U.S. Department of Commerce
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National Bureau of Standards Certificate

Standard Reference Material 4242-E

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 in 477.8 grams of approximately 4N HCl in a flame-sealed borosilicate-glass bottle of standard dimensions.

This standard was made by weighing an aliquot of a calibrated radionuclide mixture into the bottle containing the acid. The stable carrier concentration of each component in this calibrated mixture was adjusted so that the ratio of stable carrier atoms to radioactive atoms was greater than 10^4.

The nuclear gamma-ray-emission rates at 1200 EST September 1, 1975 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	--	1.2727y		1.3	3.0	4.3
^{57}Co	0.122	0.856±0.002	271.41d		0.1	2.2	2.3
^{139}Ce	0.165	0.799±0.003 (b)	137.87d		0.1	2.6	2.7
^{203}Hg	0.279	0.815±0.002	46.61d		0.1	1.1	1.2
^{113}Sn	0.392	--	115.31d		0.1	2.8	2.9
^{85}Sr	0.514	0.98±0.01 (c)	64.86d		0.1	2.2	2.3
^{137}Cs	0.662	--	30y (a)		0.1	2.0	2.1
^{60}Co	1.173	0.9988±0.0002	5.272y (d)		0.1	1.3	1.4
^{60}Co	1.333	1.00			0.1	1.3	1.4
^{88}Y	0.898	0.950±0.005 (b)	106.63d		0.2	2.8	3.0
^{88}Y	1.836	0.9937±0.0002			0.2	2.2	2.4

(a) Nuclear Data Tables, A8, Nos. 1-2 (Oct. 1970)
(b) NBS value
(c) Personal communication with Dr. Murray Martin, Oak Ridge Nuclear Data Center (April, 1975)
(d) Atomic Energy Review, Vol. 11, No.3

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The silver-109m gamma-ray-emission rate was determined by measuring 7 point sources prepared from this mixture with calibrated Ge and Ge(Li) detector systems. The total uncertainty in this value, 4.3 percent, is the linear sum of 1.3 percent, which is the random error at the 99-percent confidence level (3.707 S_m, where S_m is the standard error computed from 7 determinations), and 3.0 percent, which is the estimated upper limit of conceivable systematic error in the preparation of these sources and in the calibration of the semiconductor detectors.

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

For these eight radionuclides the total uncertainty in each of the gamma-ray-emission rates 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 "4π"γ ionization chamber.

The cobalt-57 is known to contain cobalt-56 and cobalt-58 as impurities. On September 1, 1975, the ratios of the activities were approximately 5×10^{-6} and 1×10^{-6} for $^{56}Co/^{57}Co$ and $^{58}Co/^{57}Co$, respectively. The gamma-ray spectra of the other components in the mixture were examined with a Ge(Li) detector and no impurities were detected. The detection limits of impurity gamma rays may be expressed as a percentage of the gamma-ray-emission rate of the most abundant gamma ray in each spectrum. 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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