AbstractID: 5226 Title: Analytical Neutron Shielding Calculations

Purpose: The primary purpose of this study is to estimate wall thicknesses that will limit instantaneous dose equivalent rates outside the shielding walls to less than 0.02 mSv hr-1 in areas that may be occupied by non-designated workers. The other primary design considerations are the integrated annual dose equivalent and the integrated shift dose equivalent. These integrated dose equivalents have been calculated based on a maximum workload. The design aim has been to achieve levels that are in compliance with the University of Pennsylvania's ALARA commitment and NCRP standards.

Material and Methods: In proton therapy, energies at and below 250 MeV produce neutrons when the proton beam is stopped in matter. Hence, the problem of proton shielding is a neutron shielding problem. Experimental data of various cross-sections for neutron production by energetic protons across the proton energy range of interest (~10-250 MeV) is not widely available. In order to predict the neutron spectra produced by a 250 MeV proton we used the Monte Carlo code GEANT4 v6.2 to simulate the protons passing through various targets (water, iron, carbon and tungsten) and recording the number of neutrons captured in one steradian.

Results: The output of the shielding calculation gives (1) the instantaneous dose equivalent rate, (2) integrated weekly dose equivalent and (3) integrated annual dose equivalent at various points of interest for a defined shielding thickness. These points are sources of maximum dose rates around and inside the vault.

Conclusion: We have used analytical techniques and Monte Carlo simulations to investigate neutron shielding considerations for a proposed proton therapy facility that will be situated on the University of Pennsylvania campus. These preliminary results give a good indication of what dose is expected at selected points inside and outside the treatment rooms and around the accelerator vault.