National Institute of Standards & Technology

Certificate

Standard Reference Material 4233C
Radioactivity Standard

Radionuclide	Cesium-137 Burn-up Standard
Source identification	4233C-
Source description	Liquid in a 5-mL, sealed glass ampoule (1) *
Solution composition	Cesium-137 in approximately 19 micrograms of high-purity cesium chloride per gram of 1 M HCl (2)
Mass	5.0139 ± 0.0007 grams
Reference time	1200 EST November 1, 1989
^{137}Cs atom concentration	9.850×10^{14} atoms g^{-1}
Overall uncertainty	0.54 percent (3)
Radioactivity concentration	7.255×10^{5} Bq g^{-1}
Overall uncertainty	0.94 percent (4)
Measuring instrument	"4π"γ ionization chamber previously calibrated by $4\pi\beta$-γ efficiency-extrapolation anti-coincidence counting using ^{134}Cs as a tracer, and by isotope-dilution mass spectrometry
Half life	30.0 ± 0.2 years (5)
Impurities	None observed (6)

This Standard Reference Material was developed and prepared under the direction of Jacqueline M. Calhoun. Assistance in preparation, ionization-chamber measurements and data analysis was provided by Jeffrey T. Cessna, Daniel Golas, and Donald Gray. Impurity analyses were provided by Dale D. Hoppes. The original activity measurements were performed by Alan T. Hirshfeld. The Mass Spectrometric measurements were based on the results provided by the Inorganic Analytical Research Division, for the SRM 4233B cesium-137 burn-up solution standards.

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

*Notes on back

NOTES

(1) Approximately five milliliters of solution. Ampoule specifications:

body diameter	16 ± 0.5 mm
wall thickness	0.6 ± 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 1.015 ± 0.002 grams/mL.

(3) An uncertainty of 0.48 percent was given for the solution used to calibrate NIST reference ionization chamber A in 1979. This was the "linear sum of 0.10%, which is the limit of the random error at the 99-percent confidence level - and 0.38%, which is the linear sum of the estimated upper limits of conceivable systematic errors". An additional 0.06% has been added linearly as an estimate of the uncertainty in calibrating and using the ionization chamber.

(4) Assuming a gamma-ray probability per decay of 0.851 ± 0.003, the number of 0.6616 MeV gamma ray of barium-137m emitted per second per gram of solution at 1200 EST November 1, 1989 is $6.174 \times 10^5\ \gamma s^{-1}$ ± 2.0 percent.

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

a) 78 ionization chamber measurements	0.04 percent
b) $4\pi\beta$-γ efficiency-extrapolation coincidence anti-coincidence measurements	0.12 percent
c) gravimetric measurements	0.20 percent
d) dead time	0.02 percent
e) background	0.02 percent
f) timing	0.004 percent
g) extrapolation to detection efficiency of 1.000	0.12 percent
h) half life (^{137}Cs to ^{134}Cs)	0.001 percent
i) decay-scheme data	0.072 percent
j) detection of 662-keV photons in $4\pi\beta$ proportional counter	0.02 percent
k) detection of 662-keV photons in gamma-channel detector	0.05 percent
l) ^{134}Cs tracer activity concentration	0.13 percent
m) absorption	0.02 percent
n) impurities	0.001 percent
o) original "4π"γ ionization chamber measurements	0.044 percent
p) half life	
q) radium reference sources ratio	0.026 percent

(6) NCRP Report No. 58, 2nd Edition, 1985, p. 450.

(7) Limits of detection as a percentage of the gamma-ray-emission rate of the 661.6-keV gamma-rays emitted in the decay of barium-137m are:

0.1 percent between 90 and 657 keV
0.01 percent between 666 and 1900 keV.

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