DIAGNOSTIC RADIOLOGY DOSIMETRY USING IONIZATION CHAMBERS

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INTRODUCTION

Due to the number of diagnostic X-rays equipments in operation in Brazil and to the fact that medical exposure to radiation is by far the major source of exposure to ionizing radiation of the population, the development of a control method to these equipments is being very important, including dose reduction techniques. It is clear that a lot of studies is being carried out in this field (1,2), but until now, in Brazil and Latin America, there is no operational system or method to calibrate dosemeters used in diagnostic radiology measurements. Since 1980 instruments are being calibrated at the Calibration Laboratory of IPEN at radiotherapy and radiation protection levels. Considering the indicated necessities, studies have been undertaken in order to improve the calibration service with tests at the diagnostic radiology level. The objectives of this work are the determination of diagnostic radiology qualities for instruments calibration using a therapy system and to test some instruments used in diagnostic radiology measurements.

MATERIALS AND METHODS

The X-rays generating system consists of a Rigaku Denki generator, model Geigerflex, coupled to a Philips tube model PW/2184/00 (tungsten target and beryllium window). This system was used to establish the diagnostic radiology qualities according to the German norm DIN 6872, part 1 (3), in the range from 30 to 50 kV. The main characteristics of this radiation system are shown in Table I.

Table I. Characteristics of the Rigaku Denki X-rays generating system.
Focus-chamber distance : 100 cm.

Qualities	Tube Voltage kV	Additional Filtration mm Al	Half Value Layer mm Al	Effective Energy keV	Exposure Rate x 10^{-4} C/(kg.min)
DN1	30	2	0.947	19.0	4.29
DN2	40	4	1.84	28.2	3.71
DN3	50	10	3.61	38.9	1.21

The exposure rates were measured with the secondary standard parallel plate ionization chamber (0.03 cm^3) that was calibrated at the National Physical Laboratory (NPL), England. This chamber was used considering its low energy dependence in this range. The maximum tube voltages (kVp) were determined by spectrometry using an Intertechnique spectrometer, with a HPGe Σurisys Mesures detector. Three ionization chambers made at IPEN(4) and four portable monitors usually used in Brazil for diagnostic radiology measurements were used to compare the results obtained with the seçondary standard ionization chamber. Their main characteristics are shown in Table II.

Table II. Main characteristics of the ionization chambers tested at diagnostic radiology level.

Instrument	Type	Window Material	Volume cm^3
(A) IPEN-01-Graphite	Clinical dosemeter	Aluminized Mylar	0.6
(B) IPEN-02-Aluminium	Clinical dosemeter	Aluminized Mylar	0.6
(C) IPEN-04- Graphite	Clinical dosemeter	Aluminized Mylar	3.4
(D) VICTOREEN 660-3	Portable Monitor	Equivalent tissue plastic	4
(E) BABYLINE 81-INT	Portable Monitor	Equivalent tissue plastic	515
(F) BABYLINE 81-RATE	Portable Monitor	Equivalent tissue plastic	515
(G) RADCAL 10X5-180	Portable Monitor	Policarbonate	180
(H) RADCAL 10X5-1800	Portable Monitor	Policarbonate	1800

RESULTS

The maximum tube voltages (kVp) obtained using the HPGe spectrometer are shown in the Fig. 1. The obtained values were approximately 31.5, 41.4 and 51.8 kV respectively for the qualities called DN1, DN2 and DN3 by the German norm DIN 6872. The Fig. 2 shows the spectra measured at the same qualities.

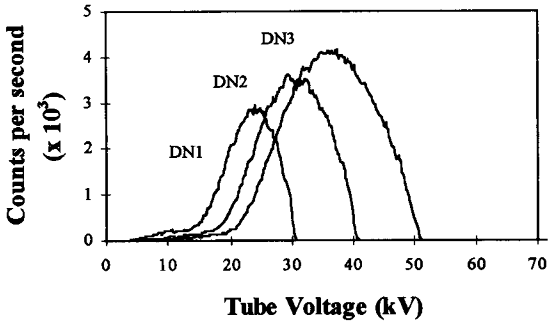

Figura 1. The maximum tube voltage (kVp) determination to DN1, DN2 and DN3 qualities.

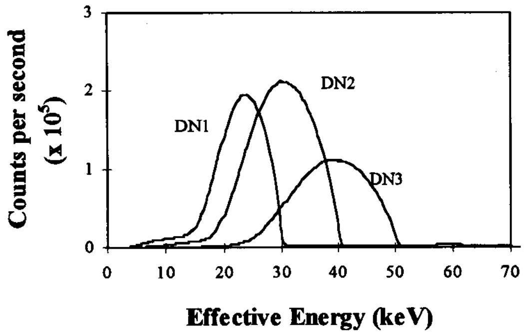

Figura 2. Spectra of the qualities DN1, DN2 and DN3.

The Fig. 3 and 4 show the energy dependence of the tested instruments.

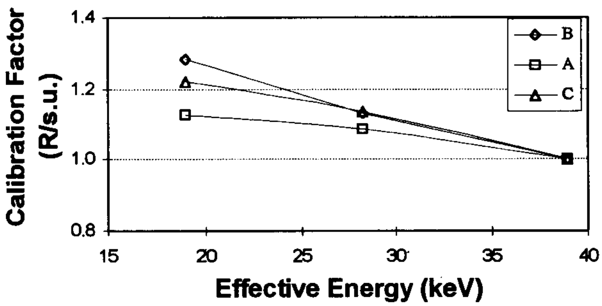

Figura 3. Energy Dependence of the IPEN parallel plate ionization chambers. All values were normalized to 50 kV to make easy the comparison.

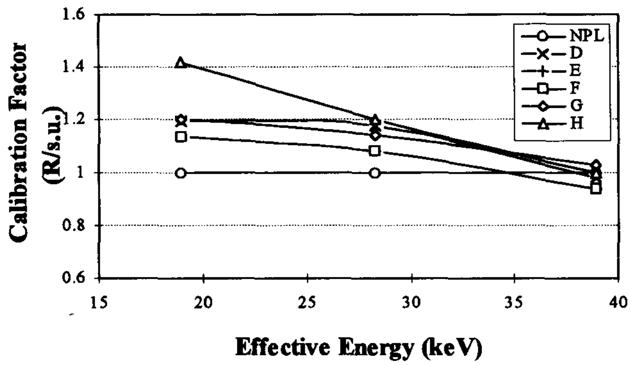

Figura 4. Energy dependence of the portable monitors. All values were normalized to measurements made with the NPL secondary standard ionization chamber measurements.

The Fig. 3 shows that among the homemade chambers the graphite electrode chamber, with a volume of 0.6 cm^3, presents the best energy dependence (13%), which could be compared with that of the secondary standard ionization chamber (8%). In the case of the portable monitors (Fig. 4) the monitors D, E, F and G show less than 20% of energy dependence related to the NPL secondary standard ionization chamber and can be recommended to be used in this range.

CONCLUSIONS

The preliminary results show the importance of the instruments tests at diagnostic radiology qualities, in the case of ionization chambers and specially for some portable monitors. This work is being extended extended for other types of instruments normally used in this kind of measurements; the establishment of the radiation qualities from 60 to 120 kV must be performed to complete the range used in diagnostic radiology, with another adequate X-rays system.

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