



Certificate of Analysis

Standard Reference Material[®] 661

AISI 4340 Steel

This Standard Reference Material (SRM) is intended primarily for use in chemical methods of analysis. SRM 661 is in the form of a rod 3.2 mm (1/8 in) in diameter and 51 mm (2 in) long.

The certified values for 29 elements are listed in Table 1; information values for 11 additional elements are listed in Table 2. For all elements, values are reported as mass fractions [1]. The uncertainties for all elements, with the exception of boron, reflect the guidance given in NBS Monograph 148 [2]. The uncertainty for boron is assessed according to the ISO and NIST Guides [3].

Table 1. Certified Values for SRM 661

Element	Composition		Element	Composition	
	Mass Fraction (in %)			Mass Fraction (in %)	
Aluminum (total)	0.021	± 0.005	Nickel	1.99	± 0.01
Antimony	0.0042	± 0.0005	Niobium	0.022	± 0.001
Arsenic	0.017	± 0.001	Phosphorus	0.015	± 0.001
Bismuth	0.0004	± 0.0001	Selenium	0.004	± 0.001
Carbon	0.392	± 0.005	Silicon	0.223	± 0.001
Cerium	0.0013	± 0.0005	Silver	0.0004	± 0.0001
Chromium	0.69	± 0.01	Sulfur	0.015	± 0.001
Cobalt	0.032	± 0.001	Tantalum	0.020	± 0.001
Copper	0.042	± 0.001	Tellurium	0.0006	± 0.0001
Lanthanum	0.0004	± 0.0001	Tin	0.011	± 0.005
Lead	0.000025	± 0.000005	Titanium	0.020	± 0.001
Manganese	0.66	± 0.01	Tungsten	0.017	± 0.005
Molybdenum	0.19	± 0.01	Vanadium	0.011	± 0.001
Neodymium	0.0003	± 0.0001	Zirconium	0.009	± 0.001

Certified Values and Uncertainties: All elements in Table 1 were measured at NIST and the cooperating laboratories using a variety of chemical methods. The certified values and uncertainties for these elements are the present best estimates of the true values based on the results of the cooperative analytical program.

Reference Value of Boron: 5.16 mg/kg ± 0.15 mg/kg

Reference Value and Uncertainty: The reference value for boron was determined by thermal prompt gamma activation analysis at NIST. The expanded uncertainty for boron is calculated as $U = ku_c$, where u_c is intended to represent, at the level of one standard deviation, the combined effect of uncertainty components associated with the measurements and with element inhomogeneity. The coverage factor, $k = 2$, is determined from the Student's t -distribution with 9.1 degrees of freedom and corresponds to an approximate 95 % confidence interval. A reference value is a noncertified value that is the best estimate of the true value; however, the value does not meet NIST criteria for certification and is provided with an associated uncertainty that may reflect only measurement precision and may not include all sources of uncertainty.

Expiration of Certification: The certification of SRM 661 is valid, within the measurement uncertainties specified, until **30 April 2016**. This certification is nullified if the SRM is damaged, contaminated, or modified in any way other than its intended use.

The technical and support aspects involved in the original preparation, certification, and issuance of this SRM were coordinated through the NIST Standard Reference Materials Program by R.E. Michaelis.

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Certificate Issue Date: 24 October 2006
See Certificate Revision History on Last Page

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

Table 2. Information Values From a Single Method of Analysis for SRM 661

Element	Composition Mass Fraction (in %)	Element	Composition Mass Fraction (in %)
Calcium	< 0.0001	Magnesium	0.0001
Germanium	0.006 ^(a)	Nitrogen	0.0037
Gold	< 0.00005	Oxygen	0.0009
Hafnium	0.0002 ^(a)	Praseodymium	0.00014
Hydrogen	< 0.0005 ^(a)	Zinc	0.0001
Iron (by difference)	95.6		

^(a) Approximate value from heat analysis

The overall direction and coordination of the original technical measurements leading to certification were performed under the direction of K.F.J. Heinrich, O. Menis, B.F. Scribner, J.I. Shultz, and J.L. Weber, Jr., of the NIST Analytical Chemistry Division. Coordination of the boron measurements leading to the reference value was performed by R.R. Greenberg and R.M. Lindstrom of the NIST Analytical Chemistry Division.

The original chemical analyses were performed by R. Alvarez, J.R. Baldwin, D.A. Becker, R.K. Bell, R.W. Burke, B.S. Carpenter, E.L. Garner, T.E. Gills, G.J. Lutz, L.A. Machlan, E.J. Maienthal, J. McKay, L.J. Moore, C.W. Mueller, T.J. Murphy, P.J. Paulsen, T.C. Rains, S.D. Rasberry, T.A. Rush, K.M. Sappenfield, B.A. Thompson, S.A. Wicks, and J. Wing of the NIST Inorganic Analytical Research Division. Prompt gamma neutron activation analyses were performed by R.M. Lindstrom of the NIST Analytical Chemistry Division.

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PREPARATION, TESTING, AND ANALYSIS

The material for this standard was vacuum melted and cast, under contract, by the Carpenter Technology Corporation, Reading, PA, to provide material of the highest possible homogeneity. The contract was made possible by a grant from the American Iron and Steel Institute (AISI). Following acceptance of the material, selected portions of the ingots were extensively tested for homogeneity by J.R. Baldwin, D.M. Bouchette, S.D. Rasberry, and J.L. Weber, Jr., of the NIST Inorganic Analytical Research Division. Certification analyses were made on composite samples representative of the accepted lot of material.

REFERENCES

- [1] Taylor, B.N.; *Guide for the Use of the International System of Units (SI)*; NIST Special Publication 811, 1995 ed. (1995).
- [2] Cali, J.P. et al; *The Role of Standard Reference Materials in Measurement Systems*; NBS Monograph 148, p. 21 (1975).
- [3] ISO; *Guide to the Expression of Uncertainty in Measurement*; ISBN 92-67-10188-9, 1st ed.; International Organization for Standardization: Geneva, Switzerland (1993); 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://physics.nist.gov/Pubs/>.

Certificate Revision History: 24 October 2006 (Corrections to the niobium value and its uncertainty); 29 May 2001 (Changes in the boron value and editorial changes); 25 December 1991 (Editorial changes); 15 September 1981 (Changes in the carbon, cobalt, sulfur, and tungsten values); 15 August 1972 (Changes in the arsenic and zirconium values, and the addition of ten certified elements); 23 July 1970 (Originally issued as a provisional certificate).

Users of this SRM should ensure that the certificate in their possession is current. This can be accomplished by contacting the SRM Program at: telephone (301) 9 75-6776; fax (301) 926-4751; e-mail srminfo@nist.gov; or via the Internet at <http://www.nist.gov/srm>.