

## Characterization of the reproducibility of LiF:Mg, Ti dosimeters and the radiator system in the quantity Hp(0.07)

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### Introduction

Dosimeters are monitors that have the purpose of quantifying the radiation dose received by the user in specific regions of the body (NASCIMENTO, 2021), extremity dosimeters are used by professionals who are subject to receiving doses in their hands during their period of service. In order for the dosimeter to have some reliability, some characterization/calibration tests must be performed (NASCIMENTO, 2021), among them, the reproducibility test, where the reproducibility of the dosimetric system and irradiation system is evaluated. In this work, the reproducibility test was based on the recommendations of CASEC (Assessment and Calibration Services Assessment Committee) (CASEC, 2013), however, in Brazil, to date, there are no recommendations for extremity dosimetry (NASCIMENTO, 2021), so the tests were adapted for end-point dosimeters. The dosimeters must be calibrated using a phantom of the region of interest, with the phantom rod being used in the end calibrations. The calibration of extremity dosimeters must be done using the quantity Hp(0.07), established by the ICRU (International Commission of Radiological Units and Measurements) (ICRU, 1992). LiF:Mg, Ti thermoluminescent dosimeters (TLD) are materials well studied and used as dosimeters, among the several characteristics that make it an excellent dosimeter, are the low effective atomic number, dose rate, chemical and mechanical resistance and the ease to be produced in different versions (tablets, powder, sticks and disks) (RÜDEN, 1977; NUNES, 2008; BATISTA, 2011), in this work the LiF:Mg, Ti detectors were used in tablet format.

### Methods

The tests carried out in this work followed the recommendations of CASEC, adapted for the extremity dosimeters. The reproducibility test was divided into two stages, in the first stage the reproducibility of the detectors was evaluated, 10 detectors were irradiated and evaluated, and the average response of each detector was analyzed, in the second stage the reproducibility of the irradiating system was evaluated, 10 detectors were irradiated and evaluated, being analyzed the average response of each irradiation, the procedures were repeated in 10 times each. For the irradiations, a Caesa-gammatron irradiator system was used with a Cesium-137 source coupled, the dose used was 10 mSv. Irradiations were performed at room temperature with a source-object distance of 1 meter. A phantom rod was used to apply the quantity Hp(0.07). The evaluation of the dosimeters was performed on a thermoluminescent reader, Harshaw model 4500.

**Results**

For this work, tests were first performed on the reproducibility of the TL response for the same radiation dose, where  $\bar{A}_i$  is the average of all 10 doses evaluated,  $s_i$  is the standard deviation of the 10 doses evaluated,  $i$  refers to each irradiation to the group,  $t_n$  is the number of samples at a 95% confidence level and  $l_i$  is the confidence interval for  $s_i$ . Then, the reproducibility test of the TL response of the dosimeters, where  $\bar{A}_j$  is the mean of the group in each irradiation,  $s_j$  is the standard deviation of the irradiation series, where  $j$  refers to each irradiation to the group,  $t_n$  is the number of samples at a 95% confidence level and  $l_j$  is the confidence interval for  $s_j$ .

Table 1: Results of the reproducibility test of the TL response of the irradiations

Irradiation	$\bar{A}_i$ mSv	$s_i$	$l_i$	$\bar{A}_i \cdot 10$	$i=110\bar{A}_i \cdot 10$	Criterion	$s_i + l_i = 110\bar{A}_i \cdot 10$
01	9.93	0.30	0.16	0.99	10.00	si+l <i>i</i> =110 <i>A</i> <sub>i</sub> 10 ≤0.075	0.045
02	10.20	0.46	0.24	1.02	10.00		0.070
03	10.04	0.44	0.23	1.00	10.00		0.067
04	10.00	0.41	0.22	1.00	10.00		0.063
05	9.85	0.46	0.24	0.98	10.00		0.070
06	10.03	0.45	0.24	1.00	10.00		0.069
07	9.97	0.42	0.23	1.00	10.00		0.065
08	10.15	0.45	0.24	1.01	10.00		0.068
09	9.94	0.33	0.18	0.99	10,00		0.051
10	9.91	0.45	0.24	0.99	10.00		0.070

Table 2: Extremity dosimeter TL response reproducibility test results

Dosimeter No.	$\bar{A}_j$ mSv	$s_j$	$l_j$	Criterion	$s_j + l_j \bar{A}_j$
01	9.89	0.16	0.08	s <i>j</i> + l <i>j</i> <i>A</i> <sub>j</sub> ≤0.075	0.025
02	10.36	0.33	0.17		0.049
03	9.47	0.09	0.05		0.015
04	10.08	0.24	0.13		0.036
05	10.19	0.25	0.14		0.038
06	10.41	0.49	0.26		0.071
07	9.85	0.34	0.18		0.053
08	10.02	0.24	0.13		0.037
09	9.54	0.38	0.20		0.061

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10	10.19	0.22	0.12		0.034
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The results show good reproducibility of the irradiations and of the evaluated dosimetric system.

**Conclusions**

The results of the reproducibility test are within the limits established by CASEC, therefore, it is concluded that LiF:Mg dosimeters, irradiated in the magnitude Hp(0.07) using a phantom rod can be used in the evaluation of the quantity Hp(0.07) in routine extremity monitoring of occupationally exposed workers.