AbstractID: 10082 Title: Neutron and Photon Fluence Distributions and Ambient Dose Equivalents for 250 MeV Proton Interactions in Tissue Using Geant4 Monte Carlo Code

Purpose: To simulate interaction of 250 MeV protons in tissues using GEANT4 (version 4.8.3) Monte Carlo code that utilizes electromagnetic and hadronic interactions to determine the energy and angular distributions of generated neutron and photon and calculate H*(10) ambient dose equivalent for shielding purposes.

Materials and Methods: A cylindrical phantom (length=42 cm, radius=21 cm, ICRU 4-element soft tissue) was placed in vacuum. A spherical scoring geometry surrounding the phantom with radius = 100 cm was implemented. The energy of generated neutron, and photon crossing this geometry was counted in 9 theta bins (twenty degree each). The physics list consisted of electromagnetic; elastic; inelastic for proton, neutron and heavy ions. Common to all were standard electromagnetic for gamma, electron and positron; low-energy parameterized electromagnetic for proton and ions; low-energy parameterized nuclear elastic (G4LElastic) for proton and ions; and low energy parameterized inelastic for ions and binary cascade nuclear inelastic for proton. The elastic and inelastic processes for neutrons with energy higher than 4 eV (G4NeutronHPorLEModel) and lower than 4 eV (G4NeutronHPThermalScattering Data available in library G4NDL3.1) were used for computation. The ambient dose equivalent, H*(10), was calculated as a product of particle fluence, Φ, with the fluence to dose equivalent conversion factor available in the ICRP 74 report (1996).

Results: The total number of generated particles per incident proton was 0.208 for neutron and 0.57 for photon. The neutron fluence (energy > 5 MeV) per proton was dominant in forward compared to lateral and backward directions. No substantial directional preferences were observed for photon fluence. H*(10) from neutron are in the forward (59%), backward (6.3%) and lateral directions (34.7%). H*(10) from photon was 7.2% to that from neutron.

Conclusions: Monte Carlo simulations thus provided an improved understanding of the directional dependence of neutron and photon spectral fluences and dose equivalents.