Evaluation of the Air Kerma Rates Stability used in Diagnostic Radiology Calibration

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Abstract. The objective of this work was to perform tests in order to evaluate the stability of the air kerma rates measured with the dosimetric reference system of the calibration laboratory of IPEN (LCI)). The diagnostic radiology reference system consists of a parallel plates ionization chamber with volume of 1cm^3, PTW, model 77334, connected to a PTW electrometer, model UNIDOS, type 10001, and it is used a ^{14}C as check source. This parallel plate ionization chamber can be also used for radiography and fluoroscopy modes measurements during the characterization of the diagnostic radiology beams. The air kerma rates obtained during the calibration measurements were are evaluated from 2005 to 2007.

KEYWORDS: Diagnostic Radiology; Ionization Chamber; Air Kerma rates

1. Introduction

Diagnostic radiology is the practice which radiation beams, usually X- rays are used to produce an image with the purpose of obtaining a diagnosis, which will exclude or assess the development of a pathological condition.

The Instruments Calibration Laboratory (LCI) of IPEN performs calibrations of all radiation measurement instruments used in diagnostic radiology (such as ionization chambers and others) using the specific radiation qualities.

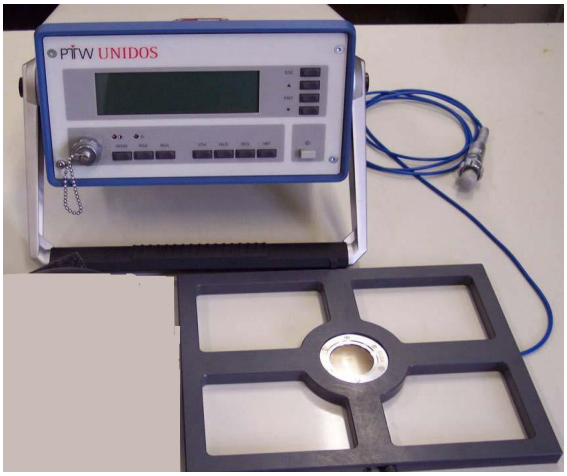
The ionization chambers are the main instruments used in diagnostic radiology dosimetry. The main advantage is to be a correct instrument with low energy dependence and few complicating factors. A ionization chamber should be calibrated in the range of energy used, since different chambers may show some variations in energy dependence. The model and the performance should meet the needs of clinical measures.

This present work shows the evaluation of the air kerma rates values used in calibration of diagnostic radiology instruments.

2. Material and methods

The diagnostic radiology reference system consists of a parallel plates ionization chamber with volume of 1cm^3, from PTW, model 77334, connected to a PTW electrometer, model UNIDOS, type 10001, and it is used a ^{14}C as a check source, as showed in Fig. 1 .This parallel plate's ionization chamber was used for radiology beams in radiography and fluoroscopy modes. Its calibration from 50kV to 150 kV was realized by the Primary Standard Dosimetry Laboratory PTB, Germany, according to the norm IEC 1267 [1].

Figure 1: The Ionization Chamber, PTW model 77334 and the electrometer UNIDOS.



To guarantee the good behavior of this reference system, a periodic quality control program is made including repeatibility tests (10 sequentially measurements using the check source) leakage and lay term stability.

The radiation Qualities established at the X-ray system Seifert/ Pantak (160Kv) are those recommended by the IEC 61267 [2]. They main characteristics are in table1. All measurements were made at 100 cm.

The evaluation of the values of air kerma rates in the RQR qualities, obtained during the period from 2005 to 2007 was made. Those measurements were performed using the reference system in the qualities RQR3, 5, 7, 9, and 10 corresponding to 50, 70, 90,120 and 150 Kv respectively.

Table 1: Main characteristics of the radiation qualities to diagnostic radiology measurements established at the calibration laboratory of IPEN.

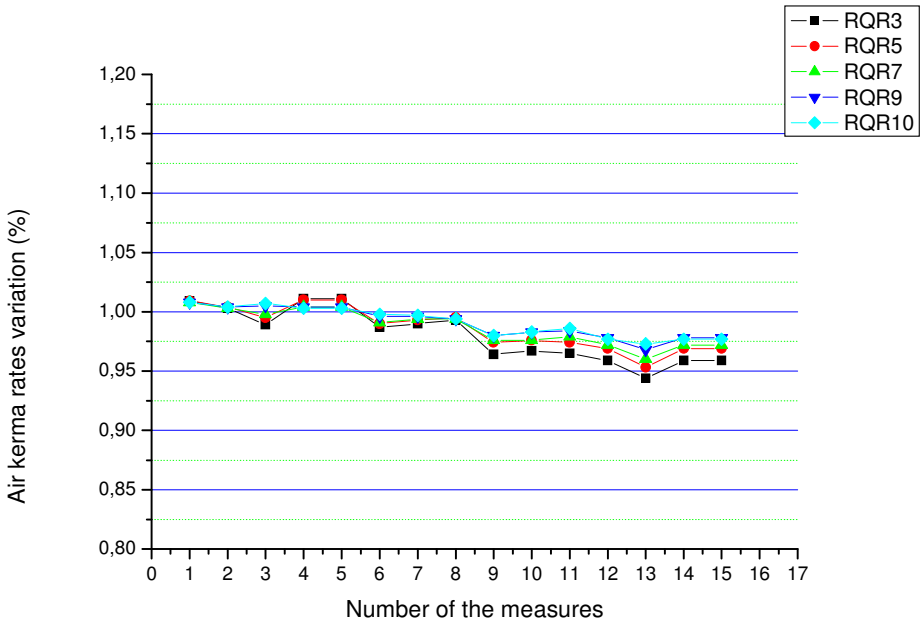
Standard Radiation Quality	X-ray Tube Voltage (kV)	Half -value layer (mm Al)	Effective Energy (keV)	Air kerma value (mGy/min)
RQR 3	50	1.78	27.20	24.06
RQR 5	70	2.58	30.65	47.17
RQR 7	90	3.48	33.65	74.51
RQR 9	120	5.00	38.05	121.8
RQR 10	150	6.57	42.30	175.19

3. Results

The results of the repeatability tests showed a good performance of the chamber 77334 due the stability tests with a maximum variation of 0.014 %. The International Norms recommended that the variation of dosimetric instrument in the diagnostic radiology must not exceed 3% (IEC, 61674, 1997, Medical Electrical Equipment) [3].

The air kerma rates obtained in the period were compared to that initially determined during the beams characterization as showed in table2. These values show stability of $\pm$ 1.0 %, considering that the maximum variation was found to RQR3 (50kV) between 0.94 and 1.01%. The uncertainties were always less than 3% in all cases.

Table 2: Air kerma rates variation in comparing with initial value obtained in the beams characterization.



4. Conclusion

This study demonstrated that the dosimetric system (ionization chamber plus electrometer) and the irradiation system (X-ray machine) have the stability necessary for the calibration service in diagnostic radiology.

Acknowledgements

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REFERENCES

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[3] INTERNATINAL ELECTROTECHNICAL COMMISSION. IEC 61674. Medical Electrical Equipment- Dosimeters with ionization chambers and/or semi-conductor detectors as used in X-ray diagnostic imaging.