Purpose: To investigate the effects of using several conditions (employing assorted radiation field sizes, doses, and depths in water) for the calibration of a plastic scintillation detector (PSD) on measurement accuracy.

Methods: The detector system comprised one PSD and a charge-coupled device (CCD) camera-based reader system designed to implement the chromatic removal method for discriminating Cerenkov light from scintillation signal. PSD systems of this type are typically calibrated using only two calibration conditions. In this study, we constructed twelve calibration conditions using field sizes of 5×5, 10×10, 20×20, and 30×30 cm2; doses of 10 and 100 cGy; and depths of 2 and 10 cm, with the PSD centered in a water phantom for 60Co irradiation. We used every combination of two or more conditions (up to twelve) to produce 4083 distinct sets of calibration factors via a combinatorial computer algorithm. We tested all calibrations against data taken using a clinical linear accelerator with the PSD placed at water-equivalent depths of dose maximum and 6.6 cm for 6 MV (setups ‘A’ and ‘B’, respectively) and 18 MV (setups ‘C’ and ‘D’, respectively) photon beams.

Results: The most accurate calibration resulted from a combination of four conditions using both depths, field sizes of 10×10 and 30×30 cm2, but all using 10 cGy doses. For setups A, B, C, and D the PSD-measured dose differed from the known dose by 0.5%, 0.9%, 0.3%, and 0.3% respectively. However, six hundred of the calibrations resulted in differences of <1% between PSD and known doses delivered by the linac across the four test setups.

Conclusions: This study suggests that the accurate calibration of PSDs is flexible with respect to the number of conditions used, though certain condition combinations should be avoided due to their considerable inadequacy in satisfying the requirements of the chromatic removal method.

Funding Support, Disclosures, and Conflict of Interest:

This work was supported in part by the National Cancer Institute through a T32 grant (CA119930-04) and an R01 grant (CA120198-01A2).