National Institute of Standards & Technology

Certificate

Standard Reference Material® 4949d

Iodine-129 Radioactivity Standard

This Standard Reference Material (SRM) consists of a solution of a standardized and certified quantity of radioactive iodine-129 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. A unit of SRM 4949d consists of approximately 5 mL of a solution, whose composition is specified in Tables 1 and 2, contained in a flame-sealed borosilicate-glass ampoule [1].

The certified **iodine-129** massic activity, at a **Reference Time of 1200 EST, 01 January 2014**, is:

(2.747 ± 0.030) kBq•g^{-1}

A NIST certified value, as used within the context of this certificate, is a value for which NIST has the highest confidence in its uncertainty assessment. It is a "measurement result" [2] obtained directly or indirectly from a "primary reference measurement procedure" [3]. The certified value is traceable to the derived SI unit, becquerel (Bq).

Additional physical, chemical, and radiological properties for this SRM, as well as details on the standardization method, are given in Tables 1 and 2. The uncertainties are calculated according to the ISO/JCGM and NIST Guides [4,5]. Uncertainties for the certified quantities are expanded ($k = 2$). Table 3 contains a specification of the components that comprise the uncertainty analysis.

Expiration of Certification: The certification of **SRM 4949d** is valid indefinitely, within the measurement uncertainty specified, provided that the SRM is handled and stored properly and that no evaporation or change in composition has occurred. The solution matrix, in an unopened ampoule, is homogeneous and stable within its half-life-dependent useful lifetime provided the SRM is handled in accordance with instructions given in this certificate (see "Instructions for Handling and Storage"). Periodic recertification of this SRM is not required. The certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

Maintenance of Certification: NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification, NIST will notify the purchaser. Registration (see attached sheet or register online) will facilitate notification.

Radiological and chemical hazard: Consult the Safety Data Sheet (SDS), enclosed with the SRM shipment, for radiological and chemical hazard information.

This SRM was prepared in the NIST Physical Measurement Laboratory, Radiation Physics Division, under the direction of M.P. Unterweger, Group Leader of the Radioactivity Group. Overall production, technical direction, and physical measurement leading to certification were provided by R. Fitzgerald, L. Laureano-Pérez and R. Collé of the NIST Radiation Physics Division, Radioactivity Group. Photon-emitting impurity analyses were provided by L. Pibida of the NIST Radiation Physics Division, Radioactivity Group.

Support aspects involved in the issuance of this SRM were coordinated through the NIST Office of Reference Materials.

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Certificate Issue Date: 14 September 2015

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Table 1. Certified Massic Activity of SRM 4949d

Radionuclide	**Iodine-129**
Reference time	**1200 EST, 01 January 2014**
Massic activity of the solution	**2.747 kBq•g^{-1}**
Relative expanded uncertainty (k = 2)	**1.08 %[(a)]**

[(a)] 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/JCGM and NIST Guides [4,5]. The combined standard uncertainty is multiplied by a coverage factor of k = 2 and was chosen to obtain an approximate 95 % level of confidence.

Table 2. Uncertified Information of SRM 4949d

Source description	Liquid in a flame-sealed 5 mL borosilicate-glass ampoule [1]
Solution composition	0.011 mol•L^{-1} NaOH and 0.007 mol•L^{-1} Na_2SO_3
Solution density	(0.999 ± 0.002) g•mL^{-1} at 23 °C[(a)]
Solution mass	(5.005 ± 0.003) g[(a)]
Photon-Emitting Impurities	None detected[(b)]
Half-lives used	^{129}I: (16.1 ± 0.7) x 10^6 a [(c)] [6]
Calibration methods (and instruments)	The I-129 massic activity was measured by live-timed beta-gamma anticoincidence counting (LTAC) with a single-PMT liquid scintillation (LS) detector for the beta channel and a NaI(Tl) well detector for the gamma channel. Confirmatory measurements were done by triple-to-double coincidence ratio (TDCR) and gamma-ray spectrometry.

[(a)] The stated uncertainty is two times the standard uncertainty. See reference 5.

[(b)] The estimated lower limits of detection for photon-emitting impurities, expressed as massic photon emission rate, in January 2014, are:

482 s^{-1}•g^{-1} in the region 25 keV ≤ E ≤ 35 keV;
14 s^{-1}•g^{-1} in the region 40 keV ≤ E ≤ 50 keV;
6 s^{-1}•g^{-1} in the region 55 keV ≤ E ≤ 95 keV;
3 s^{-1}•g^{-1} in the region 100 keV ≤ E ≤ 1480 keV, and
2.6 s^{-1}•g^{-1} in the region 1490 keV ≤ E ≤ 2000 keV;

provided that the photons are separated in energy by 4 keV or more from photons emitted in the decay of ^{129}I or progeny.

[(c)] The stated uncertainty is the standard uncertainty. See reference 5.

Table 3. Uncertainty Evaluation for the Massic Activity of SRM 4949d

	Uncertainty component	Assessment Type[(a)]	Relative standard uncertainty contribution on massic activity of ^{129}I (%)
1	Measurement repeatability; standard deviation of the distribution for 4 sources (two from one solution, two from another), measured once each.	A	0.29
2	Efficiency extrapolation; standard deviation of activity values from 7 plausible extrapolation schemes.	A	0.42
3	Live time; standard uncertainty based on limits from systematic tests.	B	0.1
4	Beta shape factor; the difference in Geant4 simulated intercept between using the shape factor of $(q^2 + 0.1\,p^2)$ and using no shape factor, averaged over the 3 extrapolations used for the final activity.	B	0.08
5	Gravimetric measurements; dilution of solutions; median standard deviation of the mean for LS measurements on two different dilution solutions.	B	0.1
6	Decay correction; due to half-life for ^{129}I of $(1.61 \pm 0.07)\cdot 10^7$ years [6].	B	<0.001
7	Impurity limit; no impurities found [See footnote b on Table 2]	B	0.06
8	Background; standard deviation of the activity values using the two different background measurements.	B	0.05
	Relative combined standard uncertainty		**0.54**
	Relative expanded uncertainty (*k* = 2)		**1.08**

[(a)] Letter A, denotes evaluation by statistical methods; B denotes evaluation by other methods.

INSTRUCTIONS FOR HANDLING AND STORAGE

Handling: If the ampoule is transported, it should be packed, marked, labeled, and shipped in accordance with the applicable national, international, and carrier regulations. The solution in the ampoule is a dangerous good (hazardous material) because of the radioactivity. Only persons qualified to handle both radioactive material and alkaline and/or acidic solutions, should open the ampoule. To minimize personnel exposure, appropriate shielding and/or distance should be used. Refer to the SDS for further information.

Storage: SRM 4949d should be stored and used at a temperature between 5 °C and 65 °C. The ampoule (or any subsequent container) should always be clearly marked as containing radioactive material.

REFERENCES

[1] NIST Physical Measurement Laboratory; *Storage and Handling of Radioactive Standard Reference Materials, Ampoule Specifications and Opening Procedure*, available at http://www.nist.gov/pml/div682/grp04/srm.cfm (accessed Sep 2015). Note: This SRM is contained in a generic borosilicate-glass ampoule and not in the standard NIST ampoule.

[2] JCGM 200:2012; *International Vocabulary of Metrology - Basic and General Concepts and Associated Terms (VIM)* (2008 version with Minor Corrections), 3rd edition; Joint Committee for Guides in Metrology: BIPM, Sevres Cedex, France; p. 19 (2012); available at http://www.bipm.org/utils/common/documents/jcgm/JCGM_200_2012.pdf (accessed Sep 2015).

[3] JCGM 200:2012; *International Vocabulary of Metrology - Basic and General Concepts and Associated Terms (VIM)* (2008 version with Minor Corrections), 3rd edition; Joint Committee for Guides in Metrology: BIPM, Sevres Cedex, France; p. 18 (2012); available at http://www.bipm.org/utils/common/documents/jcgm/JCGM_200_2012.pdf (accessed Sep 2015).

[4] JCGM 100:2008; *Guide to the Expression of Uncertainty in Measurement;* (GUM 1995 with Minor Corrections), Joint Committee for Guides in Metrology: BIPM, Sevres Cedex, France (2008); available at http://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed Sep 2015).

[5] 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://www.nist.gov/pml/pubs/index.cfm (accessed Sep 2015).

[6] Chechev, V.P. and Sergeev, V.O., June 2004. ^{129}I. LNE-LNHB/CEA Table of Radionuclides, available at http://www.nucleide.org/DDEP_WG/Nuclides/I-129_tables.pdf (accessed Sep 2015).

Users of this SRM should ensure that the Certificate in their possession is current. This can be accomplished by contacting the SRM Program: telephone (301) 975-2200; fax (301) 948-3730; e-mail srminfo@nist.gov; or via the Internet at http://www.nist.gov/srm.