National Institute of Standards & Technology

Certificate

Standard Reference Material® 4966A
Radium-226 Radioactivity Standard

This Standard Reference Material (SRM) consists of a solution of a standardized and certified quantity of radioactive Radium-226 in a suitably stable and homogeneous matrix. It is intended primarily for the calibration of instruments that are used to measure radioactivity and for the monitoring of radiochemical procedures. The solution, whose composition is specified in Table 1, is contained in a flame-sealed 5 mL, NIST borosilicate-glass ampoule (see Note 1)*.

The certified **Radium-226** massic activity value, at a **Reference Time of 1200 EST, 01 January 2007**, is:

(287.6 ± 3.7) Bq•g^{-1}

Additional physical, chemical, and radiological properties for the SRM, as well as details on the standardization method, are given in Table 1. Uncertainty intervals for certified quantities are expanded (k = 2) uncertainties calculated according to the ISO and NIST Guidelines (see Note 2). Table 2 contains a specification of the components that comprise the uncertainty analyses.

The certification of this SRM, within the measurement uncertainties specified, is valid for at least five (5) years after receipt. The solution matrix, in an unopened ampoule, is believed to be indefinitely homogeneous and stable, within its half-life-dependent, useful lifetime. NIST will monitor this material and will report any substantive changes in certification to the purchaser. Should any of the certified values change, purchasers of this SRM will be notified of the change by NIST.

This SRM may represent a radiological hazard and a chemical hazard. Consult the Material Safety Data Sheet (MSDS), enclosed with the SRM shipment, for details (see Note 1).

This Standard Reference Material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, M.P. Unterweger, Acting Group Leader. The overall technical direction and physical measurements leading to certification were provided by P.Volkovitsky of the Radioactivity Group with assistance by L.Pibida and M.Hammond of the Radioactivity Group and by D.B. Golas, Research Associate of the Nuclear Energy Institute. The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the Standard Reference Materials Program.

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*Notes and references are in page 4

Table 1. Properties of SRM 4966A

Certified values

Radionuclide	**Radium-226**
Reference time	**1200 EST, 01 January 2007**
Massic activity of the solution	**287.6 Bq•g^{-1}**
Relative expanded uncertainty (*k* = 2)	**1.3 %** (see Note 2)*

Uncertified information

Source description	Liquid in flame-sealed NIST borosilicate-glass ampoule (see Note 1)
Solution composition	1.0 mol•L^{-1} HCl with 50 µg Ba^{+2} per gram of solution (as $BaCl_2$)
Solution density	(1.017 ± 0.002) g•mL^{-1} at 20.0 °C (see Note 3)
Solution mass	(5.085 ± 0.001) g (see Note 3)
Photon-emitting impurities	None detected (see Note 4)
Half lives used	Radium-226 (1600 ± 7) a (see Note 5)
Calibration method (and instruments)	Comparative measurements of the SRM 4966A solution against SRM 4967A standard solution using NIST Pulse Ionization Chambers (PIC). Confirmatory measurements against NIST SRM 4966 and SRM 4967A using NaI(Tl) and HPGe detectors

*Notes and references are in page 4

Table 2. Uncertainty evaluation for the massic activity for SRM 4966A

	Uncertainty component	Assessment Type †	Relative standard uncertainty contribution on massic activity of radium-226 (%)
1	Precision of PIC measurements: typical standard deviation of the mean for four replicate measurements (one aliquot) of SRM 4966A.	A	0.14
2	Precision of PIC measurements: typical standard deviation of the mean for six replicate measurements (one aliquot) of SRM 4967A	A	0.08
3	Gravimetric (mass) measurements for PIC (bubbler) sources dilutions	B	0.07
4	Losses in radon transfer from bubbler to PIC	B	0.13
5	Extrapolation of PIC spectra to zero energy	B	0.12
6	Decay corrections for radium-226 (for half-life uncertainty of 0.4 %)	B	0.0005
7	Uncertainty in the certified massic activity of SRM 4967A (September 2003), including uncertainty in conversion of radium-226 mass to activity	B	0.60
8	Limit for photon-emitting impurities	B	0.08
9	Live time determination for PIC counting time intervals; includes uncorrected dead time effects	B	0.1
Relative combined standard uncertainty			**0.66**
Relative expanded uncertainty (k = 2)			**1.3**

† = (A) denotes evaluation by statistical methods; (B) denotes evaluation by other methods.

NOTES

Note 1. Refer to http://physics.nist.gov/Divisions/Div846/srm.html for the standardized ampoule dimensions and for assistance and instructions on how to properly open an ampoule. Information on additional storage and handling requirements is also included in the website.

Note 2. The uncertainties on certified values are expanded uncertainties, $U = ku_c$. The quantity u_c is the combined standard uncertainty calculated according to the ISO and NIST Guides (see references [1] and [2]). The combined standard uncertainty is multiplied by a coverage factor of $k = 2$ and was chosen to obtain an approximate 95 % level of confidence.

Note 3. The stated uncertainty is two times the standard uncertainty.

Note 4. The estimated lower limits of detection for photon-emitting impurities, expressed as massic photon emission rates, on 13 September 2007, were:

$0.62\ s^{-1}\cdot g^{-1}$ for energies between 50 keV and 80 keV, and
$0.31\ s^{-1}\cdot g^{-1}$ for energies between 100 keV and 250 keV, and
$0.45\ s^{-1}\cdot g^{-1}$ for energies between 290 keV and 600 keV, and
$0.40\ s^{-1}\cdot g^{-1}$ for energies between 700 keV and 1550 keV,and
$0.29\ s^{-1}\cdot g^{-1}$ for energies between 1650 keV and 2100 keV, and
$0.10\ s^{-1}\cdot g^{-1}$ for energies between 2150 keV and 2600 keV.

Note 5. The stated uncertainty is the standard uncertainty. See reference [3].

REFERENCES

[1] International Organization for Standardization (ISO), *Guide to the Expression of Uncertainty in Measurement*, 1993 (corrected and reprinted, 1995). Available from Global Engineering Documents, 12 Inverness Way East, Englewood, CO 80112, U.S.A. Telephone 1-800-854-7179.

[2] B. N. Taylor and C. E. Kuyatt, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, NIST Technical Note 1297, 1994. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20407, U.S.A.

[3] The evaluated Nuclear Structure Data File (ENSDF), http://www.nndc.bnl.gov/ensdf/, September 2007, lists a half life value of (1600 ± 7) a.