GAMMA RAY BUILDUP FACTOR CALCULATIONS FOR IRON BY THE DISCRETE ORDINATES CODE XSDRNP-M-S

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Abstract—Air kerma buildup factors for iron are calculated by the discrete ordinates code XSDRNP-M-S for an isotropic point source in a homogeneous medium. By comparing the results with buildup factors from literature, conditions for gamma ray deep penetration calculations are retrieved.

It turned out that many energy groups and an extremely fine space and angular mesh are needed to achieve reasonable accurate results. Because of these requirements, it is very difficult to calculate buildup factors up to 40 mfp shield thickness for energies above 5 MeV. Below this energy, calculated buildup factors agree with literature values within 10%, approximately, which seems quite reasonable.

1. INTRODUCTION

Buildup factors are used by point-kernel shielding codes to account for the scattered radiation in the medium. Until a few years ago, data compiled by Goldstein and Wilkins (1954) was used. This data served as a reference for all calculations performed since then. The need for more accurate buildup factors, extended in both energy and shield thickness, lead to a new compilation of buildup factors (Trubey, 1988). Air kerma and medium kerma buildup factors were calculated for several materials by Chilton et al. (1980) by use of a moments method code, while air kerma buildup factors for several materials were calculated by Takeuchi and Tanaka (1985) by the discrete ordinates direct integration code PALLAS. Takeuchi and Tanaka (1985) compared buildup factors including bremsstrahlung with those without that contribution. Although both Chilton et al. (1980) and Takeuchi and Tanaka (1985) used the same data library, the difference between the two results is 19% at a shield thickness of 40 mfp and energy of 0.5 MeV. In Fig. 1, the air kerma buildup factors for iron are given together with the results of Goldstein and Wilkins (1954).

Both Chilton et al. (1980) and Takeuchi and Tanaka (1985) calculated air kerma buildup factors, which are not equal to dose-equivalent buildup factors due to a slightly different detector response function. Shure (1979) compared air kerma buildup factors with dose-equivalent buildup factors. The discrete ordinates code ANISN was used for this purpose in P$_2$S$_{19}$ mode with 57 energy groups. The dose-equivalent buildup factors for iron were found to be larger than air kerma buildup factors for a wide range of energies. However, the difference was less than 13%, while the difference between the air kerma buildup factors for iron and the Goldstein compilation reached nearly 30% at a shield thickness of only 20 mfp.