National Institute of Standards & Technology

Certificate

Standard Reference Material® 4926E

Hydrogen-3 Radioactivity Standard

This Standard Reference Material (SRM) consists of a solution of a standardized and certified quantity of radioactive hydrogen-3 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 20-mL borosilicate-glass serum vial.

The certified **hydrogen-3** massic activity value, at a **Reference Time of 1200 EST, 3 September 1998**, is:

$$\mathbf{(5.038 \pm 0.036)\ kBq \cdot g^{-1}}$$

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 Guide (see Note 1)*. Table 2 contains a specification of the components that comprise the uncertainty analyses.

Expiration of Certification: The certification of **SRM 4926E** is valid, within the measurement uncertainty specified for at least five (5) years after receipt, provided the SRM is handled and stored in accordance with instructions given in this certificate (see "Instructions for Storage, Handling, and Use"). The certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

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

INSTRUCTIONS FOR STORAGE, HANDLING, AND USE

The solution matrix, in an unopened ampoule, is believed to be indefinitely homogeneous and stable, within its half-life-dependent, useful lifetime.

This SRM may represent a radiological hazard. Hydrogen-3 decays by beta particle emission. None of the beta particles escape from the SRM vial. During the decay process no photons are emitted. The SRM should be stored and used at a temperature between 5 ºC and 35 ºC. The vial (or any subsequent container) should always be clearly marked as containing radioactive material. If the vial is transported it should be packed, marked, labeled, and shipped in accordance with the applicable national, international, and carrier regulations. The SRM should be used only by persons qualified to handle radioactive materials.

This Standard Reference Material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, M.P. Unterweger, Group Leader. The overall technical direction and physical measurement leading to certification were provided by L.L. Lucas and M.P. Unterweger of the NIST Radioactivity Group.

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

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See Certificate Revision History located on Last Page

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* Notes and references are on page 4

Table 1. Properties of SRM 4926E

Certified values

Radionuclide	**Hydrogen-3**
Reference time	**1200 EST, 3 September 1998**
Massic activity of the solution	**5.038 kBq•g^{-1}**
Relative expanded uncertainty (k = 2)	**0.72 %** (see Note 1)

Uncertified information

Source description	Liquid in 20 mL borosilicate glass serum vial with a butyl-rubber stopper (septum)
Solution composition	Distilled water
Solution density	(0.998 ± 0.002) g•mL^{-1} at 20 °C (see Note 2)
Solution mass	Approximately 20 g
Radionuclidic impurities	None detected (see Note 3)
Half-lifes used	^{3}H: (4500 ± 8) d (see Note 4)
Calibration method (and instruments)	The certified massic activity for ^{3}H was obtained by 4πβ gas counting of SRM 4927E using the NIST length-compensated internal gas proportional counters and intercomparison of SRMs 4927E/4926E using two 4πβ liquid-scintillation (LS) counting systems (see Note 5)

Table 2. Uncertainty evaluation for the massic activity for SRM 4296E

	Uncertainty component	Assessment Type †	Relative standard uncertainty contribution on massic activity of ^{3}H (%)
1	Massic count rate of SRM 4927E, corrected for background and decay; standard deviation of the mean for 23 sets of gas counting measurements (see Note 5)	A	0.18
2	LS intercomparison of SRM 4926E and SRM 4927E; standard deviation of the mean for 7 sets of LS measurements	A	0.06
3	Decay corrections for ^{3}H; (for half-life uncertainty of 0.18 %)	A	0.002
4	Gram-mole determinations based on pressure, volume and temperature measurements	B	0.20
5	Livetime determinations	B	0.10
6	Extrapolation of count-rate-versus-energy to zero energy	B	0.20
7	Limit for radionuclidic impurities	B	0.05
Relative combined standard uncertainty			0.36
Relative expanded uncertainty (*k* = 2)			0.72

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

NOTES

Note 1. 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 2. The stated uncertainty is two times the standard uncertainty. See reference 2.

Note 3. The estimated lower limit of detection for radionuclidic impurities is 3 $Bq \bullet g^{-1}$.

Note 4. The stated uncertainty is the standard uncertainty. See reference 2.

Note 5. Extensive gas-counting measurements were made on the SRM 4927E solution during 1998 and 1999. The SRM 4926E solution was intercompared with the SRM 4927E using liquid-scintillation counting.

REFERENCES

[1] JCGM 100:2008; *Guide to the Expression of Uncertainty in Measurement;* (ISO 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 Jan 2011).

[2] Taylor B.N. and Kuyatt C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results,* NIST Technical Note 1297, 1994. Available at http://physics.nist.gov/Pubs/guidelines/contents.html (accessed Jan 2011).

[3] L.L Lucas; M.P. Unterweger; *Comprehensive Review and Critical Evaluation of the Half-Life of Tritium,* J. Res. Natl. Inst. Stand. Technol. Vol. 105, pp. 541-549 (2000).

Certificate Revision History: 07 February 2011 (This revision reflects minor editorial changes.); May 2008 (Expiration date revised); February 2007 (Half-life and text revised); October 2000, (Text revised and expiration date extended.); June 1999 (Original certificate issue date).

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) 926-4751; e-mail srminfo@nist.gov; or via the Internet at http://www.nist.gov/srm.