National Institute of Standards and Technology
U.S. Department of Commerce

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Standard Reference Material® 1766
Low Alloy Steel
CERTIFICATE OF ANALYSIS

Purpose: The certified values delivered by this Standard Reference Material (SRM) are intended primarily for use in validation of chemical and instrumental methods of analysis for element contents of high-purity iron, low alloy steel and similar ferrous alloys. They can be used to validate value assignment of a laboratory's in-house reference materials.

Description: A unit of SRM 1766 consists of one disk approximately 34 mm in diameter and 19 mm thick.

Certified Values: A National Institute of Standards and Technology (NIST) certified value is the present best estimate of the true value [1]. The certified values for SRM 1766 are shown in the table below and are metrologically traceable to the International System of Units (SI) derived unit of mass fraction, expressed as percent.

Certified Values for Elements in SRM 1766

Element	Mass Fraction[(a)] (%)	Element	Mass Fraction[(a)] (%)
Aluminum (Al)	0.012 ± 0.002	Nickel (Ni)	0.021 ± 0.002
Antimony (Sb)	0.0005 ± 0.0002	Niobium (Nb)	0.005 ± 0.001
Arsenic (As)	0.0035 ± 0.0005	Nitrogen (N)	0.0033 ± 0.0003
Carbon (C)	0.015 ± 0.001	Phosphorus (P)	0.002 ± 0.001
Chromium (Cr)	0.024 ± 0.001	Silicon (Si)	0.010 ± 0.005
Cobalt (Co)	0.0020 ± 0.0005	Silver (Ag)	0.0005 ± 0.0001
Copper (Cu)	0.015 ± 0.001	Sulfur (S)	0.0024 ± 0.0002
Lead (Pb)	0.003 ± 0.001	Tin (Sn)	0.0010 ± 0.0005
Manganese (Mn)	0.067 ± 0.002	Titanium (Ti)	0.0005 ± 0.0002
Molybdenum (Mo)	0.0035 ± 0.0005	Vanadium (V)	0.009 ± 0.001

[(a)] Values are expressed as $x \pm u(x)$, where x is the certified value and standard uncertainty $u(x)$ is an evaluation of the combined effects of method imprecision, possible systematic errors among methods, and material variability and is based on judgement. The true value of the analyte is believed to lie within the interval $x \pm 2u(x)$ with approximately 95 % confidence. For guidance in propagating this uncertainty, see reference 2.

Period of Validity: The certification of SRM 1766 is valid indefinitely, within the measurement uncertainty specified. The certified values are nullified if the material is stored or used improperly, damaged, contaminated, or otherwise modified. Periodic recertification of this SRM is not required.

Maintenance of Certified Values: NIST will monitor this SRM during its period of validity. 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.

Non-Certified Values: A non-certified value for one element in SRM 1766 is provided in Appendix A. For additional elements, approximate mass fraction values and limits of quantification all determined by single methods are provided in Appendix B.

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Storage: A disk of SRM 1766 should be stored in its original container in a cool, dry location at room temperature.

Use: The test surface is the side opposite to the labeled surface, which includes the SRM number. The entire thickness of the unit is certified. However, the user is cautioned not to measure disks less than 2 mm thick when using X-ray fluorescence spectrometry. Each packaged disk has been prepared by finishing the test surface using a milling machine. The user must determine the correct surface preparation procedure for each analytical technique. The user is cautioned to use care when either resurfacing the disk or performing additional polishing as these processes may contaminate the surface. It was found by NIST that abrasive paper must be changed frequently during surface grinding. Used paper loses its ability to remove contaminants from the surface of the steel.

Source: The material for SRM 1766 was obtained in rod form from a commercial manufacturer of ferrous alloys. The material was sliced and packaged at NIST.

Preparation: The material for SRM 1766 was vacuum induction melted followed by vacuum arc re-melting at Carpenter Technology Corp. (Reading, PA). The ingots were processed to rod form after material acceptance.

Analysis: Following acceptance of the composition, selected portions of ingot material were tested for homogeneity at NIST, using spark source optical emission spectrometry. Only material meeting a critical evaluation was processed to the final size. The final material was tested for homogeneity by optical emission spectrometry and X-ray fluorescence spectrometry. This material was tested using both the solid disks and chips prepared from the disks. Measurements used to certify SRM 1766 were performed at NIST and collaborating laboratories using test methods commonly used in industry laboratories at the time. Test methods included, but were not limited to, ASTM Standard E322-67 (1985) and ASTM Standard E415-85. The following laboratories participated in the program: Allegheny Ludlum Steel Corp., Analytical Associates, Inc., Bethlehem Steel Corp., Central Bureau for Nuclear Measurements, General Motors Research Laboratories, National Steel Corp., and The Timken Co. The American Iron and Steel Institute Technical Committee on Chemical Analysis provided data for nitrogen.

Notice to Users: NIST strives to maintain the SRM inventory supply, but NIST cannot guarantee the continued or continuous supply of any 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 a laboratory's 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] Beauchamp, C.R.; Camara, J.E.; Carney, J.; Choquette, S.J.; Cole, K.D.; DeRose, P.C.; Duewer, D.L.; Epstein, M.S.; Kline, M.C.; Lippa, K.A.; Lucon, E.; Phinney, K.W.; Polakoski, M.; Possolo, A.; Sharpless, K.E.; Sieber, J.R.; Toman, B.; Winchester, M.R.; Windover, D.; *Metrological Tools for the Reference Materials and Reference Instruments of the NIST Material Measurement Laboratory*; NIST Special Publication 260-136; U.S. Government Printing Office: Washington, DC (2021); available at https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.260-136-2021.pdf (accessed Nov 2021).

[2] Possolo A.M.; *Evaluating, Expressing, and Propagating Measurement Uncertainty for NIST Reference Materials*; NIST SP 260-202 (2020); available at https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.260-202.pdf (accessed Nov 2021).

Certificate Revision History: 12 November 2021 (Correction to units in Appendix B; editorial changes); 21 April 2021 (Addition of statement that non-certified element mass fraction values are found in Appendix B; editorial changes); 02 February 2021 (Correction to boron value and moved to Appendix A as a non-certified value; certificate format updated; editorial changes); 26 February 1993 (Updated values; editorial changes); 05 June 1989 (Original certificate date).

Certain commercial equipment, instruments, or materials may be identified in this Certificate of Analysis 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.

Users of this SRM should ensure that the Certificate of Analysis in their possession is current. This can be accomplished by contacting the Office of Reference Materials 100 Bureau Drive, Stop 2300, Gaithersburg, Maryland 20899-2300; telephone (301) 975-2200; e-mail srminfo@nist.gov; or the Internet at https://www.nist.gov/srm.

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APPENDIX A

Non-Certified Values

Non-Certified Values: Non-certified values are best estimates based on currently available information. However, they do not meet NIST's criteria for certification [1]. Non-certified values should not be used to establish metrological traceability to the International System of Units or other higher-order reference system. They may be used to establish traceability of test results to these values for this reference material.

A non-certified value for SRM 1766 is provided below.

Non-Certified Value for an Element in SRM 1766
This mass fraction value is metrologically traceable to the values for calibration standards used by NIST and collaborating laboratories for multiple test methods.

Element	Mass Fraction[(a)] (mg/kg)
Boron (B)	4.4 ± 0.3

[(a)] This value is expressed as $x \pm U_{95}(x)$, where x is the value and $U_{95}(x)$ is the expanded uncertainty of x. The expanded uncertainty represents the combined effects of measurement repeatability and calibration uncertainty for multiple test methods and material composition variance from multiple independent specimens. While the best estimate of the value lies within the interval $x \pm U_{95}(x)$, this interval may not include the true value. For guidance on using and propagating this uncertainty, see reference 2.

Period of Validity: These non-certified values are valid indefinitely within the measurement uncertainty specified. The value-assignments are nullified if this material is stored or used improperly, damaged, contaminated, or otherwise modified.

Maintenance of Non-Certified Values: NIST will monitor this SRM during its period of validity. If substantive technical changes occur that affect the non-certified value during this period, NIST will update this Appendix. Before using this material, users should obtain the most recent version of this documentation, available free of charge through the https://www.nist.gov/srm website.

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APPENDIX B

Other Information

Approximate mass fraction values for additional elements in SRM 1766 were obtained by one test method applied during the development project. The values have not been confirmed nor have the uncertainties of the values been assessed. This information is provided to help the user assess possible measurement interferences. It cannot be used to establish metrological traceability to the International System of Units or other higher-order reference system. Do not use these values to calibrate or to validate a test method.

Element	Mass Fraction[(a)] (%)	Element	Mass Fraction (%)
Bismuth (Bi)	<0.0001	Tantalum (Ta)	0.006
Cerium (Ce)	0.002	Tellurium (Te)	0.003
Magnesium (Mg)	<0.0005	Tungsten (W)	0.001
Selenium (Se)	0.0035	Zirconium (Zr)	0.0004

(a) The mass fraction values given as 'less than' (<) values represent estimates of the limits of detection for the test methods used to attempt to determine the amounts present in SRM 1766.

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