



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).
V11.0	Major revision to V11.0 Apr 2024 by A. Lewis to reflect new documents from BIPM.
v12.0	Updated to V12.0 5 Nov 2025 by A Lewis, to require Executive Reports for all comparisons (agreed WGMRA 2025).

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. 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, review, 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 the other CCL-Guidance Documents it refers to) conflicts with the requirements set out in the MRA documents issued by JCRB/CIPM/BIPM.
2. CCL has delegated the responsibility for approving Protocols and Final Reports of Key Comparisons (CCL and RMO) to WG-MRA; Final reports no longer require CCL approval before entering KCDB. Supplementary comparison reports are not subject to this however....
3. ...CCL requires that Final Reports of all MRA length comparisons (key and supplementary) are subject to independent review before being sent to the KCDB for publication. The sWG-KC Chair arranges for the independent review; therefore all comparison reports should be sent to the sWG-KC chair when at the stage of approved Draft B.
4. After successful dual independent review of Draft B reports, they are sent to the WG-MRA for approval. After approval, the report is renamed Final Report and sent to the KCDB.
5. RMOs can start RMO Key and Supplementary Comparisons, however only CCL can start a new (Supplementary or Key) CCL comparison. RMOs can start inter-RMO key comparisons, but require inter-RMO coordination, through WG-MRA. Participation in RMO and CCL comparisons is decided by the MRA rules. WG-MRA assists pilots in coordinating intra- and inter-RMO participation.
6. Supplementary Comparisons are normally organised by the RMOs, but CCL can also do so.
7. 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.
8. Pilot studies may be used to support CMCs, but this is not normal because Pilot studies may not be rigorously following the MRA guidance. Pilot studies are not allowed to be re-classified as Supplementary Comparisons.
9. Conduct of comparisons is according to CIPM MRA guidance document [CIPM MRA-G-11](#) with a few additions:
 - a. Template documents for Protocols, Final Reports and Executive Reports, are now made available on the [CCL publications website](#) for use by pilots. Excel files for comparison analysis are also available.
 - b. Any outliers noticed by the pilot before Draft A trigger an immediate request from the pilot to the participant to check their results for 'blunders'. The pilot should not indicate which particular measurement is wrong nor by what amount. 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 to all participants when the Draft A report is about to be sent out as this triggers a closure of the period for freely correcting 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 (usually when preparing their reports for the annual WG-MRA meeting) for corrective actions to clear these issues.

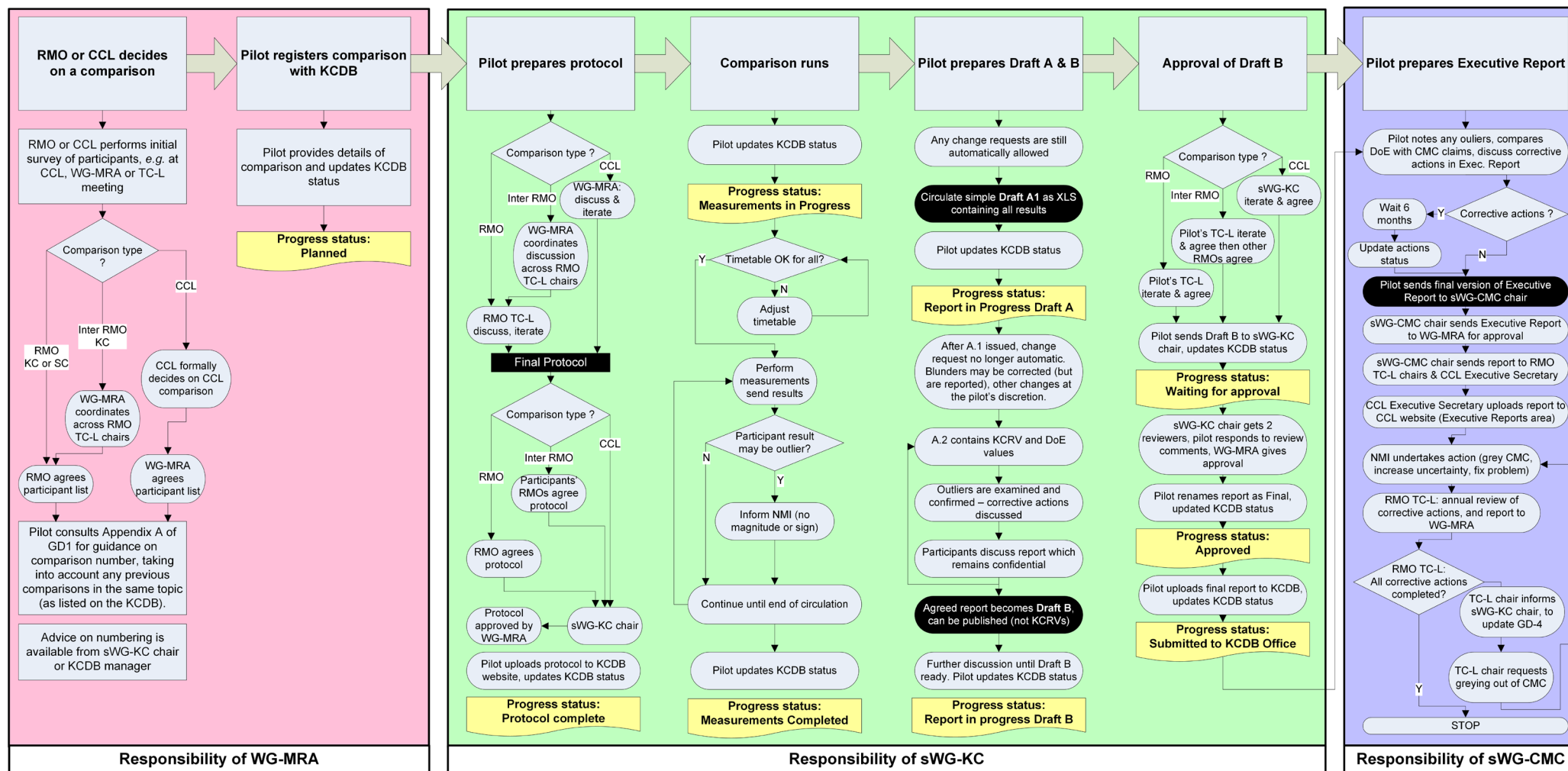
- e. An Executive Report is always produced after the Final Report. It is short and compares results (DoEs) with any existing CMCs. Corrective actions and recommendations are listed in this report which is private to the participants, the WG-MRA and the CCL. The report usually is prepared up to 6 months 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 would be very short and there are no corrective actions, the Executive Report can simply state the final list of participants and confirm that the results are all in agreement – see the Executive Report template).
10. Documents required for each comparison are therefore: Protocol, Draft A report, Draft B report, Final Report, and an Executive Report.
11. Protocol documents should contain a proposal for how to calculate KCRV(s). Protocol documents should follow the comparison numbering scheme introduced in 2021 (as shown in Appendix A).
12. When submitting results to the pilot, each participant should indicate which CMCs are to be supported by the results.
13. All versions of the Draft A report are private (to the participants). They should not be sent to anyone outside the participant list without first anonymising the results.
14. The Draft B report 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 (anonymous) 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).
15. 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-11](#) §8.3).
16. 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 (*e.g.* at a meeting of WG-MRA) and may be examined for impact on CMCs.

17. 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.
18. All participants should be prompt in sending results to the pilot and in all communications.
19. 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.
20. 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.
21. The confidence level of all uncertainties should be clearly stated: label all uncertainty bars in graphs and any mention of uncertainties in the text as either standard or expanded. All expanded uncertainties, CMC claims and En values should be at 95 % confidence level.
22. Usually only 2 significant figures should be used in uncertainties.
23. 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 comparison process is controlled at different stages by different parts of the WG-MRA:

- The **WG-MRA** is responsible for identifying the need for a CCL or RMO key comparison (usually when GD-4 is examined during or prior to a WG-MRA meeting or when sWG-CMC examines the impact of comparison reports on CMCs). An RMO may also identify a need for a key comparison.
- Inter-RMO comparisons, and classical RMO comparisons may be instigated by the **WG-MRA** and/or the RMO. Only **CCL** can instigate a CCL comparison.
- The comparison is then under the responsibility of the pilot, participants and **sWG-KC** up to the point when the Final Report enters the KCDB.
- The analysis of the published 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) 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*.

(3) Note that KCDB 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 initiation 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.

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

Protocol template document GD3.1 should be followed.

(a) Protocol preparation (all comparisons)

WG-MRA, 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. The pilot should consult with the **SWG-KC chair** and/or the KCDB Manager if the numbering is not immediately clear.

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

Pilot updates Progress status on KCDB website to Planned.

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

Pilot prepares protocol based on GD-3.1 template.

(b) Organizing CCL KC, CCL SC

Pilot sends draft protocol to **SWG-KC chair** and all **TC-L chairs**.¹

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

¹ Often this step is missed. The consequence is that the SWG-KC chair and other TC-L chairs may be unaware of the participant list until later or of issues in the protocol document and is unable to suggest additional participants to join the comparison or make corrections.

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**.²

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 sends³ 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.

In most cases, pilots have uploaded protocol documents of all comparison types to the KCDB before they were approved by the WG-MRA (WG-MRA has delegated approval from CCL to approve protocol documents). This has the advantage of saving time, but the disadvantage of lack of visibility across the RMOs.

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.

² Often this step is missed. The consequence is that the sWG-KC chair and other TC-L chairs may be unaware of the participant list until later or of issues in the protocol document and is unable to suggest additional participants to join the comparison or make corrections.

³ Although most inter-RMO participation is pre-planned in the form of Inter-RMO comparisons, the occasional extra participant may be looking to join a comparison and informing the sWG-KC chair at this point may trigger a request for an extra participant.

(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 GD-3.2 should be followed as well as guidance document GD-3.

(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 sent 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 all 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 is responsible for 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.

Executive report template document GD-3.3 should be followed as well as guidance document GD-3.

(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 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 References & links to available documents

4.1 CIPM/MRA documents

The MRA (including 2003 revision of Technical Supplement)	CIPM MRA
https://www.bipm.org/documents/20126/43742162/CIPM-MRA-2003.pdf	
Overview and implementation of the CIPM MRA (2023)	CIPM MRA-P-11
https://www.bipm.org/documents/20126/43742162/CIPM-MRA-P-11.pdf	
Coordination within the CIPM MRA: Consultative Committees, RMOs, JCRB	CIPM MRA-P-12
https://www.bipm.org/documents/20126/43742162/CIPM-MRA-P-12.pdf	
Participation in the CIPM MRA; NMIs, DIs, International Organizations (2024)	CIPM MRA-P-13
https://www.bipm.org/documents/20126/43742162/CIPM-MRA-P-13.pdf	
Measurement comparisons in the CIPM MRA: Guidelines for organizing, participating & reporting (2021)	CIPM MRA-G-11
https://www.bipm.org/documents/20126/43742162/CIPM-MRA-G-11.pdf	
Quality management systems in the CIPM MRA: Guidelines for monitoring and reporting (2021)	CPM MRA-G-13
https://www.bipm.org/documents/20126/43742162/CIPM-MRA-G-13.pdf	

4.2 CCL Guidance Documents on comparisons

Running of MRA comparisons in length metrology & monitoring their impact on CMCs	[GD-1]
https://www.bipm.org/utis/common/pdf/CC/CCL/CCL-GD-1.pdf	
Comparison scheme applied in dimensional metrology	[GD-2]
https://www.bipm.org/utis/common/pdf/CC/CCL/CCL-GD-2.pdf	
Guide to preparation of Key Comparison Reports in Dimensional Metrology	[GD-3]
https://www.bipm.org/utis/common/pdf/CC/CCL/CCL-GD-3.pdf	
KC planning	[GD-4]
https://www.bipm.org/utis/common/pdf/CC/CCL/CCL-GD-4.xls	

4.3 CCL Templates for comparisons

Example template for a key comparison technical protocol	[GD-3.1]
https://www.bipm.org/utis/common/pdf/CC/CCL/CCL-GD-3.1.doc	
Example template for a key comparison Report	[GD-3.2]
https://www.bipm.org/utis/common/pdf/CC/CCL/CCL-GD-3.2.doc	
Example template for a key comparison Executive Report	[GD-3.3]
https://www.bipm.org/utis/common/pdf/CC/CCL/CCL-GD-3.3.doc	
Excel file for use in analysing comparisons	
https://www.bipm.org/utis/common/pdf/CC/CCL/CCL-KC-evaluation.xlsx	
Excel file for use in analysing linked-loop comparisons	
https://www.bipm.org/utis/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

Appendix B – Previous Decisions & Recommendations

Since the start of the implementation of the CIPM MRA, various recommendations have been made by the WG-MRA (and by its forerunner the WGDM, in the early years of the MRA) and these have led to formal Decisions and Recommendations issued by the CCL. This Appendix collects together such items as have a bearing on the topic of this Guidance Document. They are presented in chronological order. The relevant Minutes of CCL Meetings can be downloaded from the BIPM web site.

Decisions and Recommendation of the CCL

CCL Meeting 2003

Decision CCL-WGDM-1 – key comparison topics

The Consultative Committee for Length,

taking into account the experience gained during the first round of CCL key comparisons,

decides that, following the completion of the first round of CCL key comparisons, the list of CCL key comparison topics in dimensional metrology will be revised to be:

- CCL-K1 gauge blocks (short and long)
- CCL-K2 (reserved for long gauge blocks)
- CCL-K3 angle
- CCL-K4 diameter
- CCL-K5 1-D CMM (step gauges)
- CCL-K6 (reserved for 2-D CMM artefacts)
- CCL-K7 line scales
- CCL-K8 surface roughness

Decision CCL-WGDM-2 – non numerical linking

The Consultative Committee for Length,

taking into account the decision by the CCL-WGDM at its 7th meeting that artefact-based key comparisons in dimensional metrology would not use a numerical link between the CCL key comparison and the corresponding RMO key comparison and that instead, the link would be based on competencies demonstrated by the participant laboratory which took part as linking NMI in the CCL and RMO key comparisons,

decides that artefact-based key comparisons in dimensional metrology will not use a numerical link between a CCL key comparison and any corresponding RMO key comparison. Instead, the link will be based on competencies demonstrated by the participant laboratory which took part as linking NMI in the CCL and RMO key comparisons. The CCL and RMO key comparisons will be deemed as being equivalent. For a given topic, linking can also be achieved by running inter-regional RMO key comparisons where there is:

- appropriate inter-regional participation in a network of RMO key comparisons, the coordination of which is assisted by the CCL; and
- use of compatible technical protocols approved by the CCL; and
- final review of the results of the RMO key comparisons by the CCL.

These inter-regional RMO key comparisons may be called **CCL RMO key comparisons**.

Decision CCL-WGDM-3 – CCL comparisons vs inter-RMO comparisons

The Consultative Committee for Length,

taking into account the burden of participation by CCL members in both the CCL and 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 – inter-RMO comparisons and scheduling

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 and the JCRB to organize the inter-regional RMO key 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-year cycle for each topic for each NMI.

CCL Meeting 2005

Recommendations from the CCL Workshop on Comparison Reference Values and their Analysis

- Unless there are good reasons to the contrary, the recommended steps to be followed when analysing key comparison data, are those as outlined by Dr Cox in document WGDM-05-86 [reproduced below].
- When performing analysis of dimensional metrology key comparisons, the WGDM proposes, where appropriate, the use of the Excel based 'E_n toolkit' as developed by Douglas and Steele, during and after the data acquisition phase of the comparison. [This is available as [CCL-WG-MRA Example file for comparison analysis](https://www.bipm.org/en/committees/cc/ccl/publications) which is available from the CCL publications part of the BIPM website <https://www.bipm.org/en/committees/cc/ccl/publications>].

Specifically, the steps to be followed during the analysis phase of the comparison are as follows:

1. Perform an extended chi-squared (null-hypothesis) consistency check on the data submitted by the participants (result, uncertainty, degrees of freedom) based on the inverse variance weighted mean as the KCRV.
2. If the consistency check is satisfied at the 5 % level:
 - proceed to use the weighted mean as the KCRV and use the formal uncertainty of the weighted mean as the uncertainty of the KCRV;
 - derive unilateral and bilateral degrees of equivalence for all the participants and publish them.
3. Otherwise (check has failed):
 - determine the largest subset of participants with the lowest chi-squared, the data for which is consistent with the chi-squared null hypothesis test;
 - undertake scientific dialogue with participants not in the largest subset, to try to resolve problems, where possible (blunder correction, technique differences, etc.);
 - set the weights of the participants not in the chosen largest subset, to zero, for the purposes of determining the KCRV and its formal uncertainty and determine these values;

- if the largest subset is considered to be too small, consider reporting only bi-lateral degrees of equivalence, (*i.e.* no KCRV) or performing additional modelling (*e.g.* drift, travelling artefact uncertainty). Derive unilateral and bilateral degrees of equivalence (as appropriate) for all the participants, and publish.

CCL Meeting 2009

At the 2009 meeting, the CCL formally established the WG-MRA, its sub-WG-KC and sub-WG-CMC and the Discussion Groups (as well as WG-Nano). Much of the 'Decisions' text is related to setting up these working groups and the reader is referred to the [Minutes](#).

In addition:

DECISION CCL 6 (2009) – improving the quality of key comparison final reports

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.

[NB The sWG-KC chair makes the arrangement on behalf of the pilots]

DECISION CCL 8 (2009) – reducing the delay in reporting on key and supplementary comparisons

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.

CCL Meeting 2012

DECISION CCL 1 (2012) – Terms of Reference for WG-MRA

[CCL agreed in amending the WG-MRA ToR for CCL to delegate the task to approve KC protocols and reports to the WG-MRA]

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.
- To facilitate the inter-regional CMC Review Process, by:
 - a) establishing and maintaining lists of service categories, and where necessary rules for the preparation of CMC entries;
 - b) agreeing on detailed technical review criteria;
 - c) coordinating and where possible conducting inter-regional reviews of CMCs submitted by RMOs for posting in the Appendix C of the MRA;
 - d) providing guidance on the range of CMCs supported by particular key and supplementary comparisons;
 - e) identifying areas where additional key and supplementary comparisons are needed;
 - f) coordinating the review of existing CMCs in the context of new results of key and supplementary comparisons.
- To report to CCL.

DECISION CCL 2 (2012) – Periodicity of KCs

CCL agreed in fixing a maximum value of 10 years applying to both the periodicity of KCs and the time interval an NMI needs to provide evidence for its CMCs in a KC topic.

CCL Meeting 2015

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.

Decisions and Recommendation of the former WGDM

[Documents no longer maintained on BIPM server. Only items not superseded by later WG-MRA or CCL decisions are included.]

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

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.

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.

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 WGDM Meeting 2005 [CCL/WGDM/05-50]

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 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.

Decisions and Recommendation of the WG-MRA

[Document links only work after signing in to the BIPM website.]

- [WGMRA-2010.D5](#) WG-MRA decided to use a new comparison log file (Excel worksheet) to monitor the progress and outcomes of comparisons in length metrology and inform the CMC review and policing process. [This is now CCL GD-4].
- [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-2013.D5](#) Pilots (and participants) have final decision in comparison protocols about including extra measurements by a participant (e.g. multiple instruments where only one is used to provide the CMC service). Consideration is to be given to risk of artefact damage and increased comparison duration.
- [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.D2](#) Where an NMI shows a clear intention to participate in the next upcoming comparison, the interval between two comparison participations might be extended exceptionally beyond 10 years. Nevertheless an early measurement in the schedule of the comparison should be aimed for.
- [WGMRA-2014.D3](#) Taking into account the effect of recommendation WGMRA-2014.D2 on participation frequency, it is also recommended to limit the number of bilateral comparisons.
- [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.