Report of AIST to the CCRI Section I

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1. Calibration in the unit of air kerma

At AIST, calibration has been made in the unit of exposure in the past. We started to calibrate both in the units of exposure and air kerma from this year. The value $\bar{g}$, the fraction of kerma lost to bremsstrahlung, was obtained for the irradiation fields at AIST from the values g listed on a table of the report(1) by weighting with the photon energy spectrum calculated for various positions in the irradiation fields, and by weighting with mass energy absorption coefficients of air(2).

The value of $(1-\bar{g})$ obtained was in the range from 0.99843 to 0.99846 for the ^{137}Cs gamma ray fields, and in the range from 0.99682 to 0.99715 for the ^{60}Co gamma ray fields. It was decided to use the following fixed values for each irradiation field at AIST.

X rays: $(1-\bar{g})=1.000 \pm 0.0001$

^{137}Cs: $(1-\bar{g})=0.9984 \pm 0.0001$

^{60}Co: $(1-\bar{g})=0.9970 \pm 0.0002$

2. Change in the number of ion pairs produced in free-air ionizatio-chambers

Secondary electrons emitted by x-rays in free-air ionization chambers gain or lose energy depending on the electric fields applied to collect signal charges. The change in ionization due to the electric field was calculated(3) by the EGS4 program for parallel-plate and cylindrical free-air ionization chambers. For cylindrical free-air ionization chambers, electron range was assumed not to depend on electric field strength. The net effect of the electric field is more extensive for cylindrical free-air ionization chambers because the electric field in cylindrical ionization chambers is not uniform and energies gained or lost by electrons emitted in opposite directions usually differs.

Ionization enhancement and reduction peaked for x-rays at about 40 keV because the average energy of emitted electrons decreases transiently with the increase in x-ray energy as the number of Compton recoil electrons increases in relation to that of photoelectrons. Electrons emitted by photons at an energy with in a certain range gain or lose over 0.3% of their energy. The net effect of the electric field on the signal current for typical parallel-plate and cylindrical free-air ionization chambers is usually small as shown in Figure 1 because energy gain and loss mutually compensate for each other.

3. Intercomparison of air kerma for ^{60}Co and ^{137}Cs gamma rays with BIPM

Measurements were made for intercomparison of air kerma rates of ^{137}Cs and ^{60}Co gamma rays at BIPM on January 8-19, 2001, using two different size graphite cylindrical ionization chambers. One chamber has an outer electrode with a length of 50 mm and a diameter of 40 mm, and the other has an outer electrode with a length of 19.3 mm and a diameter of 20 mm. The two outer electrodes of both ionization chambers have a thickness of 2 mm. A cap with a thickness of 1 mm covers each of the ionization chamber when it is used to measure ^{60}Co gamma rays. A chamber was placed so that the center of it becomes at the reference point of the gamma ray field and at 45 degrees from the direction of the gamma ray field. Signal current, air temperature, air pressure, and humidity were obtained by using the measurement system of BIPM. The report on the intercomparison is in preparation.

References

(1) CCEMRI(I)/85-18
(2) J.H. Hubbell and S.M. Seltzer, NIST IR 5632 (1995)
(3) N. Takata and T. Sugiyama, KEK Proceedings 2000-14, pp. 32-41

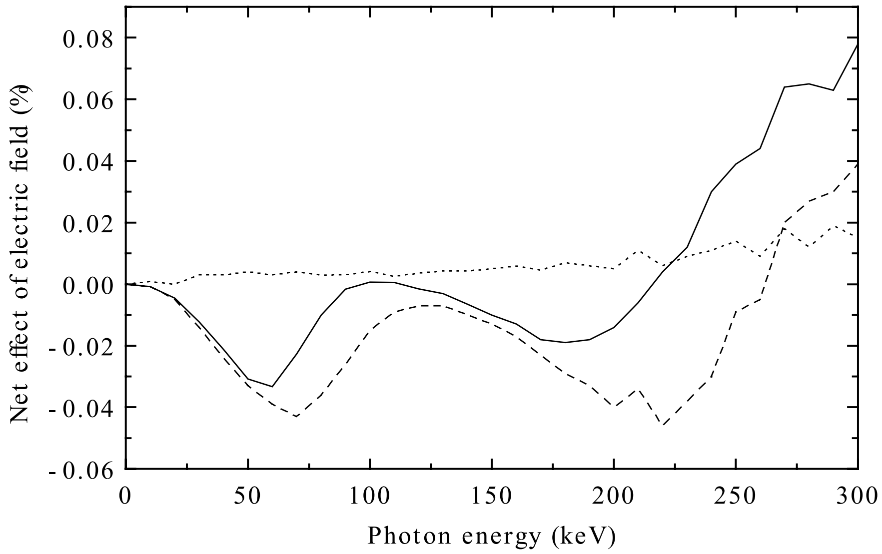

Figure 1: The net effect of electric field on signal currents from 2 different cylindrical free-air ionization chambers. Ionization chambers have electrodes with same radiuses of 0.5 and 15 cm. Distances between centers of inner and outer electrodes are 5 cm and 7.5 cm and applied voltages are 2 kV (solid lines) and 5 kV (broken lines). Dotted line shows the net effect of electric field for parallel plate ionization chambers with the applied electric field of 20 kV/m.