National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material® 2164

Low Alloy Steel
(chip form)

This Standard Reference Material (SRM) is a low alloy steel intended primarily for evaluation of methods for analysis of elements in low alloy steel and materials of a similar matrix. It can be used to validate value assignment of in-house reference materials. A unit of SRM 2164 consists of one bottle containing approximately 150 g of chips.

Certified Mass Fraction Values: Certified values for constituents in SRM 2164 are listed in Table 1 as mass fractions of the total amounts of the elements in a steel matrix [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 taken into account [2]. A certified value is the present best estimate of the true value. The certified values are metrologically traceable to the SI derived unit of mass fraction expressed as percent. The expanded uncertainty estimates are expressed at a coverage level of approximately 95 %, using a coverage factor $k = 2.00$ [3-5].

Table 1. Certified Mass Fraction Values in SRM 2164 Low Alloy Steel

Constituent	Mass Fraction (%)	Expanded Uncertainty (%)
Aluminum (Al)	0.0098	0.0021
Arsenic (As)	0.0110	0.0013
Chromium (Cr)	1.4700	0.0058
Copper (Cu)	0.5156	0.0057
Manganese (Mn)	1.219	0.011
Molybdenum (Mo)	0.1982	0.0028
Niobium (Nb)	0.0404	0.0017
Nickel (Ni)	0.2029	0.0035
Phosphorus (P)	0.02079	0.00059
Silicon (Si)	0.0575	0.0058
Sulfur (S)	0.0127	0.0013
Tin (Sn)	0.02087	0.00082
Tantalum (Ta)	0.02919	0.00031
Titanium (Ti)	0.02820	0.00054
Vanadium (V)	0.1059	0.0011
Zirconium (Zr)	0.00171	0.00065

Expiration of Certification: The certification of **SRM 2164** is valid indefinitely, within the measurement uncertainty specified, provided the SRM is handled and stored in accordance with the instructions given in this certificate (see "Instructions for Storage, Handling and Use"). Reference values are expected also to remain valid indefinitely. 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 or register online) will facilitate notification.

Carlos A. Gonzalez, Chief
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Gaithersburg, MD 20899
Certificate Issue Date: 02 April 2018

Steven J. Choquette, Director
Office of Reference Materials

Coordination of technical measurements for the certification of this SRM was performed by J.R. Sieber of the NIST Chemical Sciences Division. Statistical consultation for this SRM was provided by J.H. Yen of the NIST Statistical Engineering Division.

Measurements for value assignment of SRM 2164 were performed by A.F. Marlow, S.A. Rabb and J.R. Sieber of the NIST Chemical Sciences Division. Additional analyses were performed by collaborating laboratories, including C. McNeish, B. McNichols, A. Scrimshaw, and S. Truman of ArcelorMittal Dofasco, Mechanical and Chemical Test Laboratory (Hamilton, ON, Canada), and A. Phillips, R. Crouthamel, S. Stone, A. Deveau, and L. Dilks of Laboratory Testing, Inc. (Hatfield, PA).

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

INSTRUCTIONS FOR STORAGE, HANDLING AND 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 2164 was vacuum induction melted at Carpenter Technology Corp. (Reading, PA) and supplied in the form of rods. The material was chipped and packaged at NIST in the Office of Reference Materials. Homogeneity testing was performed at NIST using X-ray fluorescence spectrometry.

ADDITIONAL CONSTITUENTS: Noncertified values are provided for the following additional constituents in SRM 2164.

Reference Mass Fraction Values: Reference values for constituents of SRM 2164 are reported in Table 2 as mass fractions of the total element in a steel matrix. A reference value is a non-certified value that is the present best estimate of the true value based on available data; however, the value does not meet the NIST criteria for certification and is provided with an associated uncertainty that may reflect only measurement precision, may not include all sources of uncertainty, or may reflect a lack of sufficient statistical agreement among multiple analytical methods [2]. The reference values as determined by the method used, are metrologically traceable to the derived SI unit for mass fraction expressed as percent. The reference values are the equally weighted means of results obtained using the test methods in Table 4. The expanded uncertainty, U, is calculated as $U = ku_c$ where u_c is the combined standard uncertainty of the reported value and $k = 2.00$ is the coverage factor for an approximate confidence level of 95 % [3-5]. The value of u_c incorporates contributions to the uncertainty from random measurement variability, potential systematic differences between laboratories and analytical methods, and possible material heterogeneity.

Table 2. Reference Mass Fraction Values for SRM 2164 Low Alloy Steel

Constituent	Mass Fraction (%)	Expanded Uncertainty (%)
Antimony (Sb)	0.00030	0.00008
Boron (B)	0.0011	0.0001
Carbon (C)	0.598	0.005
Cobalt (Co)	0.010	0.003
Nitrogen (N)	0.0027	0.0006
Tungsten (W)	0.0009	0.0006

[(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: Information values for constituents are reported in Table 3 as mass fractions of the total elements in a steel matrix. The values reported are estimates based on technical evaluation of the results reported from one or more test methods. An information value is a value that may be of interest to the SRM user, but insufficient information is available to assess the uncertainty associated with the value. Information values cannot be used to establish metrological traceability.

Table 3. Information Mass Fraction Values for SRM 2164 Low Alloy Steel

Constituent	Mass Fraction (mg/kg)
Bismuth (Bi)	1
Calcium (Ca)	<1
Cerium (Ce)	<1
Hydrogen (H)	3
Magnesium (Mg)	<1
Oxygen (O)	110
Lead (Pb)	<0.2
Selenium (Se)	2
Tellurium (Te)	2
	(%)
Iron (Fe)	95.1

Table 4. Test Methods for SRM 2164 Low Alloy Steel

Method	Constituents Determined
Arc-spark optical emission spectrometry:	B, C, N, Al, Si, P, S, Ca, Ti, V, Cr, Mn, Co, Ni, Cu, As, Zr, Nb, Mo, Sn, Sb, Pb
Combustion with infrared detection:	C, S
Inductively coupled plasma optical emission spectrometry:	B, Mg, Al, Si, P, Ca, Ti, V, Cr, Mn, Co, Ni, Cu, As, Zr, Nb, Mo, Sn, Ce, Ta
Inductively coupled plasma mass spectrometry:	Se, Sb, Te, W, Pb, Bi
Inert gas fusion with infrared or thermal conductivity detection:	H, N, O
X-ray fluorescence spectrometry:	Al, Si, P, S, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, As, Zr, Nb, Mo, Sn, Ta, W

NOTICE TO USERS

NIST strives to maintain the SRM inventory supply, but NIST cannot guarantee the continued or continuous supply of any specific SRM. Accordingly, NIST encourages the use of this SRM as a primary benchmark for the quality and accuracy of the user's in-house reference materials and working standards. As such, the SRM should be used to validate the more routinely used reference materials in a laboratory. Comparisons between the SRM and in-house reference materials or working measurement standards should take place at intervals appropriate to the conservation of the SRM and the stability of relevant in-house materials. For further guidance on how this approach can be implemented, contact NIST by email at srms@nist.gov.

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 https://www.nist.gov/pml/special-publication-811 (accessed Apr 2018).

[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: Gaithersburg, MD (2000); available at https://www.nist.gov/sites/default/files/documents/srm/SP260-136.PDF (accessed Apr 2018).

[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 (2008); available at http://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed Apr 2018); 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/pubs/tn1297/index.cfm (accessed Apr 2018).

[4] JCGM 101:2008; *Evaluation of Measurement Data – Supplement 1 to the "Guide to the Expression of Uncertainty in Measurement" - Propagation of Distributions Using a Monte Carlo Method*; JCGM (2008); available at http://www.bipm.org/utils/common/documents/jcgm/JCGM_101_2008_E.pdf (accessed Apr 2018).

[5] Efron, B.; Tibshirani, R. J.; *An Introduction to the Bootstrap*, Chapman & Hall, UK (1993).

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.