Abstract

Saturation currents I_{sat} and collection efficiencies $f(V)$ in ionization chambers exposed to pulsed radiation beams are determined assuming a linear relationship between $1/I$ and $1/V$ in the near-saturation region, with I and V the chamber current and voltage, respectively. This assumption of linearity enables the determination of I_{sat} and $f(V)$ from currents measured at only two points in the near saturation region ("*two-voltage*" technique). However, careful measurements of ionization chamber currents with increasing voltage in the extreme near-saturation region reveal a current rising faster than that predicted by the linear relationship. This excess current, combined with conventional techniques for determination of collection efficiency, results in up to a 0.5% overestimate of the saturation current. The measured excess current is attributed to a non-dosimetric charge multiplication in the chamber air-volume and may be accounted for by an exponential term $\exp(\gamma V)$ used in conjunction with Boag's equation for collection efficiency in pulsed beams. The relationship between I and V is thus given by $1/I = [1/I_{sat} + \lambda_p/V]\exp(-\gamma V)$, with λ_p a constant, which depends on chamber as well as air parameters and is proportional to the initial charge density per pulse, and γ is the charge multiplication parameter. This semi-empirical model, which accounts for both the dosimetric charge recombination and non-dosimetric charge multiplication effects, follows the experimental data well, and yields values for the saturation current which exclude the non-dosimetric effect of charge multiplication in the ionization chamber.