National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material® 160b

Stainless Steel (Cr 18-Ni 12-Mo 2)
(AISI 316)

This Standard Reference Material (SRM) is intended for applications in chemical and instrumental methods of analysis. A unit of SRM 160b consists of a bottle containing approximately 150 g of chips.

Certified Mass Fraction Values: Certified values for nine constituents in SRM 160b are provided in Table 1. All values are reported as mass fractions [1]. 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]. A certified value is the present best estimate of the "true" value based on the results of analyses performed at NIST and collaborating laboratories.

Reference Mass Fraction Values: Reference values for three constituents are provided in Table 2. Reference values are non-certified values that are the present best estimates of the true values; however, the values do not meet the NIST criteria for certification and are provided with associated uncertainties that may not include all components of uncertainty [2].

Information Mass Fraction Values: Information values are provided for four constituents in Table 3. An information value is considered to be a value that will be of interest to the SRM user, but insufficient information is available to assess the uncertainty associated with the value. They are intended to provide additional information on the matrix.

Expiration of Certification: The certification of **SRM 160b** is valid indefinitely, within the uncertainty specified, provided the SRM is handled and stored in accordance with the instructions given in this certificate (see "Instructions for Use"). Accordingly, periodic recalibration or recertification of this SRM is not required. 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, NIST will notify the purchaser. Registration (see attached sheet) will facilitate notification.

The original characterization of this material was performed in 1969 under the direction of J.K. Taylor of the National Bureau of Standards (NBS, now NIST). Review and revision of value assignments were performed by J.R. Sieber of the NIST Chemical Sciences Division.

The original analyses were performed by J.R. Baldwin, D.A. Becker, D.W. Bouchette, C.H. Brady, C.E. Champion, E.R. Deardorff, B.I. Diamondstone, R.C. Gauer, T.E. Gills, E.J. Maienthal, M. Margoshes, T.J. Murphy, R.A. Paulson, W.R. Shields, V.C. Stewart, B.A. Thompson, J.L. Weber, and S.A. Wicks of NIST.

Statistical consultation for this SRM was provided by D.D. Leber and J.H. Yen of the NIST Statistical Engineering Division.

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

Carlos A. Gonzalez, Chief
Chemical Sciences Division

Gaithersburg, MD 20899
Certificate Issue Date: 09 November 2012
Certificate Revision History on Last Page

Robert L. Watters, Jr., Director
Office of Reference Materials

Analyses for certification were also performed by J.O. Strauss, Carpenter Technology Corporation, Reading, PA; S. Arvich, M. Crooks, G. Doerfer, A. Phillips, and J. Starr, Laboratory Testing Inc., Hatfield, PA; B. Cardenas, D. Dietz, G. Mann, and P. Schmidt, Anderson Laboratories, Greendale, WI; F. Nguyen, Element Materials Technology, Huntington Beach, CA; and C.E. Bixler, M.A. Michielutti, and K.S. Smith, ESAB Welding & Cutting Products, Hanover, PA.

INSTRUCTIONS FOR USE

To relate analytical determinations to the certified values on this Certificate of Analysis, a minimum sample quantity of 200 mg is recommended. Specimens may be used directly from the bottle without pre-treatment. The material should be stored in its original container in a cool, dry location.

PREPARATION AND ANALYSIS[1]

The material for this standard was prepared at the Duquesne Works, U.S. Steel Corporation, Pittsburgh, PA. Certification analyses were performed using the methods provided in Table 4.

Certified Mass Fraction Values: The certified value for each analyte was calculated as the mean of the means from the individual methods and laboratories. The uncertainty listed with the value is an expanded uncertainty, $U = ku_c$, based on a 95 % confidence level and is calculated according to the method in the ISO Guide [3]. The test methods are shown in Table 4.

Table 1. Certified Mass Fraction Values for SRM 160b Stainless Steel (Cr 18-Ni 12-Mo 2)

Constituent	Mass Fraction (%)	Coverage Factor, *k*
C	0.0445 ± 0.0014	3.20
Co	0.1052 ± 0.0057	2.36
Cr	18.37 ± 0.21	4.30
Cu	0.1734 ± 0.0075	2.26
Mn	1.619 ± 0.075	3.20
Mo	2.386 ± 0.024	2.23
Ni	12.35 ± 0.22	4.30
S	0.0175 ± 0.0032	4.30
V	0.0508 ± 0.0034	2.36

Reference Mass Fraction Values: The reference value for each analyte was calculated as the mean of the means from the individual methods and laboratories. The uncertainty listed with the value is an expanded uncertainty, $U = ku_c$, based on a 95 % confidence level and is calculated according to the method in the ISO Guide [3]. The test methods are shown in Table 4.

Table 2. Reference Mass Fraction Values for SRM 160b Stainless Steel (Cr 18-Ni 12-Mo 2)

Constituent	Mass Fraction (%)	Coverage Factor, *k*
As	0.01067 ± 0.00045	2.6
P	0.0200 ± 0.0012	2.4
Si	0.5093 ± 0.0049	2.6

[1] Certain commercial equipment, instruments or materials are identified in this certificate to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

Information Mass Fraction Values: The information value for each analyte is an estimate obtained from one or more NIST or collaborator test methods. No uncertainty is provided because there is insufficient information available for its assessment.

Table 3. Information Mass Fraction Values for SRM 160b Stainless Steel (Cr 18-Ni 12-Mo 2)

Constituent	Mass Fraction (%)
Bi	<0.0005
N	0.04
Pb	0.001
W	0.11

Table 4. Analytical Methods Used for SRM 160b Stainless Steel (Cr 18-Ni 12-Mo 2)

Element	Method[(a)]
As	11
Bi	13
C	1
Co	11, 15, 16, 17
Cr	8
Cu	6, 15, 16, 17, 18
Mn	2, 19
Mo	10, 15, 16, 17, 18
N	12
Ni	7
P	3
Pb	13
S	4
Si	5
V	9, 15, 16, 17
W	14

[(a)]Key to Methods:

1. Direct combustion followed by gravimetric determination
2. Neutron activation analysis
3. Spectrophotometric molybdenum-blue method
4. Iodometric titration after combustion
5. Gravimetric determination after double dehydration with sulfuric acid
6. Isotope dilution analysis
7. Gravimetric determination after precipitation with dimethylglyoxime
8. Reduction with coulometrically generated ferrous ion
9. Potentiometric titration with ferrous ammonium sulfate after nitric acid oxidation and neutron activation analysis
10. Gravimetry after precipitation with alpha benzoinoxime and ignition to MoO_3
11. Neutron activation analysis
12. Distillation – titration
13. Polarographic determination
14. Alpha-benzoinoxime precipitation, fluoride ion exchange, dithiol extraction, and spectrometric method
15. X-ray fluorescence spectrometry
16. Spark source optical emission spectrometry
17. Inductively coupled plasma optical emission spectrometry
18. Wet chemistry according to ASTM E 353
19. Spectrophotometry after oxidation with ammonium persulfate

REFERENCES

[1] 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 http://www.nist.gov/pml/pubs/index.cfm/ (accessed Nov 2012).

[2] Hahn, G.J.; Meeker, W.Q.; *Statistical Intervals: A Guide for Practitioners*; John Wiley & Sons, Inc., New York (1991).

[3] JCGM 100:2008; Evaluation of Measurement Data — Guide to the Expression of Uncertainty in Measurement (ISO GUM 1995 with Minor Corrections); Joint Committee for Guides in Metrology (JCGM) (2008); available at http://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed Nov 2012); 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://www.nist.gov/pml/pubs/index.cfm (accessed Nov 2012).

Certificate Revision History: 09 November 2012 (Revised values for cobalt, copper, molybdenum, and vanadium; cobalt and molybdenum have been assigned as certified values; editorial changes); 02 October 2009 (Revised assignments and values for all constituents based on re-evaluation of the original analytical results; editorial changes); 21 July 1986 (Revision); 31 August 1981 (Revision); 04 August 1969 (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 at: telephone (301) 975-2200; fax (301) 948-3730; e-mail srminfo@nist.gov; or via the Internet at http://www.nist.gov/srm.