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Evaluation of the Photo Neutron Contamination inside and outside of Treatment Room for High Energy Elekta Synergy® Linear Accelerator

Authors : Sharib Ahmed, Mansoor Rafi, Kamran Ali Awan, Faraz Khaskhali, Amir Maqbool, Altaf Hashmi

Abstract : Medical linear accelerators (LINAC's) used in radiotherapy treatments produce undesired neutrons when they are operated at energies above 8 MeV, both in electron and photon configuration. Neutrons are produced by high-energy photons and electrons through electronuclear (e, n) a photonuclear giant dipole resonance (GDR) reactions. These reactions occurs when incoming photon or electron incident through the various materials of target, flattening filter, collimators, and other shielding components in LINAC's structure. These neutrons may reach directly to the patient, or they may interact with the surrounding materials until they become thermalized. A work has been set up to study the effect of different parameter on the production of neutron around the room by photonuclear reactions induced by photons above ~8 MeV. One of the commercial available neutron detector (Ludlum Model 42-31H Neutron Detector) is used for the detection of thermal and fast neutrons (0.025 eV to approximately 12 MeV) inside and outside of the treatment room. Measurements were performed for different field sizes at 100 cm source to surface distance (SSD) of detector, at different distances from the isocenter and at the place of primary and secondary walls. Other measurements were performed at door and treatment console for the potential radiation safety concerns of the therapists who must walk in and out of the room for the treatments. Exposures have taken place from Elekta Synergy® linear accelerators for two different energies (10 MV and 18 MV) for a given 200 MU's and dose rate of 600 MU per minute. Results indicates that neutron doses at 100 cm SSD depend on accelerator characteristics means jaw settings as jaws are made of high atomic number material so provides significant interaction of photons to produce neutrons, while doses at the place of larger distance from isocenter are strongly influenced by the treatment room geometry and backscattering from the walls cause a greater doses as compare to dose at 100 cm distance from isocenter. In the treatment room the ambient dose equivalent due to photons produced during decay of activation nuclei varies from 4.22 mSv.h−1 to 13.2 mSv.h−1 (at isocenter),6.21 mSv.h−1 to 29.2 mSv.h−1 (primary wall) and 8.73 mSv.h−1 to 37.2 mSv.h−1 (secondary wall) for 10 and 18 MV respectively. The ambient dose equivalent for neutrons at door is 5 μSv.h−1 to 2 μSv.h−1 while at treatment console room it is 2 μSv.h−1 to 0 μSv.h−1 for 10 and 18 MV respectively which shows that a 2 m thick and 5m longer concrete maze provides sufficient shielding for neutron at door as well as at treatment console for 10 and 18 MV photons.

Keywords : equivalent doses, neutron contamination, neutron detector, photon energy
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