J. S. Department of Commerce
Malcolm Baldrige
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate

Standard Reference Material 4419L-C

Radioactivity Standard

Radionuclide	Ytterbium-169
Source identification	4419L-C-
Source description	Liquid in NBS borosilicate-glass ampoule (1)*
Solution composition	Approximately 36 micrograms of ytterbium per gram of 0.1 molar hydrochloric acid (2)
Mass	grams
Radioactivity concentration	1.859×10^{6} Bq g^{-1}
Reference time	0900 EST October 29, 1986
Overall uncertainty	1.33 percent (3)
Photon-emitting impurities (Activity ratios at reference time)	$^{46}Sc/^{169}Yb$: $(1.5 \pm 0.3) \times 10^{-4}$ (4) $^{175}Yb/^{169}Yb$: $(5.8 \pm 2.0) \times 10^{-3}$
Half life	32.03 ± 0.01 days (5)
Measuring instrument	NBS pressurized "4π"γ ionization chamber calibrated by $4\pi(e,x)$-γ coincidence efficiency-extrapolation technique

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
November, 1986

Stanley D. Rasberry, 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) Solution density 0.999 ± 0.002 g/mL at 23.3 °C.

(3) The overall uncertainty was formed by taking three times the quadratic combination of standard deviations of the mean, or approximations thereof, for the following:

a)	photon-emitting impurities in this solution	0.03 percent
b)	18 ionization-chamber measurements on this solution	0.01 percent
c)	ytterbium carrier concentration correction	0.10 percent
d)	original ionization-chamber measurements	0.02 percent
e)	standard deviation of the mean of four coincidence measurements	0.14 percent
f)	dead time	0.15 percent
g)	resolving time uncertainty	0.15 percent
h)	backgrounds	0.23 percent
i)	half life	0.05 percent
j)	dependence on length of resolving time	0.25 percent
k)	gravimetric measurements	0.05 percent

(4) Limits of detection as a percentage of the gamma-ray-emission rate of the 63.1-keV gamma rays emitted in the decay of ytterbium-169 are

0.1 percent between 20 and 303 keV
0.01 percent between 313 and 1900 keV

provided that the impurity photons are separated in energy by five keV or more from photons emitted in the decay of ytterbium-169.

(5) NCRP Report No. 58, 2nd Edition, February 1985, p. 472.

Note on ^{169}Yb Data

A 1983 publication (Int. J. Appl. Radiat. Isot. 34 1215) reports gamma-ray probabilities per decay which differ from the earlier evaluation in NCRP Report 58 (85) by several percent in some cases. We suggest that these probabilities which are in general in better agreement with our preliminary values, be used until an updated evaluation is available:

E in keV	Radiation	Photon-Emission Probabilities per decay in %
6.3	X-ray L_1	0.93(8)
6.8-7.6	X-ray $L_{\alpha 1,2}$	20.1(8)
8.1	X-ray $L_{\beta 1,3,4}$	15.9(9)
8.4	γ_1;X-ray $L_{\beta 3}$	4.5(3)
9.4	X-ray $L_{\gamma 1}$	2.19(13)
9.8	X-ray $L_{\gamma 2,3}$	0.73(5)
8.401	γ_1	—
20.75	γ_2	0.19(2)
49.77	X-ray $K_{\alpha 2}$	53.5(11)
50.74	X-ray $K_{\alpha 1}$	94.5(21)
57.5	X-ray $K_{\beta 1}$	30.9(7)
59.1	X-ray $K_{\beta 2}$	7.90(17)
63.119	γ_3	44.7(6)
93.613	γ_4	2.60(4)
109.777	γ_5	17.5(2)
118.187	γ_6	1.86(2)
130.520	γ_7	11.28(10)
177.210	γ_8	22.44(21)
197.953	γ_9	36.0(5)
240.30	γ_{10}	0.1085(12)
261.072	γ_{11}	1.68(3)
307.730	γ_{12}	10.10(22)