National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material® 2166

Low Alloy Steel

This Standard Reference Material (SRM) is low alloy steel in the form of chips sized to pass through sieve openings between 0.50 mm and 1.18 mm (35 mesh to 16 mesh). It is intended primarily for use in evaluation of chemical and instrumental methods of analysis of steel and materials of similar matrix. It should not be used for calibration. A unit of SRM 2166 consists of one bottle containing approximately 150 g of chips.

Certified Mass Fraction Values: Certified values for 19 constituents of SRM 2166 are reported in Table 1 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 using the test methods shown in Table 4.

Reference Mass Fraction Value: A reference value for one constituent is reported in Table 2. A reference value is a non-certified values that is the present best estimates of the true value. However, the value does not meet the NIST criteria for certification and is provided with an associated uncertainty that may not include all sources of uncertainty [2].

Information Mass Fraction Values: Information values for six constituents are reported 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.

Expiration of Certification: The certification of **SRM 2166** is valid indefinitely, within the measurement uncertainties 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 material 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.

Coordination of the original certification of SRM 2166 was performed by J.I. Schultz, ASTM/NIST Research Associate, and W.P. Reed of the former NIST Office of Standard Reference Materials. Coordination of the reevaluation of boron and sulfur was performed by J.R. Sieber of the NIST Analytical Chemistry Division.

Analyses in the original characterization were performed by J.A. Norris, D.E. Brown, and R.C. Gauer of what is now the NIST Analytical Chemistry Division. Analyses for certification were also performed in the following laboratories: Allegheny Ludlum Steel Corp., Brackenridge, PA by R.M. Crain, G.L. Bergstrom, and C.C. Gabrielli; Analytical Associates, Inc., Detroit, MI by C.K. Deak; Armco Research & Technology, Middletown, OH, by C.C. Borland, D.E. Gillum, and H.P. Vail; General Motors Research Laboratories, Warren, MI, by M.P. Balogh, R.L. Passeno, W.S. Antos, and N.M. Potter; Institut de Recherches de la Sidérurgie Française, Maizieres-Les-Metz, France, by D. Ravaine; Ledoux & Co., Teaneck, NJ, by S. Kallmann and C.L. Maul. Analyses for the update were performed by W.R. Kelly, J.L. Mann, R.L. Paul, and R.D. Vocke of the NIST Analytical Chemistry Division.

Stephen A. Wise, Chief
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Certificate Revision History on Last Page

Robert L. Watters, Jr., Chief
Measurement Services Division

Statistical consultation for this SRM was provided by W.F. Guthrie of the NIST Statistical Engineering Division.

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

INSTRUCTIONS FOR USE

To relate analytical determinations to the certified values in 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 tightly sealed, original bottle in a cool, dry location.

Preparation and Analysis[(1)]: The material for SRM 2166 was vacuum induction melted at the Carpenter Technology Corp., Reading, PA and supplied in the form of rods. The material was cut and packaged at NIST in the NIST Measurement Services Division. Homogeneity testing was performed at NIST and at Lukens Steel Co., Coatesville, PA using spark source optical emission spectrometry.

Certified Value Assignment: The certified values are the equally-weighted means of results obtained by NIST and the collaborating laboratories. The uncertainty is expressed as the combined uncertainty, u_c, based on a combination of replicate measurement variability and an estimation of the combined effects of method variability, possible systematic errors among methods, and material variability. The estimated effective degrees of freedom for u_c is three.

The certified value for sulfur was obtained by regression of results measured by NIST using isotope dilution thermal ionization mass spectrometry. The expanded uncertainty is calculated as $U = ku_c$ where u_c is the combined uncertainty at the level of one standard deviation, and the coverage factor, $k = 2.43$, was determined from the Student's *t*-distribution corresponding to the associated degrees of freedom and 95 % confidence level [3].

Table 1. Certified Mass Fraction Values for SRM 2166

Constituent	Mass Fraction (%)		
Aluminum	0.012	±	0.001
Antimony	0.000 5	±	0.000 2
Arsenic	0.003 5	±	0.000 5
Carbon	0.015	±	0.001
Chromium	0.024	±	0.001
Cobalt	0.002 2	±	0.000 2
Copper	0.015	±	0.001
Lead	0.003	±	0.001
Manganese	0.066	±	0.001
Molybdenum	0.003 5	±	0.000 5
Nickel	0.022	±	0.001
Niobium	0.005	±	0.001
Phosphorus	0.001 2	±	0.000 2
Silicon	0.010	±	0.005
Silver	0.000 5	±	0.000 1
Sulfur	0.002 164	±	0.000 076
Tin	0.001 0	±	0.000 5
Titanium	0.000 7	±	0.000 2
Vanadium	0.009	±	0.001

[(1)]Certain commercial organizations, services, equipment, or materials are identified in this certificate in order to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by the NIST, nor does it imply that the organizations, services, materials, or equipment identified are necessarily the best available for the purpose.

Reference Value Assignment: The reference value for boron is the mean of results obtained by NIST using prompt gamma-ray activation analysis. The expanded uncertainty is calculated as $U = ku_c$ where u_c is the combined uncertainty at the level of one standard deviation, and the coverage factor, $k = 1.98$, was determined from the Student's *t*-distribution corresponding to the associated degrees of freedom and 95 % confidence [3].

Table 2. Reference Mass Fraction Value for SRM 2166

Constituent	Mass Fraction (mg/kg)
Boron	4.365 ± 0.084

Information Value Assignment: The values reported are estimates based on technical evaluation of the results reported from one or more test methods performed by the collaborating laboratories.

Table 3. Information Values for SRM 2166

Constituent	Mass Fraction (mg/kg)
Bismuth	<1
Magnesium	<1
Selenium	35
Tantalum	110
Tellurium	30
Zirconium	4

Table 4. Test Methods for SRM 2166

Combustion with infrared or thermal conductivity detection:	C
Direct current plasma optical emission spectrometry:	Ag, Al, Co, Cr, Cu, Mg, Mn, Mo, Nb, Ni, P, Si, Ti, V, Zr
Flame atomic absorption spectrophotometry:	Cr, Cu, Mn, Ni, Sn, Ti, V
Inductively coupled plasma optical emission spectrometry:	Ag, As, Co, Cr, Cu, Mn, Mo, Nb, Ni, P, Pb, Sb, Si, Sn, Ti, V
Inert gas fusion with infrared detection:	C, S
Isotope dilution thermal ionization mass spectrometry:	S
Photometric methods:	Mn, P
Prompt gamma-ray activation analysis:	B
Zeeman atomic absorption spectrophotometry:	Ag, As, Bi, Pb, Sb, S

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 Jun 2011).

[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 http://www.nist.gov/srm/publications.cfm (accessed Jun 2011).

[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 Jun 2011); 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 Jun 2011).

Certificate Revision History: 03 June 2011 (Revised assignment of values for boron and sulfur based on new analytical determinations; editorial changes); 12 June 1989 (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) 926-4751; e-mail srminfo@nist.gov; or via the Internet at http://www.nist.gov/srm.