National Bureau of Standards
Certificate
Standard Reference Material 4254-C
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 5.28 grams of approximately 4 N HCl in a flame-sealed borosilicate-glass ampoule. The solution also contains approximately 20 μg of cation carrier per gram of solution for each of the radionuclides listed above.

This standard was made by dispensing an aliquot of a mixture of individually calibrated radionuclides into the ampoule and flame sealing it.

The gamma-ray-emission rates per gram of solution at 1200 EST September 1, 1977 are shown in the table.

PARENT RADIO-NUCLIDE	GAMMA-RAY ENERGY (MeV) (a)	GAMMA RAYS PER DECAY USED (a)	HALF LIFE (b)	γ s^{-1}g^{-1}	UNCERTAINTY (%) RANDOM (99% C.L.)	SYSTEM-ATIC	TOTAL
^{109}Cd	0.088	— — —	463.9 d	5.987×10^2	0.1	2.8	2.9
^{57}Co	0.122	0.8559±0.0019	272.4 d	9.727×10^2	0.1	2.4	2.5
^{139}Ce	0.166	0.7994±0.0013	137.7 d	6.493×10^2	0.1	1.0	1.1
^{203}Hg	0.279	0.815±0.008	46.62 d	1.663×10^3	0.1	2.0	2.1
^{113}Sn	0.392	— — —	115.0 d	2.307×10^3	0.1	2.8	2.9
^{85}Sr	0.514	0.98±0.01	64.85 d	3.382×10^3	0.1	2.2	2.3
^{137}Cs	0.662	— — —	30.0 y[a]	1.818×10^3	0.1	2.0	2.1
^{88}Y	0.898	0.950±0.005(b)	106.66 d	1.225×10^4	0.1	2.8	2.9
^{60}Co	1.173	0.9990±0.0002	5.271 y[a]	4.963×10^3	0.1	1.3	1.4
^{60}Co	1.332	0.99983±0.00001	5.271 y[a]	4.968×10^3	0.1	1.3	1.4
^{88}Y	1.836	0.9935±0.0003	106.66 d	1.281×10^4	0.1	2.2	2.3

(a) Personal communication with M. J. Martin, Oak Ridge Nuclear Data Project, May 1977.

(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 "4π" 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 to the random error of the ionization-chamber measurements at the 99-percent confidence level ($2.7S_m$, where S_m is the standard error computed from 4 sets of 20 measurements), and the estimated upper limit of conceivable systematic error. This estimate is the linear sum of uncertainties attributed to the calibration of the ionization chamber, to source preparation, and, where applicable, to the value used for gamma rays per decay.

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, strontium-85 contained rubidium-84 and rubidium-86, and cesium-137 contained cesium-134. On September 1, 1977, the activity ratios were

$$^{56}Co/^{57}Co \;=\; 9 \times 10^{-6}$$

$$^{58}Co/^{57}Co \;=\; 2 \times 10^{-6}$$

$$^{84}Rb/^{85}Sr \;=\; 3 \times 10^{-4}$$

$$^{86}Rb/^{85}Sr \;=\; 5 \times 10^{-5}$$

$$^{134}Cs/^{137}Cs \;=\; 3 \times 10^{-5}$$

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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J. Paul Cali, Chief
Office of Standard Reference Materials

SRM 4254-C