AbstractID: 10370 Title: Time Dependence of Energy Spectra of Brachytherapy Sources and Its Impact on their Half and the Tenth Value Layers

Purpose: To investigate the impacts of spectral time dependence of brachytherapy source on shielding requirements and the Nth value layers (N*thVL*). **Method and Materials:** The photon energy spectrum of brachytherapy sources is influenced by several factors including radionuclide purity. Existence of impurities in radionuclide substrate may not only alter the spectrum but also cause time dependent changes in the spectrum. A semi-empirical formalism was established to take this time dependence into account and was used to calculate the N*thVL* thicknesses for ^{103}Pd Model 200 seed. Originally, the ^{103}Pd was purified to a level less than 0.006% of the total ^{103}Pd activity, consisting of ^{65}Zn impurity that emits high energy photons and has longer half-life of 244 days which leads to spectral time dependence. The time dependence of the N*thVL* and shielding requirements were analyzed. **Results:** The 1st HVL and 1st TVL steadily increased with time for about 200 days and then reached a plateau. The increases at plateau were more than 1000 times. The 2nd and 3rd TVLs reached their plateaus in about 100 and 60 days, respectively, and the increases were about 1900% and 233%, respectively. All the TVLs demonstrated a similar time dependence pattern; with significant increases and eventual approach to a plateau. **Conclusions:** The time dependence of emitted photon spectra from brachytherapy sources may introduce significant variations of the *NthVL* with time if impurities are present. The importance of these variations should not be underestimated in considerations of radiation protection and detection. It should also be noted that the use of new processing technologies since 2005, the likelihood of existence of impurities in seeds is dramatically reduced, as demonstrated in the measured spectra from current ^{103}Pd Model 200 seeds. This study points out the importance of performing periodic photon spectroscopy of manufactured radioactive seeds.