Dosimetry for Small and Nonstandard Fields

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## Abstract

The proposed small and non-standard field dosimetry protocol from the joint International Atomic Energy Agency (IAEA) and American Association of Physicist in Medicine working group[1] introduces new reference field conditions for ionization chamber based reference dosimetry. Absorbed dose beam quality conversion factors ($k_Q$ factors) corresponding to this formalism were determined for three different models of ionization chambers: a Farmer-type ionization chamber, a thimble ionization chamber, and a small volume ionization chamber. Beam quality correction factor measurements were made in a specially developed cylindrical polymethyl methacrylate (PMMA) phantom and a water phantom using thermoluminescent dosimeters (TLDs) and alanine dosimeters to determine dose to water. The TLD system for absorbed dose to water determination in high energy photon and electron beams was fully characterized as part of this dissertation. The behavior of the beam quality correction factor was observed as it transfers the calibration coefficient from the University of Wisconsin Accredited Dosimetry Calibration Laboratory (UWADCL) $^{60}$Co reference beam to the small field calibration conditions of the small field formalism.

TLD-determined beam quality correction factors for the calibration conditions investigated ranged from 0.97 to 1.30 and had associated standard deviations from 1% to 3%. The alanine-determined beam quality correction factors ranged from 0.996 to 1.293. Volume averaging effects were observed with the Farmer-type ionization chamber in the small static field conditions. The proposed small and non-standard field dosimetry protocols new composite-field reference condition demonstrated its potential to reduce or remove ionization chamber volume dependancies, but the measured beam quality correction factors

were not equal to the standard CoP's $k_Q$, indicating a change in beam quality in the small and non-standard field dosimetry protocols new composite-field reference condition relative to the standard broad beam reference conditions. The TLD- and alanine-determined beam quality correction factors in the composite-field reference conditions were approximately 3% greater and differed by more than one standard deviation from the published TG-51 $k_Q$ values for all three chambers .

The characterization of multiple calibration conditions provides an improved understanding of how the $^{60}$Co ionization chamber absorbed dose to water calibration coefficient from an ADCL can optimally be applied to small and nonstandard field calibrations to reduce the associated dose uncertainty. The developed methodology will contribute to future research of other small field radiotherapy modalities and measurements of even smaller field sizes. The resulting database provides support for future recommendations on the implementation of small and non-standard field calibration protocols.

## References

[1] R. Alfonso, P. Andreo, R. Capote, M. Saiful Huq, W. Kilby, P. Kjall, T. R. Mackie, H. Palmans, K. Rosser, J. Seuntjens, W. Ullrich, S. Vatnitsky. Medical physics letter: A new formalism for reference dosimetry of small and nonstandard fields. 35:5179–5186, 2008.