AbstractID: 4894 Title: Illustrating Manufacturing Variability in Prostate Brachytherapy Seeds through X-ray Spectrometry and Radiochromic Film Measurements

Purpose: To illustrate the effects of manufacturing variability on ionization chamber measurements of a batch of "identical" prostate brachytherapy seeds in terms of emergent spectrum, in-air anisotropy, and internal distribution of radioactive material.

Method and Materials: A batch of six "identical" prostate brachytherapy seeds were calibrated in terms of air-kerma strength using the Wide-Angle Free-Air Chamber (WAFAC) at the National Institute of Standards and Technology (NIST). The seeds were subsequently characterized using a variety of experimental techniques including well-ionization chamber response, x-ray spectrometry, and radiochromic-film contact-exposure measurements. In-air anisotropy was quantified by the air-anisotropy ratio, α_S, calculated from x-ray spectrometry measurements performed with the seed rotated at 90-degree intervals about an axis perpendicular to the mid-point of the long axis of the seed.

Results: Variations in the internal distribution of radioactivity among the six seeds were observed in optical density profiles through the long axes of the seeds, as measured by radiochromic film. X-ray emergent spectra showed differences in the admixture of silver fluorescence x-rays between seeds, which modified the average energy of the spectra and thus the relative response of the well chamber and the WAFAC. Variations in α_S affected relative ionization chamber response due to the difference in measurement geometry solid angle between the WAFAC (cone of 8 degree half-angle) and the well chamber (approximately 4π).

Conclusions: The effects of variations in emergent spectra and anisotropy were small enough such that the well-chamber-to-WAFAC response ratio for all but one of the seeds was within the 1.00 % tolerance criterion as recommended by the Calibration Laboratory Accreditation Subcommittee of the AAPM. The "out-of-tolerance" seed was shown to have an admixture of silver fluorescence x-rays in the emergent spectrum significantly different than that of previously calibrated seeds of the same design.