Type Testing of a Harshaw™ EXTRAD Extremity Dosemeter with PTFE Filter for Measuring Dose to the Lens of the Eye in Terms of $H_p(3)$

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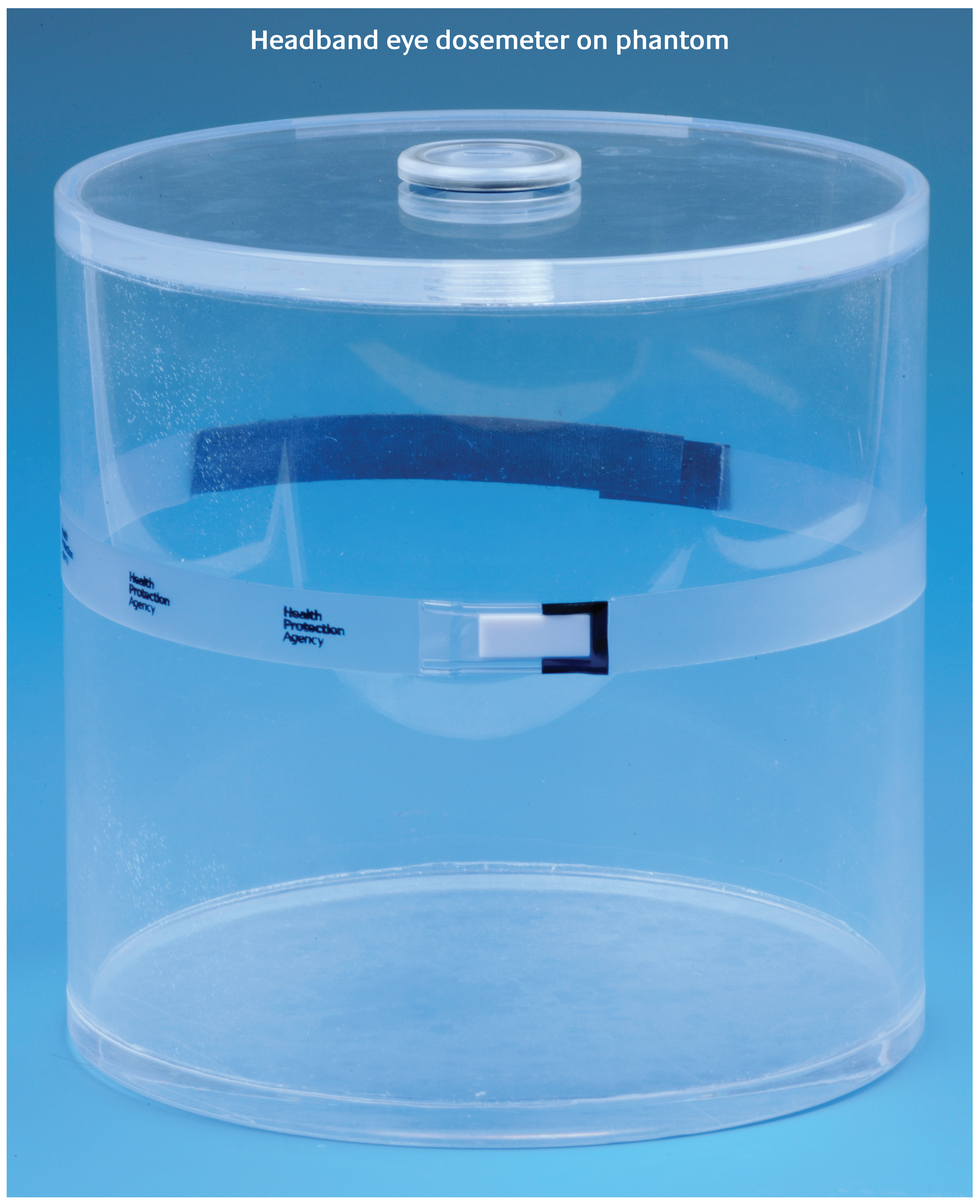
Introduction

The Health Protection Agency for some years held approval to use its body TLD as an eye dosemeter for photons only[1]. The TLD is worn on the collar. It does not measure $H_p(3)$ directly but uses an average of the H_p (0.07) and $H_p(10)$ readings. Such usage relies on uniformity of the photon field in the vicinity of the head.

Recent developments in understanding have led the International Commission on Radiological Protection (ICRP)[2] to recommend a dose limit of 20 mSv in a year, averaged over defined periods of 5 years, with no single year exceeding 50 mSv. We therefore anticipate a need for an eye lens dosemeter that will measure $H_p(3)$ in uniform and non-uniform photon and beta fields.

The new design of eye dosemeter is based on a modified headband, using the Harshaw™ EXTRAD TLD element. This uses LiF:Mg,Cu,P which is tissue equivalent, and a PTFE filter of a tissue equivalent thickness of 3 mm, so enabling the measurement of $H_p(3)$. This approach ensures that the dosemeter correctly measures the quantity in all fields and all mixtures of fields.

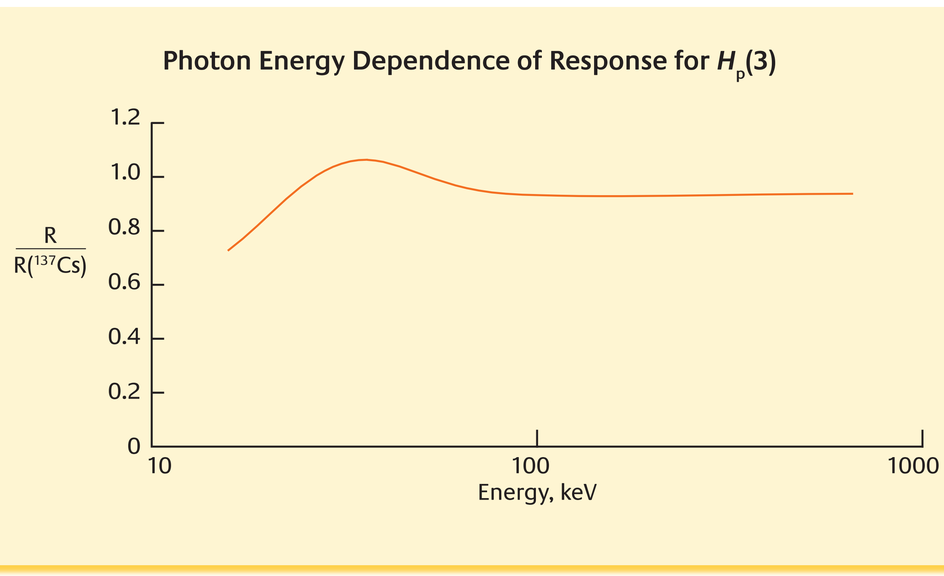
The tests were based on the ISO 12794[3] standard and included energy and angular dependence of response for photons and betas. All were done on an ORAMED-designed cylindrical head phantom[4] that we had built for this purpose. We used conversion coefficients for $H_p(3)/K_a$ (where K_a is air kerma) that were derived from the monoenergetic values calculated for the same ORAMED project[5].



Headband eye dosemeter on phantom

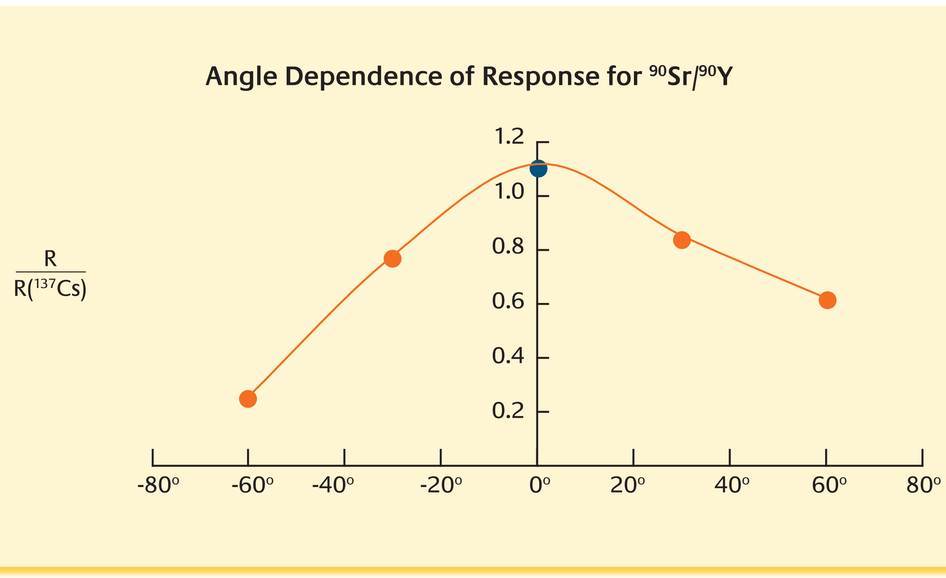
Results

The results show that the performance of this eye lens dosemeter is good, for both photon and beta radiations.



Beta Energy Response (0°)

The relative response for $^{90}Sr/^{90}Y$ is 1.10 and, as expected, there was zero response for ^{85}Kr. (Beta radiations from this radionuclide do not pass through 3 mm of tissue).



Conclusion

This headband using the Harshaw™ EXTRAD TLD element with a PTFE filter of a tissue equivalent of 3 mm would be suitable to use in the HPA's approved dosimetry service. A potential enhancement to the design would be to improve the angle dependence of the beta response by making it more symmetric.

References

(1) Gilvin et al, Type Testing of a new TLD for the UK Health Protection Agency Radiation Protection Dosimetry Vol. 128, No. 1, pp. 36–42 (2008).
(2) ICRP Statement on Tissue Reactions, April (2011).
(3) International Organization for Standardization. ISO 12794:2000 Nuclear Energy – Radiation Protection – Individual Thermoluminescence Dosemeters for the Extremities and Eyes. ISO (2000).
(4) Gualdrini G et al. Eye lens dosimetry:Task 2 within the ORAMED project. Radiation Protection Dosimetry Vol. 144, No. 1-4, pp. 473-477 (2011).
(5) Daures J et al. Monte Carlo determination of the conversion coefficients Hp(3)/Ka in a right cylinder phantom with 'Penelope' code. Comparison with 'MCNP' simulations. Radiation Protection Dosimetry, Vol. 144, No. 1-4, pp. 37-42 (2011).

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