

# MONITORING SURVEY INSTRUMENTS BEHAVIOUR IN STANDARD LOW ENERGY X-RAYS

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## INTRODUCTION

The Calibration Laboratory of São Paulo offers calibration services for monitoring survey meters with gamma, beta, alpha and X radiation. For the calibration of these instruments with X-rays, at Radioprotection level, seven standard low energy X-rays fields were established. Five of them are used at the National Physical Laboratory (NPL) (1), with energies between 16 and 38 keV, and two are recommended by the International Standard Organization (ISO) (2), with energies of 33 and 48 keV.

Different survey meters such as ionization chambers and Geiger-Müller detectors were studied on relation to their energy dependence. These instruments are used for area monitoring of gamma radiation, but some of them detect low energy X-rays too. The energy spectra in area monitoring are usually large because of the scattered radiation. Therefore it is important to know the behaviour of these instruments in a wide energy range

## MATERIALS AND METHODS

The low energy X-rays calibration system consist of a Rigaku-Denki Generator, model Geigerflex, with a Philips tube model PW/2184/00 (Tungsten target and Beryllium window). The voltage and the current can be varied between 20 and 60 kV and 2 and 80 mA, respectively. Table 1 shows the characteristics of the low energy X-rays qualities established at the Calibration Laboratory. The measurements were taken at 200 cm distance from the target, in a field of 25 cm diameter. Six ionization chambers and four Geiger-Müller detectors of different models and manufacturers were tested (Table 2).

Table 1-Characteristics of low energy X-rays qualities

Voltage kV	Additional Filtration		Effective Energy keV	1 <sup>st</sup> HVL	
	mmAl	mmCu		mmAl	mmCu
20	0.92		16	0.35	
25	1.70		20	0.66	
30	2.70		24	1.02	
40	4.92		31	1.95	
50	1.12	0.23	38	3.27	
40 (ISO)		0.21	33		0.086
60 (ISO)		0.57	48		0.232

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Table 2-Characteristics of monitoring survey instruments

Ionization Chambers		Geiger-Müller Detectors	
	Model		Model
Bicron	RSO-5 <sup>TM</sup>	Eberline	HP 270
Nardeux	Babyline 31	Eberline	HP 290
Nardeux	Babyline 81	Nortron	NMR-1000
Victoreen	450	Victoreen	Minimonitor II
Victoreen	470A		
Victoreen	471		

## RESULTS

Several monitoring survey instruments were tested, but the results of only the most representative of them are shown in this work. In the Figures 1 and 2 the results obtained with some ionization chambers can be observed; they presents an energy dependence between 7 and 33 % in the 16-48 keV range. The most suitable of these radiation detectors is the Victoreen 470A, although all of them can be used in this energy range.

In the case of the Geiger-Müller detectors, they presents a very high energy dependence, as can be seen in the Figures 3 and 4.

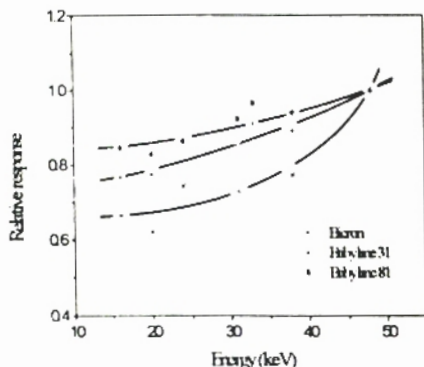


Figure 1 - Energy dependence of ionization chambers

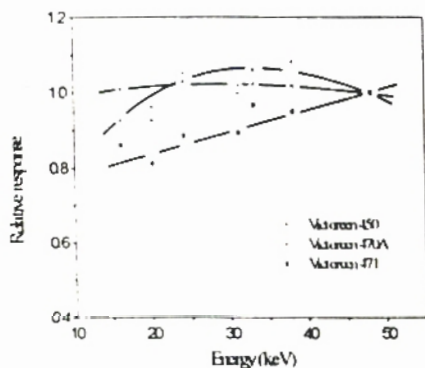


Figure 2 - Energy dependence of ionization chambers

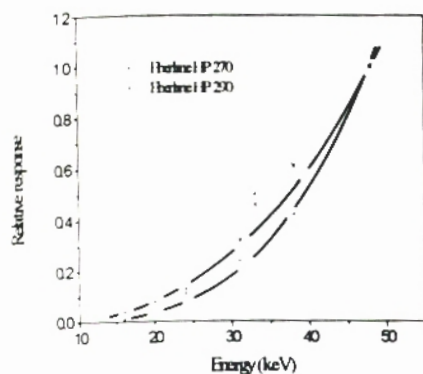


Figura 3 - Energy dependence of Geiger-Müller detectors

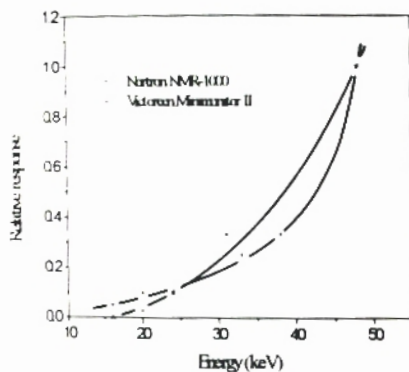


Figura 4 - Energy dependence of Geiger-Müller detectors

## CONCLUSIONS

All tested instruments, ionization chambers and Geiger-Müller detectors, can be used for low energy x-rays detection, but the results show the importance of knowing their energy dependence in order to allow the application of correction factors on the measured values of exposure rates.

## ACKNOWLEDGMENTS

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