Evaluation of the Utilization of Flat Ionization Chamber as Monitor Chamber

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Abstract. This work continues the study initiated in 2003 of the PTW 77335 ionization chamber, showing their performance and functionality to be used as transmission chamber. Those chambers have the same characteristic of monitor chamber. They are flat kind with 112cm^3 of volume, graphite window with thickness of 170μm and polarizing voltage of 100V. The chambers were named A and B, and they were connected to an electrometer Unidos also of PTW, and a ^{14}C as a check source. The repeatibility test consists in 10 measurements in fix and repeated conditions. This test shows the behaviour of the ionization chamber in short time. To verify their long time stability, this test was made for 6 months. The results showed a good performance of the chamber model 77335 to be used as transmission chamber, as published before. The stability test showed that the chamber **A** (s. 1870) had a variation of 0.16 % and the chamber **B** (s.1868) 0.20%. The long time measurements showed a variation of +/- 1.8 % for chamber **A** and +/-1.6 for chamber **B**. The values showed the functionality of the chamber to be used as transmission chamber. The results showed good performance of the studied chambers, therefore, the continuing evaluation is needed to guarantee the quality of the results showed until now.

KEYWORDS: Dosimetry, Diagnostic Radiology, Quality Assurance

1. Introduction

In the last years the Calibration Laboratory of IPEN has improved its procedures, introducing new techniques and special methodologies control the primary beam of the X ray tube, considering that several studies have been realized to specify performance standards for equipment used in diagnostic radiology, with the objective of obtaining adequate diagnostic information at acceptable levels of patient dose [1-5]. Therefore, it is important to use a monitor chamber in order to verify any instability that may occur in the system.

The objective of this work was to control the primary beam monitoring using two flat ionization chambers, designed for dose measurements behind phantoms, with filtering corresponding to a position in front of a patient, tested before as monitor chamber [6], in one clinical diagnostics radiology system, Medicor, model Roentgengyara (125 kV).

2. Material and Methods

It was used two ionization chambers PTW, model 77335, 112 cm^3 of volume, series number 1868 (A) and 1870 (B). They were connected to an electrometer PTW Unidos.

The ambient conditions were controlled. A holder was made in acrylic to guarantee a fix positioning of the chamber in the beam. Short and long term stability tests were made with a ^{14}C source. To measure the applied voltage to the X-ray tube, it was used an invasive meter Dynalizer and those values were compared with a non-invasive meter Diavolt.

The Table 1 shows the RQR qualities established at the Medicor/Neodiagnomax X ray system, following the norm IEC 61267 [7].

All measurements were made using a parallel plate ionization chamber, PTW, with 1cm^3 of volume, calibrated at the Primary Standard Dosimetry Laboratory, PTB, Germany. The distance of calibration was 50cm. A laser point was used to set the center of the beam.

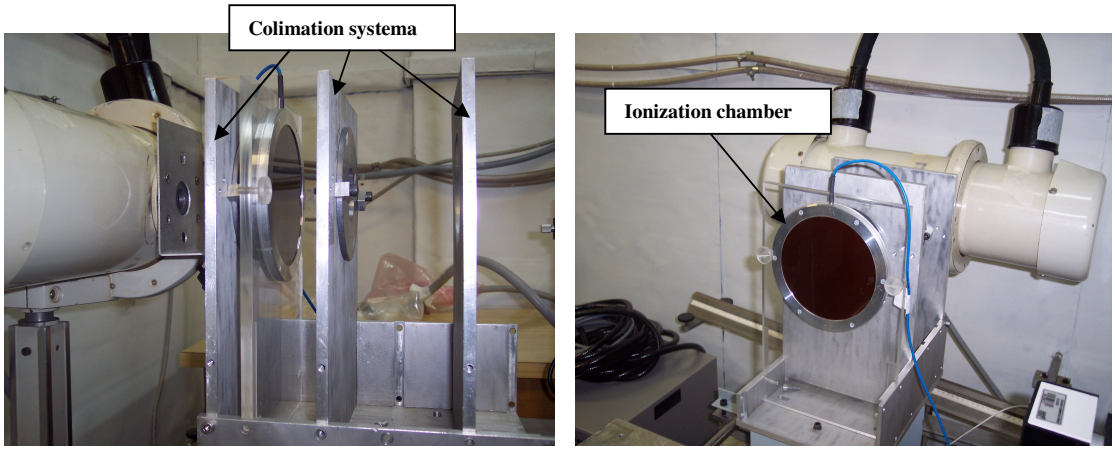
Table 1: Main characteristics of the radiation quality established at the Medicor X-ray system.

Radiation Quality	Nominal Voltage (kV)	Diavolt* (kV)	Filtration (mmAl)	HVL (mmAl)	Effective energy keV
RQR 3	50	51.38	2.5	1.82	32.0
RQR 5	70	69.64	2.5	2.45	39.2
RQR 7	90	87.8	2.5	3.10	46.0

* non-invasive measurements

The flat ionization chambers (112 cm^3) PTW, model 77335, designed for dose measurements behind phantoms, were originally calibrated from 50 to 150 kV with patient-equivalent filtering. In this work they were tested in established qualities with filtering corresponding to a position in front of a patient (total filtration of 2.5 mmAl). A ^{14}C check source with a nominal activity of 3.7 MBq (1993) was used for the stability and repeatibility tests. The chambers were connected to a PTW electrometer, model UNIDOS 10001. They were positioned, sequentially, in front of the collimator as monitor chambers. Each one of the flat chambers was irradiated at the distance of 11cm simultaneously with the reference ionization chamber (1 cm^3), positioned at the calibration distance of 50cm. The set-up used is illustrated in Figure1.

Figure 1: Set-up used to place the flat ionization chamber in the beam.

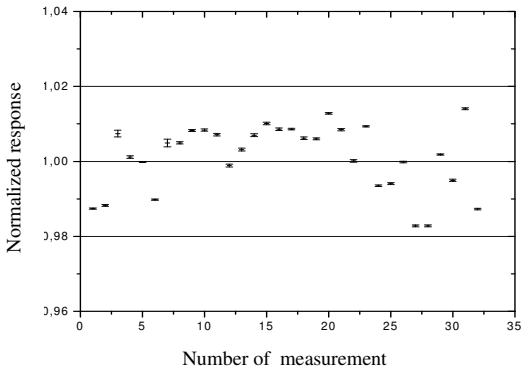


3. Results

The quality control tests (repeatability, long-term stability and leakage test showed a good performance for both flat ionization chamber: maximum variation of 0.5 % for the long term stability test; a maximum deviation of 0.3 % in the repeatability measurements were obtained and the leakage current was always less than 0.5%.The fig. 2 shows the performances of the two chambers, **A** and **B**. The IEC standards recommend a variation always less than 3% [8].

Figure 2. Repeatability and long-term stability of the flat ionization chambers A and B.

Chamber A



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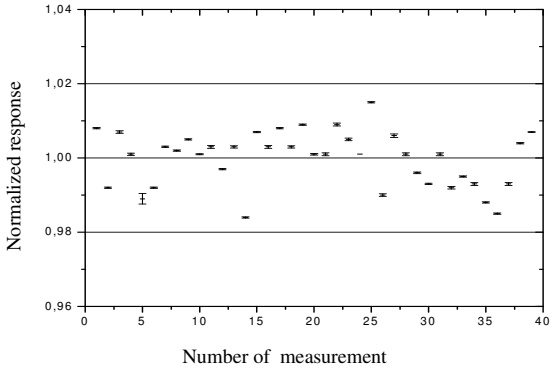
Chamber B



The air kerma rates were measured again with the flat ionization chamber positioned as a monitor chamber, sequentially. The obtained values are showed in Table 2 for both chambers.
The ionization chamber **A** showed the best behaviour, considering that the biggest variation was 9.1% to RQR 5. To the chamber **B** the variations were always higher than 10%.

Table 2: Air kerma rates obtained with and without the monitor chamber

			Air Kerma rate (mGy/mim)		
Radiation Quality	**Nominal Voltage (kV)**	**HVL (mmAl)**	**Without Monitor chamber**	**With chamber A**	**With chamber B**
RQR 3	**50**	**1.82**	**1.98**	**1.82**	**1.72**
RQR 5	**70**	**2.45**	**4.66**	**4.27**	**4.23**
RQR 7	**90**	**3.10**	**7.86**	**7.59**	**7.99**

4. Conclusions

The performance of the two ionization chambers shows the possibility of their use as monitor chambers in the Neo-Diagnomax X radiation system of the Calibration Laboratory of IPEN. The best chamber was nº 1870 with good stability and best coefficient de calibration. Moreover, the calibration coefficients obtained allow the use of the flat ionization chambers as working standards for the calibration of field instruments.

5. Acknowledgements

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6. References

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[7] INTERNATIONAL ELETHOTECHNIAL COMMSSION Medical diagnostic X-ray equipment – radiation conditions for use in the determination of characteristics (IEC 61267/1997)

[8] INTERNATIONAL ELETHOTECHNIAL COMMSSION Medical electrical equipment - Dosimeters with ionization chambers and/or semi-conductor detectors as used in X-ray diagnostic imaging (IEC 61674/1997)