XA0203826

ABSORBED DOSE CALIBRATION FACTORS FOR PARALLEL-PLATE CHAMBERS IN HIGH ENERGY PHOTON BEAMS

M.R. MCEWEN, S. DUANE, R.A.S. THOMAS
National Physical Laboratory, Queens Rd, Teddington, UK

An investigation was carried out into the performance of parallel-plate chambers in ^{60}Co and MV photon beams. The aim was to derive calibration factors, investigate chamber-to-chamber variability and provide much-needed information on the use of parallel-plate chambers in high-energy X-ray beams.

A set of NE2561/NE2611 reference chambers, calibrated against the primary standard graphite calorimeter is used for the dissemination of absorbed dose to water. The parallel-plate chambers were calibrated by comparison with the NPL reference chambers in a water phantom. Two types of parallel-plate chamber were investigated - the NACP-02 and Roos – and measurements were made at ^{60}C0 and 6 linac photon energies (6 – 19 MV). Calibration factors were derived together with polarity corrections. The standard uncertainty in the calibration of a chamber in terms of absorbed dose to water is estimated to be ± 0.75%.

The results of the polarity measurements were somewhat confusing. One would expect the correction to be small and previous measurements in electron beams have indicated that there is little variation between chambers of these types. However, some chambers gave unexpectedly large polarity corrections, up to 0.8%. By contrast the measured polarity correction for a NE2611 chamber was less than 0.13% at all energies. The reason for these large polarity corrections is not clear, but experimental error and linac variations have been ruled out.

By combining the calibration data for the different chambers it was possible to obtain experimental k_Q factors for the two chamber types. It would appear from the data that the variations between chambers of the same type are random and one can therefore define a generic curve for each chamber type. These are presented in Figure 1, together with equivalent data for two cylindrical chamber types - NE2561/NE2611 and NE2571. As can be seen, there is a clear difference between the curves for the cylindrical chambers and those for the parallel-plate chambers, which is discussed below. The small difference (around 0.3%) between the NACP and Roos chambers at the highest photon energies is within the measurement uncertainties but may indicate a slight difference in chamber response.

A number of chambers were recalibrated six months later to investigate chamber stability. It was found that the repeatability was generally better than 0.5% and the variations in time appear to be random. These differences are larger than for thimble chambers, where we have found stability at better than the 0.3% level over several years. Parallel-plate chambers in electron beams have also showed high stability (McEwen *et al*, 2001), which would indicate that parallel-plate chambers are sensitive to small variations in the beam quality of photon beams that do not affect thimble chambers.

This data can also be used to derive relative wall correction factors for the Roos and NACP. Good agreement (within 0.3%) was found with previous data (Palm *et al*, 2000; Nystrom *et al*, 1993). These measurements would seem to confirm that p_{wall} for the Roos chamber given in TRS-381 is too low by around 0.5%.

Parallel-plate chambers can be calibrated in terms of absorbed dose to water, but with an uncertainty larger than for thimble chambers. Chamber stability also appears to be worse than for thimble chambers. Polarity corrections must always be measured and applied, as the polarity effect for a particular chamber is difficult to predict.

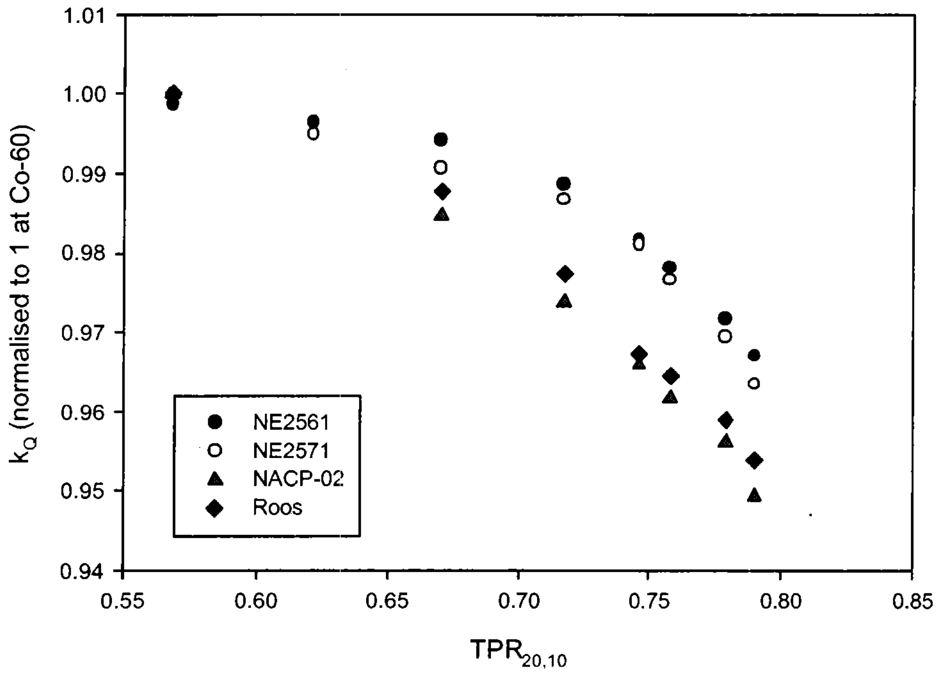

Figure 1. Comparison of experimentally determined k_Q factors for different chamber types

REFERENCES

[1] MCEWEN M R, WILLIAMS A J AND DUSAUTOY A R 2001 Determination of absorbed dose calibration factors for therapy level electron beam ionization chambers *Phys. Med. Biol.***46** p741

[2] NYSTROM H AND KARLSSON M 1993 Correction factors applied to plane-parallel ionization chambers *Phys. Med. Biol.* **38** p311-322

[3] PALM A, MATTSON O AND ANDREO P 2000 Calibration of plane-parallel chambers and determination of p_{wall} for the NACP and Roos chambers for ^{60}Co ?-ray beams *Phys. Med. Biol.* **45** p971-981