Portable meter study of ionizing radiation Teletector in high rates of air kerma.

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Abstract: A set of portable meters of ionizing radiation high rates of air kerma (teletectors) commonly used in emergencies in Brazil and sent to the Calibration Laboratory of IPEN were under several tests and analyst is parameters for the detectors behavior were established. Applied tests were: energy dependence and primarily overload with the new irradiation system. Thus it was possible to determine the most common characteristic found in these equipments (quality control programs) and new calibration criteria were established following international recommendations.

Keywords: portable meters, calibration, overload, quality control.

1. INTRODUCTION

The Instrument Calibration Laboratory (LCI) of Instituto de Pesquisas Energéticas e Nucleares (IPEN) held annually about 1100 calibration tests [1-5] (procedures performed in order to verify the operating conditions of the instruments) and calibration measures radiation monitors, which are used in radiation protection, radiation therapy, diagnostic radiology and nuclear medicine. The gauges used in radioprotection represent the vast majority of tests, about 60% of the instruments routinely tested and the irradiated samples are used in radiation protection measures and ^{137}Cs gamma radiation.[6,7].

The objective of this study is to perform tests on the new radiator system and demonstrate the main features of Teletector detector, particularly, the importance of the overload test for quality control of this equipment (teletector). And currently no Instrument Calibration Laboratory in Brazil has conditions to apply the scale burst test (overload), as it provides for the irradiation of the instrument in a range of measures ten times higher than the bottom of your larger scale, causing the test has very specific and difficult technical conditions of accomplishment, being higher rate of 10 Sv/h. [6-8]

2. METHODOLOGY

They were 15 portable meters was analyzed and in this study, 10 of them have been tested in the LCI-IPEN.

2.1. Materials

It was used the irradiator system with remote control and irradiation time control with power of ^{60}Co, ^{137}Cs, with different kerma levels in the air, brand STS, model: OB 85/1; in figure 1 (a) is possible to see irradiator. The chosen system was the irradiator Caesa-Gammatron (teletherapy irradiator) with and electric igniter through a control panel made by the LCI-IPEN, and with a controller of the irradiation time, with a single Cesium 137 power. In figure 1 (b) is possible to see the irradiator. And we used a gamma irradiator with power sources of ^{137}Cs, brand Hopewell, model G10-2-360-E. In figure 1 (c) is possible to see the irradiator Hopewell.

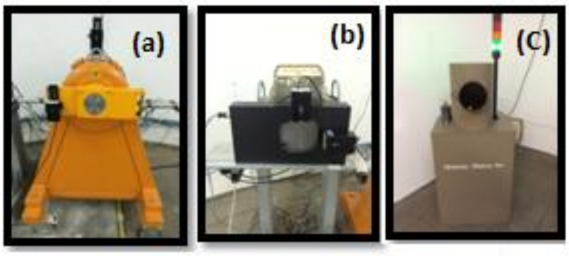

Figure 1. Radiator system type (a) STS brand, model: B 85/1 with sources of ^{60}Co, ^{137}Cs, (b) Caesa-Gammatron with source of ^{137}Cs and (c) Hopewell, model G10-2-360-E.

We used the teletectors to conduct the tests. These detectors were Geiger Müller and are have two Geiger detectors of different range. Figure 2 shows the teletector detector.

Figure 2. Detector de radiação ionizante de altas taxas de kerma no ar (teletector). O detector possui dois geiger Muller associados a sua eletrônica. O primeiro Geiger Muller possui um range e o segundo Geiger Muller tem como range.

The equipment for measurement and control of temperature and humidity were used.

We used the calibration laboratory of portable monitors

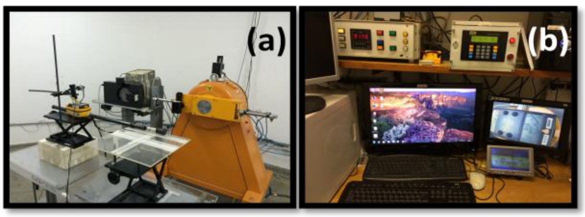

Figure 2. (a) Irradiation Room of portable monitors calibration laboratory. It is able to view the radiators B 85/1 and Caesa, positioning table and a teletector detector. (b) Control room of portable monitors calibration laboratory. Being able to see the control caesa radiator, control of automated table with their cameras to detect the reader's display and its source detector position.

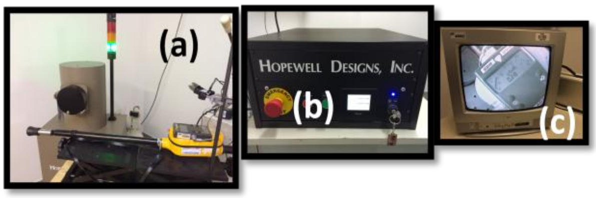

Figure 3. (a) Irradiation Room of portable monitors calibration laboratory. It is able to view irradiator Hopewell, positioning table and a teletector detector. (b) and (c) Control room of portable monitors calibration laboratory. Being able to see the control Hopewell radiator and cameras to detect the reader's display.

3. RESULTS

3.1. Energy dependence

The energy dependence of a portable radiation monitor may be understood as the change in instrument response as a function of the radiation energy, for the same kind of radiation and absorbed dose rate referenced to the tissue or in the air, in principle, for all energy range in which the equipment is designed to measure. Should keep the value of the constant exposure rate [8]. The detectors teletector`s were subjected to gamma radiation and ^{137}Cs ^{60}Co sources from the irradiator, duly aligned with the positioning system of the machine the distance between the radiation source and the equipment, keeping the center of the sensor element always aligned with the radiation beam. The air kerma rate used to perform the energy dependence test was 50 mR / hr for both ^{60}Co source and ^{137}Cs.

Table 1 shows the detectors teletector represented by T, the kerma rate values measured by the air teletector of ionizing radiation sources

^{60}Co and ^{137}Cs, and kerma rate values provided in the air by dosimetry calibration system of the sources of ionizing radiation ^{60}Co and ^{137}Cs with their uncertainties and analysis it was determined the percentage difference between the respective measures.

Table 1. kerma rate measurements in air with different detectors teletector model with sources ^{60}Co e ^{137}Cs.

Equip.	kerma rate in air (mR/h)								(%)
	^{137}Cs "real"	± σ	^{137}Cs measure	± σ	^{60}Co "real"	± σ	^{60}Co measure	± σ	
T_1	50,0	0,8	49,1	0,9	50,0	0,8	68,9	1,3	40%
T_2	50,0	0,8	49,5	0,9	50,0	0,8	69,0	1,3	39%
T_3	50,0	0,8	49,4	0,9	50,0	0,8	71,5	1,3	45%
T_4	50,0	0,8	49,5	0,9	50,0	0,8	65,2	1,2	32%
T_5	50,0	0,8	49,8	0,9	50,0	0,8	66,2	1,2	33%
T_6	50,0	0,8	49,9	0,9	50,0	0,8	68,4	1,3	37%
T_7	50,0	0,8	49,4	0,9	50,0	0,8	69,4	1,3	40%
T_8	50,0	0,8	50,0	0,9	50,0	0,8	67,8	1,3	36%
T_9	50,0	0,8	49,3	0,9	50,0	0,8	69,2	1,3	40%
T_{10}	50,0	0,8	49,2	0,9	50,0	0,8	68,6	1,3	39%

So you can see that the model teletector ionizing radiation detector has energy dependence, because there were variations in the difference of the measures of ^{60}Co and ^{137}Cs between 33% to 45%. So you can see that with ^{137}Cs readings measures were closer to the real value (dosimetry), are within the uncertainty. And the measures with ^{60}Co were out of the real value (dosimetry), being outside of the value and the associated uncertainty.

According to the NBR 10011 [8] the indication of the instrument to radiation with energies between 50 keV and 3 MeV should not differ by more than ± 25% within this energy range. Soon all equipment is outside the recommended by the standard, however the equipment is within specifications described by the manufacturer, as described in its energy dependence manual is ± 50%.

3.3. Saturation or Overload

The scale burst test is part of the tests called "Safety Conditions". For exposure rates corresponding to directions above the upper limit of any nominal range, the display of the instrument shall acknowledge burst of scale.

This assay was used with the radiator ^{137}Cs source, where the instruments were subjected to 10-fold higher exposure rates than the respective scale of funds for about 5 minutes, thus a display rate greater than 10 Sv/h.

Table shows the results of the burst tests scale portable radiation detectors.

Table 2. Scale overload tests of portable type monitor Geiger- Müller (Teletectors).

Teletector	Results
T_1	approved
T_2	approved
T_3	approved
T_4	approved

All equipment tested in table 2 was considered approved. The uncertainty in the exposure rate was not higher than 5%.

4. CONCLUSIONS

The study of international and national norms and protocols is very important to carry out measures reliably in the field of ionizing radiation. The update and the improvement still is needed by the complexity of the field. Therefore, not only tertiary laboratory calibration, which is the case LCI-IPEN, but users of these devices in their work routines, it is necessary to study, testing and quality control of the ionizing radiation detectors equipment for performing measurements reliably. So, as it was observed that the LCI reference did not have measuring equipment reliability and alternative study was conducted to perform the dosimetry of ionizing radiation fields used for calibration of portable monitors. So getting a dosimetry for quality control of their calibration instruments.

Performance tests showed results which are very important to characterize the equipment, which in this case is the model detector Automess teletector. The objective is to show that it possesses energy dependence, since there were variations in the difference between measurements of ^{60}Co ^{137}Cs between 33% and 45%, revealing that with ^{137}Cs readings were measures but close to the real value (dosimetry), are within the uncertainty. And the measures with 60Co were out of the real value (dosimetry), being outside of the value and the associated uncertainty energies. Soon all the equipment is out of the recommended standard [8], however the equipment is within specifications described by the manufacturer in his manual.

Saturation studies are needed to verify the safety conditions of the equipment. They to judge whether the equipment responds to high rates of instantly display, allowing the equipment indicates an abnormal situation, such as the situation of accidental user exposure to excessive exposure rates, or above the unit's reading limits alerting the user for a personal and property risk situation. It is essential to periodically conducting this test. The results of tests to answer other ionizing radiations show the importance of using the most appropriate equipment for the intensity and type of radiation field to be measured.

5. ACKNOWLEDGMENTS

The authors thank of Agência Internacional de Energia Atômica (IAEA), Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) e Ministério da Ciência e Tecnologia (MCT, Projeto: Instituto Nacional de Ciência e Tecnologia (INCT) em Metrologia das Radiações na Medicina) the partial financial support.

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