

# National Bureau of Standards Certificate

## Standard Reference Material 4216-B

### Mixed Radionuclide Gamma-Ray Emission-Rate Point-Source Standard

This standard consists of cobalt-57, cobalt-60, strontium-85, yttrium-88, cadmium-109, tin-113-indium-113m, cesium-137-barium-137m, cerium-139, and mercury-203, deposited as the chlorides and sulfides, on polyester tape approximately 0.006-centimeter thick and covered by another layer of the same tape.

The point source was prepared by depositing a weighed aliquot of a calibrated radionuclide mixture on the tape and exposing it to hydrogen sulfide gas to precipitate the mercuric sulfide.

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

The nuclear gamma-ray-emission rates at 1200 EST August 1, 1974, are shown in the table.

RADIONUCLIDE	GAMMA-RAY ENERGY (MeV) (a)	GAMMA-RAYS PER ntps USED (a)	HALF LIFE (b)	γ/s	UNCERTAINTY (%)		
					RANDOM (99% C.L.)	SYSTEM-ATIC	TOTAL
<sup>109</sup> Cd	0.088	--	1.2727y		0.1	2.7	2.8
<sup>57</sup> Co	.122	0.856±0.002	271.41d		.1	2.2	2.3
<sup>139</sup> Ce	.165	.799±0.003 (b)	137.87d		.1	2.6	2.7
<sup>203</sup> Hg	.279	.815±0.002	46.61d		.1	1.1	1.2
<sup>113</sup> Sn- <sup>113m</sup> In	.392	--	115.31d		.1	2.8	2.9
<sup>85</sup> Sr	.514	0.9928±0.0001	64.86d		.1	1.6	1.7
<sup>137</sup> Cs- <sup>137m</sup> Ba	.662	--	30y (a)		.1	2.0	2.1
<sup>60</sup> Co	1.173	0.9988±0.0002	5.272y (c)		.1	1.3	1.4
<sup>60</sup> Co	1.333	1.00			.1	1.3	1.4
<sup>88</sup> Y	0.898	0.934±0.007	106.63d		.1	2.9	3.0
<sup>88</sup> Y	1.836	.9937±0.0002			.1	2.2	2.3

(a) Nuclear Data Tables, A8, Nos. 1-2 (Oct. 1970)

(b) NBS value

(c) Atomic Energy Review, Vol. 11, No. 3

(over)

The total uncertainty in each of the gamma-ray-emission rates is the linear sum of 0.1 percent, which is 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 limits of conceivable systematic error in the preparation of this source and the calibration of the "4π"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; tin-113-indium-113m contained indium-114m and antimony-125; cesium-137 contained cesium-134. On August 1, 1974, the ratios of the activities were

$^{56}\text{Co} : ^{57}\text{Co}$	$6 \times 10^{-5}$
$^{58}\text{Co} : ^{57}\text{Co}$	$2 \times 10^{-5}$
$^{114\text{m}}\text{In} : ^{113}\text{Sn}$	$6 \times 10^{-4}$
$^{125}\text{Sb} : ^{113}\text{Sn}$	$3 \times 10^{-4}$
$^{134}\text{Cs} : ^{137}\text{Cs}$	$2.2 \times 10^{-3}$

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

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