



National Institute of Standards & Technology

Certificate

Standard Reference Material 4334D Alpha-Particle Solution Standard

Radionuclide	Plutonium-242
Source identification	4334D
Source description	Liquid in 5-mL flame-sealed glass ampoule ^{(1)*}
Source mass	5.883 grams ⁽²⁾
Solution composition	Plutonium-242 in 5-molar nitric acid ⁽³⁾
Radioactivity concentration	25.58 Bq g ⁻¹
Reference time (Purification time)	1200 EST, 18 December 1989
Overall uncertainty	1.12 percent ⁽⁴⁾
Radionuclidic impurities	See Table 1 ⁽⁵⁾
Half life	$(3.76 \pm 0.02) \times 10^5$ years ⁽⁶⁾
Measuring instrument	Two $4\pi\alpha$ liquid-scintillation counters, a calibrated germanium detector system, and a silicon surface-barrier detector

This standard reference material was prepared in the Center for Radiation Research, Ionizing Radiation Division, Radioactivity Group, Dale D. Hoppes, Group Leader.

Gaithersburg, MD 20899
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William P. Reed, Acting Chief
Office of Standard Reference Materials

*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) Based upon measurements of 10 ampoules, the average solution mass is 5.883 grams and the standard deviation of the distribution is 0.002 grams.
- (3) Solution density is 1.157 g ml⁻¹ at 22.8 °C.
- (4) 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) gravimetric measurements | 0.10 percent |
| c) deadtime | 0.05 percent |
| d) background | 0.03 percent |
| e) detection efficiency | 0.25 percent |
| f) count-rate-vs-energy extrapolation to zero energy | 0.25 percent |
| g) half life | 0.00 percent |
| h) radionuclidic impurities | 0.00 percent |
- (5) 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.
- (6) NCRP Report No. 58, 2nd edition (1985), p. 365.

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TABLE 1

Relative Activity of Radionuclidic Impurities at Reference Time
1200 EST, 18 December 1989^a

Radio-nuclide	Half Life (years)	Relative Activity as Determined by	
		LLNL	NIST
²³⁸ Pu	87.74±0.04 ^b	²³⁸ Pu + ²⁴¹ Am <0.000 025 ^e	-----
²³⁹ Pu	24119±26 ^c		
²⁴⁰ Pu	6564±11 ^b	²³⁹ Pu + ²⁴⁰ Pu <0.000 005 ^e	²³⁹ Pu + ²⁴⁰ Pu <0.000 043 ^e
²⁴¹ Pu	14.35±0.10 ^d	-----	0.162 ± 0.002(1σ) ^f
²⁴² Pu	376000±2000 ^b	1.000 000	1.000 000
²⁴¹ Am	432.2±0.5 ^b	²³⁸ Pu + ²⁴¹ Am <0.000 025 ^e	0.000 000 assumed

- a) Reference time is the time of purification of the ²⁴²Pu.
- b) NCRP Report No. 58, 2nd edition (1985), p. 365.
- c) Strohm, W.W., Int. J. Appl. Radiat. Isotopes 29 (1978) 481.
- d) Nuclear Data Sheets 44 (1985) 407.
- e) Using alpha-particle spectrometry, no activity was detected that could reliably be ascribed to these radionuclides. The value shown is an estimated upper limit based upon background and counting statistics.
- f) The ²⁴¹Pu relative activity at reference time was calculated from a gamma-ray measurement of the ²⁴¹Am ingrowth as of 18 August 1990.