National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material® 291

Cr-Mo Steel (ASTM A-213)
(chip form)

This Standard Reference Material (SRM) is intended primarily for use in validation of chemical and instrumental methods of analysis for element contents of low alloy steel and materials of similar matrix. It can be used to validate value assignment of a laboratory's in-house reference materials. A unit of SRM 291 consists of one bottle containing approximately 150 g of chips produced by a milling machine.

Certified Mass Fraction Values: Certified values for constituents of SRM 291 are reported in Table 1 as mass fractions of the elements in a steel alloy 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 International System of Units (SI) derived unit of mass fraction (expressed as percent). The expanded uncertainty estimates are expressed at a confidence level of approximately 95 %.

Table 1. Certified Mass Fraction Values for SRM 291

Constituent	Mass Fraction (%)	Expanded Uncertainty (%)
Aluminum (Al total)	0.0041	0.0011
Carbon (C)	0.1769	0.0054
Chromium (Cr)	1.338	0.016
Copper (Cu)	0.0474	0.0032
Manganese (Mn)	0.551	0.010
Molybdenum (Mo)	0.538	0.010
Nickel (Ni)	0.0654	0.0049
Phosphorus (P)	0.0086	0.0014
Silicon (Si)	0.2321	0.0068
Sulfur (S)	0.0198	0.0019

Expiration of Certification: The certification of **SRM 291** is valid indefinitely within the measurement uncertainties specified, provided the SRM is handled and stored in accordance with instructions given in this certificate (see "Instructions for Handling, Storage and Use"). Periodic 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. If substantive technical changes occur that affect the certification, NIST will notify the purchaser. Registration (see attached sheet or register online) will facilitate notification.

Coordination of technical measurements was performed by J.I. Schultz, formerly of NIST. Review and revision of values and uncertainty estimates were coordinated by J.R. Sieber of the NIST Chemical Sciences Division.

Carlos A. Gonzalez, Chief
Chemical Sciences Division

Gaithersburg, MD 20899
Certificate Issue Date: 24 March 2021
Certificate Revision History on Last Page

Steven J. Choquette, Director
Office of Reference Materials

Analyses leading to the value assignments of this SRM were performed by S.A. Wicks, formerly of NIST. Analytical determinations were also performed by E.W. Shipley, G.K. Stewart and P.O. Ecelberger of the United States Steel Corporation (Gary, IN, Geneva, NY, and Fairless Hills, PA), and by M. Dannis and R.L. LeRoy of the Armco Steel Corporation (Middletown, OH).

Statistical consultation for this SRM was provided by A. Possolo of the NIST Statistical Engineering Division.

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

INSTRUCTIONS FOR HANDLING, STORAGE AND USE

Cr-Mo Steel (ASTM A-213) chips may be analyzed in the as-received form. The original, unopened bottles of SRM 291 should be stored at room temperature (20 °C to 25 °C) and away from light. Test methods used to characterize the material employed sample quantities of 0.2 g or more. Before sampling, it is recommended to mix bottle contents by gently inverting and rotating the bottle by hand for at least one minute. A bottle containing unused material should be recapped immediately and stored at room temperature away from light.

PREPARATION AND ANALYSIS[(1)]

The material for SRM 291 was obtained from the United States Steel Corporation (Duquesne, PA). The material was chipped, sieved, blended and bottled at NIST.

Each certified value is an unweighted mean of the results from the methods listed in Table 2. The uncertainty listed with each certified value is an expanded uncertainty about the mean, with coverage factor, $k = 2$, calculated following the ISO/JCGM Guide [3,4].

To use the uncertainty estimates given in this certificate in propagation of uncertainty, divide the expanded uncertainty by $k = 2$ to obtain the combined standard uncertainty.

Table 2. Analytical Methods Used in Value Assignments of SRM 291

Element	Test Methods Used at NIST and Collaborating Laboratories
Aluminum (total)	Mordant blue photometric, Atomic absorption spectrometry (AAS) of soluble and fused insoluble portions
Carbon	Combustion with chromatography detection, Combustion with infrared detection
Chromium	Potassium permanganate titration of excess ferrous ammonium sulfate, AAS
Copper	Copper carbamate – ethylenediaminetetraacetic acid photometric, AAS, Thiosulfate-iodate, Ammonium complexation
Manganese	Sodium metaperiodate photometric, Persulfate-arsenate
Molybdenum	Sodium thiocyanate – stannous chloride photometric, Gravimetric, Photometric
Nickel	Dimethylglyoxime photometric, AAS, Gravimetric dimethylglyoxime precipitation
Phosphorus	Ammonium molybdate photometric, Alkaline persulfate
Silicon	Gravimetric with $HClO_4$ dehydration, Gravimetric with H_2SO_4 dehydration
Sulfur	Combustion with infrared detection, Combustion and iodate titration, Sodium borate fusion
Vanadium	Potassium dichromate titration of excess ferrous ammonium sulfate

[(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.

ADDITIONAL CONSTITUENT

An information value is provided for the following additional constituent in SRM 291. The value is not certified, because NIST cannot vouch fully for the calibrations of the test methods and other details.

Information Mass Fraction Value: An information value for one constituent in SRM 291 is reported as a mass fraction in Table 3. A NIST 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 [2]. Information values cannot be used to establish metrological traceability.

Constituent	Mass Fraction (%)
Vanadium (V)	0.004

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 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] 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 Mar 2021).

[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 https://www.nist.gov/system/files/documents/srm/SP260-136.PDF (accessed Mar 2021).

[3] Sieber, J.R.; Possolo, A.M.; Epstein, M.S.; *A Retuned Horwitz Procedure for Upgrading Certificates of Older Standard Reference Materials*; NIST Special Publication 260-198; available at https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.260-198.pdf (accessed Mar 2021).

[4] 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 https://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed Mar 2021); 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/nist-technical-note-1297 (accessed Mar 2021).

Certificate Revision History: 24 March 2021 (Revised values for certified constituents; added uncertainty estimates for certified constituents; removed reported results range expressed as percent by weight; added information value for vanadium; editorial changes); 01 October 1975 (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; e-mail srminfo@nist.gov; or via the Internet at https://www.nist.gov/srm.