

Neutron Leakage from the Entrance Maze of Medical Electron Accelerators

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For medical electron accelerators with photon energies above 15 MeV the shielding requirements in the entrance region of the treatment room are mainly determined by neutron streaming. The accelerator (especially the bremsstrahlung target and the collimator system) is the primary source of fast photoneutrons with an average energy of about 1 MeV. The neutrons are scattered from the walls of the maze resulting in a broad energy spectrum down to thermal energy. For calculating the attenuation factor of the entrance shielding door the neutron dose rate has to be determined using a reliable procedure. Several methods have been proposed for estimating neutron streaming through the maze, e.g.:

- the albedo method which is based on single scattering of fast neutrons from the maze walls,
- a semiempirical method developed by Nakamura et al. which was derived from transport calculations,
- an empirical procedure by Kersey based on measurements at various accelerator installations.

The accuracy of these three procedures was compared by calculating the neutron dose rates for various accelerator facilities for which sufficiently reliable measured data were available. Good agreement between calculated and measured values was generally obtained for the Nakamura method. The Kersey method overestimates the neutron component in some cases. The simple geometric albedo approach however severely underestimates the neutron dose rate at the entrance of the maze. This discrepancy is certainly due to the fact that the simple albedo concept does not take into account the buildup of thermal neutrons by multiple scattering. Measurements with a Bonner spectrometer indicate a considerable contribution of slow neutrons to the total dose rate at the entrance. For the design of the entrance maze the Nakamura method was found to be the most reliable one, the deviation between calculation and measurement for various representative geometries being less than a factor of two.