



# Running of MRA comparisons in length metrology and monitoring their impact on CMCs

## Document history

- V1.0 This document was originally prepared for the WGDM meeting in 2005.
- V1.1 It was revised in early 2007, at the request of the WGDM Chairman.
- V1.2 Extensive revision was made in June 2009 following updates to the JCRB web pages.
- V2.0 Updated to V2, in January 2010, after the CCL reorganization in summer 2009.
- V3.0 Updated to V3, in June 2010 for the WG-MRA meeting.
- V4.0 Updated to V4 in March 2011, after publication of CIPM MRA-D-05.
- V5.0 Updated to V5 in January 2012 at request of 2011 WG-MRA meeting.
- V6.0 Updated to V6 in February 2012 by R. Thalmann.
- V6.6 Updated to V6.6 November 2013 by A. Lewis. Recent changes in CIPM documents. Document restructuring.
- V6.7 Updated to V6.7 November 2014 by A. Lewis. Significant figures in results. No upgrade to SC from pilot study.
- V6.8 Updated to V6.8 May 2015 by A. Lewis. Added link to Metrologia Technical Supplement abstract template.
- V6.9 Updated to V6.9 July 2015 by A. Lewis. Clarification of RMO approval for draft B before sending to WG-MRA (p3).
- v7.0 Updated to V7.0 May 2018. Logfile deletion, simplification, split of duties MRA/KC/CMC, CA guidance, CCL 2015.
- v8.0 Updated to V8.0 Nov 2020 by A. Lewis. KCDB2.0. Updated document locations. ER routing. Inter-RMO process.
- V9.0 Updated to V9.0 Sep 2021 by A. Lewis & B/ Eves. New comparison numbering scheme Appendix and related edits.
- V10.0 Updated to V10.0 Nov 2022 by A. Lewis. More detailed process for Executive Reports (agreed at WG-MRA 2022).

## 1 Rationale

This is a CCL/WG-MRA Guidance Document on the requirements for running MRA key and supplementary comparisons and examining CMC claims in Dimensional Metrology after the publication of comparison Final Reports. The MRA requires that CMCs that are published in the KCDB are consistent with the results of the MRA comparisons. This document is intended to cover the entire process, from planning a comparison, carrying out the artefact circulation (including informing NMIs of discrepant results mid-comparison), reporting on the comparison through the necessary chain of authority, distribution and publication of the reports (A, B, Final Executive), examination of CMC claims affected by the comparison results, and the process for modifying CMCs as necessary.

This document does not cover the organization of pilot studies, as the results of pilot studies are not normally used to support CMC claims.

## 2 Summary of guidance

1. None of the additional guidance given by this document (and those it refers to) conflicts with the requirements set out in the MRA documents or guides issues by JCRB/CIPM.
2. CCL has delegated the responsibility for approving Key comparisons Protocols and Final Reports to WG-MRA. Final reports no longer require CCL approval before entering KCDB.
3. RMOs can start RMO Key and Supplementary Comparisons, however only CCL can start a new (Supplementary or Key) CCL comparison.
4. Supplementary Comparisons are normally organised by the RMOs, but CCL can decide to run one. Like Key Comparison Final Reports, Supplementary Comparison Final Reports should be copied to WG-MRA and CCL Executive Secretary to allow 6 weeks for comments.
5. Participation in RMO and CCL comparisons is decided by the MRA rules. WG-MRA assists pilots in coordinating intra- and inter-RMO participation.
6. Inter-RMO comparisons are conducted to minimise the workload, where appropriate. Their participants, who are also CCL members, form a 'virtual CCL comparison', in case one is needed for linking purposes.
7. Pilot studies may be used to support CMCs, but this is not normal. Pilot studies are no longer allowed to be re-classified as Supplementary Comparisons.
8. Conduct of comparisons is according to CIPM MRA guidance document CIPM-MRA-D-05 with a few additions:
  - a. Template documents for Protocols, Final Reports and Executive Reports, are now made available on the WG-MRA website for use by pilots.
  - b. Any outliers noticed by the pilot before Draft A trigger an immediate request from the pilot to the participant to check their results (no quantitative information is given by the pilot). Multiple changes are not allowed – the intention is to remove blunders/transcription errors, not offer repeated chances to 'guess' the correct value.
  - c. The pilot should make it clear when the Draft A report is about to be sent out as this triggers a closure of the period for freely correcting submitted results.
  - d. Correcting results before Draft A is allowed where there is a valid reason (pilot informs all participants). Correcting obvious blunders after Draft A is allowed at pilot's discretion and with approval of participants and endorsement by WG-MRA when approving the Final Report. Results which still cannot be explained and are not in agreement with the KCRV are termed 'significant outliers' and are listed in the Executive Report. sWG-CMC will ask RMO TC-L chairs to check annually for corrective actions to clear these issues.
  - e. An Executive Report is often produced after the Final Report. It is short and compares results (DoEs) with any existing CMCs. Corrective actions and recommendations are listed in this report which is private to the participants, the WG-MRA and the CCL. The report usually is prepared up to 6 months after the Final Report to allow time for some actions to be completed first. If there are no significant actions, the report can

follow sooner. The main audience for the report is sWG-CMC. In cases where the Final Report is very short and there are no corrective actions, the Executive Report may be omitted (and simply have its conclusions included in the Final report).

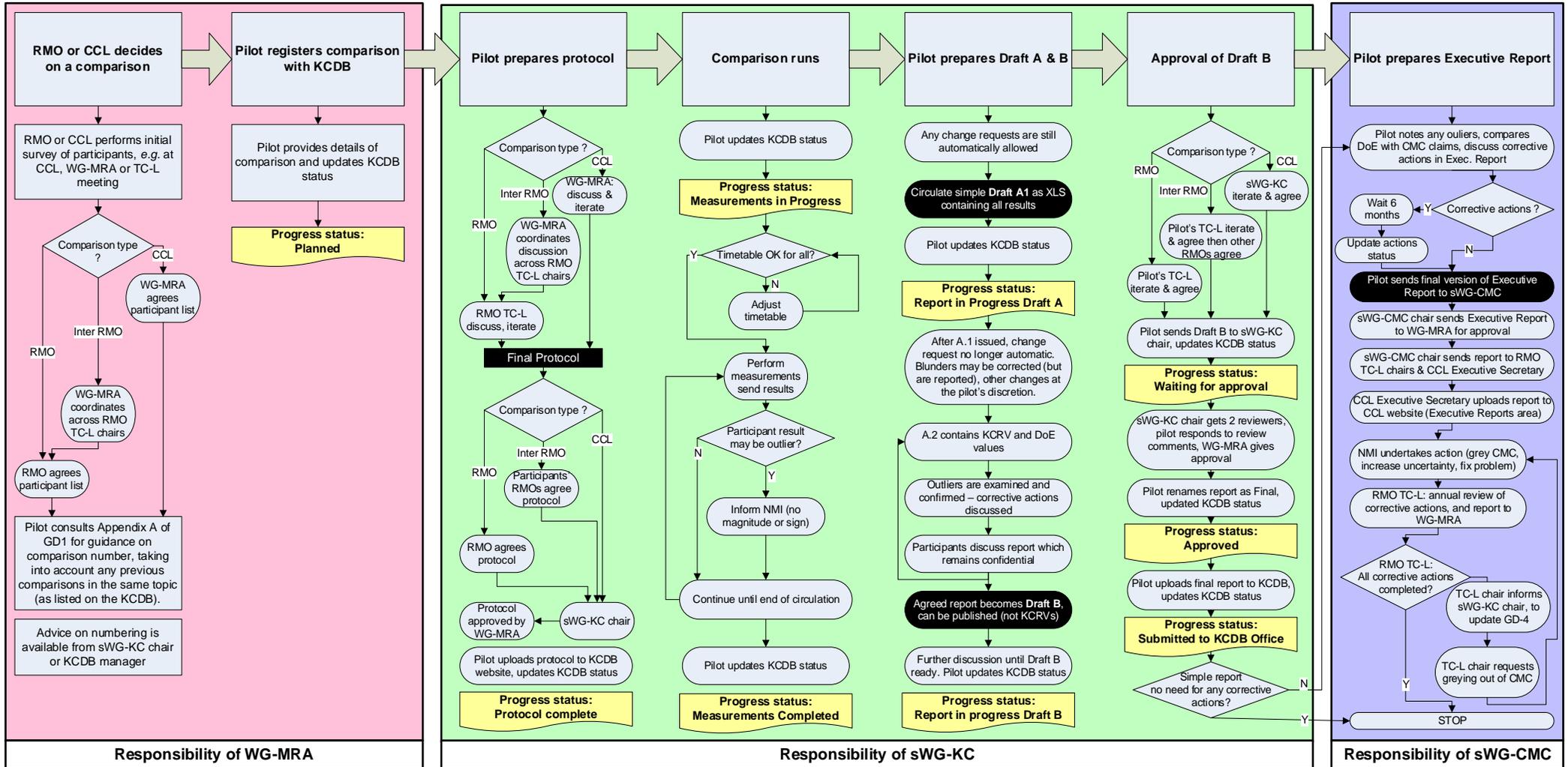
9. Documents required for each comparison are therefore: Protocol, Draft A report, Draft B report, Final Report, and possibly an Executive Report.
10. Protocol documents should contain a proposal for how to calculate KCRV(s).
11. All versions of Draft A are private (to the participants). They should not be sent to anyone outside the participant list without first anonymising the results.
12. Draft B should be checked in detail by all participants before it is sent onwards. RMO comparison reports should be approved first by the local RMO before being sent to sWG-KC. Inter-RMO comparison reports should be approved first by the RMO of the pilot laboratory, then by the RMOs of the other participants, before being sent to the chair of sWG-KC. The chair of sWG-KC will request 2 reviewers to perform a detailed review of the Draft B report before it is passed (after any necessary correction) to WG-MRA for approval as a Final Report. (CCL-K11 reports do not need this review unless substantially different from preceding years).
13. Comparison Final Reports should bear the names of all NMI participants (*e.g.* at least one person per participating NMI). The pilot is lead author. This is particularly the case when submitting the *Metrologia Technical Supplement* publication form. Further guidance on the authorship of comparison reports is published by the BIPM ([CIPM MRA-G-04](#)).
14. After WG-MRA approval, the report is renamed from Draft B to Final Report and should be uploaded by the pilot in unprotected PDF to the KCDB website. The pilot (via the RMO or CCL Executive Secretary) should ensure private and safe archival of comparison data (including analysis spreadsheets) and reports. The sWG-KC chair will inform the chair of sWG-CMC that the report is finalised and may be examined for impact on CMCs.
15. The pilot should update the status of the comparison in the **KCDB web page at all stages** and will receive emails twice a year to update the status. These updates trigger emails to be sent by the KCDB to interested parties (KCDB manager, local RMO TC-L chair, WG-MRA chair and sWG chairs).
16. All participants should be prompt in sending results to the pilot and in all communications.
17. Each NMI has primary responsibility for checking and correcting/withdrawing its CMCs. There are formal routes which can be followed to request an NMI to make changes but the eventual responsibility comes down to the RMO (usually the TC-Quality) then the NMI.
18. Any issues with CMCs supported by comparisons will be highlighted in the Executive Report together with any recommendations on corrective actions. A delay of up to 6 months is allowed to correct the issues before the report is finalised. The Executive Report should be agreed first by the participants, then by the RMO of the pilot, followed by the RMOs of the other participants, before it is sent to sWG-CMC for transmission to the WG-MRA for approval. After approval, the report is sent by sWG-CMC chair to the CCL Executive Secretary and the relevant RMO TC-L chair for storing.
19. sWG-CMC asks TC-L chairs to review CMC actions as part of their annual report to WG-MRA.

20. The confidence level of all uncertainties should be clearly stated: label all uncertainty bars in graphs and any mention of uncertainties in the test as either standard or expanded. All expanded uncertainties, CMC claims and En values should be evaluated at 95 % confidence level.
21. Usually only 2 significant figures should be used in uncertainties.
22. At the pilot's discretion (subject to time constraints and not adding extra wear/damage), a participant may use (and report) results from more than one instrument but must nominate one instrument as primary – only the results from the primary instrument will contribute to the KCRV calculations.

The process is controlled at different stages by different parts of the WG-MRA:

- The entire WG is responsible for the initiation and coordination at the planning stage of a comparison.
- The numbering, running and reporting of the comparison as far as Final Report and its entry into the KCDB, are the responsibility of sWG-KC.
- The analysis of the final reports, preparation of Executive Reports and the effect of comparison results and corrective actions on CMC claims (as well as monitoring corrective actions) are the responsibility of sWG-CMC.

The key parts of the process are summarised in a flow chart on the next page and then step by step guidance is given. Sometimes the actual process diverges from the detailed guidance (e.g. an RMO forgets to announce the comparison to the WG-MRA or forgets to obtain approval of the protocol). In such cases the process should be followed from the appropriate point in the flow chart.



### 3 Step by step guidance on the process

*Notes on use of KCDB website.*

(1) When registering a comparison, the KCDB website requests details of the following for each comparison: conducted by, approved by, identifier, type, metrology area, sub-field, linked to, summary description, measurand, measurand value(s), parameters, device or sample, progress status, additional contact person (co-pilots), measurement start year, measurement end year, supporting documents (e.g. protocol), supporting links, comments, optional message to KCDB office. The SAVE button allows contents to be saved any time without final submission.

(2) Note that after the pilot pushes the SUBMIT TO KCDB OFFICE button on the KCDB2.0 website, the website only allows editing of: start date, end date and comments. Before the button is pushed, the protocol can be uploaded, but not afterwards. Subsequent changes require liaison with the KCDB manager.

(3) The status of the comparison may be updated by the pilot on the KCDB web site. The progress status can be selected from a list of: Planned, Protocol Completed, Measurements in Progress, Measurements Completed, Report in Progress Draft A, Report in Progress Draft B, Approved, Postponed, Waiting for Approval, Submitted to KCDB office.

(4) Note that **KCDB2.0 website** sends automatic notification emails to the TC Chairs, WG Chairs, CCL Executive Secretary, Pilot and KCDB Office when: the Pilot registers a comparison; or the status of the comparison is changed. It is vitally important that the Pilot keeps the KCDB website up to date, so that these automatic emails are sent to the relevant people. Such actions on KCDB updating are **highlighted** in the guidance below.

#### 3.1 Preparations are made to run a comparison

Note that only CCL can authorize preparation of a new CCL Key Comparison (KC) or CCL Supplementary Comparison (SC) whereas RMO KC or SC can be started by any RMO, as can Inter-RMO KCs. sWG-KC has responsibility for the process until the Final report is approved.

Note that the email distribution list `ccl-wg-mra`at`bipm.org` can be used for distributing emails (where 'at' is @).

**Protocol template document WG-MRA-GD3.1 [23] should be followed.**

##### (a) Protocol preparation (all comparisons)

**RMO TC-L or CCL** proposes running a new comparison. Initial selection of participants may be discussed within the RMO or at WG-MRA meeting.

The comparison number is chosen according to the guidance in Appendix A of this Guidance Document. As the rules are explicit, the number is immediately known and can be used henceforth. The pilot should consult with the **sWG-KC chair** and/or the KCDB Coordinator if the numbering is not immediately clear.

**Pilot** registers comparison directly on the **KCDB Website**.

The KCDB Manager will consult with the **sWG-KC chair** to confirm the correct comparison number.

**Pilot updates Progress status on KCDB website to Planned.**

**Pilot** prepares protocol based on WG-MRA-GD-3.1 template.

##### (b) Organizing CCL KC, CCL SC

**Pilot** sends draft protocol to **sWG-KC chair** and all **TC-L chairs**.

**Pilot** with **TC-L chairs** (e.g. at WG-MRA meeting) chooses participants, finalize protocol.

**Pilot** sends final protocol to **sWG-KC chair** who arranges for **WG-MRA** approval. After approval, the **sWG-KC chair** informs the **Pilot** who then uploads the final protocol to the **KCDB website**.

**Pilot** updates Progress status on **KCDB website** to *Protocol complete*.

**Pilot** informs participants and prepares to run comparison.

(c) Organizing Inter-RMO KC

**Pilot** sends draft protocol to local **TC-L chair** who sends it to **sWG-KC chair** and all **TC-L chairs**.

**Pilot** with **TC-L chairs** (e.g. at WG-MRA meeting) organizes inter-regional participation, finalize protocol.

**Pilot** sends final protocol to **sWG-KC chair** who arranges for **WG-MRA** approval. After approval the **sWG-KC chair** informs the **Pilot** who then uploads the final protocol to the **KCDB website**.

**Pilot** updates Progress status on **KCDB website** to *Protocol complete*.

**Pilot** informs participants and prepares to run comparison.

(d) Organizing RMO KC, RMO SC

**Pilot** & **TC-L chair** organize local participation, finalize protocol.

**TC-L chair** sends final protocol to **sWG-KC chair** who arranges for **WG-MRA** approval. After approval the **sWG-KC chair** informs the **Pilot** who then uploads the final protocol to the **KCDB website**.

**Pilot** updates Progress status on **KCDB website** to *Protocol complete*.

**Pilot** informs participants and prepares to run comparison.

## 3.2 Running the comparison

The responsibility for the process remains within sWG-KC. Pilot runs the artefact circulation following and amending the timetable as necessary (any changes to be agreed by all participants by exception).

(a) Start of all comparisons

**Pilot** updates Progress status on **KCDB website** to *Measurements in Progress*.

**Participants** make measurements and send results to pilot within 6 weeks.

**Pilot** immediately informs NMIs of potentially discrepant results during circulation.

**Pilot** informs **TC-L chair** & **sWG-KC chair** & **Participants** of any delays or problems and tables short report on comparison status at each WG-MRA meeting (using 1 page summary template).

The **Pilot** will receive (from the KCDB website) an automatic notification at regular intervals (twice each year) with the request to update the status. If the status has not changed, the **Pilot** is still invited to consult the comparison status and indicate "save" to confirm that the comparison is still active.

**Pilot** confirms the data sent by the participants (e.g. by sending out to each participant an Excel copy of the submitted results, in the units and format intended for further analysis, to ensure correct transcription).

(b) At end of all comparisons

**Pilot** updates Progress status on **KCDB website** to *Measurements Complete*.

**Pilot** informs **Participants** of likely date for circulation of Draft A report. Pilot chases any **Participants** that have not yet submitted results. Any results arriving late (after 6 week deadline) are to be noted in the Draft B report.

### 3.3 Draft A reporting

**Pilot** prepares and sends out a Draft A.1 report to all participants. A minimum Draft A.1 report could be a simple spreadsheet of participants' data, for checking. Draft A is iterated until agreement is reached. Analysis should be consistent with existing guidelines (*i.e.* could include most consistent sub-set, based on chi-squared testing or  $E_n$  &  $R_B$  ratio testing). All iterations of Draft A reports are confidential to the participants and may not be referenced or used to support CMCs. After Draft A.1 is released, no withdrawal of results is allowed unless due to failure of travelling standard(s) or other issues, and agreement of all participants is required.

Note that the Draft A report is the one that is iterated through many versions – it starts with just the summary of the results, and is then developed into a more detailed report.

**Report template document WG-MRA-GD3.2 [24] should be followed as well as guidance document WG-MRA-GD3 [20].**

#### (a) All comparisons

**Pilot** summarizes all received data, sends to **Participants** for checking as **Draft A.1** report.

**Pilot updates Progress status on KCDB website to Report in Progress, Draft A.**

**Pilot** & **Participants** iterate Draft A report by including KCRV & DoE (DoE optional for SCs).

**Pilot** requests from each **Participant**, a list of existing CMCs which the comparison should support. This will either enter the Draft B report or the Executive Report.

If the comparison report is short, and the results support all existing CMCs, the list of supported CMCs can be included in the Draft B report. In the case that some CMCs are not supported or there are Corrective Actions, the discussion of CMCs is left to the Executive Report.

For any CMC claim not supported by comparison results the **Pilot** enters into dialogue with NMI concerned to discuss possible Corrective Action which can be included in the Executive Report. By starting this process early, there is a possibility to complete the Action before publication of the Executive Report.

### 3.4 Draft B reporting

After all participants agree on the iterated Draft A report, it is re-issued as a Draft B report, which may then be referenced and is no longer confidential (apart from the KCRVs which remain confidential until approved by WG-MRA). All Draft B reports must be approved by the WG-MRA before they can be used to support CMCs. RMOs approve RMO supplementary comparison Draft B reports (making them Final), and WG-MRA approves all other Draft B reports (making them Final). **All** reports are shown to WG-MRA, before they enter the KCDB in order to perform quality control through an anonymous review process; SWG-KC allocates 2 persons to perform a detailed review of SC and KC reports before they are finalized.

#### (a) All comparisons

**Pilot** renames final Draft A report as **Draft B** report, sends to participants.

**Pilot updates Progress status on KCDB website to Report in Progress, Draft B.**

#### (b) RMO KC, RMO SC, Inter-RMO KC

**Pilot (& TC-L chair)** arrange for discussion of Draft B report according to RMO procedures, *e.g.* at a TC-L meeting, or circulated by email, including any participants from outside RMO in the discussions (for inter-RMO KC).

The RMO of the Pilot should approve the Draft B report and participants from other RMOs should ensure that those RMOs also approve the Draft B report.

After confirmation that RMOs of all participants have approved the report, **Pilot** sends the Draft B report to **sWG-KC chair** & **TC-L chair**, requesting approval from WG-MRA.

**Pilot** updates Progress status on **KCDB website** to *Waiting for approval*.

(c) CCL KC, CCL SC

**Pilot** sends Draft B report to **sWG-KC chair** requesting approval from WG-MRA.

**Pilot** updates Progress status on **KCDB website** to *Waiting for approval*.

(d) All comparisons

**sWG-KC chair** requests 2 **Reviewers** to perform detailed review of report. The **Reviewers** send feedback to **sWG-KC chair** on report. **sWG-KC chair** passes the feedback to the **Pilot**.

**Pilot** makes corrections and renames report as Final and sends to **sWG-KC chair** who then distributes it to the whole **WG-MRA** for approval. Revisions are iterated if necessary.

After WG-MRA gives approval, **sWG-KC chair** informs and sends the Final report to both the **Pilot** and the **KCDB Manager**.

**Pilot** updates Progress status on **KCDB website** to *Approved*.

**Pilot** uploads the Final report (as unprotected PDF) to the **KCDB Website**.

**Pilot** sends abstract (using MS Word [template](#)) for *Metrologia Technical Supplement* to **KCDB Manager**.

**Pilot** updates Progress status on **KCDB website** to *Submitted to KCDB office*.

### 3.5 Preparation and use of the Executive Report

After the Final report enters the KCDB, the sWG-CMC takes over responsibility.

The pilot considers preparation of the Executive Report. This contains a discussion on whether or not participants' CMCs are supported by the results of the comparison. For any cases where CMCs are not supported due to poor results, the report includes the corrective actions agreed with the NMI(s) and whether or not the actions have been completed already. In cases where there are no corrective actions the Executive Report can be prepared and sent to WG-MRA immediately. However, normally there are corrective actions which need some time to perform and it is usual to wait 6 months after the Final Report enters the KCDB, before the Executive Report is finalised. In cases where the comparison has been fully successful (CMCs supported) and there are no corrective actions and the Final Report is short, then the pilot may decide that an Executive Report is not required and inform the **sWG-CMC chair** accordingly.

**Executive report template document WG-MRA-GD3.3 [23] should be followed as well as guidance document WG-MRA-GD3 [20].**

(a) All comparisons

#### **Pilot Prepare Executive Report**

For any cases where there was a poor result in the comparison ( $En > 1$ ), this should be discussed in the Executive Report, as well as examining if there is any impact on any existing CMC claim. Also, cases where the uncertainty given by a participant for their key comparison results is much larger than their CMC claim require further investigation.

**CMC claims not supported by comparison** – **Pilot** informs the affected **participant** which agrees corrective action with **Pilot** and **TC-L chair**. Corrective action is noted in the Executive Report. **Pilot** informs **participant**, **TC-L chair** and **sWG-CMC chair** [as required by Decision CCL2 (2015)].

Ideally, each issue should have a corrective action proposed by the NMI. This could be: long-term greying out of CMC; follow-up comparison; internal technical audit; detection of blunder and confirmation of correction. [All CMC changes must be requested by the NMI concerned, informing the **TC-L chair**].

If there are Corrective actions which can all be achieved within 90 days, **Pilot waits 90 day before proceeding to next step**.

Any corrective actions completed within 6 months are noted in the Executive Report and any CMCs that were affected and greyed out are reinstated. [All CMC changes must be requested by the NMI concerned, informing the **TC-L chair**].

**Pilot** sends Executive Report to **sWG-CMC chair** who distributes it to all **WG-MRA** members for approval.

After approval, **sWG-CMC chair** sends Executive Report to **CCL Exec. Sec.** (who stores it on the private WG-MRA website) with copy to **Pilot** who sends it to **Participants** and to **TC-L chairs** of RMOs which had participants in the comparison.

**sWG-CMC chair** and **TC-L chairs** note any corrective actions and whether or not they are cleared.

### 3.6 Corrective Action not completed after Executive Report is finalised

For any corrective action that is not cleared, the procedure in the RMO of the affected NMI should be followed. [In EURAMET, this means leaving the entry visible in the CMC Corrective Actions part of the web site for future monitoring and discussion.] **The responsibilities set out in JCRB-11/7(a) apply.**

**The NMI with the affected CMC has primary and principal responsibility.** It is expected that the NMI with an affected CMC will request either greying out of the CMC or increase of the uncertainty to cover the significant deviation.

NMI requests greying out of CMC by contacting **KCDB** and informing **TC-L chair**, and **sWG-CMC chair**.

**Through its Technical Committees/Working groups, the RMO should monitor the impact of key and supplementary comparison results on CMC claims for its member NMIs.**

The RMO TC-L should review the list of outstanding Corrective Actions annually and the TC-L chair should report to WG-MRA on their status.

**TC-L chair** informs RMO chair or RMO TC-Q of outstanding, uncorrected CMC claims. [In EURAMET, the list of Corrective Actions is discussed at each TC-L meeting.]

**When any corrective action is cleared at a later date.**

The NMI request reinstatement of CMC by contacting **KCDB**, informing **TC-L chair**, and **sWG-CMC chair**.  
*[In EURAMET, the list of Corrective Actions is updated to show the item is cleared.]*

### **3.7 If further action is required (non-clearance of Corrective Actions).**

In the case that an NMI makes no efforts to undertake or agree corrective action and/or the affected CMC remains active in the KCDB, the formal route for raising this with the appropriate authorities is as follows, with each step taking the matter higher if no action is undertaken by the NMI:

**Pilot** tries to agree corrective action at any stage until the Executive Report is finalised.

If unsuccessful, next the **sWG-CMC chair** contacts the affected NMI with the same request.

If unsuccessful, next the **sWG-CMC chair** contacts the affected RMO TC-Q with the same request.

If unsuccessful, next the **WG-MRA chair** raises the issue with **CCL**.

The **CCL**, after discussing the matter at the next meeting, raises the matter with the JCRB by asking the **WG-MRA chair** to write to the JCRB chairperson.

The key comparison process is now complete and all relevant reports have been filed. CMCs impacted by the comparison have been identified and corrective actions discussed and, hopefully, implemented.

## 4 Requirements from MRA, JCRB, CCL, WGDM & WG-MRA

This section is provided only as background information showing how the process given earlier in the document has been decided and summarizes the main requirements presented in the various reference documents governing the MRA. It is only intended as background reading.

The definitive text is that in the most recent published version of the original documents. Links to the original documents, including their full titles, may be found at the end of this document as well as in the text headings below. This section is updated whenever there are changes to the relevant parts of the reference documents. Emboldening is used here to highlight key points. This section is provided for reference – the processes detailed earlier in this guidance document are based on this summary of requirements.

### 4.1 MRA documents

#### MRA

- 6.1 Participation in a CIPM key comparison is open to laboratories having the highest technical competence and experience, normally the member laboratories of the appropriate Consultative Committee. Those laboratories that are not members of a Consultative Committee and not NMIs must be nominated by the designated national metrology institute referred to in paragraph 1.4 as being responsible for the relevant national measurement standards. **In choosing participants, the Consultative Committees should take proper account of regional representation. The number of laboratories participating in CIPM key comparisons may be restricted for technical reasons.**
- 6.2 Participation in key comparisons organized by an RMO is open to all RMO members and to other institutes that meet the rules of the regional organization (**including institutes invited from outside the region**) and that have technical competence appropriate to the particular comparison.”
- 6.3 “Participation in RMO supplementary comparisons is open to those institutes meeting the requirements specified in paragraph 6.2.

#### MRA T.7

For calibration and measurement certificates, the quantities, ranges and calibration and measurement capabilities expressed as an uncertainty (**normally at a 95 % level of confidence** but in some cases it may be at a higher, specified, level), are listed for each participating institute in Appendix C. They must be consistent with the results given in Appendix B, derived from the key comparisons. If, as a result of a key comparison, a **significant unresolved deviation from the key comparison reference value persists for the standard of a particular participating institute, the existence of this deviation is noted in Appendix C. The same applies for significant inconsistencies resulting from a supplementary comparison.** In this case, the institute has the choice of either **withdrawing from Appendix C one or more of the relevant calibration and measurement services or increasing the corresponding uncertainties given in Appendix C...**

#### CIPM - Guidelines for CIPM key comparisons

**An institute that considers its result unrepresentative of its standards may request a subsequent separate bilateral comparison with the pilot institute or one of the participants.** This should take place as soon as possible after the completion of the comparison in progress.

#### CIPM MRA-D-04

- 10.0 Modifications of a published CMC usually arise for reasons falling into one of three categories:

...b) increase of the uncertainty or reduction in scope, decided by the NMI or following a comparison result;

Modifications under category b) may be requested, for example, by an NMI wanting to reduce its engagement in the particular measurement activity or they may follow from a comparison result showing a significant unresolved deviation from the key comparison reference value. Also for this category **internal and inter-RMO reviews are not needed** and that the proposal for change is **received by the TC chairperson and transmitted to the coordinator of the BIPM database**. However, in case that the change was originated by a comparison result, **the TC chairperson should verify that the reduction in scope or the increase of the uncertainty** is sufficient to assure the equivalence of the measurements. It is desirable in this case that the relevant RMO (or the BIPM) informs the other RMOs of the changes and their motivation.

#### CIPM MRA-D-05

- 2.1.3 ... The method used to determine the key comparison reference value is part of the protocol of the comparison and is agreed by the Consultative Committee or by the appropriate working group to which the Consultative Committee has delegated this task.**
- 2.2 ... A supplementary comparison is a comparison, usually carried out by an RMO to meet specific needs not covered by key comparisons (e.g. regional needs), for instance measurements of specific artefacts, or measurements of parameters not within the “normal” scope of the Consultative Committees. **Consultative Committees may however decide to run a supplementary comparison** when there are only few participants capable of measuring the required quantity (none sharing the same RMO), when no link can be made to an RMO comparison or when the distribution of samples to measure is a constraint (for instance: measurements of radioactive matrix reference materials).
- 2.3 ... Pilot studies are a third category of comparison normally undertaken to establish measurement parameters for a “new” field or instrument, or as a training exercise. **The results of pilot studies are not normally considered sufficient support for calibration and measurement capability (CMC).**
3. ... During the course of a comparison that is registered in the KCDB, it is important that **up-to-date information on the progress of the comparison be readily available**. This implies that the **participants**, the **KCDB Office**, and the **Consultative Committee** (the **President**, the **Executive Secretary**, and the **working group** designated by the Consultative Committee for this task) should be **regularly informed by the pilot institute** of the status of the comparison. The progress of a comparison may be reported to the KCDB office with the same form used for registration.
- 4.3 The organization of a CIPM key comparison is the responsibility of the pilot institute which may be helped by the coordinating group. The first task of this group is to draw up the detailed technical protocol for the comparison (see Section 4.4) and its dispatch, inviting participation as defined by the Consultative Committee (see paragraph 6 of the CIPM MRA). In those committees having permanent working groups or sections responsible for specific areas of activity, **the draft protocol must be sent to the chair of the relevant working group or section. The invitation to participate is sent directly to the delegates of member institutes present at the previous meeting of the Consultative Committee, plus absent members. Copies of the invitation and draft protocol are also sent to the BIPM executive secretary of the Consultative Committee.**
- 4.6 The participating institutes must **report the results of the measurements to the pilot institute** as soon as possible after this date and **at the latest six weeks after the measurements are completed**. The measurement results, together with the associated uncertainties and any additional information required, should be reported in the format given in the instructions as part of the protocol, usually by completing the standard forms annexed to the instructions.

A result from a participant is not considered complete without an associated uncertainty, and is **not included in the draft report unless it is accompanied by an uncertainty** supported by a complete uncertainty budget. Uncertainties are drawn up following the guidance given in the technical protocol.

If, on examination of the complete set of results, the pilot institute finds results that appear to be anomalous, the corresponding **institutes are invited to check their results for numerical errors but without being informed as to the magnitude or sign of the apparent anomaly**. If no numerical error is found, the result stands, and the complete set is sent to all participants.

- 4.7 The pilot institute is responsible for writing the report of the key comparison. The report passes through a number of stages before publication, and these are referred to here as Draft A, Draft B and Final Report.

The first draft, **Draft A, is prepared as soon as all the results have been received** from the participants. It includes the results transmitted by the participants, identified by name, and a first calculation of the key comparison reference value. **However, the results are not communicated if there are any outliers, until the participants concerned have been contacted to ensure that there are no arithmetic, typographical or transcription errors involved.**

The participants may make comments on their own results and these may be modified if there were errors in the report of the result (typographical errors, different units, transcription errors from the institute report to the Draft A report). **In the case of results that are not consistent with published CMCs or are discrepant with the reference value, the participants are not allowed to withdraw their results from the report unless a reason not attributable to the performance of the laboratory can be assigned (for example, if an excessive drift or a malfunction is detected in the traveling standard). Individual values and uncertainties may be changed or removed or the complete comparison abandoned, only with the agreement of all participants and on the basis of a clear failure of the traveling standard or some other phenomenon that renders the comparison or part of it invalid.**

As the results may be changed due the reason explained above, **Draft A (in all its versions) must be considered confidential and distributed among the participants only**. As results may change, Draft A reports cannot be used as support for claiming CMCs.

**Until all the participants have agreed on the report, it should be considered to be in Draft A stage, it being possible to have successive versions (Draft A1, A2, ...etc.).**

**In calculating the key comparison reference value, the pilot institute will use the method considered most appropriate for the particular comparison (normally that proposed in the protocol), subject to confirmation by the participants and, in due course, the key comparison working group and the Consultative Committee.** After deciding the key comparison reference value and its uncertainty, the deviation from the reference value and the expanded uncertainty at a 95% level of confidence ( $k = 2$  for infinite number of degrees of freedom) of the deviation are deduced for each of the individual results (degrees of equivalence). **At this stage the participants may review the initial decision to include or not bilateral degrees of equivalence, subject to approval of the corresponding CC.**

Once the final version of Draft A, which includes the proposed key comparison reference value and degrees of equivalence, is approved by the participants, the report is considered as Draft B. It must then be submitted for approval by the corresponding Consultative Committee. At this stage, the results are not considered confidential and can be used to support CMCs and used for presentations and publications, except for the key comparison reference value and the degrees of equivalence which must be considered confidential until they are approved by the Consultative Committee and published in the KCDB.

The **working group on key comparisons is normally charged with examining Draft B** prior to its distribution to all members of the Consultative Committee, to ensure that it meets all the requirements set by the committee. In the case of those Consultative Committees having permanent

working groups dealing with specific areas of activity, the Consultative Committee may ask these working groups to undertake the functions of the key comparison working group.

Entry of the results, including the degrees of equivalence, into the KCDB must wait until Draft B has been approved by the Consultative Committee, at which point the Draft becomes the Final Report. **At that stage, the mention “Draft B” in the title or contents should be replaced by the mention “Final Report”.** Approval by the Consultative Committee may be given by correspondence on the recommendation of the working group on key comparisons. Each Consultative Committee will set its own procedures for approving the results of key comparisons in the most efficient and timely way possible.

In the event of disagreement concerning the results or the interpretation of the results of a key comparison, which cannot be resolved by the participants, by the key comparison working group or by the Consultative Committee, **the matter is referred to the CIPM** for a decision.

7. ... Supplementary comparisons are normally organized by the RMOs to cover areas or techniques not covered by key comparisons. These are complementary to key comparisons and are not intended as second-level comparisons. Their final reports are published in the KCDB, **but degrees of equivalence are not necessarily computed.**
- 7.2 Preparation of the reports of **supplementary comparisons** should follow the same three-stage process: Draft A, Draft B, Final Report. The differences are:
  - **approval is given by the corresponding RMO committee;**
  - degrees of equivalence relative to a supplementary comparison reference value may be computed, but this is not mandatory.

**Reports approved by the RMO must be forwarded to the CC Executive Secretary and the Chair of the relevant working group (e.g. Key Comparison or CMC Working Group) of the CC to allow for a six-week period of comment and editorial control.** If at the end of the period, no objections have been raised within the working group of the CC, the final report, accompanied by a statement that the control and comment procedure has been completed, will be **sent by the RMO TC Chair to the KCDB Office for publication in the KCDB.** Those CCs that wish to discuss RMO supplementary comparison reports and formally approve them at the meetings of their relevant CC working groups **may do so as an alternative.** To be used as support for CMCs the Final Reports should be published in the KCDB.

8. **The comparison Final Reports for publication must be sent in portable document format (pdf) to the corresponding Consultative Committee’s executive secretary and, after approval, to the KCDB Office, together with a clear statement that the report is approved by the RMO and/or the CC. It should be accompanied by a short abstract in Word format. For key comparisons, it should also be accompanied by an EXCEL spreadsheet file containing the data and graphs to be published in the KCDB.**

It is recommended that the Final Reports of all comparisons are published in a technical journal such as the Technical Supplement of Metrologia, or any other publicly available publication.

9. The chain of responsibility to ensure that CMC claims made by an NMI are consistent with the results obtained in key and supplementary comparisons is identified as follows:
  1. **The NMI making the CMC claim has primary and principal responsibility.**
  2. Through its technical committees/working groups, the RMO should monitor the impact of key and supplementary comparison results on CMC claims for its member NMIs.
  3. The Consultative Committee working groups on CMCs **are intended to:**

- provide guidance on the range of CMCs supported by particular key and supplementary comparisons;
- identify areas where additional key and supplementary comparisons are needed;
- coordinate the review of existing CMCs in the context of new results of key and supplementary comparisons.

The procedure for monitoring the impact of comparisons is as follows:

1. After Draft B is approved, if the NMI detects a discrepancy between the published CMC and the result of a comparison, the NMI should send a communication to the corresponding RMO technical committee and to the chair of the RMO technical committee/working group responsible for approval of NMI quality management systems.

If the pilot institute detects the discrepancy between the results of a laboratory in a comparison and published CMCs, **the pilot institute should write to the NMI alerting them to any potential problems in their results for the comparison, copying to the NMI's RMO technical committee.**

In both cases, the communication should be **copied to the Consultative Committee working group on CMCs** with jurisdiction over the comparison, **the JCRB** and the **President** of the **Consultative Committee**.

2. Within ninety days, the RMO should write to the **Consultative Committee working group on CMCs, the JCRB and the President of the Consultative Committee (with copy to NMI)** stating the action plan for correcting any potential problems. A resolution statement, in the next RMO annual report on the status of quality systems, should follow stating the results of the corrective action. In cases where the action plan fails to resolve the problems within six months, the RMO should request from the JCRB the temporary removal of the CMCs from the KCDB.
3. The RMO should request from the JCRB the reinstatement of temporarily removed CMCs once the corrective action has been implemented.
4. The Consultative Committee should inform the CIPM of the incident as part of its annual report.

## 4.2 JCRB documents

### [JCRB-11/7\(a\)](#)

The chain of responsibility to ensure that CMC claims made by an NMI are consistent with the results obtained in key and supplementary comparisons is identified as:

1. **The NMI making the CMC claim has primary and principal responsibility.**
2. Through its Technical Committees/Working Groups, the RMO should monitor the impact of key and supplementary comparison results on CMC claims for its member NMIs.
3. The Consultative Committee Working Groups on CMCs are intended to: ...coordinate the review of existing CMCs in the context of new results of key and supplementary comparisons.
4. If, based on the results of a key or supplementary comparison, an RMO/NMI has concerns about the CMC claims of a particular NMI within another RMO, it should contact the NMI directly to seek resolution. If this is not successfully concluded, then the matter should be directed to the relevant RMO of the NMI making the CMC claims. In the event that further intervention is required, the JCRB Chairman should then be requested to help resolve the issue.

### 4.3 WGDM documents

#### Items decided at WGDM Meetings 2000-2001 [CCL/WGDM-01-44]

7. **Modifying Data during Key Comparisons:** The WGDM confirms that participants of CCL KCs may modify data/uncertainties after submission to the Pilot, provided that the participants are still blind to one another's results. The Pilot must notify all of the participants of any such request for change, seeking from each participant confirmation that no communication has occurred that might compromise the blindness of the comparison.
8. **Finalizing Protocol during Key Comparisons:** The WGDM confirms that the Technical Protocol of CCL KCs may be finalized after commencing the artefact circulation, provided that the main elements of the protocol (especially participants, schedule, measurand definition) have been established and agreed to by the participants. Changes should not have any effect on the collection of data once the first participant has started measurements. Any change must be agreed to by all of the participants. An example of an acceptable change would be the final text for an illustrative uncertainty budget.
9. **Re-measures during Key Comparisons:** The WGDM confirms that the Pilot and participants have the authority to decide if a participant may re-measure during the KC (i.e., before the results are shared). Re-measuring should be an exceptional event, allowed only if the participant can show equipment failure or other valid reason for not meeting the scheduled participation. A re-measure should be allowed if it overall improves the technical validity of the KC (such as ensuring sufficient linking representation to regions), and should be denied if it overall degrades the technical validity of the KC (such as delaying the results too long). Disputes about re-measure not resolved by the WGDM will be submitted to the CCL. Participants may request a re-measure after the KC is closed for official circulation, and their results may be linked to the KC report results for 'information only' (not for inclusion in Appendix B).

#### Items decided at 7th WGDM Meeting 2002 [CCL/WGDM-02-44]

3. **Comparison Performance Supports Claimed CMC Uncertainty:** Given that WGDM has chosen CCL-KC topics that each correspond to a specific MRA CMC, then WGDM will confirm by memo to CCL when submitting the KC Final Report, that the performance results support the uncertainty claimed by each participant NMI for the relevant CMC(s).
4. **Comparison Performance Conflicts with Claimed CMC Uncertainty:** When significant outliers (or outright performance failure) cannot be resolved by the KC pilot, either first in consultation with the affected NMI and other participants, or then in joint consultation with WGDM, then WGDM will advise by memo to CCL when submitting the KC Final Report that the affected NMI must confer with their RMO regarding an appropriate increase in their MRA-listed CMC uncertainty.
5. **Numerical Blunder Recovery, with Finding:** When participant KC results can be salvaged from a computational blunder to give good performance without re-measurement, that NMI's corrected results will be used in the Final Report (and the claimed uncertainty deemed acceptable), along with a reported finding for the RMO that the blunder by the affected NMI must be investigated for propagation through past client reports that would call for corrective actions. WGDM will advise by memo to CCL that the affected NMI must confer with their RMO on this finding.

#### Items decided at 9th WGDM Meeting 2004 [CCL/WGDM-04-50-5]

4. **Approval of CCL comparison results and reports:** According to the text of the CIPM MRA, the Consultative Committees, and therefore their Working Groups, have certain responsibilities for examining and approving reports and results of comparisons performed under the CIPM MRA. The WGDM therefore reminds pilots of CCL comparisons that all dimensional metrology key and supplementary comparison reports and results should be sent, after completion of Draft B stage of the report, to the WGDM for its approval. The WGDM will then present the Final Report to the CCL for formal approval.

5. **Entry of CCL comparison data into the KCDB:** After approval of the results and of the Final Report of a CCL key or supplementary comparison by the CCL, the WGDM Chairman will then ask the pilot to send both the Final Report (in its .pdf version) and the accompanying Excel file of the results, to the KCDB coordinator.
6. **Approval of RMO comparison results and reports:** According to the text of the CIPM MRA, the Consultative Committees, and therefore their Working Groups, also have responsibilities for examining and approving Final Reports and results of RMO comparisons performed under the CIPM MRA. The WGDM therefore asks RMO TC chairpersons to remind pilots of RMO key and supplementary comparisons that all dimensional metrology key and supplementary comparison Final Reports and results should be sent, after completion of Draft B stage of the report, to the WGDM for its approval. The WGDM will then present the Final Report to the CCL for formal approval.
7. **Entry of RMO comparison data into the KCDB:** After approval of the results and of the Final Report of a RMO key or supplementary comparison by the CCL, the WGDM Chairman will ask, via the TC Chairperson, the pilot to send both the Final Report (in its .pdf version) and the accompanying Excel file of the results (for key comparisons only), to the KCDB coordinator.
8. **Approval and KCDB entry of CCL RMO key comparison results and reports:** At the 2003 meeting of the CCL, the WGDM's recommendation to run a new style of 'CCL RMO key comparisons', was accepted. The WGDM reminds RMO TC Chairpersons that these new comparisons are operated according to the CIPM MRA rules for key comparisons, and asks RMO TC Chairpersons to remind RMO pilots of the need to comply with the procedure shown above in items 6 and 7, when running CCL RMO key comparisons.

#### **Minutes of 8th Meeting of WGDM, 2003 [CCL/WGDM/03-55]**

- 8.3. The WGDM strongly recommends that pilots of KCs provide interim reports to participants as soon as it is technically possible. Where the participant clearly has reported an anomalous result, the participant should be invited to check their results for numerical errors but not informed of the magnitude or sign of the apparent anomaly.

#### **Items Decided at WGDM Meeting 2005 [CCL/WGDM/05-50]**

12. Corrective actions after a key comparison: The WGDM agreed that a possible way of reviewing corrective actions following poor key comparison performance could be to delay the preparation of the Executive Report until by 6 months and to include in the report details of corrective actions taken and any items remaining outstanding. The WGDM agreed that it is the job of the NMI concerned to convince the pilot or CMC reviewer of whether or not further action is required.

#### **4.3.1 WG-MRA documents**

- WGMRA-2010.D5** WG-MRA decided to use a new comparison to monitor the progress and outcomes of comparisons in length metrology and inform the CMC review and policing process.
- WGMRA-2010.D10** WG-MRA decided that the default authorship list for comparison reports should be the pilot, followed by the participants from the NMIs.
- WGMRA-2011.D7** The CCL WG MRA decided that comparison pilots would do the linking; sWG-KC would advise the pilot on which comparisons to link and TG-L would be responsible for the linking technique.
- WGMRA-2011.D9** The CCL WG MRA agreed to use the 'common graph approach' (demonstrate linking is OK using Bayesian statistics, but make no numerical link or changes to KCRVs) when linking comparisons.

- [WGMRA.2011.R5](#) The CCL WG MRA recommends that each NMI should aim to participate at least once in every ten years in all comparisons applicable to their declared CMCs. The CCL WG-MRA and the RMOs are responsible for providing the necessary opportunities to take part, on a regular basis.
- [WGMRA.2011.R6](#) The CCL WG MRA recommends that pilots of comparisons request from participants, a list of CMCs which the comparison is intended to support, along with the current CMC values in these services, when submitting results to the pilot.
- [WGMRA.2011.R7](#) The CCL WG MRA recommends that pilots of comparisons use common sense as the ultimate requirement when assessing comparison results, in support of CMC claims. The CCL WG MRA recommends pilots to take notice of the new wording which will be added to GD1 on this matter.
- [WGMRA-2013.D6](#) Chair of sWG-KC will allocate (volunteers) approximately 2 reviewers for each key and supplementary comparison report that is received by WG-MRA, to perform a careful review of the report at Draft B stage. This detailed review will take place before the report is sent of WG-MRA approval. A list of reviewers will be kept by chair of sWG-KC.
- [WGMRA-2014.D1](#) CCL-K11 reports need in the future no longer be refereed unless there are substantial changes.
- [WGMRA-2014.D4](#) When a laboratory submits results for a key comparison, it should also submit - if applicable - the corresponding CMC including its service identifier. If their CMC uncertainty needs to be increased due to large artefact contributions, this should also be explained or justified.
- [WGMRA-2014.D5](#) The WG-MRA decides that scientific studies are not allowed to be upgraded to supplementary comparisons. The same shall apply in the future also to CCL pilot studies, unless it has already been decided otherwise. Nevertheless, these results can be used to support CMC claims.

## 4.4 CCL documents

### Decision [CCL-WGDM-3 \(2003\)](#)

The Consultative Committee for Length, taking into account the burden of participation by CCL members in both the CCL and their RMO key comparisons, which has significantly slowed the progress of RMO key comparisons, decides that CCL key comparisons in dimensional metrology will be conducted only when there is a technical need that is not satisfied by inter-regional RMO key comparisons.

### Decision [CCL-WGDM-4 \(2003\)](#)

The Consultative Committee for Length, recognizing the need to ensure suitable NMI participation in key comparisons to support the MRA and that participation in inter-regional RMO key comparisons may be an alternative to participation in bilateral comparisons, urges the CCL-WGDM to work with the RMOs to organize the inter-regional RMO comparisons on a time-staggered basis, across topics and across regions, so as to even out the comparison workload and to achieve an approximate seven-yearly cycle for each topic for each NMI.

### Decision [CCL 8 \(2009\)](#)

The Consultative Committee for Length (CCL), considering that: the key comparison guidelines call for prompt reporting of results to the pilot, after measurement by a participant; several NMIs have expressed dissatisfaction at the time taken for comparison reports to be published and become openly referable -

supports action by comparison pilots to enforce more strict guidelines concerning the late transmission of results to the pilot laboratory.

**Decision [CCL 6 \(2009\)](#)**

The Consultative Committee for Length (CCL), considering that: errors have been detected in key comparisons reports submitted to the KCDB from several consultative committees; the key comparison reports are a visible part of the operation of the MRA - asks pilots of key and supplementary comparisons in length metrology to arrange for independent review of the comparison final reports before they are submitted to the KCDB.

**Decision [CCL 1 \(2012\)](#)**

CCL agreed in amending the WG-MRA ToR for CCL to delegate the task to approve KC protocols and Reports to WG-MRA and some other minor corrections in the Organization.

The final redaction is as follows:

**Terms of Reference WG-MRA**

1. Tasks

- To maintain links with the regional metrological cooperation organizations, seeking to ensure the involvement of member laboratories of the CCL in major comparisons in the field of length, thereby providing the means for assuring world-wide traceability and equivalence of length measurements at the highest levels of accuracy.
- To make recommendations to the CCL on the needs and priorities for additional international comparisons in length under the auspices of the CCL.
- To ensure the coordination of CCL and RMO key and supplementary comparisons.
- **To approve the Length key comparison protocols and reports.**

**Decision [CCL 2 \(2015\)](#)**

**Procedure for discrepant result corrective actions**

CCL decided that the WG-MRA proposal for dealing with corrective actions after discrepant results in comparisons will be adopted, *viz.*

after a discrepant result is confirmed in an agreed Final Report, this is communicated to the NMI, their RMO TC-Length and the sWG-CMC;

the NMI proposes corrective actions which are agreed by the RMO (e.g. TC-L) within 90 days, informs the pilot of these (for inclusion in the Executive Report) and then implements them;

successful implementation of corrective actions allows the RMO (e.g. TC-L) to immediately request CMC reinstatement via the JCRB for any greyed out/enlarged uncertainty CMCs;

unsuccessful corrective action (in the opinion of the RMO) requires the RMO to request greying out of CMCs via the JCRB;

the sWG-KC will develop guidance for pilots on what constitutes a significantly discrepant result.

**Decision [CCL 3 \(2015\)](#)**

**Dealing with the existing list of discrepant results**

The CCL decided that the WG-MRA shall inform the affected NMI/DIs of the problem with their comparison results, according to the list drawn up by sWG-CMC with this information being copied to the relevant TC-L committees in the RMOs. The NMI/DIs will propose (if not done so already) necessary corrective actions for these items to their local TC-L and these will be implemented and monitored by the RMO following the procedure outlined in Decision CCL 2 (2015). The Terms of Reference of WG-MRA and sWG-MRA should be amended to reflect the change in emphasis from 'coordinating' the CMC corrective actions to 'monitoring' them.

## 5 References to available documents

### 5.1 CIPM/MRA documents

The MRA	[CIPM MRA]
<a href="http://www.bipm.org/en/cipm-mra/mra_online.html">http://www.bipm.org/en/cipm-mra/mra_online.html</a>	
MRA Technical supplement	[CIPM MRA-T]
<a href="http://www.bipm.org/utis/en/pdf/mra_techsuppl2003.pdf">http://www.bipm.org/utis/en/pdf/mra_techsuppl2003.pdf</a>	
The CIPM MRA: 2005 Interpretation Document	[CIPM/2005-06REV]
<a href="http://www.bipm.org/cc/CIPM/Allowed/94/MRAINTERPRETCIPM06_REV_.pdf">http://www.bipm.org/cc/CIPM/Allowed/94/MRAINTERPRETCIPM06_REV_.pdf</a>	
Guide to the implementation of the CIPM MRA	[CIPM MRA-G-01]
<a href="http://www.bipm.org/utis/common/CIPM_MRA/CIPM_MRA-G-01.pdf">http://www.bipm.org/utis/common/CIPM_MRA/CIPM_MRA-G-01.pdf</a>	
Calibration and Measurement Capabilities in the context of the CIPM MRA	[CIPM MRA-D-04]
<a href="http://www.bipm.org/utis/common/CIPM_MRA/CIPM_MRA-D-04.pdf">http://www.bipm.org/utis/common/CIPM_MRA/CIPM_MRA-D-04.pdf</a>	
Measurement comparisons in the CIPM MRA	[CIPM MRA-D-05]
<a href="http://www.bipm.org/utis/common/CIPM_MRA/CIPM_MRA-D-05.pdf">http://www.bipm.org/utis/common/CIPM_MRA/CIPM_MRA-D-05.pdf</a>	
Guidelines for CIPM Key Comparisons	[CIPM KC guidelines]
<a href="http://www1.bipm.org/utis/en/pdf/guidelines.pdf">http://www1.bipm.org/utis/en/pdf/guidelines.pdf</a>	
Nomenclature of the key comparisons	[Nomenclature]
<a href="http://www.bipm.org/utis/en/pdf/nomenclature.pdf">http://www.bipm.org/utis/en/pdf/nomenclature.pdf</a>	
Rules of procedure for the CCs created by CIPM, CC WGs and CC workshops	[CIPM-D-01]
<a href="http://www.bipm.org/cc/CIPM/Allowed/98/CIPM2009-26revised.pdf">http://www.bipm.org/cc/CIPM/Allowed/98/CIPM2009-26revised.pdf</a>	
CIPM MRA Guidelines for Authorship of [...] Comparison Reports	[CIPM MRA-G-04]
<a href="http://www.bipm.org/utis/common/CIPM_MRA/CIPM_MRA-G-04.pdf">http://www.bipm.org/utis/common/CIPM_MRA/CIPM_MRA-G-04.pdf</a>	

### 5.2 JCRB documents

JCRB Key/Bilateral/Supplementary Comparison flow charts	[JCRB-20/6]
<a href="http://www.bipm.org/utis/common/documents/jcrb/flowchart_comparisons_processes.pdf">http://www.bipm.org/utis/common/documents/jcrb/flowchart_comparisons_processes.pdf</a>	
Supplementary comparisons – definition	[JCRB-11/8(5)_rev]
<a href="http://www.bipm.org/utis/common/documents/jcrb/supplementary_defn.pdf">http://www.bipm.org/utis/common/documents/jcrb/supplementary_defn.pdf</a>	
A note on supplementary comparisons	[JCRB-10/7_rev]
<a href="http://www.bipm.org/utis/common/documents/jcrb/supplementary_comparisons.pdf">http://www.bipm.org/utis/common/documents/jcrb/supplementary_comparisons.pdf</a>	
Monitoring the impact of key and supplementary comparison results on CMC claims	[JCRB-11/7(a)]
<a href="http://www.bipm.org/utis/common/documents/jcrb/impact_comparisons.pdf">http://www.bipm.org/utis/common/documents/jcrb/impact_comparisons.pdf</a>	

### 5.3 CCL/WGDM documents

WGDM decision on discrepant results during a comparison circulation	[WGDM-03-55-§8.3]
<a href="http://www.bipm.org/wg/CCL/CCL-WG/Restricted/Minutes/WGDM-03-55-Minutes-Issue1.pdf">http://www.bipm.org/wg/CCL/CCL-WG/Restricted/Minutes/WGDM-03-55-Minutes-Issue1.pdf</a>	
[Requires CCL-WG logon]	
WGDM guidelines on key comparison analysis	[WGDM-05-80, CCL12-§9]
<a href="https://www.bipm.org/utis/common/pdf/CC/CCL/CCL12.pdf">https://www.bipm.org/utis/common/pdf/CC/CCL/CCL12.pdf</a>	

## 5.4 CCL/WG-MRA Guidance Documents on comparisons

Running of MRA comparisons in length metrology & monitoring their impact on CMCs [WG-MRA-GD-1]  
<https://www.bipm.org/utils/common/pdf/CC/CCL/CCL-GD-1.pdf>

Comparison scheme applied in dimensional metrology [WG-MRA-GD-2]  
<https://www.bipm.org/utils/common/pdf/CC/CCL/CCL-GD-2.pdf>

Guide to preparation of Key Comparison Reports in Dimensional Metrology [WG-MRA-GD-3]  
<https://www.bipm.org/utils/common/pdf/CC/CCL/CCL-GD-3.pdf>

KC planning [WG-MRA-GD-4]  
<https://www.bipm.org/utils/common/pdf/CC/CCL/CCL-GD-4.xls>

## 5.5 CCL documents

Minutes of meetings of the CCL  
<https://www.bipm.org/en/committees/cc/ccl/publications-cc.html>

## 5.6 General MRA & KCDB reference

Many of the above documents can be accessed via the CIPM MRA documents web page:  
<http://www.bipm.org/en/cipm-mra/documents/>

A clickable index diagram is also available: <https://www.bipm.org/utils/common/documents/CIPM-MRA/CIPM-MRA-documents.pdf>

The KCDB2.0 may be found online: <https://www.bipm.org/kcdb/> It is necessary to login before using the database for any updates e.g. registering comparisons.

It has a detailed 'Getting started' document:  
[https://www.bipm.org/utils/common/pdf/KCDB\\_2.0/Getting\\_started\\_KCDB\\_platform.pdf](https://www.bipm.org/utils/common/pdf/KCDB_2.0/Getting_started_KCDB_platform.pdf)

There is also a Quick Start document on comparisons:  
[https://www.bipm.org/utils/common/pdf/KCDB\\_2.0/QUICK\\_START\\_comparisons.pdf](https://www.bipm.org/utils/common/pdf/KCDB_2.0/QUICK_START_comparisons.pdf)

## 5.7 CCL/WG-MRA Templates for comparisons

Example template for a key comparison technical protocol [WG-MRA-GD-3.1]  
<https://www.bipm.org/utils/common/pdf/CC/CCL/CCL-GD-3.1.doc>

Example template for a key comparison Report [WG-MRA-GD-3.2]  
<https://www.bipm.org/utils/common/pdf/CC/CCL/CCL-GD-3.2.doc>

Example template for a key comparison Executive Report [WG-MRA-GD-3.3]  
<https://www.bipm.org/utils/common/pdf/CC/CCL/CCL-GD-3.3.doc>

Excel file for use in analysing comparisons  
<https://www.bipm.org/utils/common/pdf/CC/CCL/CCL-KC-evaluation.xlsx>

Excel file for use in analysing linked-loop comparisons  
<https://www.bipm.org/utils/common/pdf/CC/CCL/CCL-KC-evaluation-linked-loops.xls>

## Appendix A - Comparison Coding Scheme 2021+

The following coding scheme has been adopted at the 2021 meeting of the WG-MRA, based on discussions initiated at the preceding meeting. Any length metrology comparisons registered after the 2021 WG-MRA meeting should follow this new scheme. The scheme is designed to make it much clearer what is the topic of a Supplementary Comparison (by using a number related to the DimVIM) and also to be clearer in the sequence number of Key Comparisons (the prior coding scheme often included a date which was not always the best descriptor of the ordering of comparisons). The coding scheme set out below has been agreed with the KCDB Coordinator. Pilot of comparisons are to follow this scheme – the sWG-KC Chair and the KCDB Coordinator are able to assist when choosing the code.

The coding scheme for length metrology Key and Supplementary Comparisons is based upon section 5.1 of the CIPM-MRA-G-11 guidance document. The new coding scheme is shown below where the **blue text** highlights the sections that are to be modified when generating a new code:

**BODY[.]L-KAlias.nXX[.X]**

or

**BODY[.]L-SClass.nXX**

- BODY** the operator, e.g. Consultative Committee (CC), or specified RMO. A separating dot [.] is added to RMO names for clarity.
- Alias** a number representing one of the Key Comparison topic areas. Each topic area can relate to one or more DimVIM entries, e.g. the K3 topic includes entries 3.1.1 for optical polygons, 3.3.1 for autocollimators, and 3.4.1 for angle blocks.
- Class** the first two digits, i.e. the class, of the CCL Service Category number most representative of the supplementary comparison. The CCL Service Category numbers are defined by the DimVIM.
- XX** two-digit number, starting at '01', identifying the sequential ordering of comparisons. There is an independent number sequence for each operator (CC or RMO), and topic area (Alias or Class) combination. The **XX** for Key Comparisons can be followed by '.X' where **X** is a single digit number to indicate a subsequent bilateral or multilateral comparison.

It is important to note that all comparison topics for an RMO or the CC will start the sequential numbering from '01' regardless of the number of previously registered comparison codes. A number of examples codes are provided below:

- |              |  |
|--------------|--|
| CCL-K1.n01   | first key comparison in gauge blocks using the 2021+ coding scheme |
| CCL-K1.n01.1 | subsequent comparison  |

CCL-K1.n02	repeat gauge block key comparison (10 year cycle)
SIM.L-K1.n01	first gauge block key comparison in the SIM region using the 2021+ coding scheme
APMP.L-S2.3.n01	first regional supplementary comparison in class 2.3 (grid plates, on this occasion) using the 2021+ coding scheme
APMP.L-S2.3.n02	second regional supplementary comparison in class 2.3 (gratings, on this occasion) using the 2021+ coding scheme
APMP.L-S2.3.n03	third regional supplementary comparison in class 2.3 (tapes, on this occasion) using the 2021+ coding scheme
COOMET.L-S4.2.n01	first regional supplementary comparison on roundness (class 4.2) using the 2021+ coding scheme
COOMET.L-S4.2.n02	second regional supplementary comparison on roundness (class 4.2) using the 2021+ coding scheme