

Rules for Ionizing Radiation CMCs

# Regional Metrology Organization Working Group, September 2020

**Introduction**

This document sets out the international rules for submitting or modifying CMCs using the Key Comparison Database (KCDB) interface. The rules have been devised to ensure consistency between and within regional metrology organizations.

The rules should be read together with the instructions set out in CIPM-MRA-D-04 “CMCs in the context of the CIPM MRA” (available on the BIPM website). Information on using the KCDB interface is available on the BIPM website (contact [bipm.kcdb@bipm.org](mailto:bipm.kcdb@bipm.org) for links to the latest information). Reference is also made to the CCRI CMC Service Categories document.

The field of ionizing radiation is divided into three groups corresponding to the three sections of the CCRI: Dosimetry, Radioactivity and Neutron measurements. The data entry options depend on the section (branch) selected.

1. **Classification of services** 
   1. **Branch**

Choose Dosimetry, Radioactivity or Neutron Measurements

* 1. **Institute service identifier**

Each laboratory can choose how to specify its internal service identifiers. Examples are a simple consecutive number or the NMI catalogue number. This may be completed by a link.

**Dosimetry, Radioactivity and Neutron Measurements**:

The NMI service identification must be unique for each CMC entry. This will enable its fast location by the service administration. The following format must be used:

* EUR-RAD for EURAMET
* APM-RAD for APMP
* SIM-RAD for SIM
* COO-RAD for COOMET
* AFR-RAD for AFRIMETS

followed by the acronym for the NMI, then a four-digit number stating with

* 1xxx for dosimetry,
* 2xxx for measurement of radionuclides,
* 3xxx for neutron measurements

e.g., COO-RAD-VNIIM-2001

Note: It is important to ensure that the four-digit number has not been used previously for another CMC.

Numbering should be sequential, without omissions, for each NMI. This will not affect the order of display when the database is interrogated. Note that a single identifier must be used for a multi-nuclide source and a single identifier must be used for a material containing more than one radionuclide.

* 1. **Link to institute service identifier**

A specific link to the service, to the institute web page for services, etc. can be indicated (it is the responsibility of the originating institute to update the link as needed).

1. **Measurand** 
   1. **Quantity**

The latest version of the Service Categories for Ionizing Radiation CMCs must be followed. Any other quantities on the pull-down menu are historic and remain only to ensure backward compatibility.

**Dosimetry:**

The following quantities are the agreed service categories (see ‘CMC Service Categories’, available on the BIPM website):

* Kerma/rate (Note: Exposure should not be used)
* Reference kerma rate
* Ambient dose equivalent/rate
* Directional dose equivalent/rate
* Kerma Length product
* Kerma Area product
* X-ray tube voltage
* Absorbed dose/rate
* Personal dose equivalent/rate

Note: Dose and dose rate are no longer to be submitted as independent entries, nor are air kerma and air kerma rate.

**Radioactivity:**

The word radioactivity should not be used as a quantity. The following quantities are the agreed service categories (see ‘CMC Service Categories’, available on the BIPM website):

* Activity
* Surface emission rate
* Emission rate
* Efficiency

Note: Surface emission rate is expected to be as measured in 2π.

Note: Efficiency refers to of ionization chamber, γ-ray spectrometer, or contamination monitor

**Neutron Measurements:**

he following quantities are the agreed service categories (see ‘CMC Service Categories’, available on the BIPM website):

* Emission rate
* Fluence/rate
* Absorbed dose/rate

* 1. **Instrument or Artifact**

This section should describe the instrument or artifact (source) which is calibrated:

**Dosimetry:**

* In the description the term “dosemeter” should be used for, e.g., an area meter and “dosimeter” for a personal monitor
* The term “doseratemeter” is not used
* The NMI should specify the instrument or artifact as closely as possible e.g., ionization chamber, personal dosimeter, survey meter, chemical dosimeter.

**Radioactivity:**

The item to be measured could be

* A single or multiple nuclide, solid, gas or solution or extended area source, then the use of the source in some cases may be added in brackets (e.g., surface contamination or medical or gamma-ray detectors), or
* A reference material, or
* An instrument e.g., spectrometer, ionization chamber, etc.

**Neutron measurement:**

The item to be measured could be

* (Sealed) neutron source
* Neutron sensitive device
* Dosemeter (neutron survey meter) or
* Neutron personal dosimeter
  1. **Instrument type or method**

**Dosimetry:**

A brief description of the calibration with reference to the transfer instrument (if applicable) and phantom material. For example:

* Calibration against a transfer standard in a water phantom (for an instrument)
* Irradiation in a calibrated field in air (for a personal dosimeter)

**Radioactivity:**

The method by which the service is performed should be given (e.g., 4πβ-γ absolute measurement, high pressure well type ionization chamber, HPGe spectrometer, liquid scintillation counter, 2π proportional counter).

**Neutron measurement:**

A brief description of the calibration with reference to the transfer instrument (if applicable) and phantom material should be given, for example:

* Calibration in a manganese bath or
* Calibration relative to (or with) a national standard source
* Calibration relative to a calibrated monitor or a primary standard instrument.
  1. **International standard**

Indicate if a specific international standard or other recommendation is followed.

* 1. **Medium**

Indicate medium (refer to CMC Service Categories for the options).

* 1. **Nuclide**

Indicate the nuclide (visible only when the branch “Radioactivity” has been selected).

* 1. **Source**

Indicate source (refer to CMC Service Categories for the options).

**Dosimetry:**

The radiation type is specified as indicated in the “classification of services”.

**Radioactivity:**

The radionuclide in question is specified as indicated in the “classification of services”. One line being used per radionuclide, even for multi-nuclide sources and for reference materials containing more than one radionuclide.

Note: Multi-radionuclide sources and reference materials will be grouped together in the database according to their institute service identification (section 1.2) as single CMCs (despite multiple lines).

**Neutron measurement:**

The neutron radiation type is specified, as indicated in the “classification of services”.

Note: When specifying the fluence or the dose rate the distance from the (point) source may be added here (e.g., [at 1 m from the source]).

* 1. **Specification on nuclide or source**

**Dosimetry**:

* The radiation quality should be specified in sufficient detail, e.g. give values for beam quality specifiers.
* If used, the standard ISO conversion factor applied to extend the results from an air kerma comparison to support a claim for ambient dose equivalent must be specified.

**Radioactivity**:

More details on the type of source may be given, such as:

* in the case of 3H, “Tritiated water”
* the chemical form
* source geometry
* in the case of a reference material, the matrix *must* be given (e.g., “bone ash”)

**Neutron Measurements**:

The neutron quality is specified in more detail, e.g.:

* Neutron spectrum according to standard ISO 8529-1 (e.g., for radionuclide sources such as Cf-252, Am-241-Be-9, etc.).
* Neutron producing reaction, neutron energy and, in some cases, standard ISO 8529-1 (in the case of accelerator-based neutron sources).
* Neutron dose equivalent quantities *must* be specified with ref. to, e.g., ICRU 57 or ICRP 74 for the definition and conversion functions.
  1. **Unit**

The unit is chosen in a fixed drop-down menu; “(dimensionless)” may be chosen for measurands without units, such as ratios or indices, and will create an empty space when displayed. If a unit is not available, the Writer is invited to contact the KCDB Office: (bipm.kcdb@bipm.org).

* SI units must be used and should be that of the quantity to be measured.
* Superscripts should be used. Slashes, prefixes and decimal points should be avoided.

**Dosimetry**:

* In the fields of radiotherapy and industrial processing, units may be expressed in Gy and Gy s-1
* In the field of radiation protection, units may be expressed in Gy or Sv and mGy h-1 or Sv h-1
* Other examples:
  + Kerma length product mGy cm
  + Kerma area product mGy cm2
  + Tube voltage kV

**Radioactivity**:

* Activity Bq
* Surface emission rate s-1
* Emission rate s-1
* Efficiency calibration factor units e.g., s–1 Bq–1 or “indicated Bq Bq–1”

**Neutron Measurements**:

* In the field of radiation protection, dose units may be expressed in mGy h-l or in Sv h-1
* Other examples:
  + Fluence cm-2
  + Fluence rate cm-2 s-1
  + Emission rate s-1
  1. **Lower and upper limits**

If the lower and upper limits are identical (such as when a service is offered at a specific level), they should be indicated the same in both “Lower limit” and “Upper limit” fields.

**Dosimetry, Radioactivity and Neutron Measurements**:

A point (.) is used as the decimal separator. The symbol “E” represents exponential of 10 (e.g., 10300 may be expressed as 1.03E04; 0.0067 may be expressed as 6.7E-03). Only significant digits should be specified.

* 1. **Parameters**

As many as five sets of parameters may be indicated if needed by opening the parameter window. Laboratory conditions impacting the measurement, such as temperature or humidity, can be indicated.

1. **Expanded uncertainty:**

**Dosimetry, Radioactivity and Neutron Measurements**:

The uncertainty quoted should be the lowest that can be achieved under normal conditions, and made available to customers, with the types of instruments or artifacts used in the calibration.

Note: The expanded uncertainty relating to a CMC for an NMI should not normally be smaller than the expanded uncertainty given in the supporting evidence unless the circumstances in the RMO warrant this.

* 1. **Units**

**Dosimetry, Radioactivity and Neutron Measurements:**

The uncertainties should be stated as relative uncertainties in % despite the longer list on the pull-down menu.

* 1. **Lower and upper limit**

A range of uncertainties can be given if the uncertainty varies linearly within the range given. e.g., for an activity ranging from 100 Bq to 1000 Bq, the uncertainty range 10 % to 1 % is valid if the uncertainty at 500 Bq is 6 % and is inversely proportional to the activity range. Otherwise, the range may be split into bands for which the uncertainties are the same with the consequent additional lines for the radionuclide, an uncertainty equation can be used, or a table can be used.

* 1. **Coverage factor**

**Dosimetry, Radioactivity and Neutron Measurements**:

The coverage factor must be stated. In the absence of knowledge of the distribution function, a value of *k*= 2 (default value) should be applied. If the distribution is known to be other than Gaussian, the default value can be modified.

* 1. **Level of confidence**

**Dosimetry, Radioactivity and Neutron Measurements**:

This field should not be left blank. A normal distribution function is generally assumed with a confidence level of about 95 % (~95 %), which is the default value.

* 1. **Absolute or Relative uncertainty**

The uncertainties should be stated as relative uncertainties for all ionizing radiation CMCs.

1. **References**

Each CMC should have a corresponding supporting comparison or publication. The publication must be available to reviewers. This section must not be left blank.

* 1. **Reference standard used in calibration:**

**Dosimetry, Radioactivity and Neutron Measurements**:

The relevant national reference standard(s) of the calibrating laboratory should be stated. Examples are: free air chamber, graphite calorimeter, 4πβ-γ absolute measurement, hydrogen gas proportional counter, or secondary standard ionization chamber.

If different method is used in the calibration, then this should also be stated. *All* standards used to provide the calibration traceable to the SI should be indicated.

* 1. **Source of traceability**

**Dosimetry, Radioactivity and Neutron Measurements**:

If the NMI national standard is a primary standard, this should state the acronym for the NMI itself; if the NMI does not hold the appropriate primary standard, the laboratory from which its traceability was obtained should be indicated. The CMC should show each source of traceability for the different standards used in the particular calibration.

* 1. **Group identifier**

Optional; may be used to indicate a unique label (a number or a short string) for those CMCs that are associated with one another such as a multi-radionuclide source.

* 1. **KCDB support for CMC claim**

This section allows for the CMC to be linked to the comparisons published in the KCDB.

* 1. **Other support** (evidence supporting the measurement / calibration service)

Indicate the titles or references (other than those published in the KCDB) that support the CMC claim, and upload them under the “Add supporting document” button (section 4.7).

Note: These will *not* be available to viewers of the database. It is part of the review and verification process for the RMOs and the JCRB.

**Dosimetry, Radioactivity and Neutron Measurements**:

If no directly related comparison is available, a similar type of comparison or other validation can be used to support the CMC, but the reference should be preceded by the words “similar to” or some other indication as to the indirect nature of the comparison.

* If an NMI holds primary standards, supporting comparisons are expected to include key comparisons. As far as practical, there should be a supporting comparison for a CMC.
* If an NMI receives its traceability from another laboratory, supporting comparisons referring to this other laboratory should not be listed here. A regional comparison or other validation supporting the NMI's own calibration capability should be cited.
* Any comparison or other validation supporting the measurement capability of the NMI with secondary standards should be given.
* Traceability of a secondary method to a primary method (for which there is a supporting comparison) is to be fully supported within the NMI’s RMO-approved quality management system.
* If an NMI has more than one validation supporting its capability, only one of these should be quoted and the expanded uncertainty of the calibration should reflect that used in the validation chosen.

For key and supplementary comparisons, such as BIPM, CCRI or RMO comparisons, only the reference is required. For multilateral comparisons, the reference of the publication (or internal report) plus between brackets the participating laboratories and the year should be indicated (for RMO), CCRI- and BIPM comparisons, see BIPM website).

**Dosimetry**:

* A comparison of air kerma may be used to support a CMC of ambient dose equivalent using the appropriate ISO conversion factor. The ISO conversion factor that is used must be indicated.
* In general, a comparison for low-dose-rate source-based brachytherapy (e.g., I-125) may be used to support claims for other low-dose-rate brachytherapy radionuclides (e.g., Pd-103) independent of seed type.

**Radioactivity**:

The “Measurement Methods Matrix (MMM”) (available on the BIPM website) on primary measurement methods should be used to optimize comparison support for CMCs, noting that:

* A comparison result from a radionuclide measured using a specific primary method *generally* cannot support claims for that radionuclide measured by other primary methods.
* Claims are allowed for radionuclides in the same column of the MMM **only**, and according to degree of difficulty (red allowing claims for red, yellow, green; yellow allowing claims for yellow and green; green allowing claims only for green)

**Neutron Measurements**:

* A comparison result for the quantity ‘emission rate’ using a primary method (e.g., Mn bath   
  measurements with a 252Cf source) can also support claims for other types of neutron sources (e.g., AmBe).
* Comparison results for the quantity ‘fluence rate’ for monoenergetic neutrons using either a primary method or a secondary method (e.g., proton recoil counter or Long Counter) can be used to support claims for other monoenergetic neutron energies. The energies must be within the operational range of the device and there should normally be supporting results from comparisons both higher and lower in energy.
  1. **Comments to be published via the KCDB**

Any comments here will appear in the KCDB for the customer to see. Adding information here is optional but can be important for clarification, e.g.,

* Production of a point source by the institute
* Reference material production
* Derivation of the dose measurement (e.g., dose derived by integral of dose-rate)
* Derivation of dose equivalent/rate

This is a free-fill block and text will wrap around as it reaches the end of the line. Bullets may be used to list specific comments in the block.

* 1. **Add Supporting Document**

Upload any documents (other than accessible KCDB comparisons) to which you refer as well as the necessary supporting evidence of the RMO approval of the Quality Management System. This gives direct access to the documents for the reviewing experts but will not appear with the published CMC.

Note: Tick the box at the bottom of the page to confirm authorization to submit the CMC and to confirm that there exists a validated Quality Management System. The CMC cannot be submitted without having confirmed this information.

**5. Comments to reviewers**

Add comments to assist reviewers to efficiently review your CMC e.g. indicate whether it is just an administration change, or uncertainty change.

# **Revision history**

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| --- | --- | --- |
| Version number | Date | Revision comments |
| - | 29 April 2010 | Based on agreed Table of 29 April 2010 (as currently posted) |
| - | 13 March 2018 | Revisions from RMO WG Meeting 13 March 2018 |
| 1.0 | 16 September 2020 | Revisions to align with the KCDB 2.0 1 September 2020 |