M-96.5

DG 8783/87
DB 878/25-27
1987 Dec 14

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
GAITHERSBURG, MD 20899

REPORT OF TEST

50 mCi $^{90}Sr+^{90}Y$ Beta-Particle Source — Amersham Source #318-~~103~~ ~~98~~ for E. 103 is correct for E.

Submitted by Battelle Pacific Northwest Laboratory
Richland, WA 99352

Received: 1987 Nov 3
Calibrated: 1987 Nov 6

Beta-particle sources are calibrated in terms of the absorbed-dose rate to water. Absorbed-dose rate is determined from current measurements with an extrapolation ionization chamber that has a polymethylmethacrylate collecting electrode. The water absorbed-dose rate is given in SI units by:

$$\dot{D} = (W/e)(S_{water}/S_{air})(\rho_{air}A)^{-1}\ (di_{corr}/ds) \qquad Gy/s$$

where (W/e) = 33.7 J/C is the mean energy expended per unit charge in air, (S_{water}/S_{air}) is the ratio of the mean mass stopping power of water to that of air, ρ_{air} = 1.197 kg/m^3 is the density of air at the reference temperature and pressure (22°C and 1 standard atmosphere), A = 7.069 x 10^{-4} m^2 is the area of the collecting electrode, and di_{corr}/ds is the rate-of-change of corrected current with air-gap spacing in amperes per meter.

The corrected current is given by:

$$i_{corr} = i \cdot f_{TP}\ f_{side}\ f_{back}\ f_{recom}\ f_{atten}\ f_{phot}\ f_{div}\ k_{dec}\ k_{hum}\ k_{alt}$$

where i is the measured current and the f's are, respectively, corrections for air density variations inside the chamber, for scatter from and/or shielding by the side walls of the chamber, for excess backscatter from the collection electrode, for recombination and diffusion of ions inside the chamber, for attenuation by the chamber air, for the presence of photons accompanying the beta particles, and for beta-particle beam divergence. The k's are, respectively, correction factors for source decay to the listed calibration date, for humidity variations, and for density variations in the air between source and chamber.

For the source submitted, three calibrations were made. The rate of change of corrected current with air-gap thickness was determined from measurements with air-gap thicknesses of 0.5, 1.0, 1.5, 2.0, and 2.5 mm. The average water absorbed-dose rate is given in the table in SI units (grays per second). The tabulated dose rate applies to the date of calibration, to the source-phantom distance and phantom depth given in the

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table, and to the reference temperature and pressure of 22°C and 101.325 kPa (1 standard atmosphere). If the air density differs significantly from the density at the reference temperature and pressure, it may be necessary to apply a correction as given in: J. S. Pruitt, "The effect of altitude on beta-ray source calibrations," Radiation Protection Dosimetry 11, 151-157 (1985).

The f factors associated with the extrapolation chamber, and the k factors associated with the ambient conditions, are given in the table in the same order that they are listed in the above equations; if a factor varied during the measurements, the maximum and minimum values are given.

The overall uncertainty is two times the square root of the quadratic sum of the component uncertainties, which were estimated and treated as if they were standard deviations. For this calibration it is estimated to be ±3% and is considered to have the approximate significance of a 95% confidence limit.

Information on the technical aspects of this report can be obtained from J. S. Pruitt, Radiation Physics C214, National Bureau of Standards, Gaithersburg, Maryland 20899, (301) 975-5587.

Calibration performed by J. S. Pruitt JSP

Report approved by R. Loevinger RL

For the Director
by
David M. Gilliam

David M. Gilliam, Deputy Chief
Ionizing Radiation Division
Center for Radiation Research
National Measurement Laboratory

Source	S_{water}/S_{air}	Correction Factors f	k	Phantom Distance (cm)	Phantom Depth (mg/cm^2)	Water Absorbed-Dose Rate (Gy/s)
318-~~103~~ 98 for E.	1.125	1.017-1.027	1.000	35	7.0	4.85 E-5
103 is correct for E.		0.985-0.997	1.000			
		1.006	0.997-0.998			
		1.001-1.003				
		1.000				
		1.000				
		1.002-1.008				

M-Q6.5

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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
GAITHERSBURG, MD 20899

REPORT OF TEST

2 mCi $^{90}Sr+^{90}Y$ Beta-Particle Source Amersham Source #318-102

Submitted by Battelle Pacific Northwest Laboratory
Richland, WA 99352

Received: 1987 Nov 2
Calibrated: 1987 Nov 6

Beta-particle sources are calibrated in terms of the absorbed-dose rate to water. Absorbed-dose rate is determined from current measurements with an extrapolation ionization chamber that has a polymethylmethacrylate collecting electrode. The water absorbed-dose rate is given in SI units by:

$$\dot{D} = (W/e)(S_{water}/S_{air})(\rho_{air}A)^{-1}\ (di_{corr}/ds) \qquad Gy/s$$

where (W/e) = 33.7 J/C is the mean energy expended per unit charge in air, (S_{water}/S_{air}) is the ratio of the mean mass stopping power of water to that of air, ρ_{air} = 1.197 kg/m^3 is the density of air at the reference temperature and pressure (22°C and 1 standard atmosphere), A = 7.069 x 10^{-4} m^2 is the area of the collecting electrode, and di_{corr}/ds is the rate-of-change of corrected current with air-gap spacing in amperes per meter.

The corrected current is given by:

$$i_{corr} = i \cdot f_{TP}\ f_{side}\ f_{back}\ f_{recom}\ f_{atten}\ f_{phot}\ f_{div}\ k_{dec}\ k_{hum}\ k_{alt}$$

where i is the measured current and the f's are, respectively, corrections for air density variations inside the chamber, for scatter from and/or shielding by the side walls of the chamber, for excess backscatter from the collection electrode, for recombination and diffusion of ions inside the chamber, for attenuation by the chamber air, for the presence of photons accompanying the beta particles, and for beta-particle beam divergence. The k's are, respectively, correction factors for source decay to the listed calibration date, for humidity variations, and for density variations in the air between source and chamber.

For the source submitted, two calibrations were made. The rate of change of corrected current with air-gap thickness was determined from measurements with air-gap thicknesses of 0.5, 1.0, 1.5, 2.0, and 2.5 mm. The average water absorbed-dose rate is given in the table in SI units (grays per second). The tabulated dose rate applies to the date of calibration, to the source-phantom distance and phantom depth given in the

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table, and to the reference temperature and pressure of 22°C and 101.325 kPa (1 standard atmosphere). If the air density differs significantly from the density at the reference temperature and pressure, it may be necessary to apply a correction as given in: J. S. Pruitt, "The effect of altitude on beta-ray source calibrations," Radiation Protection Dosimetry 11, 151-157 (1985).

The f factors associated with the extrapolation chamber, and the k factors associated with the ambient conditions, are given in the table in the same order that they are listed in the above equations; if a factor varied during the measurements, the maximum and minimum values are given.

The overall uncertainty is two times the square root of the quadratic sum of the component uncertainties, which were estimated and treated as if they were standard deviations. For this calibration it is estimated to be ±3% and is considered to have the approximate significance of a 95% confidence limit.

Information on the technical aspects of this report can be obtained from J. S. Pruitt, Radiation Physics C214, National Bureau of Standards, Gaithersburg, Maryland 20899, (301) 975-5587.

Calibration performed by J. S. Pruitt JSP

Report approved by R. Loevinger RL

For the Director
by
David M. Gilliam

David M. Gilliam, Deputy Chief
Ionizing Radiation Division
Center for Radiation Research
National Measurement Laboratory

Source	S_{water}/S_{air}	Correction Factors f	k	Phantom Distance (cm)	Phantom Depth (mg/cm^2)	Water Absorbed-Dose Rate (Gy/s)
318-102	1.125	1.013-1.027	1.000	35	7.0	1.63 E-6
		0.985-0.997	1.000			
		1.006	0.997-0.999			
		1.001-1.003				
		1.000				
		1.000				
		1.002-1.008				