AbstractID: 10950 Title: Diagnostic X-Ray Beam Hardening as a Function of Patient Size

Purpose: To investigate changes in x-ray energy spectrum as a function of depth in phantoms representing lean and overweight individuals.

Methods: Three phantom torsos comprised of tissue equivalent material were modeled as elliptical cylinders using MCNPX. Two x-ray beams used in planar radiography (80 kVp HVL = 2.42 mm Al; 140 kVp HVL= 5.15 mm Al) and one beam used in CT (140 kVp HVL =9.09 mm Al) irradiated each phantom and normalized photon spectrum was examined at several depths. Separate comparisons were also made with data presented by Birch *et al* who examined spectral changes as a function of depth but did not include Compton scattered photons.

Results: Good agreement with data from Birch et al is obtained for the lean phantom when Compton scattered photons are *not* included. These results show substantial beam hardening as evidenced by a shift in the peak beam energy from 32 keV (entrance) to 54 keV (exit) for the 80 kVp beam and 40 keV to 64 keV for the 140 kVp (HVL=5.15 mm Al) beam.

However, substantial beam hardening is not observed when Compton scattered photons are included in the measurement. For the 80 kVp beam, the average energy of the photons traversing the phantom changes by only 15 % in traversing the lean, 20 cm diameter thick phantom, and by only 18% in traversing the very overweight 45 cm thick phantom. For the hardest beam (140 kVp HVL=9.09 mm Al), average beam energy changes by only 7.4% in traversing through 45 cm tissue.

Conclusion: Under conditions of broad beam geometry such as radiography, spectral hardening of the radiography and CT x-ray beams examined is not substantial, even after traversal through very thick phantoms. However, when narrow beam geometry is approximated, spectral beam hardening is significant.