AbstractID: 8565 Title: An evaluation of solid phantoms for the dosimetry of low energy photon beams

Purpose: To evaluate water equivalency of solid phantoms for the dosimetry of low energy photon beams.

Method and Materials: The physical properties and composition of the solid phantoms studied were taken from the IAEA TRS398 dosimetry protocol. Doses were calculated using the PENELOPE Monte Carlo code V2006 for photon beams in the energy range of 50 to 280 kVp. The incident photon spectra were calculated using an analytical method (Ma and Seuntjens 1999). The following was calculated: (1) central axis depth doses through the phantoms and (2) dose to a small voxel of water located at the surface of the solid phantom. The number of incident particles was selected to provide statistical uncertainties of less than 0.5%.

Results: For the depth dose calculations, the greatest variation occurred using the 50 kVp x-ray beam. The depth doses measured in white polystyrene (RW3) and Plastic Water had the greatest variation of up to +14% and -19% respectively as compared to water. For the dose to the water surface voxel, the changes in dose varied between –4.5% to 10.6% for the 50 kVp x-ray beams with the polystyrene and RW3 solid phantoms giving the worst results. In comparison, the doses measured in the RMI457 Solid Water were in excellent agreement with doses to water, giving differences of less than 2%.

Conclusion: We have demonstrated that some solid phantoms can give significant dose differences if used for dosimetry of low energy photon beams. This occurs whether the solid phantom is used for depth dose measurements or for providing backscatter material. These differences should be quantified before clinical use of the solid phantom as a substitute for water.

Reference: Ma, C. M. and J. P. Seuntjens (1999). "Mass-energy absorption coefficient and backscatter factor ratios for kilovoltage x-ray beams." Phys Med Biol 44(1): 131-43.