International Joint Conference Radio 2022

Assessment of energy and angular dependence of LiF:Mg,Ti dosimeters irradiated in the quality $H_p(0.07)$

Nascimento[a] G. G., Silva[b] C. R., Campos[a] V. P., Campos[a] L. L.

[a]Instituto de Pesquisas Energéticas e Nucleares, Av. Lineu Prestes, 2242, Cidade Universitária, São Paulo – SP

[b]Faculdade Santa Marcelina, Rua Utupanema, 40, Itaquera, São Paulo - SP

gabrielgn@usp.br

Introduction: Dosimeters are devices that have the purpose of quantifying the dose that the worker received in a certain region of the body during his period of activities involving ionizing radiation [1, 2]. A dosimeter must have, at least, one physical property that varies as a function of the measured dosimetric quantity [3], in addition to the physical properties, the dosimeter must pass the calibration tests; the energy dependence and angular dependence tests are essential tests for the dosimeter calibration process [3]. Dosimeter calibration is essential both in the medical area (technicians, technologists, nurses, and doctors) and in the research area (production of radiopharmaceuticals and performance in different stages of the fuel cycle). In Brazil, so far, there are no standards for extremity dosimeters, therefore, in this work the recommendations of the Evaluation Committee of Testing and Calibration Services (CASEC) for whole-body dosimeters adapted for extremity dosimeters were used [1; 2]. The objective of this work is to evaluate the dependence of the dose evaluated in thermoluminescent dosimeters as a function of the energy and incidence angle of radiation.

Methodology: The irradiations were performed in the quality $H_p(0.07)$ using a phantom rod in a Cs-137 source and an irradiator Pantak/Seifert model Isovolt160 HS in the clinical radiodiagnostic range (50 kV - 150 kV) with energies of 48, 65, 83 and 118 KeV and dose of 10 mSv.
In the angular dependence test angles of 0, 20, 40 and 60° were evaluated using energy of 118 KeV and dose of 10 mSv. The Harshaw model 4500 reader was used for dosimeter readings and in the heat treatment process.

Results: To the energy dependence test 10 TLDs were irradiated 10 times with each energy and the TL response evaluated. To the angular dependence test 10 TLDs were irradiated 10 times at each angle and the TL response evaluated.
The average of the TL readings ($\bar{A}_i$) and the standard deviation (s_i) were obtained and are compared to the specified by the CASEC recommendations relative to energy and angular dependence of LiF:Mg, Ti dosimeters that using mathematical equations, must present the following limits: 0.7> <1.3 for energy dependence and 0.85> <1.15 for angular dependence. Tables 1 and 2 show the results of the energy dependence and angular dependence tests, respectively.

Energy keV	$\bar{A}_i$ **mSv**	s_i	$0.7 \geq \frac{\bar{A}_i}{\bar{A}_5} \pm I_i \leq 1.3$
48	9.58	0.265	1.13
65	10.17	0.378	1.27
83	10.57	0.341	1.28
118	10.83	0.322	1.30
Cs-137	10.16	0.419	1.30

Table 1: Energy dependence test: average TL response and standard deviation as a function of incident energy.

Angle	$\bar{A}_i$ **mSv**	s_i	$0.85 \geq \frac{\sum_{i=1}^{4} \bar{A}_i}{4_{\bar{A}_1}} \mp I_i \leq 1.15$
0°	10.52	0.229	1.146
20°	10.31	0.205	1.148
40°	10.29	0.198	1.145
60°	10.19	0.189	1.149

Table 2: Angular dependence test: average TL response and standard deviation as a function of incidence angle.

Conclusions: The results obtained in the energy and angular dependence tests present a small range of variation ±0,5% for energy dependence and ±0,001% for angular dependence, according to the CASEC recommendations. The results indicate that the dosimetry system studied meets the calibration requirements in the quality $H_p(0.07)$, using a phantom rod recommended by ICRU in Report 47 [4] in gamma radiation field (Cs-137) and X radiation at energies of 48, 65, 83 and 118 KeV recommended by CASEC and adapted to the equipment used.

References:

1. NASCIMENTO, G. et al. *Characterization and calibration of thermoluminescent dosimeters of LiF: Mg, Ti in the quantity Hp (0.07)*, INAC 21, 2021.
2. CASEC, Comitê de Avaliação de Serviços de Ensaio e Calibração, Desempenho de Monitoração Individual – Critérios e Condições, 2013.
3. OKUNO, Emico; YOSHIMURA, Elisabeth Mateus. Física das radiações. Oficina de Textos, 2016.
4. ICRU, International Commission on Radiation Units and Measurements, *Measurement of Dose Equivalent from External Photon and Electron Radiation*, Report 47, 1992.