



# Calibration and Measurement Capabilities in the context of the CIPM MRA

**CIPM MRA-D-04**

**Version 5**

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## 1. Definition of Calibration and Measurement Capability (CMC)

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

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

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

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

*Where the term NMI is used it is intended to include Designated Institutes (DIs) within the framework of the CIPM MRA.”*

### NOTES

*N1. The meanings of the terms Calibration and Measurement Capability, CMC, (as used in the CIPM MRA), and Best Measurement Capability, BMC, (as used historically in connection with the uncertainties stated in the scope of an accredited laboratory) are identical. The terms BMC and CMC should be interpreted similarly and consistently in the current areas of application.*

*N2. Under a CMC, the measurement or calibration should be:*

- performed according to a documented procedure and have an established uncertainty budget under the management system of the NMI or the accredited laboratory;*
- performed on a regular basis (including on demand or scheduled for convenience at specific times in the year); and*
- available to all clients.*

*N3. The ability of some NMIs to offer “special” calibrations, with exceptionally low uncertainties which are not “under normal conditions,” and which are usually offered only to a small sub-set of the*

*NMI's clients for research or for reasons of national policy, is acknowledged. These calibrations are, however, not within the CIPM MRA, cannot bear the equivalence statement drawn up by the JCRB, and cannot bear the logo of the CIPM MRA. They should not be offered to clients who then use them to provide a commercial, routinely available service. Those NMIs which can offer services with a smaller uncertainty than stated in the database of Calibration and Measurement Capabilities in the KCDB of the CIPM MRA, are, however, encouraged to submit them for CMC review in order to make them available on a routine basis where practical.*

*N4. Normally there are four ways in which a complete statement of uncertainty may be expressed (range, equation, fixed value and a matrix). Uncertainties should always comply with the Guide to the Expression of Uncertainty in Measurement (GUM) and should include the components listed in the relevant key comparison protocols of the CIPM Consultative Committees. These can be found in the reports of comparisons published in the CIPM MRA KCDB as a key or supplementary comparison.*

*N5. Contributions to the uncertainty stated on the calibration certificate and which are caused by the client's device before or after its calibration or measurement at a laboratory or NMI, and which would include transport uncertainties, should normally be excluded from the uncertainty statement. Contributions to the uncertainty stated on the calibration certificate include the measured performance of the device under test during its calibration at the NMI or accredited laboratory. CMC uncertainty statements anticipate this situation by incorporating agreed-upon values for the best existing devices. This includes the case in which one NMI provides traceability to the SI for another NMI, often using a device which is not commercially available.*

*N5a. Where NMIs disseminate their CMCs to customers through services such as calibrations or reference value provision, the uncertainty statement provided by the NMI should generally include factors related to the measurement procedure as it will be carried out on a sample, i.e., typical*

*matrix effects, interferences etc. must be considered. Such uncertainty statements will not generally include contributions arising from the stability or inhomogeneity of the material. However, the NMI may be requested to evaluate these effects, in which case an appropriate uncertainty should be stated on the measurement certificate. As the uncertainty associated with the stated CMC cannot anticipate these effects, the CMC uncertainty should be based on an analysis of the inherent performance of the method for typical stable and homogeneous samples.*

*N5b. Where NMIs disseminate their CMCs to customers through the provision of certified reference materials (CRMs) the uncertainty statement accompanying the CRM, and as claimed in the CMC, must indicate the influence of the material (notably the effect of instability, inhomogeneity and sample size) on the measurement uncertainty for each certified property value. The CRM certificate should also give guidance on the intended application and limitations of use of the material.*

*N6. The NMI CMCs which are published in the KCDB provide a unique, peer reviewed traceability route to the SI or, where this is not possible, to agreed - upon stated references or appropriate higher order standards. Assessors of accredited laboratories are encouraged always to consult the KCDB (<http://kcdb.bipm.org>) when reviewing the uncertainty statement and budget of a laboratory in order to ensure that the claimed uncertainties are consistent with those of the NMI through which the laboratory claims traceability.*

*N7. National measurement standards supporting CMCs from an NMI or DI are either themselves primary realizations of the SI or are traceable to primary realizations of the SI (or, where not possible, to agreed - upon stated references or appropriate higher order standards) at other NMIs through the framework of the CIPM MRA. Other laboratories that are covered by the ILAC Arrangement (i.e. accredited by an ILAC Full Member Accreditation Body) also provide a recognized route to traceability to the SI through its realizations at NMIs which are*

*signatories to the CIPM MRA, reflecting the complementary roles of both the CIPM MRA and the ILAC Arrangement.*

*N8. Whereas the various parties agree that the use of the definitions and terms specified in this document should be encouraged, there can be no compulsion to do so.*

In the KCDB, a CMC is described by the measured quantity and its range, and is characterized by an uncertainty generally given at a 95 % level of confidence, together with the method or instrument used, the values of the influence parameters if any, and any other relevant information.

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## 2. Drawing up CMCs files

There are two different cases to be taken into consideration:

- CMCs files from a institute that has not previously submitted CMCs in a particular area (New CMCs)
- CMCs files than imply the modification or expansion of already approved CMCs.

Blank Excel files and particular instructions for the different areas can be found in the JCRB website, under “[Instructions for drawing up CMC excel files](#)”:

- [Basic excel template](#)
- [Excel template with uncertainty matrices and closely related CMCs](#)
- [Excel template for CMCs in chemistry](#)
- [Instructions for closely related CMCs](#)
- [Additional instructions for CMCs files in EM](#)
- [Instructions for uncertainty matrices in CMC files](#)
- [International rules for filling in the CMC tables for ionizing radiation](#)
- [Additional instructions for CMC files in AUV](#)
- [Additional instructions for CMC files in PR](#)

### 2.1. General instructions, format of the CMCs file.

The following rules should be followed to ensure the reliability of the information included in the part "Appendix C" of the BIPM key comparison database. The submission of CMCs for the review process is done in EXCEL files, in the formats established in general by the JCRB and with particular cases for QM, EM and IR.

It is essential that the submissions are done following the prescribed formats, to allow the upload in the KCDB of the reviewed and approved data.

The information to be submitted in the EXCEL file is shown in the following figure:

**Calibration and Measurement Capabilities in the context of the CIPM  
MRA  
CIPM MRA-D-04**



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	<b>CMC Table for (Name of the NMI or DI doing the submission)</b>																					
2	Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty				Reference Standard used in calibration		List of Comparisons supporting this measurement/calibration service	Comments to be published via the web page	Administration					
3	Quantity/ Class	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Standard	Source of traceability			NMI Service Identifier	Service Category	NMI	Review Status	Review Comments
4																						
5																						

The BIPM Appendix C database provides information contained in the "white part" of the CMC Excel files, namely "Calibration and measurement service" (Columns A-C), "Measurand level or range" (Columns D-F), "Measurement conditions/independent variable" (Columns G-H), "Expanded uncertainty" (Columns I-M), and in the column of comments (Column Q) on the CMC lines. Three additional columns are also needed: the yellow column including the NMI acronym (Column T), the yellow column including the NMI service identifier (Column R, not mandatory to be filled) and the yellow column including the service number (Column S) drawn up from the Classifications of Services<sup>1</sup>/Categories<sup>2</sup> defined by the CC of each metrology area. The remaining columns, especially the "blue part" and any additional columns of information useful for the regional and inter-regional review are for review purposes only and are not part of the KCDB. It follows that these instructions concern only the "white part" of CMC Excel files and the three columns mentioned above.

1. **Use one Excel file per country, per metrology area and per branch<sup>3</sup>/category<sup>4</sup>.** If you submit CMC for more than one branch /category of metrology area, you have to use separate Excel file for each branch/category. Each Excel file may include several worksheets, but all CMCs should be listed in one single worksheet, the additional worksheets being used for information needed in the intra- or inter-regional review.
2. **IMPORTANT.** Since the search engine of the database relies upon the Classification of Services/Categories, care should be taken to use **the most recent Classification of**

<sup>1</sup> For all fields except the field of chemistry and biology

<sup>2</sup> For the field of chemistry and biology

<sup>3</sup> For all fields except the field of chemistry and biology

<sup>4</sup> For the field of chemistry and biology



**services/categories** for choosing the service numbers<sup>5</sup>. This list can be downloaded from the KCDB website.

[http://kcdb.bipm.org/appendixC/AUV/AUV\\_services.pdf](http://kcdb.bipm.org/appendixC/AUV/AUV_services.pdf)

[http://kcdb.bipm.org/appendixC/EM/EM\\_services.pdf](http://kcdb.bipm.org/appendixC/EM/EM_services.pdf)

[http://kcdb.bipm.org/appendixC/L/L\\_services.pdf](http://kcdb.bipm.org/appendixC/L/L_services.pdf)

[http://kcdb.bipm.org/appendixC/M/M\\_services.pdf](http://kcdb.bipm.org/appendixC/M/M_services.pdf)

[http://kcdb.bipm.org/appendixC/PR/PR\\_services.pdf](http://kcdb.bipm.org/appendixC/PR/PR_services.pdf)

[http://kcdb.bipm.org/appendixC/QM/QM\\_categories.pdf](http://kcdb.bipm.org/appendixC/QM/QM_categories.pdf)

[http://kcdb.bipm.org/appendixC/RI/RI\\_services.pdf](http://kcdb.bipm.org/appendixC/RI/RI_services.pdf)

[http://kcdb.bipm.org/appendixC/T/T\\_services.pdf](http://kcdb.bipm.org/appendixC/T/T_services.pdf)

[http://kcdb.bipm.org/appendixC/TF/TF\\_services.pdf](http://kcdb.bipm.org/appendixC/TF/TF_services.pdf)

3. Translate all words into **English**.
4. Use the **period** "." as the decimal separator rather than a **comma** ",".
5. Choose the setting "**text**" for all the cells of the useful part of the file. **Do not** choose "**percentage**" or "**scientific**". Formatting all cells in text ensures that information is safely imported into the database. In addition, as mentioned below, it does not prevent, and even often simplifies, the writing of statements such as "95%" or "4.25E-03".
6. Format all the cells of the useful part of the file in "**Center**" and "**Wrap text**".
7. Use by default the font "**Arial 10**" and not "Times new roman 10 or 12". The "**μ**" is obtained directly from your keyboard or by typing "**ALT+0181**" and the "**±**" by typing "**ALT+0177**". Greek letters cannot be written in "Arial 10": use instead "Symbol 10" for these special characters (for instance for "**Ω**", "**Ø**", etc.). Avoid using any other fonts than the two cited here.
8. **Italics** should be used for **quantities** (for instance "**L**" for a length), but never for units.

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<sup>5</sup> For the field of chemistry and biology term "service number" corresponds to the category number

9. For cells including words (for instance the column describing the method), **avoid abbreviation** (for instance write "relative" instead of "rel.") and the wording should **always begin with a capital letter** but **no other capital letters** should be used in the same cell, except if an acronym is to be given (for instance "Relative AC/DC voltage difference", but not "Relative AC/DC Voltage Difference"). This applies to all cells except those giving the **specifications of parameters**, which **should never begin with a capital letter** (this case is very rare since the parameter specifications generally consist of value ranges).
10. Be careful with the insertion of blank characters into cells. **Blank characters should be used only to separate words** (for instance "AC/DC voltage difference"), **to separate a number from its unit** (for instance "20 °C"), **after a colon ":" and a comma ","** (such as "Length: central length, *L*") but never preceding a colon or comma. All **other blank characters should be deleted**, even if it slightly degrades the presentation (for example, do not write "1 mm, 10 mm, 100 mm" to make the "100 mm" appear well-centered in the cell).
11. **Do not use the semicolon ";"** inside a cell, which may be interpreted as a cell separator when importing the file into the database. You can, however, use the colon ":" and the comma ",".
12. **Do not imbed returns, spaces or tabs in a single cell** to force word wrapping, even if it appears to improve the presentation. In particular, **never use the function "Alt+Return"** (it inserts a "carriage return" inside an Excel cell).
13. Multiple entries in a single cell must be separated vertically into separate cells and cells **must not be merged** vertically. This holds specially when the description of one CMC is valid for different measurand ranges and/or includes several parameters with their specifications. In these cases:
  - use only **one measurand range per CMC** and repeat all other relevant information;
  - place each parameter and specification in its own cell.
  - See examples in appendix 1.



14. **Superscripts** and **subscripts** can be used, but **not for numbers** (especially not for powers of ten, see instruction 17). Superscripts must be used in the expression of units such as "m/s<sup>2</sup>".
15. A blank character may be used in a complicated unit [for example " $\mu\text{W}/(\text{V A})$ "]. In such a case the blank character may be used but is not necessary. **Avoid using the "dot above the line"** (Alt+0149) which has the meaning of "multiplication" of units (this character is not accepted by the database; better to insert a blank character or nothing at all).
16. If a unit like "dB" needs a **reference value**, include it in column B "Instrument or Artifact" under the form: "Reference value for the unit: 1  $\mu\text{V}$ ".
17. **Use as often as possible the scientific notation "YE-XX" when writing numbers, especially powers of ten.** Note that since the cells are defined as "text" the characters "Y", "E" and "-XX" are sequentially typed without defining any other settings such as the number of decimals. The part "Y" may be a number including decimals; the point "." should be used as the decimal separator (for example "1.0E-09" does not convey the same meaning as "1E-09" since an additional decimal is given in the first case). **Do not separate the part "Y" from the part "E-XX"** by a blank or any other character. Always write the part "-XX" with three characters (and not two): a "-" or "+" sign and two integers (for instance, avoid writing expressions such as "1E-9" for "1E-09", or "4.23E04" for "4.23E+04"). The sign "-" is obtained in Arial as a short dash.
18. **Do not use "±" in the uncertainty column;** "±" is reserved for ranges in the specification of parameters.
19. The part "Expanded uncertainty" should at least be divided into five columns corresponding to the headings "Value", "Unit", "Coverage factor", "Level of confidence", and **"Is the expanded uncertainty a relative one?"**. Answer this question in the CMC lines by inserting **"Yes"** or **"No"**. A blank entry with no answer to the question cannot be accepted. Note that in Chemistry, the part "Value" is split into two columns "From" and "To".
20. **Do not use a blank character in the multiplication of a number by a quantity** (thus "0.24L" and not "0.24 L").

21. It may happen that the expanded uncertainty is a function of a quantity. In such a case, be sure to **define the quantity and its symbol** and specify the unit. This unit should be by default the unit given for the measurand range, but this has not always proved to be the case; it is obligatory that the unit be given explicitly (thus "Q[20, 0.24L]" should be written as "Q[20, 0.24L], *L* central length in mm").
22. Parameters are often specified as a range of values. Use the **ISO standard presentation for value ranges**: the unit should be given at both ends of the range. In addition use "to" instead of "-" as the "-" may be interpreted as the "minus" sign (for example the specification of the parameter "Frequency", "10 - 20 Hz", should be written as "10 Hz to 20 Hz").
23. It was suggested that a typical range of values be given for the expanded uncertainty when this uncertainty is expressed as a function. This can be particularly informative, especially when the uncertainty value depends upon a number of parameters. Experience gained from the CMCs already published shows, however, that this is not often done and that some calculation errors were incurred in computing both ends of the values' range. This thus remains an option, but there is no obligation in this regard. **If a range of uncertainty values is given, it is important that it is computed correctly** (as no checks are made at the BIPM) and that the units of both limits of the range are given (see point 22 above). Thus "Q[20, 0.24L], *L* central length in mm, values range from 20 to 31" should be written as "Q[20, 0.24L], *L* in mm, values range from 20 nm to 31 nm".
24. The level of confidence should be written as a **percentage** (such as "95%") and **not as the number** "0.95". Since all cells should have been previously defined in "text", this result is obtained by typing "9" "5" "%" without inserting any blank character.
25. **Check that the NMI acronym is given for all the CMC lines included in the file.** The NMI acronym should be written with no blank character added before or after the acronym. Blank characters may be added inside the acronym if the acronym is composed of two or more words. A hyphen or a slash can be inserted in the acronym; adding blank characters before and after the hyphen is a choice that the laboratory should make. Once the acronym is chosen, **it should be unique and always written in the same way.**

26. Each laboratory can choose how to identify its internal service identifiers. The NMI internal service identifiers are often given by a simple number (for instance "23"), which is fine. It may also correspond to the identifiers of the catalogue of services provided by the laboratory (and often available via its website). An internal identifier that includes blank characters or a series of words.
27. **It is imperative that the service numbers refer to services which are actually listed in the Classification of Services/Categories of the relevant metrology area (see point 2).** A service number is usually presented as "a.b.c", where "a", "b", and "c" are integers (for instance "2.1.3"). Sometimes it includes only two integers (as in Chemistry), or an additional identifier ("Co-60" for "Cobalt 60" as in the field of Ionizing Radiation); this depends on the agreed Classification of Services/Categories. In any case, only 1 service number should be written in the appropriate cell. If the CMC line corresponds to two services of the Classification, then either one single service number is actually adequate for the cited service, or the Classification is not precise enough; in the latter case the CMC line should be repeated twice with two different service numbers. **Do not add any blank character before, within or after the service number** (thus "2.1. 3" is forbidden).
28. **The cell of comments on the CMC line is published via the database. These comments, inserted in a white cell, should not be confused with review comments that are inserted in blue or yellow cells.** The comments to be published may include a complete sentence or a simple series of words. It should begin with a capital letter, should include no other capital letters (except acronyms), may include a period "." and a comma "," but the semicolon ";" should be avoided. It can also include the URL address of a website. In such a case, the link will be inserted by the BIPM. **Never use footnotes for information to be published via the database.**
29. All header/footnotes inserted in CMC Excel sheets are not used for the database. On the contrary, they are all suppressed for construction of the .pdf files and replaced by "Calibration and Measurement Capabilities", "The BIPM key comparison database", the date, and the page numbering. RMOs may thus decide upon their own header/foot notes for the identification of their Excel sheets (for example, the date of the internal RMO review and the arrangement of pages).

30. Information included in the blue and yellow cells relevant to a given CMC may include several items. **Write all items in the same cell or use other cells on the same line.** This would activate new columns of the CMC line and has no impact on the importation of the CMC into the database. **In general, do not add artificial lines to a CMC for notes, references, or special specifications; always add columns for this purpose.**

## 2.2. Specifying the scope of CMCs

1. CMC declarations should be self-consistent. A CMC specification should not depend on references to other services as the BIPM KCDB web page is capable of displaying a single CMC.
2. CMC declarations should have three unambiguous characteristics (see examples at the end):
  - a) Measurand

Only one measurand is allowed per CMC even if several closely-related variables can be reported. Examples of this are electric power and energy or mass and volume flow rate. In these cases each variable should be reported in a separate line with the correct units and uncertainty statement.

### b) Range

The measurement range can be expressed explicitly or implicitly (i.e. through a range of parameters) but never with a reference to other services (see 1). Implicit specifications must provide enough information in the parameters section so as to indicate the range of validity of the uncertainty statement.

### c) Uncertainty

There should be no ambiguity as to the uncertainty that can be expected from a CMC, in particular when the measurand covers a range of values. This is generally achieved employing one of the following methods:

- i. The uncertainty is declared as a single value, which is valid throughout the measurement range.



- ii. The uncertainty is declared as a range. In this case the assumption is that linear interpolation may be used to find the uncertainty at intermediate values.
- iii. The uncertainty is declared as an explicit function of the measurand or a parameter
- iv. The uncertainty is declared as a matrix where the values of uncertainty depend on the values of the measurand and one parameter or on two parameters.

Open intervals (e.g. “<X”) are not allowed in the specification of uncertainties.

Examples of CMCs with common errors and correct CMC tables can be found in Appendix 2.

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### 3. Criteria for acceptance of CMCs

The JCRB requires that CMCs submitted for publication in Appendix C are accompanied by an RMO report indicating that the local Technical Committee/Working Group has approved the range and uncertainty of said CMCs and that each one of them is supported by a fully implemented Quality System reviewed and approved by the local RMO.

Furthermore, the JCRB requires that the range and uncertainty of the CMCs submitted be consistent with information from some or all of the following sources:

1. Results of key and supplementary comparisons
2. Documented results of past CC, RMO or other comparisons (including bilateral)
3. Knowledge of technical activities by other NMIs, including publications
4. On-site peer-assessment reports
5. Active participation in RMO projects
6. Other available knowledge and experience

While the results of key and supplementary comparisons are the ideal supporting evidence, all other five sources listed above may be considered to underpin CMCs not directly related to the available comparison results and those for which comparison results are not yet available.

The NMIs that issue the CMCs are primarily responsible for providing, through their local TC/WGs, the information that they believe is necessary to support their claims. TC/WGs from other RMOs may request additional information, if needed.

#### 3.1. Requirements for traceability

A National Metrology Institute (NMI) or other Designated Institute (DI) publishing Calibration and Measurement Capabilities (CMCs) in the BIPM Key Comparison Database (KCDB) has two choices for establishing its traceability route to the SI:

1. via a primary realization or representation of the unit of measurement concerned, in which case traceability must be declared to its own demonstrable realization of the SI;
2. via another NMI or DI having relevant CMCs with appropriate uncertainty published in the KCDB or through calibration and measurement services offered by the BIPM, in which case traceability must be declared through the laboratory providing the service.



In exceptional cases, where neither of these two routes can be strictly applied, alternative paths for establishing the traceability to recognized standards may be proposed to the CIPM through the corresponding Consultative Committee. Any such exceptions, once approved by the CIPM, will be available in the CIPM MRA documents part of the BIPM website. The list of exceptions for each field should be periodically reviewed by the corresponding Consultative Committee.

Note 1: In order for a primary realization or representation of the unit of measurement to be considered valid, it requires the approval of the relevant Consultative Committee.

Note 2: The NMI or DI must make available a full assessment of the uncertainty budget and the traceability route for its measurement activity when submitting CMCs for intra- and inter-Regional review.

Note 3: For auxiliary influence quantities, not part of the main traceability path to the SI for a particular measurand and with uncertainties that can be shown to make only a minor contribution to the total combined uncertainty of the CMC, an NMI or other DI is free to use measurement services provided by laboratories accredited by a signatory to the ILAC Arrangement.

Note 4: Traceability route 1 includes the case of NMIs or DIs using certified reference materials (CRMs) or high-purity primary chemical reference materials that have been value-assigned by applying their own measurement capabilities as described and recognized within published CMCs.

### **3.2. Special criteria for CRMs**

The CIPM Mutual Recognition Arrangement (CIPM MRA) makes provision for the listing of certified reference materials (CRMs) in Appendix C. One or more CRMs can be listed in a field entitled “Mechanism(s) for Measurement Service Delivery”, in association with amount of substance CMCs that are directly related to the ability of the designated NMIs and other designated institutes to characterize and assign traceable values to CRMs.

Appendix C of the CIPM MRA is not intended to be a catalogue of CRMs that can be delivered by the NMIs or other designated institutes. In order to have a CRM listed in Appendix C of the CIPM MRA as a mechanism of disseminating traceability, the NMI or designated institute must have demonstrated its measurement capabilities and competence in the field concerned, which are also explicitly or implicitly claimed by the institute in



Appendix C. Furthermore, all CRMs listed in Appendix C must meet the requirements of the [ISO 17034:2016](#) and as far as applicable and useful of the ISO Guide 35, which pertain to the production of CRMs and to the assignment of certified values.

In order for a CRM to be listed in Appendix C, the review process should take into account the following criteria:

1. NMIs and other designated institutes listing CRMs in Appendix C of the CIPM MRA shall have a quality system in accordance with ISO/IEC 17025 and [ISO 17034:2016](#) or equivalent. The quality system must include a complete description of the whole CRM production and certification process, also defining the internal organization responsible for the certification process;
2. Values assigned to CRMs have to be traceable to the SI or if this is not (yet) feasible, to other internationally agreed references;
3. The institute may list a CRM as a service delivery mechanism in Appendix C only if the institute has an in-house competence and the measurement capabilities for assigning values to the measurand in question and the characterization (homogeneity and stability) of the CRM. The institute must take full responsibility and liability for the quality of the CRMs listed in Appendix C;
4. Value assignment and characterization should be carried out in conformity with relevant ISO guides, such as ISO Guide 35;
5. The value(s) assigned to the CRM can be a direct result from in-house measurement capabilities in the field concerned. Alternatively, the CRM value assignment capability can be the result of combining measurement results obtained internally with results obtained from other collaborating/subcontracted, competent institutes;
6. The claimed measurement uncertainties in the assigned value of a CRM must be representative of the capabilities and competence of the institute listing the CRM as a means of delivering traceability to its customers;
7. On request the complete certification report should be made available to the client;
8. The physical preparation of CRMs is not necessarily a task to be carried out solely by the institute, but the institute listing CRMs must carry out the value assignment and must include measurements that demonstrate adequate homogeneity and stability of the CRM;

9. In the case that an institute, in addition to its in-house capabilities and competences in the field concerned, collaborates for a part of the work with another (non-designated) expert laboratory the conditions mentioned before in this document and mentioned in the document CIPM/JCRB [“Subcontracting of measurements under the CIPM MRA”](#) have to be fulfilled;
10. If for special reasons it is desirable, or if it is considered desirable, CRMs listed in Appendix C may be subject to international comparisons by NMIs or designated institutes of other states or economies;
11. The institute listing CRMs in Appendix C must participate in relevant CCQM and/or RMO activities, which include CCQM and RMO studies and key comparisons and RMO supplementary comparisons;
12. Inasmuch as in many cases claimed CMCs and listed CRMs are not directly underpinned by the results of a comparison or pilot study, it is highly recommended to have additional information available, justifying the claimed CMC and listed CRM, preferably by peer reviewed publications in an international journal or by an on-site peer review.

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## 4. Intra-regional review of CMCs.

Prior to be submitted for the inter-regional review, the CMCs should be reviewed and approved by the RMO from which the NMI or DI is part of.

Each RMO is responsible for establishing the process for the intra-RMO review. This process must follow the general guidelines and assure that the CMCs submitted for the inter-regional review have sufficient technical support.

## 5. Inter-regional review of CMCs.

### 5.1. Overview

The process is conducted through an interactive website at [www.bipm.org/JCRB](http://www.bipm.org/JCRB). A manual for the website (CIPM-D-05) is available online ([http://www.bipm.org/JCRBCMCs/JCRB\\_webpage\\_manual-2.pdf](http://www.bipm.org/JCRBCMCs/JCRB_webpage_manual-2.pdf)).

Passwords to obtain access to the interactive website may be obtained from the [JCRB Executive Secretary](#).

Every time that there is an intervention on the website, automatic e-mails are sent to the TC/WG chairs of the metrology area concerned, the RMO representatives to the JCRB and to the JCRB Executive Secretary. It is responsibility of the RMOs to maintain updated the names and addresses of the technical contacts for each metrology area. RMOs may opt for a partial notification option in which they only receive automatic e-mails when they update the status of a CMC submission or when somebody else updates the status of their CMCs (see the website manual).

Reviewing TC/WGs approve the submitted CMCs based on the criteria for acceptance of data for Appendix C and are the primary responsible for maintaining the JCRB website updated. However, RMO representatives to the JCRB also have access to the website and may update it for the TC/WG chairs if necessary.

The JCRB Executive Secretary has full control over the JCRB database and may perform any update or correction to the data should this be needed.

Controversies are resolved by the JCRB which may request arbitration by the CIPM.



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## 5.2. Submission of CMCs

1. TC/WG Chairs or RMO Representatives may submit a set of CMCs for inter-regional review at any time.
2. Only CMCs that are supported by a fully-implemented quality system, reviewed and approved by the respective RMO may be submitted for inter-regional review. All submissions must be accompanied by a declaration from the Chair of the RMO Quality Systems Working Group, indicating that this requirement has been met.
3. Each submission may contain CMCs from several NMIs belonging to the same technical area. CMCs from different areas must be forwarded as separate submissions. Metrology areas have been classified according to the nomenclature of the Consultative Committees of the CIPM, as follows:
  - Acoustics Ultrasound and Vibrations (AUV)
  - Electricity and Magnetism (EM)
  - Length (L)
  - Mass and related quantities (M)
  - Photometry and Radiometry (PR)
  - Amount of Substance (QM)
  - Ionizing Radiation (RI)
  - Thermometry (T) and
  - Time and Frequency (TF)

The French acronyms shown in parenthesis are used in the CMC designations described in the next sub-section.

### 4. Naming of a CMC submission

CMCs submissions are named according to the following nomenclature:

**RMO.Area.N.Year**

Where,

**RMO** is the organization submitting the CMC file

**Area** is the corresponding acronym of the metrology area, as specified in the previous numeral

**N** is a consecutive integer for each RMO and Area, started with the first submission (not restarted each year).

**Year** the year when the CMCs are submitted to the JCRB

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### 5.3. Steps followed in the inter regional review

1. After posting, the CMCs file is distributed by e-mail to:
  - RMO representatives
  - TC/WG Chairs in the area of the submitted CMCs
  - JCRB Executive Secretary
2. TC/WG chairs indicate their interest in participating in the review of the posted CMCs by acknowledging receipt in the website and indicating the date by which they plan to send their first comments.
3. In order to identify the TC/WGs that are interested in reviewing a particular submission, the chairs are requested to provide the date for sending comments no later than three weeks after the CMCs are posted in the website. After two weeks an automatic reminder is generated. After one further week, if the TC/WG chair has not provided a date for sending comments, the respective RMO relinquishes its right to continue with the review.

**NOTE:** It is not sufficient to acknowledge receipt of a CMC submission to continue with the review. Only those TC/WGs that provide a date for sending comments are assumed to have expressed their interest.

4. TC/WG chairs post their first comments in the JCRB website by the date they set when they accepted to review them. Three weeks before the RMOs chosen date an automatic reminder is generated. If they have not sent their comments by their chosen date, in the absence of any other communication with the JCRB Executive Secretary, they relinquish their right to continue with the review.

5. If a TC/WG chair needs to change the date specified for sending their first comments he/she should make the change through the JCRB website before the origin deadline has expired. Note, however, JCRB Executive Secretary constantly monitors the review status and repeated or unduly long extensions may cause some questions and need discussion with the originating RMO.
6. After posting their first comments in the JCRB website the reviewing TC/WGs shall continue their communications directly with the originating TC/WG or even individual NMIs. There is no obligation on their part to copy the JCRB Executive Secretary or to post these comments in the JCRB website. However, should a TC/WG wish to take advantage of the distribution facilities of the website, they may post as many comments as they wish. Each one will be distributed to the reviewing TC/WGs, the RMO representatives and the JCRB Executive Secretary. Only the latest file will be available for download but all the posted comments will be saved at the BIPM for future reference.
7. The inter-regional review continues until all TC/WG chairs agree that the originating TC/WG has produced a submission that can be approved by all.
8. The originating RMO shall submit a revised Excel file through the website for final approval, which will be used for the publication in the KCDB.
9. The RMOs TC/WG chairs now have three weeks for considering the final vote. Two weeks after the final submission, a remainder e-mail will be sent and after one further week the RMO loses its right to vote and is considered an abstention. The final approval is done on a consensus basis. All the RMOs should approve or abstain to vote, but a single vote against is enough for not approving the CMCs.

## 6. Publication of CMCs

After the final approval is obtained, the BIPM proceeds to publish the CMCs in the KCDB.

The publication is performed by the BIPM through the KCDB office. Once the publication is done, the JCRB Executive Secretary sends an email to the RMOs and TC/WG chairs as a confirmation of the publication and availability of the CMCs in the KCDB website.

## 7. BIPM interventions on CMCs.

The description of CMCs published in Appendix C of the CIPM MRA comes directly from the Excel files posted for approval in the JCRB web page. Therefore, it is the responsibility of the BIPM to assure that these files are not modified in any form that invalidates the inter-regional approval process.

However, the BIPM may make certain modifications to assure compliance with JCRB rules. The criteria normally reviewed by the BIPM are:

- Spelling and format
- CMC range and uncertainty specification
- NMI listing in Appendix A

Spelling and format modifications are done by the BIPM KCDB office on the final files posted for approval. The technical contacts of the issuing NMIs may be consulted to clarify certain points if the BIPM KCDB office deems it necessary.

Compliance with criteria for CMC range and uncertainty specifications as well as designation of laboratories is verified by the JCRB Executive Secretary and the BIPM KCDB office. The first one normally reviews files submitted for inter-regional review and the second final files posted for approval, in case non-conformities with the rules still remain.

If the JCRB Executive Secretary or the BIPM KCDB office finds a non-conformity with paragraph 2.2 they will notify each other and the JCRB Chairman. The JCRB Executive Secretary will then inform the RMO representative of the problem and will ask for a modification of the submitted CMCs.

CMCs from laboratories that have not been officially designated by their governments to participate in the CIPM MRA (i.e. listed in Appendix A) will not be published in Appendix C and are deleted from the approved file. RMO representatives and signatory NMIs will be promptly informed by the JCRB Executive Secretary whenever this situation arises. As soon as those laboratories are officially designated, their previously-approved CMCs are immediately published in the KCDB.

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## **8. CMC inter regional review through the CC Working Groups on CMCs**

To facilitate the Inter-regional CMC Review Process, the CIPM recommended that each Consultative Committee form a Working Group on CMCs. The objectives of the WGs are:

- a) To establish and maintain lists of service categories, and where necessary rules for the preparation of CMC entries;
- b) To agree on detailed technical review criteria;
- c) To coordinate and where possible conduct inter-regional reviews of CMCs submitted by RMOs for posting in Appendix C of MRA;
- d) To provide guidance on the range of CMCs supported by particular key and supplementary comparisons;
- e) To identify areas where additional key and supplementary comparisons are needed;
- f) To coordinate the review of existing CMCs in the context of new results of key and supplementary comparisons.

This WG should include representation from all RMOs that have NMIs active in the relevant technical area. WG membership is expected to come from the relevant RMO committees involved in CMC reviews; appropriate experts being chosen depending upon the particular field under review.

CC-WG on CMCs may establish their own rules and timelines for coordinating the inter-regional review of CMCs. Therefore, posting, distribution and submission of comments on CMC submissions may be done without the use of the JCRB website and without following the deadlines specified for this purpose.

However, in order to maintain a record of the formal approval of all CMCs, once the CC-WGs on CMCs have agreed on a set of submissions, these will be posted in the JCRB website only for final approval.

Reviewing TC/WG chairs will then be asked to confirm their acceptance of the final files posted in the website.

The CMCs will be published if the JCRB Executive Secretary has received a formal notification that they meet the MRA quality system requirements. Otherwise, the JCRB Executive Secretary will contact the RMO representative to request this information and the



CMCs will not be published until this requirement is satisfied and formally communicated by the RMO.

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## 9. Fast track approval of CMCs

An NMI may request through its TC/WG Chair that a small group of already-published CMCs be reviewed by the other TC/WG in the same area without the formality of posting the file for review in the web page. This may occur, for example, when an upgrade of the laboratory facilities justifies an improvement of the declared scope of the published CMCs.

In this case, all communications will be done directly among the TC/WG Chairs. There is no need to inform the JCRB Executive Secretary or post any information in the JCRB website. After they reach a consensus on the new scope of the revised CMCs the CMCs will be posted only for final approval.

The reviewing TC/WG chairs shall approve the posted file in the JCRB website.

Once the reviewing TC/WG chairs have approved the CMCs under review the JCRB Executive Secretary verifies that the originating RMO has confirmed that the MRA quality system requirements have been met. In such a case, the KCDB office is notified that the approved CMCs must be published in Appendix C.

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## 10. Modification of existing CMCs

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

- a. material or editorial errors and improvements to the explanatory text for a quantity, instrument, method etc.;
- b. increase of the uncertainty or reduction in scope, decided by the NMI or following a comparison result;
- c. change of the method of measurement or reduction of the uncertainty or increase in scope.

Modifications under category a) do not change the essence of the CMC (instrument, range of the quantity and of the parameters, method, uncertainty, traceability) but improve its content for the benefit of the user. For this category of modifications, the internal and the inter-RMO reviews are unnecessary. The NMI will send its proposal for change to the Technical Committee (TC) chairperson of its RMO, who will contact the coordinator of the BIPM database ([BIPM.KCDB@bipm.org](mailto:BIPM.KCDB@bipm.org))

Modifications under category b) may be requested, for example, by an NMI wanting to reduce its engagement in the particular measurement activity or they may follow from a comparison result showing a significant unresolved deviation from the key comparison reference value (see Note 2). Also for this category internal and inter-RMO reviews are not needed. The proposal for change is received by the TC chairperson and transmitted to the coordinator of the BIPM database. However, in case that the change was originated by a comparison result, the TC chairperson should verify that the reduction in scope or the increase of the uncertainty is sufficient to assure the equivalence of the measurements. It is desirable in this case that the relevant RMO (or the BIPM) informs the other RMOs of the changes and their motivation.

Modifications under category c) should follow the full procedure of intra- and inter-RMO review as if they were new CMCs.

#### **NOTES:**

1. **Modifications must be made only on the Excel files available from the link “Get published CMCs”** located in the Summary box of the JCRB CMCs Website. These files have been produced by the BIPM KCDB office from the files posted for final approval and it has been verified that they do not contain any formatting errors.
2. To avoid overloading the BIPM, it is advisable not to submit individual modifications but to group a number of them together.
3. Modifications must be made clearly visible by the use of the following color code:

- a. bold red characters for corrections to be brought to a published CMC and for presenting a new CMC not yet published
- b. highlighting with a light pink background a CMC that should be deleted, the words “to be deleted from the KCDB” must also be placed in the “comments” column of the CMC.

CMCs should be modified if they are inconsistent with the results of a comparison.

The NMIs making the claims have the primary responsibility of assuring that they are consistent with comparison results.

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.

If, based on the results of a key or supplementary comparison, an RMO/NMI has concerns about the CMC claims of a particular NMI within another RMO, it should contact the NMI directly to seek resolution. If this is not successfully concluded, then the matter should be directed to the relevant RMO of the NMI making the CMC claims. In the event that further intervention is required, the JCRB Chairman should then be requested to help resolve the issue.

**NOTE:** It should be kept in mind that the Consultative Committee Working Groups on CMCs have among their responsibilities 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; and
- coordinate the review of existing CMCs in the context of new results of key and supplementary comparisons.

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## 11. Monitoring process of published CMCs

The process for monitoring the validity of published CMCs is covered in document CIPM MRA-G-02.

## 12. Greying-out of published CMCs

A greyed-out CMC is a calibration and measurement capability that had been published in the KCDB, but for some reason has been temporarily suspended (with the intention to reinstate it at some future date).

The greyed-out CMCs are not visible in the open KCDB website, but are retained in the database so are not lost.

The maximum period for the greyed-out status is five years.

Greying-out of published CMCs usually arises through non-compliance with the criteria for acceptance of CMCs as described in Section 3, but may also occur when an NMI/DI indicates that the service has been temporary suspended.

Each RMO is responsible for establishing the process to track the continued validity of all published CMCs within its authority.

Records on the greyed-out CMCs are maintained by the KCDB Office. This information is reported at each JCRB meeting as part of the regular KCDB report. An alert is given at each JCRB meeting on the CMCs that will reach the five-year limit for greyed-out status within the six months following the meeting.

The KCDB Office sends information on greyed out CMCs that have reached the five-year limit to the JCRB Executive Secretary. In turn the JCRB Executive Secretary sends a formal e-mail notice to:

- the NMI/DI to which the CMCs belong, copied to
  - the relevant RMO representative to the JCRB,
  - the chair of the relevant TC/WG,
  - the chair of the RMO's TC/WG on QS.

The notice states that the maximum five year period has been reached and that to prevent deletion of the CMCs a detailed reinstated plan must be submitted within six weeks, and advising that the proposed period to execute the plan cannot exceed one year.

If no response to the first notice is received within three weeks, then a second (and final) notice is sent. If no satisfactory response is received within three further weeks the greyed-out CMCs is permanently deleted from the KCDB.

There are two possible courses of action following the issuing of a notice:

**a) Deletion of the CMCs.**

This course of action occurs when:

- (i) no reply has been received to the second notice;
- (ii) the response received by the JCRB from the RMO or NMI/DI indicates approval for deletion;
- (iii) an agreed reinstatement plan has not been successfully executed.

Under each of these circumstances the JCRB Executive Secretary will send a request to the KCDB Office to permanently delete the relevant CMCs from the KCDB.

Confirmation that CMCs have been deleted from the KCDB will be sent to the relevant RMO representative to the JCRB, the chair of the relevant TC/WG, the chair of the RMO's TC/WG on QS and the NMI/DI involved.

**b) The RMO, after consulting with the NMI/DI, responds with reinstatement plan including a timetable to have the CMCs reinstated.**

If the reply received by the JCRB from the RMO representative indicates that appropriate specific actions will be taken for the reinstatement of the CMCs within a timetable and deadline for completion not exceeding one year, the JCRB Executive Secretary will forward the information to the KCDB Office requesting that the relevant CMCs are maintained in greyed-out status for the time period specified in the reply. During the reinstatement process the NMI/DI to which the CMCs belong must follow the requirements for modification of existing CMCs as described in Section 10. Following successful implementation of the agreed actions the CMCs in question will be reinstated.

Confirmation that the CMCs have been reinstated in the KCDB will be sent to the relevant RMO representative to the JCRB, the chair of the relevant TC/WG, the chair of the RMO's TC/WG on QS and the NMI/DI involved.



If the reinstatement plan has not been successfully implemented by the deadline, the CMCs concerned will be deleted. No further extension to the time allowed for greyed-out status of the CMCs will be permitted.

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## 13.Related documents

[CIPM MRA](#) - Mutual recognition of national measurement standards and of calibration and measurement certificates issued by national metrology institutes

[ISO/IEC 17025:2005](#) - General requirements for the competence of testing and calibration laboratories

[ISO 17034:2016](#) - General requirements for the competence of reference material producers

[The CIPM MRA: 2005 Interpretation Document](#)

[NMIs and other Designated Institutes](#)

[CIPM MRA-D-05](#) - Measurement comparisons in the context of the CIPM MRA

[“Use of the JCRB website for inter-regional review of CMCs.”](#)

[Basic excel template](#)

[Excel template with uncertainty matrices and closely related CMCs](#)

[Excel template for CMCs in chemistry](#)

[Instructions for closely related CMCs](#)

[Additional instructions for CMC files in EM](#)

[Instructions for uncertainty matrices in CMC files](#)

[International rules for filling in the CMC tables for ionizing radiation](#)

[Additional instructions for CMC files in AUV](#)

[Additional instructions for CMC files in PR](#)

[Services available to Associates States and Economies of the CGPM and their participation in the CIPM MRA](#)

[Calibration and measurement capabilities](#) - A paper by the joint BIPM/ILAC working group

[Subcontracting of measurements under the CIPM MRA](#)

[Recommendations for on-site visits by peers and selection criteria for on-site visit peer reviewers](#)

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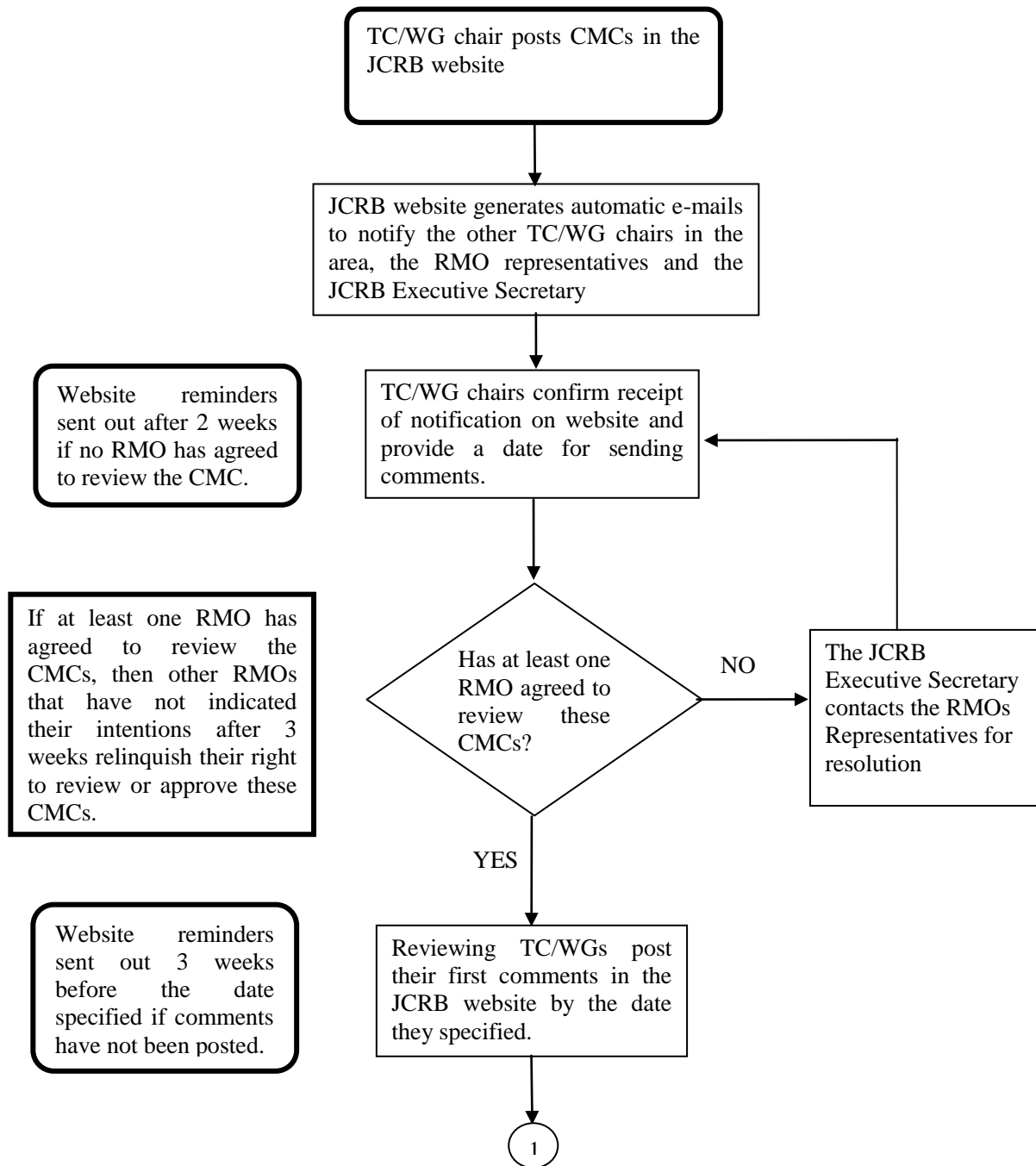


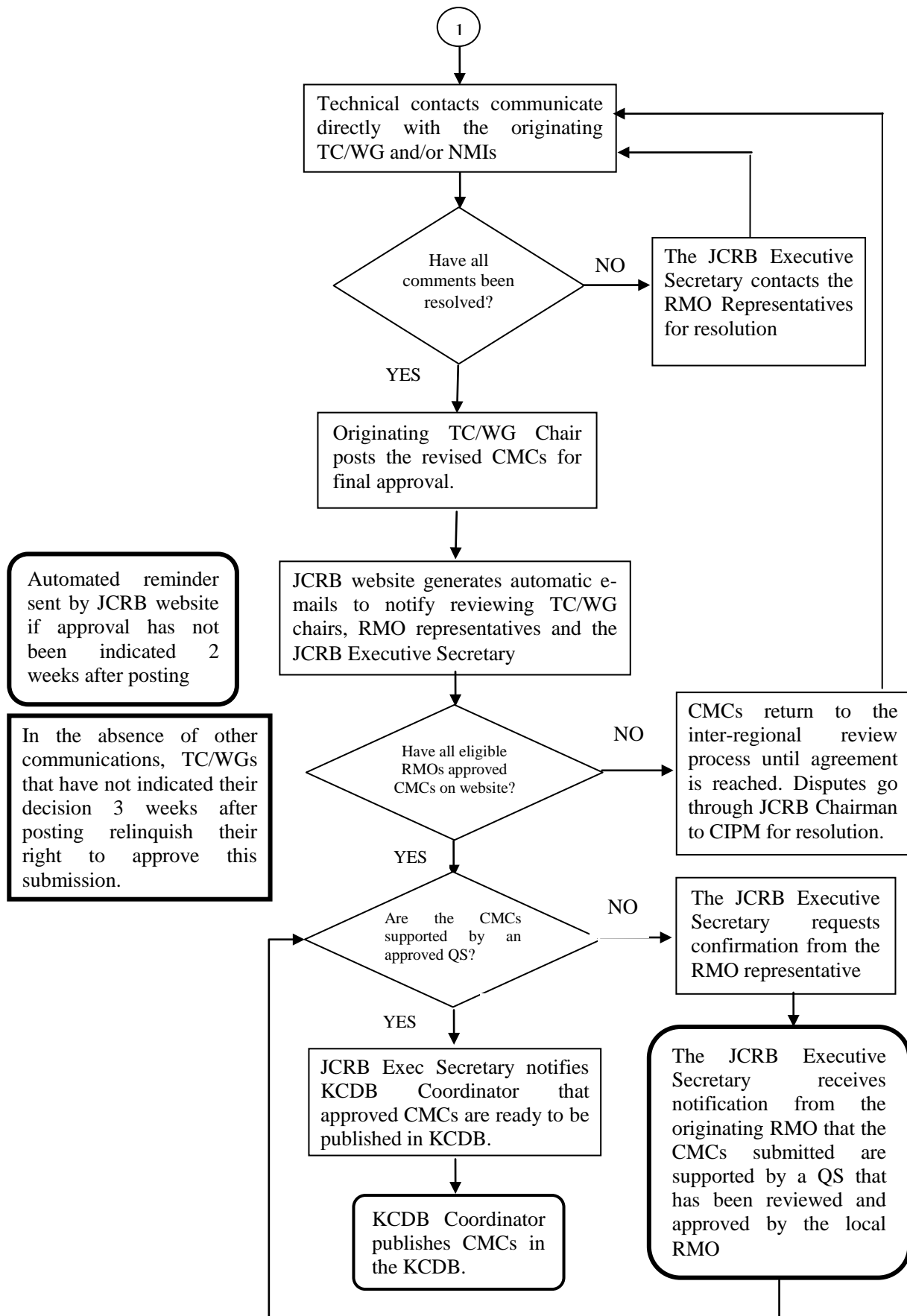
## 14.Revision History

Version number	Date of Issue/Review	Summary of changes	
1	2001-10-09	Supersedes documents:	
		JCRB 8/10	Procedure for modifying CMCs already in Appendix C
		JCRB 8/18	Definitions of terms used in the CIPM MRA
		JCRB 11/06(3)	Primer for TC/WG Chairpersons on the CMC Review Process
		JCRB 11/06 (2)	Terms of Reference Consultative Committee Working Groups on CMCs
		JCRB 12/06 (2)	JCRB Procedure for specifying the scope of CMCs
		JCRB 12/06(3)	BIPM interventions on CMC files
		JCRB 14/06(1)	JCRB Rules of Procedure for CMC entry into Appendix C
		JCRB 14/06(2a)	Criteria for acceptance of data for Appendix C
	CIPM-05/08	Guidelines for the Acceptance of CRMs in Appendix C of the CIPM MRA	
	-	-	
	2008-10-12	Approved by CIPM	
2	2010-09-30	Inclusion of the traceability policy approved by the CIPM in October 2009. General editorial review. Approved by the JCRB.	
	2010-10-15	Changes approved by CIPM	
3	2013-03-20	Shortening the time taken for the inter-RMO review. Approved by the JCRB	
	2013-06-21	Changes approved by CIPM	
4	2013-09-19	New section “12. Greying-out of published CMCs” Approved by the JCRB	
	2013-10-25	Changes approved by CIPM	
5	2017-03-16	Changes in references. Approved by JCRB	

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Appendix 1 – Flowchart of the CMCs review process





### Appendix 2 – Examples of correct CMCs tables and CMC tables with frequent mistakes.

General case

Parameters and specifications

Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variables		Expanded Uncertainty				
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage factor	Level of Confidence	Is the expanded uncertainty a relative one?
Encapsulated source strength	Radioactive source	Ionization chamber	0	0.1	Gy/s	Temperature Pressure Relative humidity	22.0 °C 101.325 kPa 20% to 80%	0.01		2	95%	Yes

Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty				
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage factor	Level of Confidence	Is the expanded uncertainty a relative one?
Encapsulated source strength	Radioactive source	Ionization chamber	0	0.1	Gy/s	Temperature	22.0 °C	0.01		2	95%	Yes
						Pressure	101.325 kPa					
						Relative humidity	20% to 80%					

Each parameter and specification in its own cell.

Angle by circle-dividers	Optical polygon: face angle	Index table & autocollimator, full closure	360/n, n = 24	360/n, n = 3	°	n, number of faces	3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24	0.15	"	2	95%	No
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But this example is correct, since these are distinct values for a single parameter

# Calibration and Measurement Capabilities in the context of the CIPM MRA

## MRA-D-04



### Different measurand ranges

Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty				
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage factor	Level of Confidence	Is the expanded uncertainty a relative one?
Luminous intensity	Tungsten lamp	Network of lamps & photometers, photometric bench	0.001 1 1000 –	1 1000 100000 –	cd	Distribution temperature	2000 K to 3200 K	1.5 to 0.4 0.4 0.4 to 1.5 with measurand	%	2	95%	Yes

Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty				
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage factor	Level of Confidence	Is the expanded uncertainty a relative one?
Luminous intensity	Tungsten lamp	Network of lamps & photometers, photometric bench	0.001	1	cd	Distribution temperature	2000 K to 3200 K	1.5 to 0.4	%	2	95%	Yes
Luminous intensity	Tungsten lamp	Network of lamps & photometers, photometric bench	1	1000	cd	Distribution temperature	2000 K to 3200 K	0.4	%	2	95%	Yes
Luminous intensity	Tungsten lamp	Network of lamps & photometers, photometric bench	1000	100000	cd	Distribution temperature	2000 K to 3200 K	0.4 to 1.5	%	2	95%	Yes

Individual measurand levels and uncertainties must have separate complete lines.

# Calibration and Measurement Capabilities in the context of the CIPM MRA

## MRA-D-04



No vertical cells merging

Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty					Reference Standard used in calibration	
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage factor	Level of Confidence	Is the expanded uncertainty a relative one?	Standard	Source of traceability
Gas flow	Gas flow meters	Sonic nozzles, turbine, laminar, P.D, rotameters, etc	0.05	50	l/min	Fluid	dry air	0.2	%	2	95%	Yes	Piston-Prover	CENAM
			50	710				0.3						
			710	2800				0.3						

Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Standard	Source of traceability
Gas flow	Gas flow meters	Sonic nozzles, turbine, laminar, P.D, rotameters, etc	0.05	50	l/min	Fluid	dry air	0.2	%	2	95%	Yes	Piston-Prover	CENAM
						Temperature	19 °C to 21°C							
						Pressure	up to 0.8 MPa							
Gas flow	Gas flow meters	Sonic nozzles, turbine, laminar, P.D, rotameters, etc	50	710	l/min	Fluid	dry air	0.3	%	2	95%	Yes	Bell-Prover	CENAM
						Temperature	19 °C to 21°C							
						Pressure	up to 0.8 MPa							
Gas flow	Gas flow meters	Sonic nozzles, turbine, laminar, P.D, rotameters, etc	710	2800	l/min	Fluid	dry air	0.3	%	2	95%	Yes	Bell-Prover	CENAM
						Temperature	19 °C to 21°C							
						Pressure	up to 0.8 MPa							

No vertical cell merging. Repeat all relevant information for each row.

**Calibration and Measurement Capabilities in the context of the CIPM MRA**  
MRA-D-04



**EXAMPLES OF MEASURAND SPECIFICATION**

Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty				
Class	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?

**CORRECT**

Mass water flowrate	Water meter	Coriolis	14	833	kg/s	Fluid	water	0.06	%	2	95%	Yes
						Pressure	100 kPa to 400 kPa					
						Temperature	ambient					
Volume water flowrate	Water meter	Positive displacement, turbine, differential pressure, ultrasonic, vortex meter, electromagnetic	13.9	833	dm <sup>3</sup> /s	Fluid	water	0.06	%	2	95%	Yes
						Pressure	100 kPa to 400 kPa					
						Temperature	ambient					

**Calibration and Measurement Capabilities in the context of the CIPM MRA**  
MRA-D-04



Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty				
Class	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?
<b>INCORRECT</b>												
Mass or Volume Water Flowrate	Water meter	Coriolis	14	833	kg/s	Fluid	water	0.06	%	2	0.95	Yes
						Pressure	100 kPa to 400 kPa					
						Temperature	ambient					



**Calibration and Measurement Capabilities in the context of the CIPM MRA**  
MRA-D-04



**EXAMPLES OF IMPLICIT RANGE SPECIFICATION**

Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty				
Class	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?

**CORRECT**

Pressure sensitivity level	Measurement microphone type: IEC 61094-1 LS1P, LS2aP and LS2F	IEC 61094-2			dB (reference: 1 V/Pa)	Frequency	63 Hz to 6.3 kHz	0.06	dB	2	95%	No
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**INCORRECT**

Volume of heat conveying flowing liquid (for thermal energy measurements)	Any flow measurement instrument or flow device	Pulsed, electrical, digital and optical outputs, various methods				Water	See lines 7 and 9	As above	%	2	95%	Yes
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# Calibration and Measurement Capabilities in the context of the CIPM MRA

## MRA-D-04



### EXAMPLES OF UNCERTAINTY SPECIFICATION

Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty				
Class	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?

#### CORRECT

End standards	Gauge block: central length L	Interferometry, exact fractions	0.5	100	mm			Q[26, 0.4L], L in mm, values range from 26 nm to 48	nm	2	95%	No
Mass	Mass standard	Weighing in air	1	100	mg			0.4 to 0.8	μg	2	95%	No

In the last case it is assumed that the uncertainty, for example, at 50 mg, is 0.6 μg

#### INCORRECT

Mass	Mass standard	weighing in air	1	100	mg			< 0.8	μg	2	95%	No
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# Calibration and Measurement Capabilities in the context of the CIPM MRA

## MRA-D-04



### EXAMPLES OF UNCERTAINTY SPECIFICATION: Correct Uncertainty Matrix (Page 1)

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty				
2	Quantity	Instrument or Artifact	Method of Measurement	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?
3	AC voltage: AC-DC transfer difference at low voltages	AC-DC transfer standard	Comparison with reference standard	0.002	0.5	V	Frequency	10 Hz to 1MHz	6 to 800	μV/V	2	95%	Yes
	N	O	P	Q	R	S	T	U	V				
	Reference Standard used in calibration		List of Comparisons supporting this measurement/ calibration service	Euromet Electricity Services Administration									
	Standard	Source of traceability		NMI Service Identification	Service category	NMI	Internal Comment	Comments to be published via the database	Uncertainty Matrix				
	a: MJTC, b: resistive divider	a: BEV, b: SP		22a	5.1.1	BEV			Matrix 1				

⏪ ⏩ ⏴ ⏵ CMC\_spreadsheet Matrix 1

**EXAMPLES OF UNCERTAINTY SPECIFICATION: Correct Uncertainty Matrix (Page 2)**

The uncertainty matrix is stored in an Excel spreadsheet in the same Workbook, with the name indicated in column V (in this case, Matrix 1):

	A	B	C	D	E	F	G	H	I	J
1		10 Hz	20 Hz	30 Hz	40 Hz	55 Hz	100 Hz	500 Hz	1 kHz	5 kHz
2	2 mV	400	360	360	360	360	360	360	340	340
3	10 mV	230	200	180	180	180	180	170	150	150
4	100 mV	100	80	80	80	80	80	60	60	60
5	200 mV	20	10	8	8	8	8	8	8	8
6	500 mV	16	8	6	6	6	6	6	6	6

