National Institute of Standards & Technology

Certificate

Standard Reference Material 4966
Radioactivity Standard

Radionuclide	Radium-226 [1]*
Source identification	SRM 4966
Source description	Liquid in a 5-mL, flame-sealed NIST borosilicate-glass ampoule [2]
Solution composition	Approximately 1.4 mol•L^{-1} HCl[3] containing 1.67 mg $BaCl_2$ per gram of solution[4] and Ra^{+2} [5]
Solution density	1.020 ± 0.001 g•mL^{-1} at 22 °C [6]
Solution mass	5.1138 ± 0.0030 g [7]
Radium-226 activity concentration	268.2 Bq•g^{-1} [8]
Reference time	1200 EST 9 September 1991
Overall uncertainty	1.19 percent [9]
Half life	1600 ± 7 years [10]
Calibration method	NIST pressurized "4π"γ ionization chamber "A" calibrated with the national radium standards[11]; and confirmatory measurements [12]

This standard reference material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, Dale D. Hoppes, Group Leader.

Gaithersburg, MD
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William P. Reed, Chief
Standard Reference Materials Program

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NOTES

(1) This standard was prepared by gravimetric dilutions of the "1947 series" of ^{226}Ra standards which were recalibrated at NIST (NBS) in 1967. The "age" of the radium, with accompanying in-growth of ^{210}Pb, is at least 44.3 years.

(2) 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

(3) Corresponding to a 15.3% (by weight) solution of NIST, high-purity, vacuum-distilled hydrochloric acid (nominal 10 $mol \cdot L^{-1}$) in doubly-distilled water.

(4) The $BaCl_2$ reagent used to prepare the carrier solution was measured in a NaI(Tl) well counter and found to contain ≤ 0.01 Bq ^{226}Ra per gram of $BaCl_2$.

(5) The atom ratio of barium carrier to radium in the solution is approximately 2.5×10^5.

(6) The uncertainty in the density is three times the standard deviation of the mean for three independent gravimetric determinations. Confirmatory measurements based on the total master solution mass and individually dispensed masses in known volumes were in agreement.

(7) Mean mass of the dispensed solution in the ampoule. The uncertainty is three times the standard deviation of 15 individually weighed masses of solution from which the mean mass was calculated.

(8) Corresponding to 7.333×10^{-9} g ^{226}Ra per gram of solution assuming a conversion factor of 36.576 $kBq \cdot \mu g^{-1}$.

(9) The overall uncertainty, 1.19 percent, was formed by taking three times the quadratic combination of the standard deviation of the mean, or approximations thereof, for the following component uncertainties:

a) four ion chamber "A" measurements on samples of 2 dilutions	0.069 percent
b) twenty-two comparative ion chamber "A" measurements on 8 "1947(1967 recalibrated) series" of ^{226}Ra standards	0.040 percent
c) ion chamber calibration for the "1947(1967 recalibrated) series" [with respect to the "radiation balance" primary measurements on the "1957 series" and national radium standards (see note 11)]	0.34 percent
d) gravimetric dilution factor	0.1 percent
e) half-life correction	0.0046 percent
f) ^{226}Ra mass to activity conversion	0.16 percent

(10) NCRP Report No. 58, 2nd ed., Appendix A3 (Feb. 1985).

(11) For further details on NIST (NBS) radium series calibrations see W.B. Mann, et al., J. Res. NBS 62, 21-26 (1959). The 1967 recalibration of the "1947 series" and "1957 series" intercomparisons were made with chamber "A".

(12) For confirmation, this ^{226}Ra standard series was also directly compared against preparations of the "1947 (1967 recalibrated)", "1978", and "1984" ^{226}Ra series by ^{222}Ra analyses with the NIST pulse-ionization-chamber Primary Radon Measurement system [R. Collé, et al., J. Res. NIST 95 155-165 (1990); J.M.R. Hutchinson, et al., Appl. Rad. Isot. 43, 175-189 (1992)], by liquid scintillation counting, and by NaI(Tl) well-crystal and Ge γ-spectrometry.

For further information please contact R. Collé, (301) 975-5527.