AbstractID: 6486 Title: Model-Specific Uncertainties in Air-Kerma Strength Measurements of Low-Energy Photon-Emitting Brachytherapy Sources

Purpose: To utilize the results of characterization measurements on low-energy photon-emitting brachytherapy sources to determine a source-model-specific component of the total uncertainty in well-ionization chamber measurements of air-kerma strength.

Method and Materials: The air-kerma strength of low-energy photon-emitting brachytherapy sources is directly realized at the National Institute of Standards and Technology (NIST) using the Wide-Angle Free-Air Chamber (WAFAC). This primary standard is transferred to the AAPM Accredited Dosimetry Calibration Laboratories (ADCLs), source manufacturers, and clinics, where well-ionization chambers are used to perform NIST-traceable air-kerma strength measurements. For quality assurance purposes, additional characterization measurements performed at NIST include well-ionization chamber response, emergent spectrum, and anisotropy. Normal variations in source characteristics have been established for each seed model, allowing identification of anomalous sources and preventing their use in establishing or maintaining secondary standards.

Results: The variabilities in well-chamber response for three models of Pd-103 sources and eight models of I-125 sources have been quantified. Ten of the source models studied exhibited a range of values of the well-chamber response coefficient (well-chamber current divided by WAFAC-measured air-kerma strength) between 2 % and 4 %, while one source model had a range of well-chamber response coefficient values of 5.5 %. Analysis of emergent spectra demonstrated that the cause of the high variability in well-chamber response was an unexpectedly large variation in the admixture of silver fluorescence x-rays.

Conclusion: Data from characterization measurements on hundreds of sources has been used to demonstrate that an additional component of uncertainty exists in well-ionization chamber measurements of air-kerma strength as a result of variations in source fabrication. The magnitude of this uncertainty component varies with source model, and exists due to the sensitivity of well-ionization chamber response to spectrum and anisotropy variations among sources.