Department of Commerce
Malcolm Baldrige
Secretary

ional Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate

Standard Reference Material 4328

Radioactivity Standard

Radionuclide	Thorium-229 (1)*
Source identification	4328
Source description	Liquid in a 2-mL, flame-sealed borosilicate-glass ampoule
Solution composition	Thorium-229 in 1-molar nitric acid
Solution mass	1.990 ± 0.001 grams (2)
Reference time	1405 EST, May 7, 1984
Radioactivity concentration	884.0 Bq g^{-1}
Overall uncertainty	1.5 percent (3)
Alpha-particle-emitting impurities (Activity ratio at reference time)	$^{228}Th/^{229}Th$: $\leq$ 0.002 (4)
Measuring instrument	Alpha spectrometer (5)
Half life	7340 ± 160 years (6)

This Standard Reference Material was prepared in the Center for Radiation Research, Nuclear Radiation Division, Radioactivity Group, Dale D. Hoppes, Group Leader.

Gaithersburg, MD 20899
May, 1985

Stanley D. Rasberry, Chief
Office of Standard Reference Materials

*Notes on back

NOTES

(1) The thorium-229 was chemically separated from progeny at the reference time. The ingrowth of progeny can be deduced from data given on the attached Supplemental Information Sheet.

(2) The average of 10 individually weighed masses of solution. The uncertainty is the estimated standard deviation of the mean.

(3) The overall uncertainty is three times the value found from combining quadratically the standard deviations of the mean, or approximations thereof, of the following:

a)	3 alpha-spectrometer measurements	0.09 percent
b)	gravimetric measurements	0.10 percent
c)	system live time	0.05 percent
d)	background	0.01 percent
e)	detection efficiency	0.25 percent
f)	count-rate-vs-energy extrapolation to zero energy	0.25 percent
g)	impurities	0.20 percent
h)	calibration of plutonium-238 standard	0.25 percent

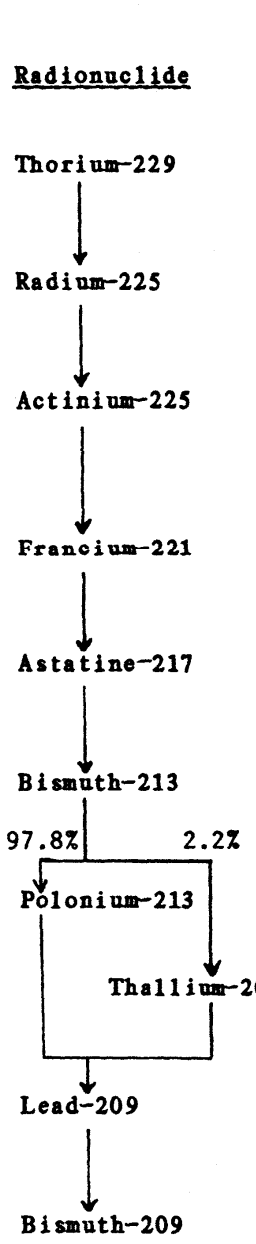
(4) Impurities were searched for by three alpha-spectrometer and two gamma-ray-spectrometer measurements. The reported $^{228}Th/^{229}Th$ activity ratio is the highest of these five measurements.

(5) A thorium-229 source was intercompared, in a silicon surface-barrier detector, with a Standard Reference Sample of plutonium-238 which had been calibrated in the NBS "0.8π" alpha defined-solid-angle counter with scintillation detector.

(6) Proposed Recommended List of Heavy Element Radionuclide Decay Data, International Nuclear Data Committee, INDC (NDS)-149/NE, December, 1983.

For further information contact J.M.R. Hutchinson at (301) 921-2396 or FTS-921-2396.

Thorium-229 Supplemental Information Sheet
Some Decay Properties of Thorium-229 and Its Progeny



Radionuclide	Half Life and Uncertainty	Prominent Alpha-Particle Energies (MeV)
Thorium-229	7340±160 y	4.8453 4.9010
Radium-225	14.8±0.2 d	
Actinium-225	10.0±0.1 d	5.7310 5.792 5.8290
Francium-221	4.9±0.2 m	6.1255 6.3398
Astatine-217	0.0323±0.0004 s	7.066
Bismuth-213	45.59±0.06 m	
97.8% / 2.2%		
Polonium-213	$4.2 \pm 0.8 \times 10^{-6}$ s	8.377
Thallium-209	2.20±0.07 m	
Lead-209	3.253±0.014 h	
Bismuth-209	Stable	

For more information see: INDC (NDS)-149/NE, December 1983, and, Radioactive Decay Data Tables, David C. Kocher, DOE/TIC-11026 (1981).