Non-reference condition correction factor $k_{NR}$ of typical radiation detectors for the dosimetry of high-energy photons

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The non-reference correction factor $k_{NR}$ is computed using the quotient of the detector sensitivity under reference conditions $x_{ref}$ against that under general conditions $x$:

$$k_{NR} = \frac{Y_t(x_{ref})}{Y_t(x)} \quad (1)$$

The weighted sensitivity of detector type $t$ at point $x$, $Y_t(x)$, is obtainable by summing over all spectral components and taking the quotient of the spectral dependent response against the dose to water (kerma approximation):

$$Y_t(x) = \sum_{i=1}^{n} r_t(E_i) \left( \frac{\mu_{en}(E_i)}{\rho} \right)_w \phi_E(E_i) E_i \quad (2)$$

Factor $\mu_{en}(E)/\rho$ is the mass energy absorption coefficient of water and $\phi_E(E)$ the spectral photon fluence at energy $E$. Values of the energy-dependent detector responses $r_t(E)$, normalized to unity at 1.25 MeV, are shown in Fig. 1a for the Farmer chamber$^1$, TLDs LiF:Mg,Ti$^2$ and LiF:Mg,Cu,P$^3$, diodes EDP-10 (shielded) and EDD-5 (unshielded)$^3$. Fig. 1b shows typical dependence of $k_{NR}$ on the photon mean energy for LiF:Mg,Ti chips, determined from Monte Carlo computed spectra in a large water phantom under 6 MV and 15 MV photon beams at a Siemens Primus linac. The user can then simply infer $k_{NR}$ if the beam quality at the point of interest is known. Similar relations have been obtained for the other radiation detectors investigated.

Fig 1 (a) Energy dependent responses $r_t(E)$ to monoenergetic photons for various radiation detectors. (b) Variation of $k_{NR}$ for LiF:Mg,Ti chips with mean photon energy $E_m$. Symbols with field sizes: Calculated $k_{NR}$ values, based on experimental response values for quasi-monoenergetic photons$^2$ and on Monte-Carlo calculated photon spectra of 6 and 15 MV photon beams$^4$. Symbols with error bars: Measured $k_{NR}$ values$^5$ in 6 MV photon beams at various field sizes, depths and off-axis distances.

References: