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Evaluation of Activated Areas in the Particle Radiotherapy Facilities

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Recently, number of particle radiotherapy hospitals is increasing in Japan. Accelerators for several hundred MeV proton and/or carbon beam irradiation are used. In case of decommissioning these facilities, it is important to estimate the radioactivity induced in the accelerator room. Three types of accelerator facilities, such as proton acceleration by cyclotron, proton acceleration by synchrotron and carbon acceleration by synchrotron acceleration, were selected for the survey of activation under their routine operation conditions. Then, the induced activity caused by charged particles and secondary neutrons was measured on the accelerator and its surrounding areas in order to evaluate the activated/non-activated area. First of all, we set the three types of neutron monitors, such as track detector CR-39, TLD and Au foils, inside the accelerator room and on the beam line during operation. Then, surface dose rate and induced activity were measured in order to confirm the activated area on accelerator, beam line, surrounding materials, and floor and wall of accelerator room. Moreover, we compared the monitored neutron flux with the calculated value derived using the Monte Carlo simulation using PHITS code. In case of carbon acceleration, neutron fluxes obtained by the measurement of 24Na activity in floor concrete of accelerator room were the order of 10 cm-2·s-1, and induced activity of beam lines were very low. In case of proton acceleration by synchrotron, several parts of accelerators were activated. Neutron fluxes inside the accelerator room during operation were almost 1 × 10 cm-2·s-1 and maximum flux of 1.1 × 102 cm-2·s-1 was observed under the electrostatic degrader. In case of proton acceleration by cyclotron, beam loss was mainly occurred at the deflector for beam extraction and the energy degrader outside of cyclotron. Then the maximum neutron flux of 1.1 × 105 cm-2·s-1 was obtained around the degrader. Then, residual activity in the cyclotron and the degrader was high. In this irradiation condition, we have to consider the activation of floor concrete under the degrader. Recently, beam current for treatment was reduced, because the spot scanning method was developed for irradiation. In order to reduce activation of accelerator room, a neutron shield surrounding of the degrader and an improvement of beam transport technique are also important.

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