National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material® 1634c

Trace Elements in Fuel Oil

This Standard Reference Material (SRM) is intended for use in the evaluation of methods and the calibration of apparatus used for the determination of trace elements in fuel oils and other materials of a similar matrix. SRM 1634c is a commercial "No. 6" residual fuel oil as defined by ASTM D396 - 13c *Standard Specification for Fuel Oils* [1]. A unit of SRM 1634c consists of 100 mL of the fuel oil.

Certified Values: A NIST certified value is a value for which NIST has the highest confidence in its accuracy in that all known or suspected sources of bias have been investigated or taken into account [2]. The certified values for SRM 1634c were established using the equally weighted means of the results of two independent analytical methods. Certified values reported as mass fractions and their uncertainties are listed in Table 1 [3].

Reference Values: A NIST reference value is a noncertified value that is the best estimate of the true value based on available data; however, the value does not meet the NIST criteria for certification [2] and is provided with associated uncertainties that may reflect only measurement reproducibility, may not include all sources of uncertainty, or may reflect a lack of sufficient statistical agreement among multiple analytical methods. Reference values reported as mass fractions and their uncertainties are listed in Table 2 [3].

Information Values: A NIST information value is considered to be a value that will be of use to the SRM user, but insufficient information is available to assess the uncertainty associated with the value or only a limited number of analyses were performed [2]. Information Values cannot be used to establish metrological traceability. Information values as mass fractions and property values are given in Table 3 [3].

Expiration of Certification: The certification of **SRM 1634c** lot is valid, within the measurement uncertainty specified, until **31 December 2023**, provided the SRM is handled and stored in accordance with instructions given in this certificate (see "Instructions for Storage 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.

Overall direction and coordination of the analytical measurements leading to certification were performed by R.L. Watters, Jr., of NIST.

Additional analyses in support of this certification were performed by J. Sieber formerly of Texaco, Inc., (Beacon, NY); and by U. Reus, H. Buddeker, and A. Prange of GKSS Research Center (Geesthacht, Germany).

Homogeneity studies by X-ray fluorescence were performed by P.A. Pella and A.F. Marlow and certification analyses for the various elements were performed by D.A. Becker, R. Demiralp, J.D. Fassett, R.R. Greenberg, W.R. Kelly, K.E. Murphy, P.J. Paulsen, M.S. Rearick, R.Saraswati, G.C. Turk, L.J. Wood, and L. Yu of the NIST Chemical Sciences Division.

Statistical analysis was performed by S.B. Schiller of the NIST Statistical Engineering Division.

Carlos A. Gonzalez, Chief
Chemical Sciences Division

Gaithersburg, MD 20899
Certificate Issue Date: 21 October 2020
Certificate Revision History on Last Page

Steven J. Choquette, Director
Office of Reference Materials

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

INSTRUCTIONS FOR STORAGE AND USE

Storage: When the material is not in use, it should be stored in the tightly sealed bottle.

Use: Because of the viscosity of this material, the SRM unit must first be warmed to 40 °C on a water bath and then shaken vigorously or stirred with a clean stirrer before sampling. Also, the oil contains particulate matter that causes it to be distinctly heterogeneous. Certification of SRM l634c is based on a well-mixed sample size of 1 g as determined by studies performed by X-ray fluorescence, as well as on data from certification analyses. Therefore, a minimum sample size of 1 g should be used for analysis to assure that results are representative of data that can be expected to fall within the uncertainties of the certified values shown on this certificate.

Table 1. Certified Values

Element	Mass Fractions (mg/kg)	Methods of Analysis
Cobalt	0.1510 ± 0.0051	ICP-MS, INAA
Nickel	17.54 ± 0.21	ID-ICPMS, LEI
Vanadium	28.19 ± 0.40	ICP-AES, INAA

The expanded uncertainties of the certified values are at a level of confidence of approximately 95 % and include within-method sources of uncertainty, which were either statistically evaluated (Type A) or evaluated by other means (Type B) [4]. The measurand is the total mass fraction for each analyte listed in Table 1. The certified values are metrological traceable to the SI unit of gram, expressed as milligrams per kilogram.

Table 2. Reference Values

Element	Mass Fraction (mg/kg)	Method of Analysis
Arsenic	0.1426 ± 0.0064	FIA-HAAS, INAA
Selenium	0.1020 ± 0.0038	FIA-HAAS, INAA

The expanded uncertainties of the reference values are estimates at a 95 % confidence level and include within-method sources of uncertainty, which were either statistically evaluated (Type A) or evaluated by other means (Type B) [4]. For arsenic, an allowance for the difference between the methods is also included. The measurand is the mass fraction for each analyte as determined by the methods indicated in Table 2. Reference values are metrological traceable to the SI unit of gram, expressed as milligrams per kilogram and percent.

Table 3. Information Values

Element	Mass Fraction (mg/kg)	Method of Analysis
Barium	1.8	INAA
Chlorine	45	INAA
Sodium	37	INAA
	(%)	
Sulfur	2	ID-TIMS

Properties[(a)]

Kinematic Viscosity	0.000 301 m^2/s at 40 °C
Flash Point	43 °C

[(a)] Properties are based on analysis provided by a commercial laboratory using ASTM methods.

Table 4. Methods of Analysis

FIA-HAAS	Flow-injection hydride generation atomic absorption spectrometry
ICP-AES	Inductively coupled plasma atomic emission spectrometry
ICP-MS	Inductively coupled plasma mass spectrometry
ID-ICPMS	Inductively coupled plasma dilution isotope mass spectrometry
ID-TIMS	Isotope dilution thermal ionization mass spectrometry
INAA	Instrumental neutron activation analysis
LEI	Laser-enhanced ionization

REFERENCES

[1] ASTM D396-13; *Standard Specification for Fuel Oils*, Annual Book of ASTM Standards, Vol. 05.01 (2013).

[2] May, W.; Parris, R.; Beck, C.; Fassett, J.; Greenberg, R.; Guenther, F.; Kramer, G.; Wise, S.; Gills, T.; Colbert, J.; Gettings, R.; MacDonald, B.; *Definitions of Terms and Modes Used at NIST for Value-Assignment of Reference Materials for Chemical Measurements;* NIST Special Publication 260-136; U.S. Government Printing Office: Washington, DC (2000); available at https://www.nist.gov/system/files/documents/srm/SP260-136.PDF (accessed Oct 2020).

[3] Thompson, A.; 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 (2008); available at: https://www.nist.gov/pml/special-publication-811 (accessed Oct 2020)

[4] JCGM 100:2008; *Evaluation of Measurement Data — Guide to the Expression of Uncertainty in Measurement* (GUM 1995 with Minor Corrections); Joint Committee for Guides in Metrology (JCGM) (2008); available at https://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed Oct 2020); 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 https://www.nist.gov/pml/nist-technical-note-1297 (accessed Oct 2020).

Certificate Revision History: 21 October 2020 (Change of expiration; editorial changes); **04 June 2014** (Extension of certification period; change of arsenic and selenium mass fractions to reference values; editorial changes); **08 February 2002** (Extension of certification period); **29 August 1995** (Nickel value corrected); **07 August 1995** (Original certificate date).

Users of this SRM should ensure that the Certificate of Analysis 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 https://www.nist.gov/srm.