

BRAMMER STANDARD COMPANY, INC.

Certificate of Analysis

BS 130/3

Certified Reference Material for High Carbon Ferrochromium¹

	Certified Value ²	Estimate of Uncertainty ³	Certified Values ⁴
C	6.47	0.04	
Cr	49.1	0.2	
Mn	0.76	0.02	
P	0.015	0.002	
S	0.028	0.003	
Si	6.20	0.09	

Informational Values^{4,5}

Cu (0.01)	Mo (0.003)	Pb (0.0001)	Sn (0.001)	Ti (0.41)
V (0.38)				

Revision: This certified reference material was originally certified as a reference material on June 15, 1987. It was revised on September 03, 2009 to show the statistics used to produce the certified values and estimates of uncertainty. This revision demonstrates stability with additional laboratory testing from ISO 17025 accredited laboratories. Revised values for all elements except Mn are presented. The new revised values all fall within the previous uncertainties, proving stability.

¹ This certificate is a revision. For more information on the nature and extent of the revision, see the revision statement above.

² For each element, the certified value listed is the present best estimate of the true value based on the mean of the weighted results of an interlaboratory testing program. See page 2 for more information on its calculation.

³ For each element, the uncertainty listed is based on a statistical evaluation of the contributions of homogeneity and the interlaboratory testing program. See page 2 for more information on its calculation.

⁴ Values are given in weight percent.

⁵ Values in parentheses are not certified and are provided for information only.

The requirements of ISO Guides 31, 34, and 35 were followed for the preparation of this Certified Reference Material and certificate of analysis. This is a Certified Reference Material as defined by ISO Guide 30.

BS 130/3 * Code for method Certified values listed as weight percent

Analysis	*	C	*	Cr	*	Mn	*	P	*	S	*	Si
1	1	6.261	16	48.77	16	0.67	16	0.011	1	0.014	16	6.06
2	1	6.42	16	48.91	16	0.75	4	0.012867	1	0.025	16	6.10
3	1	6.44	16	49.05873	16	0.75	16	0.013	1	0.026	16	6.1131
4	1	6.51	16	49.08	4	0.763333	16	0.014	1	0.028	16	6.13
5	1	6.51	16	49.21	16	0.78	16	0.014	1	0.030233	16	6.27
6	1	6.52	16	49.31	16	0.78	16	0.015	1	0.031	16	6.30
7	1	6.64			16	0.79	16	0.02	1	0.032	16	6.44
8							16	0.020	1	0.034		
Average		6.47157		49.05646		0.75476		0.01498		0.02753		6.20187
Std dev		0.00038		0.00041		0.00038		0.00035		0.00035		0.00038
H		0.041468		0.236048		0.008508		0.000946		0.001254		0.040082
U ₁		0.041		0.24		0.0085		0.0010		0.0013		0.040
t-statistic		2.45		2.57		2.45		2.36		2.36		2.45
U ₂		0.10		0.61		0.021		0.0024		0.0031		0.098
U ₃		0.038		0.25		0.0079		0.00084		0.0011		0.037
Certified		6.47		49.1		0.76		0.015		0.028		6.20
Uncertainty		0.04		0.2		0.02		0.002		0.003		0.09
Tolerance		0.10		0.6		0.06		0.006		0.009		0.27

BS 130/3 * Code for method Informational values listed as weight percent

Analysis	*	Cu	*	Mo	*	Pb	*	Sn	*	Ti	*	V
1	16	0.009033	5	0.003367	5	0.0001	5	0.0011	4	0.413867	4	0.344433
2	4	0.012									16	0.41
Average		0.01		0.003		0.000100		0.0011		0.41		0.38
Std dev		0.17		0.054		0.000055		0.0087		1.00		1.82
H		0.000793		0.000497		0.00021		0.000359		0.005699		0.005429
U ₁		0.17		0.054		0.00022		0.0087		1.00		1.82
t-statistic		12.71		12.71		12.71		12.71		12.71		12.71
U ₂		2.15		0.68		0.0028		0.11		12.71		23.13
U ₃		1.52		0.68		0.0028		0.11		12.71		16.35
(Informational)		(0.01)		(0.003)		(0.0001)		(0.001)		(0.41)		(0.38)

For each element, in accordance with the requirements of ISO Guides 34 and 35, an effort must be made to account for the effects on the certified value of the uncertainty estimate from homogeneity testing (H) and the uncertainties of the contributing laboratories. The average (A) is calculated using a weighted mean where the reciprocal of the square of each laboratory's combined uncertainty (C_L), calculated from its standard deviation (S_L) and its uncertainty estimate (U_L), is used as the weight (W_L) for its mean (M_L). The standard deviation (S) is calculated as the square root of the reciprocal of the sum of the weights. U₁ is the combined uncertainty from homogeneity and labs. U₂ is U₁ times the coverage factor (95 % t-statistic). U₃ is U₂ divided by the square root of the number of determinations (n). Thus:

$$C_L = \sqrt{S_L^2 + U_L^2} \quad W_L = \frac{1}{C_L^2} \quad A = \frac{\sum_{i=1}^n W_L M_L}{\sum_{i=1}^n W_L} \quad S = \frac{1}{\sqrt{\sum_{i=1}^n W_L}} \quad U_1 = \sqrt{H^2 + S^2} \quad U_2 = t \times U_1 \quad U_3 = \frac{U_2}{\sqrt{n}}$$

All but the final reported values are taken to two significant figures as determined by each quantity's uncertainty estimate. The final reported Uncertainty is U₃ rounded to one significant figure and represents the half width of the 95 % confidence interval for the **Certified** value. The final reported **Certified** value is A rounded to the same decimal place as the Uncertainty. The Tolerance is the half width of the 95 % confidence interval for measurements rounded to the same decimal place as the Uncertainty. The Uncertainty is a measure of the quality of the **Certified** value. The Tolerance is a measure of the expected performance of an analysis.

For further information regarding the confidence interval for the certified value see ISO Guide 35:2006 section 6.

Analytical Method Codes:

Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895
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|---------------------------|---------------------------|---------------------------|
| 1 Combustion (ASTM E1019) | 7 Photometric | 13 Titrimetric |
| 2 Fusion (ASTM E 1019) | 8 Flame Atomic Absorption | 14 DCP Atomic Emission |
| 3 Spark Atomic Emission | 9 GF Atomic Absorption | 15 HG Atomic Fluorescence |
| 4 ICP Atomic Emission | 10 X-Ray Fluorescence | 16 Wet Method |
| 5 ICP Mass Spectrometry | 11 GD Atomic Emission | |
| 6 Gravimetric | 12 GD Mass Spectrometry | |

ICP = Inductively Coupled Plasma GF = Graphite Furnace GD = Glow Discharge
 DCP = Direct Current Plasma HG = Hydride Generation

<u>Laboratory</u>	<u>Location</u>	<u>Registrar</u>	<u>Accreditation</u>
Anderson Laboratories, Inc.	Greendale, WI		
Andrew S. McCreath & Son, Inc.	Harrisburg, PA		
Booth, Garrett, & Blair, Inc.	Ambler, PA		
Carpenter Technology Corporation	Reading, PA		
Ledoux & Company	Teaneck, New Jersey		
R.M. Hardy & Associates LTD.	Edmonton, Alberta		
Union Carbide	Marietta, OH		
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025

PRI = Performance Review Institute

Nadcap = National Aerospace and Defense Contractors Accreditation Program

Analysis: Chemical analyses were made from representative samples for the certified portion of the lot in accordance with ASTM Standard Practice E 1806. The laboratories participating in the testing generally followed the requirements of ISO Standard 17025 before it's existence, although many are now ISO 17025 accredited. Methods of analysis used were a those listed on page 2.

Traceability: Certified Reference Materials were used to validate the analytical data listed on page 2, including SRM, ECRM, and BAS samples.

Homogeneity: This Certified Reference Material (CRM) was tested for homogeneity in accordance with ASTM Standard Method E 826 and found acceptable.

Validity statement: ISO Guide 31 states that the certification should contain an expiration date for all materials where instability has been demonstrated or is considered possible, after which the certified value is no longer guaranteed by the certifying body. The certification of BS 130/3 is valid for at least 20 years at which time stability is verified and a new certificate will be issued. The material needs to be stored in cool, dry conditions to avoid any moisture contamination. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

Source: The stock for this CRM was produced by Union Carbide Corp., River View, OH.

Form: This CRM is bottled with approximately 100 g of powder by Brammer Standard Company, Inc.

Use: This CRM is intended for use by any method of analysis capable of analyzing powders or pressed powders. Refer to ISO Guide 33 for information about the use of Certified Reference Materials.

Sample Preparation: For best results, thoroughly mix the ferrous alloy material immediately before weighing. "Sampling of the sample" weighing techniques should be used. Pour approximately 5 g of the material onto glazed paper and take small portions from various areas of the 5 g. sample when weighing for analysis.

Certificate Number: The unique identification number for this certificate of analysis is REV130/3-091516. You may obtain information on revisions of certificates from the internet at www.brammerstandard.com.

Safety Notice: A Material Safety Data Sheet (MSDS) is not required for this material. This material will not release or otherwise result in exposure to a hazardous chemical, under normal conditions of use. Inquiries concerning this Reference Material should be

directed to:

Brammer Standard Co., Inc.
14603 Benfer Road
Houston, Texas 77069-2895 USA

Phone: (281) 440-9396 Web: www.brammerstandard.com
Fax: (281) 440-4432 Email: contact@brammerstandard.com

Brammer Standard Company, Inc., is accredited by the American Association For Laboratory Accreditation (A2LA) to ISO Guide 34 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials (Certificate Number 656.02)

Brammer Standard Company's Chemical Laboratory is accredited by A2LA to ISO Standard 17025. (Certificate Number 656.01)

By Certificate Number 10539, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9001:2008 by National Quality Assurance (NQA), U.S.A.

The scopes of accreditation are listed on the website: www.brammerstandard.com

References:

Versions used were those available at the time of testing and characterization

- E 826 Standard Practice for Testing Homogeneity of a Metal Lot or Batch in Solid Form by Spark Atomic Emission Spectrometry
- E 1019 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques
- E 1806 Standard Practice for Sampling Steel and Iron for Determination of Chemical Composition

ISO Standard 17025:2005 General requirements for the competence of testing and calibration laboratories

ISO Standard 9001:2008 Quality Management Systems - Requirements

ISO Guide 30:2015 Terms and definitions used in connection with reference materials + 2008 amendment

ISO Guide 31:2015 Reference materials - Contents of certificates and labels

ISO Guide 33:2015 Uses of certified reference materials

ISO Guide 34:2009 General requirements for the competence of reference material producers

ISO Guide 35:2006 Reference Materials - General and statistical principles for certification

ASTM documents available from ASTM, 1916 Race Street, Philadelphia, PA, 19103.

ISO Guides and Standards available from Global Engineering - www.global.ihs.com

Other useful documents available from NIST, U.S. Department of Commerce, Gaithersburg, MD 20899.

NIST Special Publication 260-100, Handbook for SRM Users

NIST Special Publication 829, Use of NIST Standard Reference Materials for Decisions on Performance of Analytical Chemical Methods and Laboratories

Certified by: _____ on September 15, 2016

Beau R. Brammer