National Institute of Standards & Technology

Certificate

Standard Reference Material® 4322C

Americium-241 Radioactivity Standard

This Standard Reference Material (SRM) consists of a solution of a standardized and certified quantity of radioactive Americium-241 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 **americium-241** massic activity value, at a **Reference Time of 1200 EST, 16 May 2007**, is:

(106.4 ± 0.3) Bq•g^{-1}

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

Expiration of Certification: The certification of this SRM 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.

Maintenance of Certification: 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. Registration (see attached sheet) will facilitate notification.

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 measurement leading to certification were provided by R. Collé and L. Laureano-Pérez of the NIST Radioactivity Group, with production assistance by D.B. Golas and O. Palabrica, Research Associates of the Nuclear Energy Institute, with confirmatory measurement assistance by R. Fitzgerald, and with impurity analyses by L. Pibida and I. Outola.

Support aspects involved with the certification and issuance of this SRM were coordinated through the NIST Measurement Services Division.

Lisa R. Karam, Deputy Chief
Ionizing Radiation Division

Gaithersburg, Maryland 20899
July 2007

Robert L. Watters, Jr., Chief
Measurement Services Division

Table 1. Properties of SRM 4322C

Certified values

Radionuclide	**Americium-241**
Reference time	**1200 EST, 16 May 2007**
Massic activity of the solution	**106.4 Bq•g^{-1}**
Relative expanded uncertainty (k = 2)	**0.26 %** (see Note 2)*

Uncertified information

Source description	Liquid in a flame-sealed 5 mL NIST borosilicate-glass ampoule (see Note 1)
Solution composition	0.91 mol•L^{-1} HNO_3
Solution density	(1.030 ± 0.002) g•mL^{-1} at 22 °C (see Note 3)
Solution mass	(5.1546 ± 0.0003) g (see Note 3)
Alpha-particle-emitting impurities	None detected (see Note 4)
Photon-emitting impurities	None detected (see Note 5)
Half-life used	^{241}Am : (432.6 ± 0.6) a (see Note 6) [1]
Calibration method (and instruments)	The certified massic activity for ^{241}Am was obtained by 4πα liquid scintillation (LS) spectrometry with three commercial LS counters. Confirmatory measurements were performed by 4πα(LS) - γ(NaI) anticoincidence counting.

Table 2. Uncertainty evaluation for the massic activity of SRM 4322C

	Uncertainty component	Assessment Type †	Relative standard uncertainty contribution on massic activity of ^{241}Am (%)
1	LS measurement precision; standard deviation of the mean for $\nu = 89$ degrees of freedom, based on 3 replicate measurements on each of 3 different LS counters (on 4 separate measurement occasions) of 2 LS cocktails for each of 5 cocktail compositions; $n = \nu+1 = 3\times3\times5\times2 = 90$ (accept normal distribution assumption at 99 % level)	A	0.024
2	Background; wholly embodied in 1	A	--
3	Gravimetric (mass) measurements for LS sources	B	0.05
4	Live time determinations for LS counting time intervals, including uncorrected dead time effects	B	0.06
5	LS detection efficiency, including extrapolation of spectra to zero energy and possible LS wall effect losses	B	0.1
6	^{241}Am decay corrections for half-life uncertainty of 0.14 %	B	2×10^{-5}
7	Limit for alpha-emitting impurities	B	0.006
8	Limit for photon-emitting impurities	B	0.01
Relative combined standard uncertainty			**0.13**
Relative expanded uncertainty (k = 2)			**0.26**

† = (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 SRM ampoule dimensions and for assistance and instructions on how to properly open an ampoule. Information on additional storage and handling requirements is also included on 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 [2-3]. 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. See reference [3].

Note 4: The estimated limits of detection for alpha-emitting impurities were:
$0.006\ s^{-1} \bullet g^{-1}$ for energies between 3.5 MeV and 5.0 MeV, and
$0.002\ s^{-1} \bullet g^{-1}$ for energies between 5.5 MeV and 12 MeV.

Note 5. The estimated lower limit of detection for photon-emitting impurities, expressed as massic photon emission rate, on 11 May 2007 was:
$0.006\ s^{-1} \bullet g^{-1}$ for energies between 65 keV and 3600 keV.

Note 6. The stated uncertainty is the standard uncertainty. See reference [3].

REFERENCES

[1] *Table of Radionuclide ;* Vol. 2 – A = 151 to 242, M.M. Bé, et al., Bureau International des Poids et Measures, Pavillon de Breteuil F-92312 Sèvres Cedex FRANCE http://www1.bipm.org/utils/common/pdf/monographieRI/Monographie_BIPM-5_Tables_Vol2.pdf (2004).

[2] ISO; G*uide to the Expression of Uncertainty in Measurement*; ISBN 92-67-10188-9, 1st ed.; International Organization for Standardization: Geneva, Switzerland (1993); see also Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*; NIST Technical Note 1297; U.S. Government Printing Office: Washington, DC (1994); available at http://physics.nist.gov/cuu/Uncertainty/index.html.

[3] Taylor, B.N.; *Guide for the Use of the International System of Units (SI)*; NIST Special Publication 811; U.S. Government Printing Office: Washington, DC (1995).

Users of this SRM should ensure that the certificate in their possession is current. This can be accomplished by contacting the SRM Program at: telephone (301) 975-6776; fax (301) 926-4751; e-mail srminfo@nist.gov; or via the Internet at http://www.nist.gov/srm.