



Measurement comparisons in the CIPM MRA

CIPM MRA-D-05

Version 1.6

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1. Background

1.1. On the CIPM MRA

[Paragraph 3 of the CIPM MRA](#) defines the technical basis of the arrangement:

3.1 The technical basis of this arrangement is the set of results obtained in the course of time through key comparisons carried out by the Consultative Committees of the CIPM, the BIPM and the regional metrology organizations (RMOs), and published by the BIPM and maintained in the key comparison database¹. Detailed technical provisions are given in the Technical Supplement to this arrangement.

3.2 Key comparisons carried out by Consultative Committees or the BIPM are referred to as CIPM key comparisons; key comparisons carried out by regional metrology organizations are referred to as RMO key comparisons; RMO key comparisons must be linked to the corresponding CIPM key comparisons by means of joint participants. The degree of equivalence derived from an RMO key comparison has the same status as that derived from a CIPM key comparison.

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2. Definitions

2.1. Key comparison

A key comparison is one of the set of comparisons selected by a Consultative Committee to test the principal techniques and methods in the field.

Note: Key comparisons may include comparisons of representations of multiples and sub-multiples of SI base and derived units as well as comparisons of artefacts.

¹ At present the key comparison data base (KCDB) is maintained by the KCDB office of the BIPM

2.1.1. CIPM key comparison

A CIPM key comparison is a key comparison executed in the framework of a Consultative Committee or by the BIPM. A CIPM key comparison leads to a key comparison reference value².

Note: BIPM key comparisons consist of series of successive bilateral comparisons between NMIs and the BIPM performed when the BIPM holds a unique facility (e.g. SIR for activity of radionuclides).

2.1.2. RMO key comparison

A RMO key comparison is a key comparison executed in the framework of a regional metrology organization.

2.1.3. Key comparison reference value

The key comparison reference value is the reference value resulting from the measurements taken in a CIPM key comparison, accompanied by its uncertainty (normally the standard uncertainty).

Only CIPM key comparisons (carried out by a Consultative Committee or the BIPM) result in a key comparison reference value. For a key comparison carried out by a regional metrology organization (RMO key comparison) the link to the key comparison reference value is obtained by reference to the results from those institutes which have also taken part in the CIPM key comparison.

Note: 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.

2.1.4. Degrees of equivalence

The degree of equivalence relative to the key comparison reference value of a measurement standard or of a measurement result is the degree to which the measured value is consistent with the key comparison reference value. This is expressed quantitatively by two

² See 3.1 [nomenclature of comparisons](#)

terms: the deviation from the key comparison reference value and the expanded uncertainty of this deviation computed at a 95 % level of confidence (in practice, this is often approximated by using a coverage factor k equal to 2). The “graph of equivalence” shows the degrees of equivalence relative to the key comparison reference value.

The degree of equivalence between two measurement standards or two measurements results (also known as “bilateral degree of equivalence”, or “pair-wise degree of equivalence”) is expressed quantitatively by two terms: the deviation of one measured value with respect to the other, calculated as the difference between their respective deviations from the key comparison reference value and the expanded uncertainty of this deviation computed at a 95 % level of confidence (in practice, this is often approximated by using a coverage factor k equal to 2)³.

The matrix of equivalence consists of the full set of degrees of equivalence. This may be published in the KCDB but in the event that it is not published, the details relating to its calculation are available in the final report.

2.2. Supplementary comparisons

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).

³ In special cases, the CCs may decide that the degrees of equivalence be expressed in relative values, after normalization relatively to the key comparison reference value or the nominal value of the measurand.

2.3. Pilot studies

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 alone are not normally considered sufficient support for calibration and measurement capability⁴ (CMC).

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3. Registration of comparisons in the KCDB and status report

Registration of comparisons must be made through the BIPM key comparison database office (KCDB Office), using the [Key and supplementary comparison registration and progress form](#). Only key and supplementary comparisons are registered in the KCDB. Participants who are either i) signatories of the CIPM MRA, or ii) designated institutes for their country through the process of CIPM MRA-D-06, will be listed in the public website of the KCDB for the comparison.

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 shall be reported to the KCDB office with the same form used for registration. Once the progress of the comparison is reported to the KCDB office, the updated status will be made public on the KCDB website.

3.1. Nomenclature of key comparisons

Upon registration with the KCDB Office, each key or supplementary comparison is identified by a unique nomenclature.⁵

⁴ See document [CIPM MRA-D-04](#)

⁵ Some RMOs also use an internal identifier before the comparison is registered. This identifier may be kept in the KCDB and can be found using the website free form search engine.

The first part of the name identifies the comparison. A second part may be used to identify sub-sets of a particular comparison (see below).

- First, the body under the auspices of which the comparison is carried out. This can be:
 - Consultative Committee: CC
 - BIPM: BIPM.
 - Regional metrology organization designated by its acronym: AFRIMETS., APMP., COOMET., EURAMET., SIM., etc.

The dot (.) is added for the BIPM and for the acronym of a regional metrology organization for clarity in reading the nomenclature.

- Second, the field of measurement, designated as in the titles of Consultative Committees:

AUV for Acoustics, Ultrasound and Vibration;

QM for Amount of Substance;

EM for Electricity and Magnetism;

RI for Ionizing Radiation;

L for Length;

M for Mass and related quantities;

PR for Photometry and Radiometry;

T for Thermometry;

TF for Time and Frequency.

- Third, which applies only when the comparison is specifically chosen by a given Consultative Committee working group, part of the acronym of the working group preceded by a dot, for instance:

.RF for the Working Group on Radio Frequencies of the CCEM;

.M for the Working Group on Mass Standards of the CCM;

.P for the Working Group on Pressure of the CCM;

.F for the Working Group on Force of the CCM;

.D for the Working Group on Density of the CCM;

.H for the Working Group on Hardness of the CCM.

This also applies to the three sections of the CCRI (without the dot):

(I) for Section I;

(II) for Section II;

(III) for Section III;

as well as to the CCAUV:

.A for Acoustics;

.U for Ultrasound;

.V for Vibration;

.W for Underwater acoustics.

- Fourth, a hyphen (-).
- Fifth, a capital letter, K for key comparison, S for supplementary comparison and P for pilot study.
- Sixth, a number, generally in the successive order 1, 2, 3, etc.

The second part of the nomenclature may be omitted, but is useful to distinguish between several sub-comparisons of a key or supplementary comparison. It can take any form but should always be preceded by a dot (.). The most usual cases are:

- .a, .b, .c for several sub-comparisons, corresponding to different ranges of measurements of the same quantity;
- .Xy- $\alpha\beta\gamma$ which appears in the field of ionizing radiation for identifying the measurement of a specific radionuclide $^{\alpha\beta\gamma}\text{Xy}$.
- .1, .2, .3 for subsequent bilateral comparisons to a key comparison.
- the year in which the comparison is initially registered in the KCDB.

Dots or hyphens can be added as desirable for clarity in this second part of the nomenclature.

Two or more key comparisons corresponding to the same description but carried out over two different time intervals must have different identifiers. Normally, these comparisons

are identified with different numbers, in which case the second part may be kept unchanged. However, it is possible to keep the same number, in which case changing the second part is mandatory.

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4. CIPM key comparisons

The Consultative Committees are responsible for choosing the key comparisons. In each field a set of key comparisons is identified which covers a range of standards in order to test the principal techniques in the field.

The procedures used by Consultative Committees for selecting, conducting and evaluating key comparisons, including their detailed technical protocols and periodicity, are designed to ensure that:

- the comparisons test all the principal techniques in the field;
- the results are clear and unequivocal;
- the results are robust;
- the results are easy to compare with those of corresponding comparisons carried out subsequently by regional metrology organizations;
- overall, the comparisons are sufficient in range and frequency to demonstrate and maintain equivalence between the laboratories participating in the CIPM MRA.

4.1. Participation in CIPM key comparisons

According to [paragraph 6 of the CIPM MRA](#):

6 Participation in key and supplementary comparisons

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.

At its 2005 meeting, the CIPM decided on the following policy concerning the participation of laboratories in Associates of the CGPM⁶.

- *paragraph 1.5 of the CIPM MRA should be interpreted with greater flexibility than before. Any participation of NMIs and designated institutes from Associates in CC comparisons or other activities should be carefully considered by the relevant committee or working group on a case by case basis. Specifically and **in exceptional cases** Associates may be invited to take part in CC comparisons, studies, pilots and other formal activities where:*
 - *this adds scientific or other value to the work or to the results obtained by other participants;*
 - *reference samples are only produced for the purposes of the CC comparison and no linked RMO comparisons are possible; and*
 - *their participation increases the efficiency or adds effectiveness to the relevant activity.*
- *that reports of CC comparisons in which NMIs and other designated institutes from Associates take part may be included in the KCDB although these reports should make clear those results which come from Associates. Their results should not normally contribute to a key comparison reference value in comparisons which are*

⁶ [CIPM 2005-05, paragraph 2.4](#). In the text, CC refers to Consultative Committees and KC refers to key comparisons.

arranged by the Consultative Committee unless it may be shown to be of significant scientific value to other participants;

- *Associates who are invited to take part in a KC organized by a Consultative Committee may be invited to attend working group meetings at which the results from that comparison are discussed;*
- *that representatives of NMIs or DIs from Associates may be invited, on a one-off, case by case basis, to attend CCs or working groups as guests; and*
- *Associates may be asked to pay, as provided for under Article 15 (1921) of the Convention of the Metre, for any extra costs incurred by the BIPM of their participation in comparisons, particularly those which are piloted by the BIPM.*

It is important to note that a national metrology institute (NMI) or designated institute (DI) that has never participated in a comparison may wish to acquire a benchmark of its performance before participating in a key comparison. This can be achieved by running pilot studies in parallel to a key or supplementary comparison or by participating in a key or supplementary comparison in “pilot study” mode. The results of the NMIs or DIs participating in the pilot study are not to be used to compute reference values, and the name of the institute will not be published in the KCDB. Participation in “pilot studies” run in parallel to comparisons must be agreed before the comparison measurements starts. Results from pilot studies are not considered sufficient support of CMCs.

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4.2. Initiating a CIPM key comparison

CIPM key comparisons are initiated at a Consultative Committee meeting.

The Consultative Committee at each of its meetings examines the need for comparisons and decides which ones from a list of key comparisons should be initiated at that meeting, taking into account, among other things, the views of regional metrology organizations. For each comparison, a pilot institute is identified to take the main responsibility for running the CIPM key comparison.

In drawing up the provisional list of participants and an approximate timetable, the Consultative Committee ensures that an adequate number of participants from each of the

main RMOs take part so that corresponding regional comparisons can be properly linked to the CIPM comparison.

In some CIPM key comparisons the number of participants may be limited for technical reasons.

The Consultative Committee may form a coordinating group, nominating two or three institutes from the provisional list to help the pilot institute in drawing up the technical protocol and timetable for the comparison.

The timetable of this and any other comparisons decided by the Consultative Committee should be discussed to ensure that the workload of the whole set is not too great for the participating and pilot institutes, and that the results will be available for the next meeting, normally in three (or occasionally two) years' time. For this the total circulation time of the standards must be fixed and should not exceed eighteen months unless there are exceptional circumstances.

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4.3. Organization of a CIPM key comparison

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 Committee⁷.

The main points to be decided by the group headed by the pilot institute are the following:

⁷ Consultative Committees or working groups may decide to publish these documents in their corresponding website. When approved, the technical protocol may be published in the KCDB.

- List of participants with full details of mailing and electronic addresses.
- Travelling standard or standards to be used in the comparison.
- Whether or not a pilot comparison or any other preliminary work needs to be carried out among a restricted number of participants to verify the performance of the travelling standard.
- Pattern of the full-scale comparison, which ranges from the simple circulation of a single travelling standard around all the participants to the sending of an individual travelling standard directly to each participant from the pilot institute, or from each participant to the pilot institute or some combination of these.
- Starting date, detailed timetable, means of transport and itinerary to be followed by each travelling standard. This starting date is subsequently referred to as the starting date for the comparison.
- Procedure in the case of failure of a travelling standard.
- Procedure in the case of unexpected delay at a participating institute.
- Customs documents to accompany the travelling standards, either ATA carnet or other for those participants not qualifying for the ATA scheme.

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4.4. Technical protocol for a key comparison

The coordinating group⁸ draws up the detailed technical protocol. This technical protocol is an important part of the comparison and specifies in detail the procedure to be followed. It is important to remember, however, that the purpose of a key comparison is to compare the standards as realized in the participating institutes, not to require each participant to adopt precisely the same conditions of realization. The protocol should, therefore, specify the procedures necessary for the comparison, but not the procedures used for the realization of the standards being compared.

The points treated in the protocol should include the following:

⁸ For those cases where there is no coordinating group, the responsibility relies on the pilot institute.

- Detailed description of the devices: make, type, serial number, size, weight, packaging, etc., and technical data needed for their operation.
- Advice on handling the travelling standards, including unpacking and subsequent packing and shipping to the next participant. This should include a complete list of the content of the package including handbooks, etc., and the weight and size of the whole package.
- Action to be taken on receipt of the standards in a participating institute.
- Any tests to be carried out before measurement.
- Conditions of use of travelling standards during measurement.
- Instructions for reporting the results.
- Proposal for the method of determination of the key comparison reference value .
- List of the principal components of the uncertainty budget to be evaluated by each participant, and any necessary advice on how uncertainties are estimated (this is based on the principles laid out in the ISO *Guide to the Expression of Uncertainty in Measurement*). In addition to the principal components of the uncertainty, common to all participants, individual institutes may add any others that they consider appropriate. Uncertainties are evaluated at a level of one standard uncertainty and information must be given on the number of effective degrees of freedom required for a proper estimation of the level of confidence.
- Timetable for communicating the results to the pilot institute. Early communication helps to reveal problems with the travelling standard during the comparison.
- Financial aspects of the comparison, noting that in general each participating institute is responsible for its own costs for the measurements, transport and any customs charges as well as any damage that may occur within its country. Overall costs of the organization of the comparison, including the supply of the transfer devices, are normally borne by the pilot institute.
- Insurance of transfer devices is decided by agreement among the participants taking account of the responsibility of each participant for any damage within its country.

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4.5. Circulation of transfer standards and customs formalities

The pilot institute is responsible for organizing the circulation and transport of the standards and ensuring that the participants make proper arrangements for local customs formalities.

The equipment must be handled with care, i.e. only by qualified metrology personnel. It is desirable and in some cases essential that the transfer instruments be hand-carried. If this is not deemed essential, certain precautions must nevertheless be taken. As goods are usually delivered to a shipping department in an institute a warning note should be attached to the package indicating that the package should be opened only by laboratory personnel. The participating institutes are responsible for transport to the next institute according to the circulation scheme. The method of transport as defined in the instructions should be respected.

Before dispatching the package, each participant must inform the next participant and the pilot institute, giving transport details.

If an ATA carnet is used, it must be used properly. Upon each movement of the package the person organizing the transit must ensure that the carnet is presented to customs on leaving the country, and upon arrival in the country of destination. When the package is sent unaccompanied, the carnet must be included with the other forwarding documents so that the handling agent can obtain customs clearance. In no case should the carnet be packed with the device in the package. In some cases it is possible to attach the carnet to the package.

After arrival of the package, the participating institute should inform the pilot institute of this by completing and returning a form that is included in the package. Immediately after receipt, the participating institute should check for any damage of the standards, in particular scratches and rust, and report this to the pilot institute.

If a delay occurs the pilot institute should inform the participants and if necessary revise the time schedule or the order of circulation between countries.

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4.6. Reporting the results of the measurements

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.

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4.7. Report of a CIPM key comparison

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 discrepant with the reference value or are not consistent with their published CMCs, 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 travelling 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 travelling 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 can be 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.

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. The subsequent bilateral comparison is considered as a new and distinct comparison.

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5. RMO key comparisons

To allow the participation in key comparisons of all the NMIs and DIs of an RMO, the RMOs may organize their own key comparisons.

5.1. Participation in RMO key comparisons

Participation in RMO key comparisons is decided by the corresponding committees of the RMO, but only the results corresponding to NMIs or DIs from Member States of the BIPM or Associate States and Economies of the CGPM that have signed the CIPM MRA will appear in the tables of numbers (including the degrees of equivalence) and in the graphs (including the graphs of equivalence) published in the KCDB. The policy for reporting comparisons that involve participants who are non-signatories to the CIPM MRA is stated in paragraph 8.

As participation in CIPM key comparisons may be limited in number for technical reasons, it is recommended that if possible, RMO key comparisons be open to participation of NMIs of other regions.

The RMO key comparisons must be linked to the corresponding CIPM key comparisons by means of joint participants. This is mandatory to demonstrate global equivalence. To achieve this, it is recommended that at least two of the participants in the preceding CIPM key comparison participate also in the RMO key comparison.

5.2. Organization of RMO key comparisons

The RMO key comparisons must follow the same protocol as a preceding CIPM key comparison and must be approved in advance as “key” by the corresponding Consultative Committee. Instead of the method to determine a reference value, the RMO key comparison protocol must include the way in which the results will be linked to the corresponding CIPM key comparison reference value.

The mechanism for approval depends on the particular Consultative Committee’s practice.

5.3. Reports of RMO key comparisons

The procedure for reporting an RMO key comparison is basically the same as that described in Section 4.7. Only key comparisons carried out by a Consultative Committee or the BIPM (CIPM key comparisons) lead to a key comparison reference value. For a key comparison carried out by an RMO, the link to the CIPM key comparison reference value is obtained by reference to the results from those institutes that have also taken part in the CIPM key comparison.

The complete results of the linked RMO key comparison are shown in exactly the same form in the pages of the original CIPM key comparison in the KCDB. However, the link for “participants” in the page for the RMO comparison lists only the laboratories that participated in this exercise.

The degree of equivalence relative to the CIPM key comparison reference value derived from an RMO key comparison has the same status as that derived from a CIPM key comparison.

6. Subsequent bilateral key comparisons

Subsequent bilateral key comparisons are normally carried out for one of the following reasons:

- After completing a key comparison, an institute that considers its result unrepresentative of its standards may request a subsequent bilateral comparison with one of the other participants.
- An institute that was not ready to participate at the time a key comparison was conducted may request a subsequent bilateral comparison with one of the participants.

The results of subsequent key comparisons may be added to the data for the previous key comparison in the KCDB, with a note specifying that these results correspond to the subsequent comparison. Except for BIPM ongoing comparisons, when a Consultative Committee chooses to include new participants, no key comparison reference value is computed for these new results and they are not normally used to modify the key comparison reference value obtained from the results of the original participants. The results are linked to the original key comparison through the joint participation and the linking laboratories original results remain valid. In such cases, degrees of equivalence are computed for the participants in the subsequent comparison with respect to all other participants and to the previous key comparison reference value.

The results of subsequent key comparisons may be assigned a separate identifier at the request of a Consultative Committee. This identifier will usually be the name of the previous comparison plus a suffix.⁹ As with the results of RMO key comparisons, the complete results of the linked subsequent comparisons are shown in exactly the same form in the pages of the original CIPM key comparison and that of the subsequent comparison. However, the link for “participants” in the page for the subsequent comparison lists only the laboratories that participated in this exercise.

⁹ Bilateral comparisons are no longer assigned the special identifier “BK” for registration in the KCDB. This allows potential additional participants to join in the comparison without the need to modify the identifier.

Bilateral comparisons of standards with long-term stability carried out by the BIPM may be conducted according to special arrangements not necessarily covered by this document.

7. Supplementary comparisons

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.

The rules for the participation in CIPM and RMO key comparisons also apply to CIPM and RMO supplementary comparisons (paragraphs [4.1](#) and [5.1](#)).

Bilateral supplementary comparisons should follow the same procedure as multilateral supplementary comparisons.

7.1. Participation in supplementary comparisons

Participation in supplementary comparisons is decided by the organizing body, usually the RMO. As with RMO key comparisons, it is recommended that participation is open to NMIs and DIs from other RMOs. The policy for reporting comparisons that involve participants who are non-signatories to the CIPM MRA is stated in paragraph 8.

7.2. Reports of supplementary comparisons

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. Publication of comparisons in the KCDB

Measurement comparison reports should be written to reflect the experiment that was actually performed, including summary results from all participants. These reports should be accessible from the online Key Comparison Database, but the graphs and tables of equivalence explicitly shown should include results only from signatory NMIs and DIs. The results for non-signatory participants should be considered as evidence of metrological competence for any future CMC submissions in the event that the laboratory becomes a signatory to the CIPM MRA. Note that this would not apply to laboratories participating in a measurement comparison under less stringent rules than the signatory laboratories (e.g. as a 'pilot study' participant for a measurement comparison in chemistry).

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 that is also included in the Final Report. 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.

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9. Monitoring the impact of comparison results

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 or any other participant 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 and the chair of the RMO technical committee/working group responsible for approval of NMI quality management systems.

In both cases, the communication should also 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.

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10. Related documents

[CIPM MRA](#) – Mutual recognition of national measurement standards and of calibration and measurement certificates issued by national metrology institutes, Paris, 14 October 1999.

CIPM MRA [Technical Supplement](#) revised in October 2003.

[CIPM MRA-D-04](#) - Calibration and Measurement Capabilities in the context of the CIPM MRA.

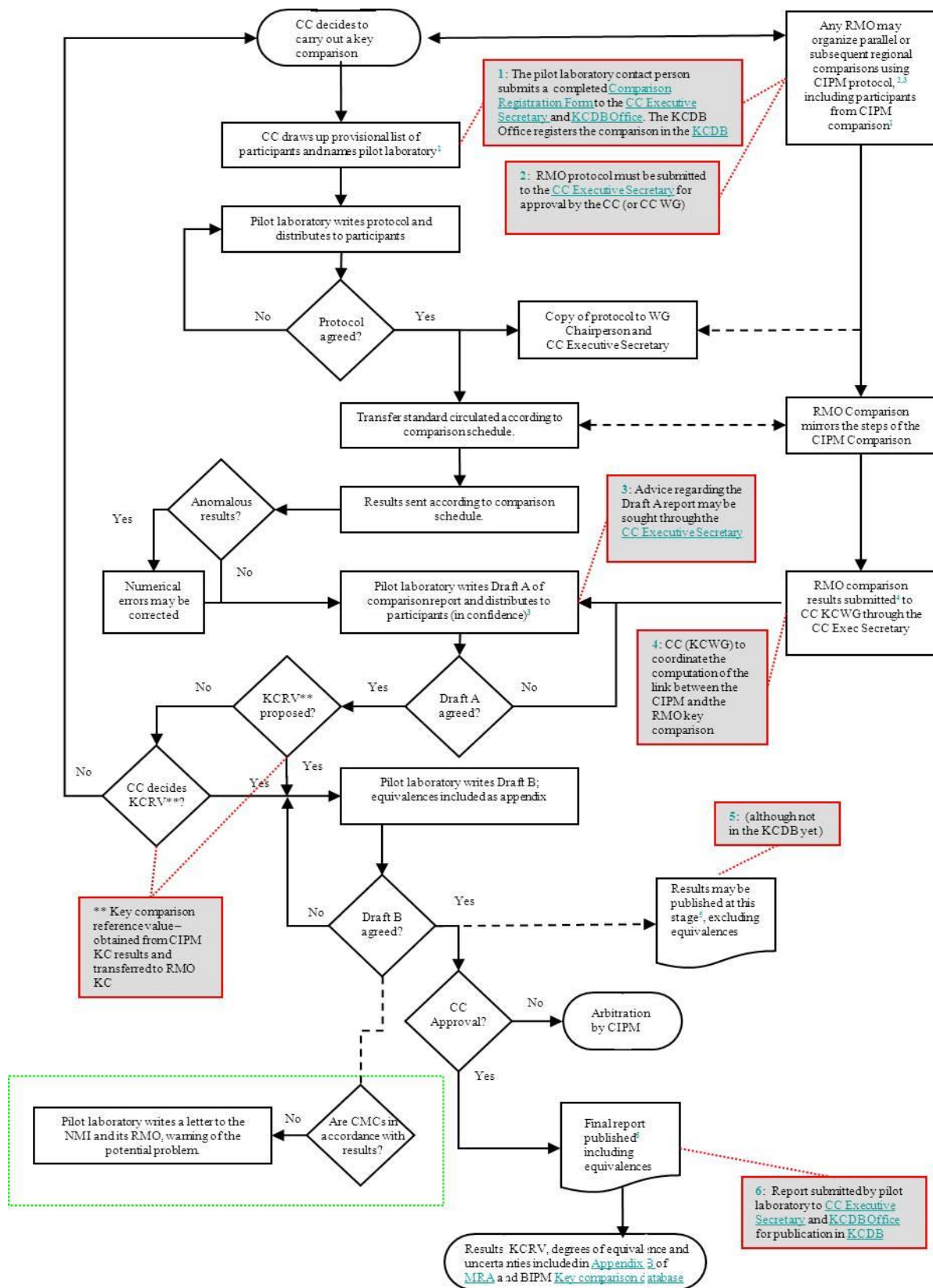
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11. Revision history

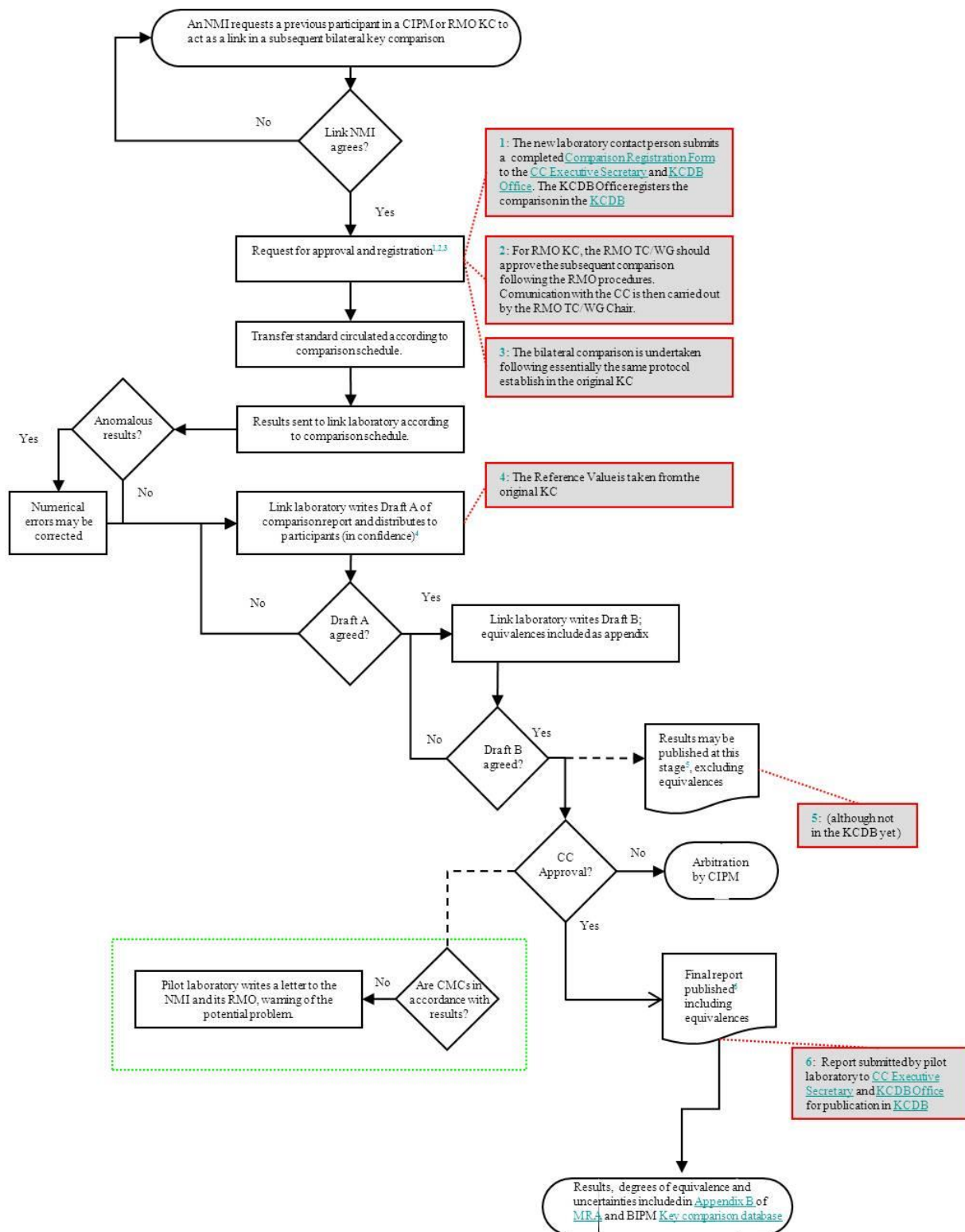
Version number	Date of issue/review	Summary of changes	
1	2009-10-25	Approved as CIPM 2009-25 Supersedes documents:	
		JCRB 9/9(1)	Key and supplementary comparison registration form
		JCRB 20/6	Flowcharts of the processes for key comparisons, bilateral comparisons, and supplementary comparisons
		JCRB 11/08(5)	Supplementary comparisons – definition
		JCRB 10/07 (2)	A note on supplementary comparisons
		–	Guidelines for CIPM key comparisons
		–	Nomenclature of the key comparisons
–	Monitoring the impact of key and supplementary comparison results on CMC claims		
1.1	2011-08-31	–	Points of clarification primarily concerning

			the flow charts and the publication process
	2011-10-13		Changes approved by CIPM
1.2	2012-04-04	–	Change in procedure for approval and publication of supplementary comparison reports approved by JCRB
	2012-06-07		Changes approved by CIPM
1.3	2012-09-25	–	Change in procedure for monitoring the impact of comparison results
	2012-10-19		Changes approved by CIPM
1.4	2013-03-20	–	Change in definition of pilot study comparison approved by JCRB
	2013-06-21		Changes approved by CIPM
1.5	2014-03-06	–	Change in procedure for registration of comparisons in the KCDB and status report approved by JCRB
	2014-03-14		Changes approved by CIPM
1.6	2016-03-16	–	Changes of policy on reporting results of comparisons with participants who are non-signatories to the CIPM MRA. Clarification in policy on participants who can be listed on the public website of the KCDB.

Appendix 1 – Flowchart of CIPM and RMO key comparisons



Appendix 2 – Flowchart of subsequent bilateral comparisons



Appendix 3 – Flowchart of supplementary comparisons

