PRELIMINARY RESULTS ON THE CALIBRATION OF INSTRUMENTS AT DIAGNOSTIC STANDARD RADIATION QUALITIES USING A THERAPY SYSTEM

Maria da Penha Albuquerque and Linda V. E. Caldas

Instituto de Pesquisas Energéticas e Nucleares
Comissão Nacional de Energia Nuclear - SP
Caixa Postal 11049
05422-970, São Paulo, Brazil

ABSTRACT

Standard radiation qualities were established using a low energy X-rays system (60 kV) of the Calibration Laboratory of São Paulo in order to develop a calibration procedure of instruments used at diagnostic level. The radiation qualities of the German norm DIN 6872, Part 1, were established. The properties of the radiation fields were determined in terms of half-value layers, effective energies and exposure rates from 30 to 50 kV, using aluminium filtration from 2 to 10 mm. In this range the energy dependence of the monitor chamber was studied and the exposure rates were measured using a secondary standard ionization chamber calibrated at the National Physical Laboratory, England. The results were applied to some instruments used in diagnostic radiology in order to study their behaviour during irradiation .

INTRODUCTION

Substantial efforts are being put into quality control programmes and into radiation protection in diagnostic radiology all over the world. These efforts have the objectives to avoid the unnecessary X-rays exposure to patients and workers and to improve the medical utilization of radiation[1-7].

Due to the number of diagnostic X-rays equipments working 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 are being carried out in this field [8, 9], 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 [10], 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 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.

Preliminary tests were applied to three ionization chambers made at IPEN[11] and to four portable monitors usually used in Brazil for diagnostic radiology measurements in order to study their energy dependence. 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 450	Portable monitor	Aluminized Mylar	200
(E) VICTOREEN 450P	Portable monitor	Conductive plastic	300
(F) VICTOREEN 660-3	Portable monitor	Equivalent tissue plastic	4
(G) BABYLINE 81-INT	Portable monitor	Equivalent tissue plastic	515
(H) BABYLINE 81-RATE	Potable monitor	Equivalent tissue plastic	515

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.

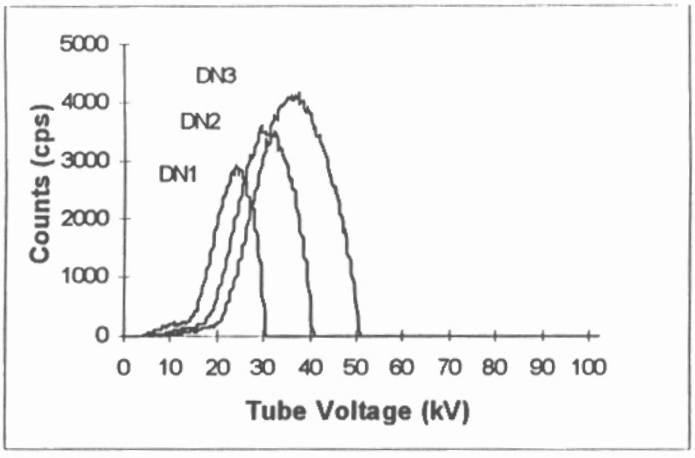

Fig. 1. Spectra of the qualities DN1, DN2 and DN3.

The energy dependence curve of the secondary standard ionization chamber calibrated at NPL was used for the calibration factors determination in the studied range. The low energy dependence of this chamber is shown in the Fig. 2.

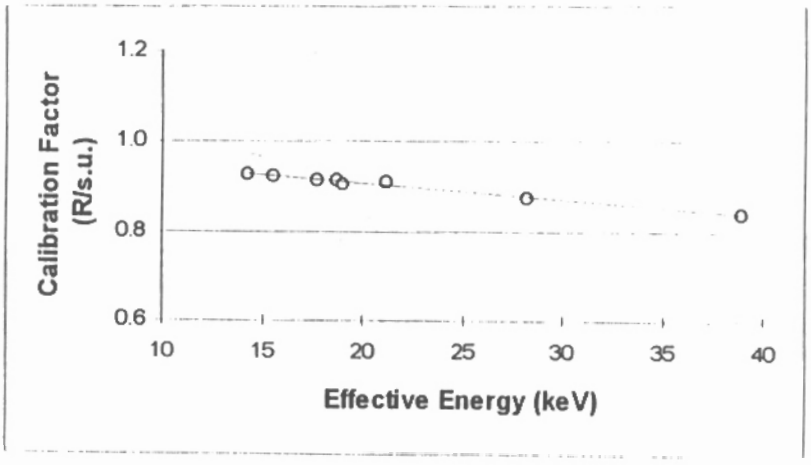

Fig. 2 Energy dependence of the Secondary Standard Ionization Chamber NPL (volume 0.03 cm^3) including the DN1, DN2 and DN3 qualities. The NPL certificate (1981) provides the calibration factors in Roentgen per scale unit (R/s.u.).

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

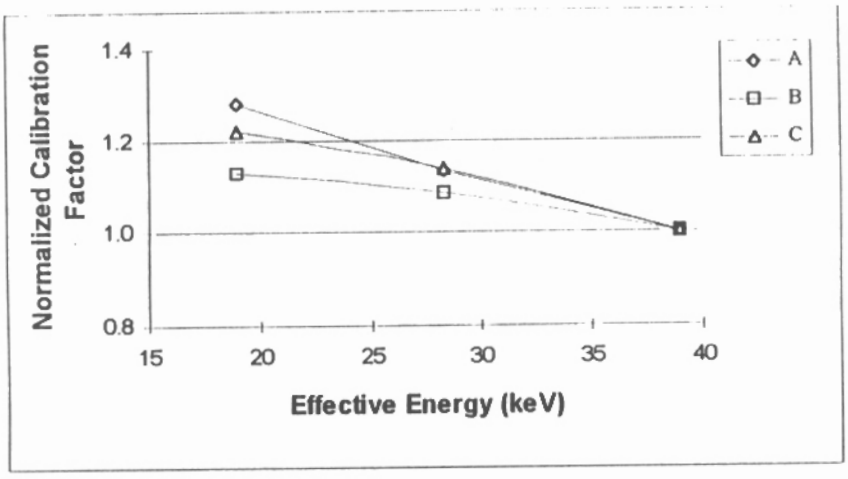

Fig. 3. Energy Dependence of the IPEN parallel plate ionization chambers. All values were normalized to 38.9 keV.

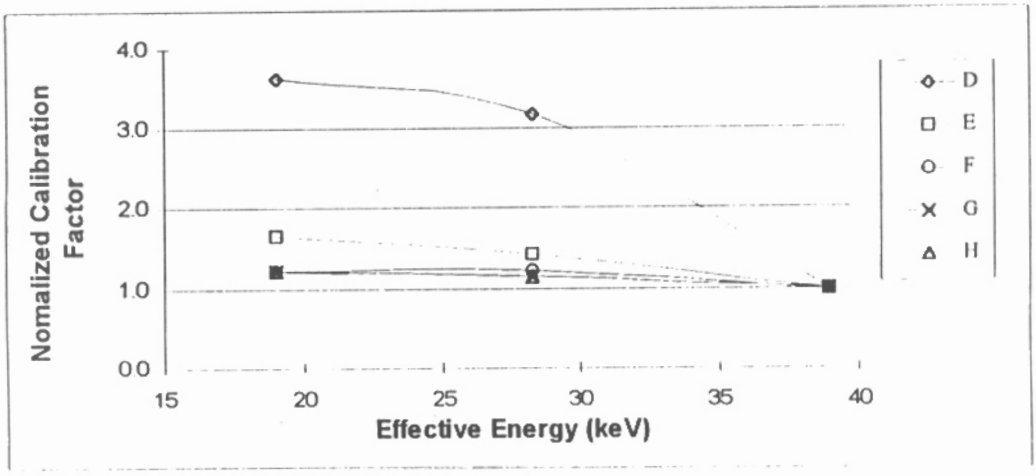

Fig. 4. Energy dependence of the portable monitors. All values were normalized to 38.9 keV.

The Fig. 3 shows that among the homemade chambers the graphite electrode chamber (volume of 0.6 cm^3) present the best energy dependence (13%), comparable to the secondary standard ionization chamber (8%). In the case of the portable monitors (Fig 4), the instruments F, G and H show almost the same good behaviour 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, for ionization chambers and specially for some portable monitors. This work will be extended for other types of instruments normally used in this kind of measurements. The determination of the radiation qualities from 60 to 120 kV must be still performed to complete the range used in diagnostic radiology, using another adequate X-rays system.

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