Purpose: To determine the relationship between maximum and average doses in thin Fricke layers irradiated with soft x-rays.

Methods: The MC code PENELOPE was used to modeling a Fricke solution pillbox-like volume 0.30 cm thick and 1.5 cm diameter embedded in the center and flushing the surface of a 0.50-cm thick, 1125 cm3 solid water tank filled with water. The pillbox was covered with a 0.0030 cm thick polystyrene film and the reference point for the absorbed dose calculations was its geometric center for all the simulations performed at a source-detector distance of 30.0 cm using the PTB (Physikalisch-Technische Bundesanstalt-Germany courtesy: R. Kramer) calibration therapy TW30 kV, TW50 kV TW 70kV and TW100 kV spectra. The same procedure was followed with pillbox thickness varying from 0.0010 to 0.40 cm. For each x-ray quality, the average energy per unit mass (average dose) in the pillboxes were normalized for the 0.30 cm thick Fricke solution and their maximum average dose values were assigned as being the CPE region. The effect of the beam divergence on the average dose and the water/Fricke dose relationship are being investigated.

Results: As the thickness of the pillbox increases, the average dose increases, reaching a maximum after descending due to attenuation in the solution. With an uncertainty of ±0.3%, a deviation between the maximum and average doses of 17.0% (0.010-cm depth), 5.2% (0.025-cm depth), 0.23% (0.15-cm depth) and 0.00% (0.30-cm depth) were observed for 30, 50, 70 and 100 kV, respectively.

Conclusions: As expected, different thickness of Fricke solution are required to determine the absorbed dose under CPE condition. Nevertheless, the data provided in this work may serve for absolute calibration of the Fricke solution using a similar setup, radiation qualities and the calculated relationship between maximum and average dose presented herein.