# Comparison of air kerma measurements of the low and medium energy X-ray radiation qualities used in diagnostic radiology

**EURAMET project #1221**

# Technical Protocol for EURAMET.RI(I)-S10

## 1. Description of the project

The IAEA Dosimetry Laboratory at Seibersdorf, Austria, performs the calibration of the reference radiation protection dosemeters of IAEA/WHO SSDL[1] Network members (more than 80 laboratories in worldwide). As a signatory of the CIPM MRA, the laboratory maintains a quality management system (QMS) complying with ISO 17025 and the laboratory published its dosimetry CMC claims in 2007, in the Appendix C database of the CIPM MRA. To maintain these CMC claims, periodically updated “supporting evidence” for the measuring capabilities are required in addition to the traceability of the measured quantities. The previous comparison was the EUROMET.RI(I)-S4 comparison held in 2000. The relevant IAEA secondary standard ionization chambers are traceable to the PTB in terms of air kerma. The comparison partner PTB has a primary standard for air kerma with degrees of equivalence (DoE) values in the key comparison database (KCDB) of the CIPM MRA based on their results in BIPM.RI(I)-K7 key comparison series.

For the comparisons four IAEA reference-class transfer chambers were selected. The technical details of the chambers are in the Table 1. The beam quality series applied in the comparison are the RQR, RQA, RQT, RQR-M, RQA-M beam qualities, established in the IEC standard 61267:2005, and additional three Mo/Rh mammography qualities using rhodium filtration. The PTB identification of these qualities are MRV28; MRV30, MRV 35. Technical details of the selected beam qualities are in the Table 2.

## 2. Participants

| Institute | Country | Contact | e-mail |
|---|---|---|---|
| IAEA DMRP | Int. Org. (Austria) | Igor Gomola<br>Istvan Csete | i.gomola@iaea.org<br>i.csete@iaea.org |
| PTB | Germany | Ludwig Büermann | Ludwig.Bueermann@ptb.de |

## 3. Procedure

### 3.1. Object of the comparison

The objective of this comparison is to support the published IAEA-RAD-1006 and IAEA-RAD-1007 CMC lines for mammographic chamber calibration by linking through the PTB to the BIPM.RI(I)-K7 series and also to support some new claims of the IAEA for general diagnostic chamber calibration. The outcome of these comparisons, i.e. the ratios of the calibration coefficients of transfer chambers determined at the two laboratories, should be consistent within their stated uncertainties not including [1] the uncertainty of the calibration coefficients of the appropriate IAEA reference chamber being traceable to the PTB primary standard. If this is the case, it can validate the calibration practice of the participants, supporting the CMC claims of the IAEA. The DoE values of IAEA standard could also be calculated for the RQR-M beam qualities based on the PTB DoE values.

### 3.2 Transfer chambers

Table 1 Technical data of the transfer chambers

| Type | Reference point | Nominal volume | *Polarizing voltage (V) | Wall thickness | Outer diameter (mm) |
|---|---|---|---|---|---|
| Exradin A3, spherical chamber | chamber centre | 3.6 $cm^3$ | +300 | 0.25 mm | 19.5 |
| Exradin A4, spherical chamber | chamber centre | 30 $cm^3$ | +400 | 0.50 mm | 39.2 |
| Radcal 10X5-6M parallel plate chamber | marked on the chamber | 6 $cm^3$ | +300 | 0.7mg/$cm^2$ | 43<br>30 (effective) |
| Magna A 650 parallel plate chamber | int. surface of the window | 3 $cm^3$ | +300 | 3.9 mg/$cm^2$ | 53<br>42 (effective) |

*) Applied to the collector

### 3.4 Reference conditions

The calibration coefficients for the transfer chambers should be given in terms of air kerma per charge in units of mGy/nC and refer to standard conditions of air temperature, $T = 295.15$ K, pressure of $P = 101.325$ kPa and relative humidity $h = 50\%$. The recommended source to chamber distance is 1.0 m to ensure the homogeneity of the radiation field, used by the transfer chambers. No other corection factors for the chambers will be applied.

### 3.5 Course of comparison

The IAEA transfer chambers will be calibrated by both participants in their own respective x-ray beams. The IAEA will cover the cost of transportation of the chambers to the PTB and back to the IAEA. For the purpose of a constancy check, the IAEA laboratory will repeat the determination of the calibration coefficients after return of the transfer chambers to the IAEA. The measurement results together with the associated uncertainties will be reported to the CCRI(I) Executive Secretary and will be disclosed to both participants after completion of measurements at both laboratories.

### 3.6 Prospective schedule

Perform the measurements at both laboratories: August-September 2012
Evaluation of data and drafting the report: October 2012
Publication of the result in the *Techn. Suppl.* of *Metrologia*: December 2012

### 3.3 Radiation qualities

Table 2 Technical data of the beam qualities

| | Quality | Tube voltage | PTB HVL | IAEA HVL | IEC 61267 HVL |
|---|---|---|---|---|---|
| | | kV | mm Al | mm Al | mm Al |
| 1 | RQR-2 | 40 | 1.42 | 1.46 | 1.42 |
| 2 | RQR-5 | 70 | 2.57 | 2.61 | 2.58 |
| 3 | RQR-10 | 150 | 6.55 | 6.76 | 6.57 |
| 4 | RQA-2 | 40 | 2.18 | 2.27 | 2.2 |
| 5 | RQA-5 | 70 | 6.73 | 6.97 | 6.8 |
| 6 | RQA-10 | 150 | 13.23 | 13.52 | 13.3 |
| 7 | RQT-9 | 120 | 8.48 | 8.56 | 8.4 |
| 8 | RQR-M1 | 25 | 0.29 | 0.300 | 0.28 |
| 9 | RQR-M2 | 28 | 0.32 | 0.332 | 0.31 |
| 10 | RQR-M3 | 30 | 0.33 | 0.352 | 0.33 |
| 11 | RQR-M4 | 35 | 0.37 | 0.391 | 0.36 |
| 12 | MMV-40 | 40 | 0.40 | 0.421 | --- |
| 13 | MMV-50 | 50 | 0.43 | 0.461 | --- |
| 14 | RQA-M2 | 28 | 0.61 | 0.629 | 0.60 |
| 15 | MMH-40 | 40 | 0.82 | 0.822 | --- |
| 16 | MMH-50 | 50 | 0.99 | 0.957 | --- |
| 17 | MRV-28 | 28 | 0.38 | 0.400 | --- |
| 18 | MRV-30 | 30 | 0.39 | 0.419 | --- |
| 19 | MRV-35 | 35 | 0.43 | 0.455 | --- |

### 3.7 Evaluation of the results

The CCRI(I) Executive Secretary will provide the participants with the other partner's results. The partners will evaluate the comparison together and prepare a Draft B report to include the calculated DoE values proposed for the IAEA standard.

### 3.8 Publication of the results

After review of the Draft B report by the CCRI(I), the final report will be published in the key comparison database of the CIPM MRA as a *Metrologia Technical Supplement*. A summary of the comparison report will also be published in the SSDL Newsletter.

### 4. References:


1. IEC 61267:2005
2. IAEA Technical Report Series no. 457, Dosimetry in Diagnostic Radiology: An International code of Practice, 2007
3. ICRU Report 74, Patient Dosimetry for X-rays Used in medical Imaging, 2006
4. ISO/IEC Guide to the Expression of Uncertainty of Measurement, 2008



I. Csete, I. Gomola, L. Buermann

2012-05-07