National Institute of Standards & Technology

Certificate

Standard Reference Material 4929F
Iron-55 Radioactivity Standard

This Standard Reference Material (SRM) consists of a solution of a standardized and certified quantity of radioactive iron-55 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 **iron-55** massic activity value, at a **Reference Time of 1200 EST, 30 November 2005**, is:

(58.43 ± 0.99) kBq•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, Dr. M.P. Unterweger, Acting Group Leader. The overall technical direction and physical measurements leading to certification were provided by Drs. R. Collé and L. Laureano-Pérez of the Radioactivity Group with production assistance by D.B. Golas and O. Palabrica, Research Associates 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 4929F

Certified values

Radionuclide	**Iron-55**
Reference time	**1200 EST, 30 November 2005**
Massic activity of the solution	**58.43 kBq•g^{-1}**
Relative expanded uncertainty (k = 2)	**1.7 %** (see Note 2)*

Uncertified information

Source description	Liquid in flame-sealed NIST borosilicate ampoule (see Note 1)
Solution composition	1.0 mol•L^{-1} HCl with 19 μg Fe^{+3} per gram of solution (as $FeCl_3$)
Solution density	(1.014 ± 0.002) g•mL^{-1} at 20.0 °C (see Note 3)
Solution mass	(5.080 ± 0.001) g (see Note 3)
Photon-emitting impurities	None detected (see Note 4)
Half lives used	Iron-55 (1001.1 ± 2.2) d (see Note 5)
Iron-55 average energy per decay	(5.87 ± 0.02) keV (see Note 6)
Calibration method (and instruments)	Comparative measurements of matched sources of the SRM solution against a primary NIST iron-55 standard solution using three liquid scintillation counters. The NIST primary standard solution was gravimetrically linked to a solid source that was primarily standardized by isothermal microcalorimetry.

*Notes and references are in page 4

Table 2. Uncertainty evaluation for the massic activity for SRM 4929F

	Uncertainty component	Assessment Type †	Relative standard uncertainty contribution on massic activity of iron-55 (%)
1	LS measurement precision; reproducibility in activity ratio with 44 sets of cocktails of matched composition; standard deviation of the mean for $\nu = 765$ degrees freedom	A	0.44
2	LS cocktail stability and composition mismatch effects; standard deviation of the mean for $\nu_{eff} = 11$ effective degrees freedom (3 scintillants; 4 aqueous fractions; 2 dilutions)	A	0.58
3	Background LS measurement variability; wholly embodied in components 1& 2	A	---
4	LS counter (energy threshold) dependencies	A	0.06
5	Scintillator dependencies; wholly embodied in components 1 & 2	A	---
6	Gravimetric (mass) measurements for LS sources	B	0.05
7	Gravimetric (mass) measurements for dilutions	B	0.07
8	Live time determinations for LS counting time intervals; includes uncorrected dead time effects	B	0.06
9	Decay corrections for iron-55 (for half-life uncertainty of 0.2 %)	B	0.012
10	Limit for photon-emitting impurities	B	0.08
11	Calorimetric primary standardization of NIST iron-55 solutions	B	0.39
Relative combined standard uncertainty			**0.84**
Relative expanded uncertainty (k = 2)			**1.7**

† = (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 27 Dec. 2005, were:

$500\ s^{-1}\ g^{-1}$ for $20\ keV < E < 30\ keV$
$400\ s^{-1}\ g^{-1}$ for $30\ keV < E < 60\ keV$
$600\ s^{-1}\ g^{-1}$ for $60\ keV < E < 280\ keV$
$900\ s^{-1}\ g^{-1}$ for $280\ keV < E < 1800\ keV$

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

Note 6. The average energy per decay of iron-55 is a nuclear data parameter that was required for the primary iron-55 standardization. It is needed to convert calorimetric power measurements into activity. The adopted value was taken from reference [4].

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), April 2006, lists a half life value of (999.7 ± 4.0) d. The value used here, (1001.1 ± 2.2) d, was taken from the *Table of Radionuclides, Vol. 1 – A=1 to 150*, M.M. Bé, et al., Bureau International des Poids et Measures, Pavillon de Breteuil F-92312 Sèvres Cedex FRANCE (2004) for consistency with international comparisons.

[4] M.M. Bé, National Laboratoire Henri Becquerel, Saclay, France, private communication, September 2004.