

National Bureau of Standards

Certificate

Standard Reference Material 4242-F

Mixed Radionuclide Gamma-Ray Emission-Rate Solution Standard

This Standard Reference Material consists of cobalt-57, cobalt-60, strontium-85, yttrium-88, cadmium-109-silver-109m, tin-113-indium-113m, cesium-137-barium-137m, cerium-139, and mercury-203, and approximately 10^4 atoms of stable isotope to each radioactive atom, in 479.0 grams of approximately 4 N HCl in a flame-sealed borosilicate-glass bottle of standard dimensions.

This standard was prepared by dispensing an aliquot of a mixture of individually calibrated radionuclides into the bottle containing the acid.

The gamma-ray-emission rates at 1200 EST September 1, 1976 are shown in the table.

PARENT RADIO- NUCLIDE	GAMMA-RAY ENERGY (MeV) (a)	GAMMA RAYS PER DECAY USED (a)	HALF LIFE (b)	γ/s	UNCERTAINTY (%)		
					RANDOM (99% C.L.)	SYSTEM- ATIC	TOTAL
¹⁰⁹ Cd	0.088	---	464.2 d	3.396×10^3	0.1	3.2	3.3
⁵⁷ Co	0.122	0.8559 ± 0.0019	272.4 d	4.211×10^3	0.1	2.8	2.9
¹³⁹ Ce	0.166	0.8006 ± 0.0013	137.5 d	3.391×10^3	0.1	1.4	1.5
²⁰³ Hg	0.279	0.815 ± 0.008	46.61 d	1.001×10^4	0.1	1.5	1.6
¹¹³ Sn	0.392	---	115.2 d	1.151×10^4	0.1	3.2	3.3
⁸⁵ Sr	0.514	0.98 ± 0.01	64.86 d	1.704×10^4	0.1	2.6	2.7
¹³⁷ Cs	0.662	---	30.0 y(a)	9.471×10^3	0.1	2.4	2.5
⁶⁰ Co	1.173	0.9990 ± 0.0002	5.271 y(a)	2.696×10^4	0.1	1.7	1.8
⁶⁰ Co	1.332	1.00	---	2.699×10^4	0.1	1.7	1.8
⁸⁸ Y	0.898	$0.950 \pm 0.005(b)$	106.66 d	6.311×10^4	0.1	3.2	3.3
⁸⁸ Y	1.836	0.9935 ± 0.0003	---	6.600×10^4	0.1	2.6	2.7

(a) ORNL-5114, M. J. Martin, Ed. (March 1976).

(b) NBS value.

(over)

The activities of solutions of each of the nine radionuclides used in the preparation of the mixture were measured in the National Bureau of Standards calibrated "4 π " γ ionization chamber, and the corresponding gamma-ray-emission rates calculated using published nuclear-decay parameters, where necessary.

For each radionuclide the total uncertainty in the gamma-ray-emission rate is the linear sum of the limit of the random error of the relative measurements using the ionization chamber, at the 99-percent confidence level (2.7 S_m , where S_m is the standard error computed from 4 sets of 20 measurements), and the estimated upper limit of conceivable systematic error in the preparation of this source and the calibration of the "4 π " γ ionization chamber.

The gamma-ray spectrum of each component of the mixture was examined using a Ge(Li) detector: cobalt-57 was found to contain cobalt-56 and cobalt-58; cadmium-109 contained zinc-65 and silver-110m; and tin-113 contained antimony-125. On September 1, 1976, the ratios of the activities, to an overall accuracy of about ± 20 percent, were

$^{56}\text{Co}/^{57}\text{Co}$	9×10^{-5}
$^{58}\text{Co}/^{57}\text{Co}$	2×10^{-5}
$^{65}\text{Zn}/^{109}\text{Cd}$	5×10^{-7}
$^{110m}\text{Ag}/^{109}\text{Cd}$	5×10^{-7}
$^{125}\text{Sb}/^{113}\text{Sn}$	6×10^{-4}

No other gamma-ray-emitting impurities were observed. The detection limits for impurity gamma rays may be expressed as a percentage of the gamma-ray-emission rate of the most abundant gamma ray from each nuclide. These limits are approximately 0.1 percent for gamma rays with energies below that of the major gamma ray in each spectrum and 0.01 percent for gamma rays with energies above that of the major gamma ray.

This standard was prepared in the NBS Center for Radiation Research, Radioactivity Section, W. B. Mann, Chief.

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Office of Standard Reference Materials

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