of uncertainty in calibration, or in any guidance subsequently developed by the JCRB, for approval by the CIPM.

## NOTES

- N1. The meanings of the terms Calibration and Measurement Capability, CMC, (as used in the CIPM MRA), and Best Measurement Capability, BMC, (as used historically in connection with the uncertainties stated in the scope of an accredited laboratory) are identical. The terms BMC and CMC should be interpreted similarly and consistently in the current areas of application.
- N2. Under a CMC, the measurement or calibration should be:
  - performed according to a documented procedure and have an established uncertainty budget under the management system of the NMI or the accredited laboratory;
  - performed on a regular basis (including on demand or scheduled for convenience at specific times in the year); and
  - available to all clients.
- N3. The ability of some NMIs to offer “special” calibrations, with exceptionally low uncertainties which are not “under normal conditions,” and which are usually offered only to a small sub-set of the NMI's clients for research or for reasons of national policy, is acknowledged. These calibrations are, however, not within the CIPM MRA, cannot bear the equivalence statement drawn up by the JCRB, and cannot bear the logo of the CIPM MRA. They should not be offered to clients who then use them to provide a commercial, routinely available service. Those NMIs which can offer services with a smaller uncertainty than stated in the database of Calibration and Measurement Capabilities in the KCDB of the CIPM MRA, are, however, encouraged to submit them for CMC review in order to make them available on a routine basis where practical.

- N4. Normally there are four ways in which a complete statement of uncertainty may be expressed (range, equation, fixed value and a matrix). Uncertainties should always comply with the *Guide to the Expression of Uncertainty in Measurement* (GUM) and should include the components listed in the relevant key comparison protocols of the CIPM Consultative Committees. These can be found in the reports of comparisons published in the CIPM MRA KCDB as a key or supplementary comparison.
- N5. Contributions to the uncertainty stated on the calibration certificate and which are caused by the client's device before or after its calibration or measurement at a laboratory or NMI, and which would include transport uncertainties, should normally be excluded from the uncertainty statement. Contributions to the uncertainty stated on the calibration certificate include the measured performance of the device under test during its calibration at the NMI or accredited laboratory. CMC uncertainty statements anticipate this situation by incorporating agreed-upon values for the best existing devices. This includes the case in which one NMI provides traceability to the SI for another NMI, often using a device which is not commercially available.
- N5a. Where NMIs disseminate their CMCs to customers through services such as calibrations or reference value provision, the uncertainty statement provided by the NMI should generally include factors related to the measurement procedure as it will be carried out on a sample, i.e., typical matrix effects, interferences etc. must be considered. Such uncertainty statements will not generally include contributions arising from the stability or inhomogeneity of the material. However, the NMI may be requested to evaluate these effects, in which case an appropriate uncertainty should be stated on the measurement certificate. As the uncertainty associated with the stated CMC cannot anticipate these effects, the CMC uncertainty should be based on an analysis of the inherent performance of the method for typical stable and homogeneous samples.

- N5b. Where NMIs disseminate their CMCs to customers through the provision of certified reference materials (CRMs) the uncertainty statement accompanying the CRM, and as claimed in the CMC, must indicate the influence of the material (notably the effect of instability, inhomogeneity and sample size) on the measurement uncertainty for each certified property value. The CRM certificate should also give guidance on the intended application and limitations of use of the material.
- N6. The NMI CMCs which are published in the KCDB provide a unique, peer-reviewed traceability route to the SI or, where this is not possible, to agreed - upon stated references or appropriate higher order standards. Assessors of accredited laboratories are encouraged always to consult the KCDB (<http://kcdb.bipm.org>) when reviewing the uncertainty statement and budget of a laboratory in order to ensure that the claimed uncertainties are consistent with those of the NMI through which the laboratory claims traceability.
- N7. National measurement standards supporting CMCs from an NMI or DI are either themselves primary realizations of the SI or are traceable to primary realizations of the SI (or, where not possible, to agreed - upon stated references or appropriate higher order standards) at other NMIs through the framework of the CIPM MRA. Other laboratories that are covered by the ILAC Arrangement (i.e. accredited by an ILAC Full Member Accreditation Body) also provide a recognized route to traceability to the SI through its realizations at NMIs which are signatories to the CIPM MRA, reflecting the complementary roles of both the CIPM MRA and the ILAC Arrangement.
- N8. Whereas the various parties agree that the use of the definitions and terms specified in this document should be encouraged, there can be no compulsion to do so. We believe that the terms used here are a significant improvement on those used before and provide additional guidance and help so as to ensure consistency in their use, understanding, and application worldwide. We therefore hope that, in due course, they will become commonly accepted and used.

## BIPM/RMO-ILAC/RAB WORKING PARTY

- V1 AJW, 17 April 2007.
- V2 Changes agreed during the JCRB meeting (Johannesburg) in May 2007. included by AJW1 June 2007. This version was presented to and agreed by the ILAC AIC on 10 May in Vienna.
- V3 Including "Note 5". 16 July 2007.
- V4 25 July with changes from LM/JMcL/MK.
- V5 1 August 2007 agreed during the meeting at St Paul.
- V6 Drafted by AJW 07 September 2007 as a result of comments received on v5.

Proposed path for endorsement is by:

1. BIPM
2. JCRB (for recommendation to the CIPM for approval)
3. ILAC General Assembly
4. The CIPM