Energy response of Victoreen digital survey meter, model 660-1, with its probe, model 660-5

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Ionizing Radiation Standards

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1 Introduction

The energy response of a Victoreen digital survey meter, model 660-1 [1] with its probe, model 660-5 [2] , was measured with x-rays and Co^{60} radiation.

For x-rays, the measurement of the response of the instrument was carried out by direct comparison with our primary standard for exposure, and air kerma, a free-air chamber. For ^{60}Co gamma radiation, it was based on measurements made with our exposure and air kerma standard, a carbon-walled cavity chamber.

The results have been expressed in terms of the calibration factor N_X, which is the factor by which the instrument readings are multiplied to obtain the quantity exposure, X. The calibration factor is the inverse of the response per unit exposure.

2 Procedure

Irradiations of the survey meter probe were made with the axis of the incident beam of radiation perpendicular on one of the plane faces of the chamber. The location of the point of measurement was taken to lie midway between the two plane faces of the ionization chamber. The survey meter was positioned at a distance of 4.9 m from the focal spot. The x-ray field had a diameter of about 34 cm. The exposure rate was about 25 mR min^{-1} for all the x-ray qualities except for the measurement at 20 kV, where it was 13 mR min^{-1}.

[1] serial number 246

[2] serial number 331

Table 1: Calibration factors

Radiation Qualities						Calibration factor
Generating Potential kV	Filtration inherent mm	added mm	mm	HVL mm	E_{eff} keV	N_X
20	1 Be	0.77 Al		0.37 Al	15.	1.104
40	1 Be	1.6 Al		1.2 Al	24.	0.978
80	2 Al	0.77 Al		2.7 Al	32.	0.965
100	2 Al	2.0 Al		4.3 Al	38.	0.960
135	2 Al	2.5 Al		5.5 Al	42.	0.958
135	2 Al	1.0 Al	0.25 Cu	0.6 Cu	64.	0.957
200	2 Al	1.0 Al	1.3 Cu	1.8 Cu	105.	0.965
250	2 Al	1.0 Al	1.8 Cu	2.7 Cu	128.	0.972
^{60}Co	gamma radiation					1.041

Details of the x-ray qualities that were used are given in Table 1. The x-rays were generated with a constant potential difference, given in the first column, and an inherent filtration given in the second column. The added filtration is given in the third column and fourth column and the half value layer, HVL, in the fifth column. The effective energy E_{eff} is given in the next column. The effective energy of a x-ray spectrum is defined as the energy of mono-energetic beam having the same HVL.

For ^{60}Co radiation measurement, the irradiations were made in free air at a distance of 7 m from the source where the field size was about 1×1 m^2 . The exposure rate was 115 mR min^{-1}.

The readings were corrected for leakage or drift in the absence of the radiation to be measured. The leakage rate was less than 0.1% of the reading.

3 Results

The calibration factors and the x-ray qualities are given in Table 1 [3]. The uncertainty in the calibration factor for this instrument is about ±1%. This is the quadratic sum (rounded up) of the uncertainty in the measurement standards of ±0.6% and uncertainties of ±0.5% in the reading and leakage or drift determination of the survey meter.

Figure 1 shows the variation of the calibration factor ,N_X, as a function of the quality of the radiation as expressed by the effective energy, E_{eff}. For the purpose of placing the ^{60}Co gamma radiation calibration factor on the graph, the effective energy is assumed to be 1 MeV.

[3]The reference conditions are temperature 22°C, pressure 101.325 kPa (760.0 mm of Hg), and moist air(relative humidity range from 10% to 90%).

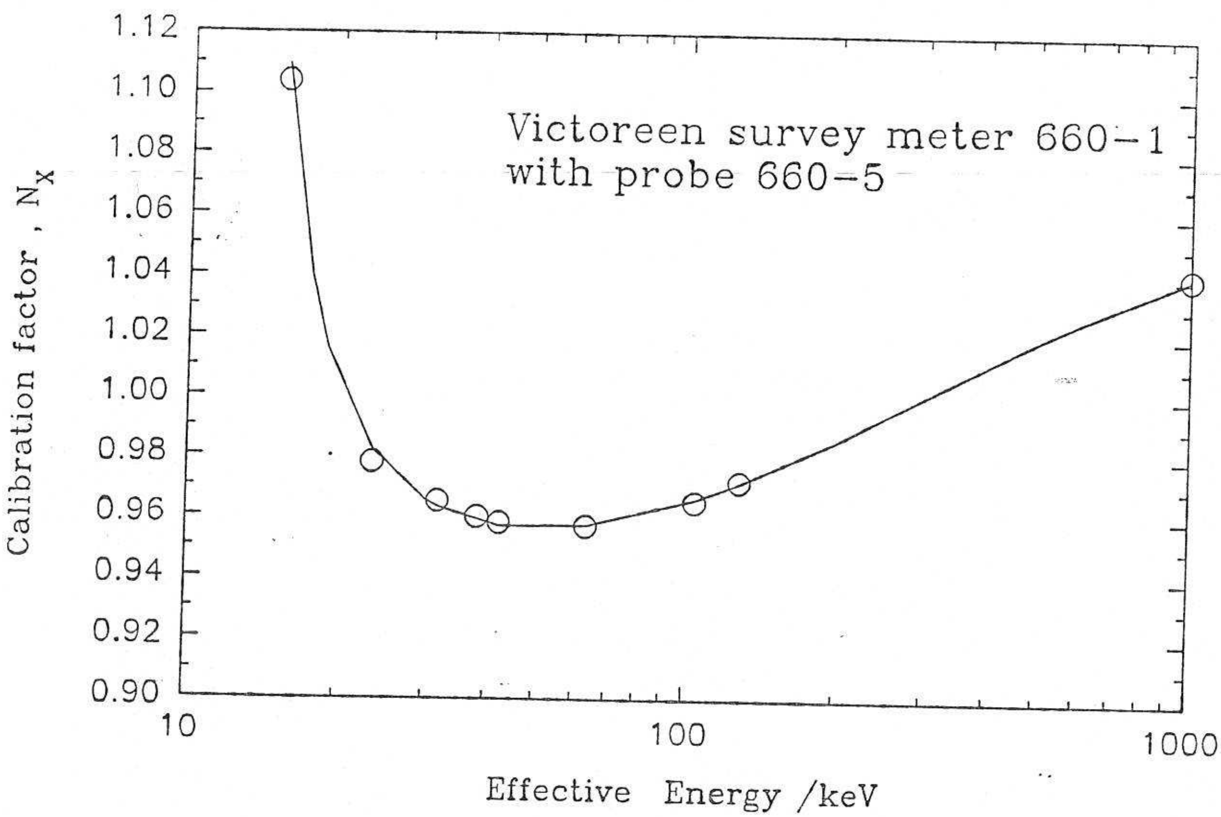

Figure 1: Variation of the calibration factor, N_X,as a function of the effective energy, E_{eff}. A smooth curve has been drawn through the points.