

Letters to the Editor

Concrete Buildup Factors Based on the American National Standard for Flux-to-Dose-Rate Conversion

It has been traditional for gamma-ray buildup factors used for radiation protection purposes to be based on the type of dose known as "exposure" or some closely related concept such as "air kerma." This convention has persisted so long because "exposure" (used in its narrow sense) has been usually accepted as an adequate basis of radiological hazard for x-ray and gamma-ray photons.

With the publication of the American National (ANSI) Standard¹ "Neutron and Gamma-Ray Flux-to-Dose-Rate Factors," a positive step has been taken to get away from the exposure concept toward the more realistic one of the maximum dose equivalent in an idealized tissue phantom, in assessing radiation hazards from these two types of penetrating radiation. It is tempting to suggest, as some have done, that the buildup factors for x-ray and gamma-ray photons should be recalculated in the context of this new standard approach to biological dose and dose-rate calculations. Unfortunately, these factors are not entirely consistent with what is recommended by the International Commission on Radiation Units and Measurements (ICRU), also a standard setting entity, in that the phantom prescribed by the latter organization is a sphere,² whereas the phantom visualized in the ANSI standard is a slab. (The ICRU calls the concept based on the spherical phantom a "dose equivalent index.") The numerical differences in the factors under the two different approaches are probably not great; but before undertaking a large new program of buildup-factor calculations, the ANSI standard should be revised to be consistent with the ICRU specification. It is understood that research workers are already considering the problem of photon fluence-to-dose-equivalent-index conversion factors based on the ICRU sphere, and results should become available shortly.

Meanwhile, in the interim it is possible to use the ANSI Standard as the basis for a temporary adjustment to the old buildup factors. For example, Shure³ has provided correction factors for the point source/buildup factors for water, iron, and lead originally given by Goldstein and Wilkins.⁴ In similar fashion, we have calculated corrections over a limited energy

¹"Neutron and Gamma-Ray Flux-to-Dose Rate Factors," American National Standard ANSI/ANS-6.1.1-1977 (N666), American Nuclear Society, La Grange Park, Illinois (Mar. 17, 1977).

²"Radiation Quantities and Units," ICRU Report 19, International Commission on Radiation Units and Measurements, Washington, D.C. (July 1, 1971).

³K. SHURE, *Nucl. Sci. Eng.*, **69**, 532 (1979).

⁴H. GOLDSTEIN and J. E. WILKINS, Jr., "Calculations of the Penetration of Gamma Rays," NYO-3075, Nuclear Development Associates (1954).

TABLE I

Ratio of "Standard Biological Dose" Buildup Factor to Air Kerma Buildup Factor for Point Source in Concrete

mfp	Energy Group of Photon Source (MeV)		
	8 to 10	4 to 5	1.5 to 2
1	1.04	1.05	1.07
2	1.05	1.07	1.11
4	1.06	1.08	1.16
7	1.06	1.09	1.16

range and for limited penetration distances to buildup factors for concrete provided by Eisenhower and Simmons⁵ (see Table I.)

The method of calculation was very similar to that of Shure and involved the folding of ANISN flux calculations for a point source into the conversion factors provided in the ANSI Standard. The results are quite comparable to those of Shure, and generally fall between his results for water and for iron. They are somewhat closer to his results for water, as one would expect since the average *Z* of concrete is closer to that of water than to the *Z* of iron.

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⁵C. M. EISENHAUER and G. L. SIMMONS, *Nucl. Sci. Eng.*, **56**, 263 (1975).

Comment on "Concrete Buildup Factors Based on the American National Standard for Flux-to-Dose-Rate Conversion"

Chilton and Brown have raised two issues in their Letter.¹ We will take their latter point first and agree that correction

¹A. B. CHILTON and R. W. BROWN, "Concrete Buildup Factors Based on the American National Standard for Flux-to-Dose-Rate Conversion," *Nucl. Sci. Eng.*, **73**, 301 (1980).