



National Institute of Standards & Technology

Certificate

Standard Reference Material 4334E Radioactivity Standard

Radionuclide	Plutonium-242
Source identification	4334E
Source description	Liquid in flame-sealed NIST borosilicate-glass ampoule ^{(1)*}
Solution mass	Approximately 5.8 grams
Solution composition	Plutonium-242 in 5 mol·L ⁻¹ nitric acid ⁽²⁾
Reference time (Purification time)	1200 EST, 18 December 1989
Radioactivity concentration	26.37 Bq·g ⁻¹
Overall uncertainty	1.12 percent ⁽³⁾
Radionuclidic impurities	See Table 1 ⁽⁴⁾
Half life	(3.733 ± 0.012) x 10 ⁵ years ⁽⁵⁾
Measuring instrument	Two 4π α liquid-scintillation counters, a calibrated germanium detector system, and a silicon surface-barrier detector

This standard reference material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, J.M. Robin Hutchinson, Acting Group Leader.

Gaithersburg, MD
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*Notes on back

NOTES

- (1) Approximately five milliliters of solution. Ampoule specifications:
- | | |
|----------------------|------------------------|
| body diameter | 16.5 ± 0.5 mm |
| wall thickness | 0.60 ± 0.04 mm |
| barium content | less than 2.5 percent |
| lead oxide content | less than 0.02 percent |
| other heavy elements | trace quantities |
- (2) Solution density is 1.170 ± 0.001 g·mL⁻¹ at 21.65 °C.
- (3) The overall uncertainty was formed by taking three times the quadratic combination of the standard deviations of the mean, or approximations thereof, for the following:
- | | |
|--|--------------|
| a) alpha-particle-emission-rate measurements | 0.02 percent |
| b) background | 0.03 percent |
| c) livetime | 0.05 percent |
| d) detection efficiency | 0.25 percent |
| e) count-rate-vs-energy extrapolation to zero energy | 0.25 percent |
| f) half life | 0.00 percent |
| g) gravimetric measurements | 0.10 percent |
| h) radionuclidic impurities | 0.00 percent |
- (4) Values for ²³⁸Pu + ²⁴¹Am and for ²³⁹Pu + ²⁴⁰Pu were calculated based upon measurements performed at the Lawrence Livermore National Laboratory (LLNL) shortly after purification of the ²⁴²Pu in December of 1989. Values for ²³⁹Pu + ²⁴⁰Pu and for ²⁴¹Pu were calculated based upon measurements performed at the National Institute of Standards and Technology (NIST) in August of 1990.
- (5) Evaluated Nuclear Structure Data File (ENSDF), February 1990.

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TABLE 1

RELATIVE ACTIVITY OF RADIONUCLIDIC IMPURITIES AT REFERENCE TIME 1200 EST, 18 DECEMBER 1989 ^(a)			
RADIONUCLIDE	HALF LIFE (YEARS)	RELATIVE ACTIVITY AS DETERMINED BY	
		LLNL	NIST
²³⁸ Pu	87.74 ± 0.04 ^(b)	²³⁸ Pu + ²⁴¹ Am <0.000 025 ^(c)	-----
²³⁹ Pu	24119 ± 26 ^(b)		
²⁴⁰ Pu	6570 ± 6 ^(b)	²³⁹ Pu + ²⁴⁰ Pu <0.000 005 ^(c)	²³⁹ Pu + ²⁴⁰ Pu <0.000 043 ^(c)
²⁴¹ Pu	14.35 ± 0.10 ^(b)	-----	0.162 ± 0.002(1σ) ^(d)
²⁴² Pu	373300 ± 1200 ^(b)	1.000 000	1.000 000
²⁴¹ Am	432.2 ± 0.5 ^(b)	²³⁸ Pu + ²⁴¹ Am <0.000 025 ^(c)	0.000 000 assumed

- (a) Reference time is the time of purification of the plutonium-242.
- (b) Evaluated Nuclear Structure Data File (ENSDF), February 1990.
- (c) Using alpha-particle spectrometry, no alpha-particle emission was detected that could reliably be ascribed to these radionuclides. The value shown is an estimated upper limit based upon background and counting statistics.
- (d) The plutonium-241 relative activity at reference time was calculated from a gamma-ray measurement of the americium-241 ingrowth as of 18 August 1990.