BNM-LNHB

Monte Carlo calculations of the *1/Awall* correction factor [1 and 2] for the air kerma standard ionization chamber of BNM-LNHB

The calculation was devoted to the LNHB chamber, which has a cylindro-spherical shape (radius 1.1 cm, volume 10 cm^3) and 3 mm graphite wall. ($A_{wall} = A_{sc} * A_{att}$)

date	cobalt-60 spectrum	code	initial particules (millions)	$1/A_{wall}$	special conditions
1998	Morel	EGS4 v3	200	1.01727(14)	
1998	Morel	PENELOPE 1996	584	1.01592(14)	
2001	Morel	EGSnrc v2	200	1.01636(24)	
2001	Morel	PENELOPE 2000	262	1.01652(21)	
2001	MCNP4	EGSnrc v2	200	1.01652(30)	
2002	Morel	PENELOPE 2001	6	1.01722(163)	
2002	MCNP4	PENELOPE 2001	6	1.01669(163)	
2002	MCNP4	PENELOPE 2002 (beta)	6	1.01624(157)	I graphite = 78 eV
2002	MCNP4	PENELOPE 2002 (beta)	6	1.01632(153)	I graphite = 81 eV

("Morel" means that the spectrum was measured and "MCNP4" that it was calculated with MCNP4)

calculations with radial thickness caps : 1,0096(21)
calculations with a "mean" thickness caps : 1,0145(21) + 0.5 %
calculations with EGSnrc v2 : 1.0165(3) + 0.7 %

Benchmark:

1- Additional calculations were made, with PENELOPE 1996 (Morel spectra), to follow the variation of this correction factor as a function of wall thickness. These calculations reproduced the measuring conditions met when applying the extrapolation method. The experimental ionization currents obtained when using additional graphite caps were corrected by the corresponding *1/Awall* correction factors given by Monte Carlo calculation. The corrected currents should then be equal. Only a slight bias appears with increasing thickness (see table below), almost insignificant considering the uncertainties. It can be pointed out that even the largest correction factor (1.05), obtained for 0.9 cm wall thickness, is properly taken into account by the calculation. The tables uncertainties are just statistical uncertainties.

Total graphite thickness (wall+additional cap) (cm)	0,3	0,497	0,693	0,895
Calculated correction factor $1/A_{wall}$	1,0162(7)	1,0279(18)	1,0385(15)	1,0498(15)
Value of measured current corrected for wall effect, relative to corrected current for 0,3 cm (wall without cap)	**1**	**1,0011**	**1,0013**	**1,0016**

2- Calculations were done with PENELOPE 1996 and EGS4 v3 to calculate the Awall correction factor for some NIST ionization chambers [3].

Awall	[3]	EGS4 v3		PENELOPE 1996	
1 cm^3	0.9797(8)	0.9793(4)	-0.04%	0.9798(9)	+0.01%
50 cm^3 -3	0.9586(7)	0.9583(5)	-0.03%	?	

[1] D.W.O. Rogers and A.F. Bielajew, Wall attenuation and scatter corrections for ion chambers : measurements versus calculations, *Phys. Med. Biol*. **35** (1990) 1065-1078

[2] A. F. Bielajew, Ionisation cavity theory - a formal derivation of perturbation factors for thick-walled ion chambers in photon beams, *Phys. Med. Biol*. **31** (1986) 161-170

[3] A. F. Bielajew and D.W.O. Rogers, Implications of new correction factors on primary air kerma standards in 60Co beams, *Phys. Med. Biol*. **31** (1992) 1283-1291