Assessing the Performance of LiF:Mg,Ti and LiF:Mg,Cu,P Extremity Dosemeters

Luís C. Freire,1,2 Ana Calado,1 Miguel Pereira,1 Luís Santos,1 João Cardoso,1 João G. Alves1

1Departamento de Protecção Radiológica e Segurança Nuclear, Instituto Tecnológico e Nuclear, Estrada Nacional 10, 2686-953 Sacavém, Portugal
2Atomedical, Laboratório de Medicina Nuclear, Rua Helena Félix 11 D, 1600-121 Lisboa, Portugal

Abstract

In this paper, we present the results aimed at assessing the performance of two varieties of LiF detectors (LiF:Mg,Ti and LiF:Mg,Cu,P, of the EXT-RAD type), relatively to reproducibility, detection threshold and angular dependence criteria defined in the ISO 12794:2000 Standard and other documents. The fading properties of these two dosemeter varieties were also investigated.

In all experiments, five or eight dosemeters of each LiF variety were randomly selected out of the respective batches, which comprise one hundred dosemeters each. In all experiments, the LiF:Mg,Ti and the LiF:Mg,Cu,P dosemeters were simultaneously submitted to the same steps (pre-irradiation treatment, irradiation and readout) in order to guarantee the direct comparison of the results.

Reproducibility was assessed by irradiating sets of five dosemeters of each LiF variety with a $^{90}$Sr-$^{90}$Y source built-in one Harshaw 6600 reader. On the other hand, the detection threshold was investigated based on the above mentioned standard.

The assessment of the isotropy criterion was done by irradiating four sets of five dosemeters of each LiF variety with a N-80 beam (mean energy of 65 keV), at different angles of incidence, namely $0^\circ$, $\pm 20^\circ$, $\pm 40^\circ$ and $\pm 60^\circ$ and the response was calculated relatively to a $^{137}$Cs reference beam.

The fading properties of both LiF varieties were evaluated by comparing the signal yielded by dosemeters of each LiF variety irradiated to a reference dose at different stages relatively to storage, comprising sets stored after (SA) and stored before (SB) irradiation. Increasing periods of 2, 4, 6 and 8 weeks, similar to the ones used in routine monitoring, were considered.

For the reproducibility and detection threshold performance tests, the ISO 12794:2000 Standard defines acceptance limits of 10% and 1 mSv, respectively. For the isotropy performance test, an isotropy coefficient is defined, and verified, if it yields values comprised in the 0.85-1.15 range. On the other way, Portuguese legislation defines that the fading effects shall be lower than 10% per month (Decreto-Lei 167/2002).

The reproducibility results yielded values below 2.01% and 1.65% for LiF:Mg,Ti and LiF:Mg,Cu,P dosemeters respectively, which are well below the 10% limit mentioned before.

In terms of detection threshold, the evaluated values for each LiF variety are comprised between 0.08 and 0.17 mSv for LiF:Mg,Ti and between 0.53 and 0.85 mSv for LiF:Mg,Cu,P, also below the 1 mSv limit.

* Presenting author, E-mail: lfreire@itn.pt
The angular dependence was verified for both dosemeter types, for all the irradiation angles. The isotropy coefficients are comprised between 0.96 and 0.99 for LiF:Mg,Ti and between 0.94 and 0.98 for LiF:Mg,Cu,P, well within the limits.

Finally, the fading experiment showed that LiF:Mg,Cu,P dosemeters have a lower fading effect than LiF:Mg,Ti ones (monthly values respectively between 0.7 and 3.8%, and 4.2 and 21.4%).

The results show that both LiF varieties are well-suited for extremity monitoring. However, previous studies and the fading properties of LiF:Mg,Cu,P dosemeters re-inforce the idea that LiF:Mg,Cu,P is best suited for this purpose provided the residual signal is kept under control.

KEYWORDS: Extremity monitoring; LiF:Mg,Ti; LiF:Mg,Cu,P; ISO 12794, 2000; Decreto-Lei 167/2002, performance tests.