AbstractID: 5018 Title: A Monte Carlo Investigation of the Temperature-Pressure Correction Factor for Kilovoltage X-rays

Purpose: To investigate the validity of the standard temperature-pressure correction factor (P_{TP}) for kilovoltage x-rays incident on various ionization chambers using Monte Carlo simulations of radiation transport.

Method and Materials: The EGSnrc Monte Carlo computer code was used to calculate the response due to 20 kV, 40 kV and 60 kV beams as a function of chamber air density for thimble and spherical ionization chambers. The chambers studied had both graphite and C-552 plastic walls to investigate the effect of the wall material in addition to the dimensions of the cavity. In principle, the P_{TP}-corrected response is independent of air density. Thus, a breakdown of the P_{TP} correction factor is identified by any variation in the calculated response as the air density is varied. The air density associated with the reference temperature and pressure conditions in North America (22 ^{o}C, 101.325 kPa) is 1.205 kg/m^3.

Results: At an air density of 1.0 kg/m^3, typical of Denver Colorado, the normalized P_{TP}-corrected response of a graphite-walled thimble chamber due to the 20 kV and 40 kV spectra is as much as 1.7% and 1.2% below the expected response, respectively. For a graphite spherical chamber at the same air density, the calculated response is 3.8% below unity for 40 kV and 60 kV beam qualities. Calculated responses of chambers with C-552 plastic walls are all within 0.5% of the expected response at air densities as low as 0.84 kg/m^3. Comparisons of calculated air kerma calibration coefficients at different air densities indicate that the breakdown of the P_{TP} correction factor should be easily detected experimentally.

Conclusion: Variations in the P_{TP}-corrected response indicate that for low-energy x-rays the P_{TP} correction factor inadequately accounts for the dependence of ion chamber response on the temperature and pressure. Additional correction factors are therefore necessary under these circumstances.