ABSORBED DOSE AND COLLISION KERMA RELATIONSHIP FOR HIGH-ENERGY PHOTONS (DOSIMETRY, CALIBRATION, RADIATION)

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Historically, exposure has been used as an important quantity to specify X- or (gamma)- ray beams. For any photon beam the energy fluence is proportional to the exposure. Exposure can be calculated and/or measured if the spectrum of the beam is known and charged particle equilibrium (CPE) exists.

For low energy photons (up to approximately 1 MeV), due to the existence of CPE, absorbed dose (D) is equal to the collision kerma (K(,c)). For megavoltage photons this equality is lost due to CPE failure, which also restricts the measurement of exposure. It is possible, though, to find a relationship between the absorbed dose and collision kerma when transient charged particle equilibrium (TCPE) exists. This basic idea was originally proposed by Roesch in 1958 and its refinement has been discussed by Attix in 1979 and 1983. The modified Roesch's formula which enables us to measure exposure even for high-energy photons is given by D = (beta) K(,c) (TURNEQ) K(,c) (1 + (mu)' <x>) where (mu)' is the effective linear attenuation coefficient and <x> is the mean distance the secondary electrons carry kinetic energy in the direction of the photon beam while depositing it as absorbed dose. The symbol (beta) is the quotient of the absorbed dose and the collision kerma.

The importance of Roesch's formula has been recognized and used implicitly in the recent dosimetry protocol of the AAPM (Task Group 21). However, the <x> value used in the protocol is based on theoretical calculations which do not include photon scattering. As a result of the present effort the parameters (mu)' and <x> have been determined experimentally, <x> for the first time. The dependence of (beta) on several factors has been studied and (beta) has been obtained including the effects of scattering.

Calculations were also performed for several photon energies and materials, using the Roesch method, which does not include photon scattering effects. Comparisons of measured and calculated values of <x> show reasonable agreement.