

Brammer Standard Company, Inc.

Certificate of Analysis

BS 3952

Certified Reference Material for Carbon-Molybdenum Steel

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³	Certified Value ¹	Estimate of Uncertainty ²
Al	0.048	0.002	N	0.0006	0.0003
B	0.0003	0.0001	Ni	0.111	0.004
C	0.208	0.006	P	0.011	0.001
Cr	0.104	0.003	S	0.021	0.002
Cu	0.201	0.006	Sb	0.0034	0.0009
Fe	98.0	0.2	Si	0.263	0.007
Mn	0.543	0.008	V	0.0014	0.0005
Mo	0.525	0.007			
	Reference Value ¹	Estimate of Uncertainty ²	Reference Values ^{3,4}	Reference Value ¹	Estimate of Uncertainty ²
As	<0.005		Sn	0.0009	0.0005
Ca	<0.005		Ta	0.003	0.002
Co	0.003	0.001	Ti	0.002	0.001
Mg	0.00008	0.00003	W	<0.005	
Nb	<0.005		Zr	<0.005	
Pb	0.0009	0.0006			

¹ 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 3 for more information on its calculation.

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

³ Values are given in weight percent. Values in brackets are reported by difference.

⁴ Reference values are not certified and are provided for information only.

Trace element information values for O are shown on page 4.

The requirements of ISO Guides 30, 31, and 35 were followed for the preparation of this Certified Reference Material and certificate of analysis.

Analysis	*	Al	*	B	*	C	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo	*	N	*	Ni
1	17	0.0435	11	0.0003	3	0.2	3	0.101	3	0.192	3	97.93	3	0.532	11	0.518	2	0.00025	3	0.107
2	4	0.04685	3	0.00031	3	0.202	17	0.10115	3	0.195	16	[97.96]	4	0.537	4	0.518	2	0.00055	3	0.108
3	4	0.04695	3	0.00032	1	0.203	17	0.1025	4	0.1975	16	[97.97]	11	0.538	17	0.5185	2	0.00055	3	0.108
4	3	0.047	3	0.00034	11	0.203	11	0.103	17	0.1995	16	[97.97]	3	0.539	4	0.521	2	0.000677	4	0.109
5	3	0.047	3	0.0004	1	0.2045	3	0.103	4	0.2	16	[97.99]	3	0.539	4	0.521	2	0.0007	17	0.1095
6	4	0.0472			1	0.206	4	0.103	4	0.20			4	0.5415	3	0.524	2	0.00105	4	0.11
7	17	0.04745			1	0.206	4	0.1035	4	0.200			4	0.5415	17	0.5255			17	0.110
8	17	0.0475			1	0.206	3	0.104	3	0.200			4	0.5425	3	0.527			11	0.111
9	11	0.0478			1	0.2067	3	0.104	17	0.200			17	0.544	3	0.528			4	0.1115
10	4	0.048			3	0.208	4	0.105	17	0.2005			17	0.5455	4	0.5285			4	0.1115
11	3	0.0482			1	0.20965	4	0.1055	4	0.2005			4	0.5455	4	0.529			4	0.1125
12	3	0.0482			3	0.211	4	0.1055	11	0.202			17	0.547	4	0.53			3	0.113
13	4	0.0485			1	0.2135	17	0.1065	4	0.202			3	0.547	4	0.5335			4	0.1135
14	4	0.0485			1	0.214	4	0.1115	3	0.206			4	0.55					17	0.1135
15	4	0.050			4	0.22			4	0.206			4	0.5505					4	0.115
16									4	0.2085			4	0.553					4	0.115
Average		0.047510		0.00033		0.207557		0.104225		0.200594		97.964		0.543313		0.524769		0.00063		0.1114
Std Dev		0.000082		0.00013		0.000082		0.000085		0.000079		0.042		0.000079		0.000088		0.00013		0.0029
H		0.0022		0.00029		0.0046		0.0032		0.0045		0.19		0.0077		0.0076		0.00036		0.0034
U ₁		0.0022		0.00031		0.0046		0.0032		0.0045		0.20		0.0077		0.0076		0.00038		0.0044
t-statistic		2.14		2.78		2.14		2.16		2.13		2.78		2.13		2.18		2.57		2.13
U ₂		0.0047		0.00087		0.010		0.0070		0.010		0.54		0.016		0.016		0.0010		0.0094
U ₃		0.0012		0.00039		0.0026		0.0019		0.0024		0.24		0.0041		0.0046		0.00040		0.0024
Certified		0.048		0.0003		0.208		0.104		0.201		98.0		0.543		0.525		0.0006		0.111
Uncertainty		0.002		0.0001		0.006		0.003		0.006		0.2		0.008		0.007		0.0003		0.004
Tolerance		0.006		0.0002		0.018		0.009		0.018		0.5		0.024		0.021		0.0005		0.012

Analysis	*	P	*	S	*	Sb	*	Si	*	V										
1	4	0.00785	1	0.0192	11	0.0022	4	0.246	17	0.0008										
2	11	0.0094	3	0.0194	3	0.0028	3	0.258	3	0.001										
3	3	0.01	1	0.0195	3	0.004	3	0.258	4	0.00105										
4	3	0.0102	1	0.01965	3	0.004	11	0.259	3	0.0011										
5	4	0.0105	1	0.02005	3	0.004	4	0.2605	11	0.0018										
6	4	0.01055	1	0.0202			3	0.261	3	0.0019										
7	4	0.0107	1	0.0205			6	0.2615	3	0.002										
8	4	0.01075	11	0.0205			4	0.262												
9	3	0.011	1	0.0205			4	0.2625												
10	3	0.011	3	0.021			17	0.2625												
11	4	0.011	3	0.021			17	0.2625												
12	4	0.0125	1	0.0216			4	0.2665												
13	18	0.0125	3	0.022			4	0.268												
14			1	0.02285			4	0.27												
15			4	0.023			3	0.273												
16							4	0.2815												
Average		0.010612		0.02081		0.00340		0.263281		0.00138										
Std Dev		0.000088		0.00092		0.00014		0.000079		0.00012										
H		0.0011		0.0015		0.00069		0.0052		0.00048										
U ₁		0.0011		0.0018		0.00070		0.0052		0.00050										
t-statistic		2.18		2.14		2.78		2.13		2.45										
U ₂		0.0024		0.0038		0.0019		0.011		0.0012										
U ₃		0.00067		0.0010		0.00087		0.0028		0.00046										
Certified		0.011		0.021		0.0034		0.263		0.0014										
Uncertainty		0.001		0.002		0.0009		0.007		0.0005										
Tolerance		0.003		0.006		0.0027		0.021		0.0013										

Analysis	*	As	*	Ca	*	Co	*	Mg	*	Nb	*	Pb	*	Sn	*	Ta	*	Ti	*	W
1	3	0.0008	3	0.00002	3	0.002	3	0.000050	11	0.000085	11	0.0002	3	0.0002	3	0.003	3	0.0006	3	0.0008
2	3	0.001	3	0.00003	3	0.002	3	0.00005	3	0.00030	3	0.0003	3	0.001	3	0.003	11	0.0009	11	0.001
3			11	0.0001	3	0.003	3	0.00006			3	0.001	3	0.001	3	0.003	3	0.003	3	0.002
4			3	0.00011	11	0.0033	3	0.00006			3	0.001	4	0.00115			3	0.003		
5			3	0.0005	3	0.0037	11	0.0002			3	0.002	3	0.0013			3	0.003		
Average		0.00100		0.000033		0.00280		0.00008		0.000296		0.00090		0.00093		0.00300		0.00210		0.00091
Std Dev		0.00045		0.000015		0.00014		0.00014		0.000070		0.00014		0.00014		0.00074		0.00014		0.00094
H		0.00043		0.00014		0.00063		0.00018		0.00028		0.00041		0.00041		0.00065		0.00057		0.0004
U ₁		0.00062		0.00014		0.00065		0.00023		0.00028		0.00043		0.00044		0.00099		0.00058		0.0010
t-statistic		12.71		2.78		2.78		2.78		12.71		2.78		2.78		4.30		2.78		4.30
U ₂		0.0078		0.00039		0.0018		0.00064		0.0036		0.0012		0.0012		0.0042		0.0016		0.0044
U ₃		0.0055		0.00017		0.00081		0.00029		0.0026		0.00054		0.00054		0.0024		0.00072		0.0026
Reference		<0.005		<0.005		0.003		0.00008		<0.005		0.0009		0.0009		0.003		0.002		<0.005
Uncertainty						0.001		0.00003				0.0006		0.0005		0.002		0.001		
Tolerance						0.002		0.00007				0.0008		0.0008		0.002		0.001		

Analysis	*	Zr																		
1	11	0.0007																		
2	3	0.001																		
3	3	0.001																		
Average		0.0008																		
Std Dev		0.0014																		
H		0.0004																		
U ₁		0.0014																		
t-statistic		4.30																		
U ₂		0.0061																		
U ₃		0.0035																		
Reference		<0.005																		
Uncertainty																				
Tolerance																				

For each element, in accordance with the requirements of ISO 17034 and Guide 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 multiplied by 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 Uncertainty is a measure of the quality of the **Certified** value.

The Tolerance is a measure of the expected performance of an analysis. This involves further expanding the sample uncertainty to include instrument and operator uncertainty, for those without access to such calculations.

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

Analysis	*	○																		
1	2	3.4																		
2	2	7.3																		
3	2	12																		

Analytical Method Codes:

1	Combustion (ASTM E1019)	7	Photometric	13	Titrimetric
2	Fusion (ASTM E1019)	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	Difference
5	ICP Mass Spectrometry	11	GD Atomic Emission	17	AAS
6	Gravimetric	12	GD Mass Spectrometry	18	Wet

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

Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, 17034
VHG Labs	Manchester, NH	A2LA	17025
W.B. Coleman Testing Laboratories	West Chester, PA		
Dirats Laboratories	Westfield, MA	ANAB	17025
Crucible Specialty Metals	Syracuse, NY		
LECO Corporation	St. Joseph, MI	A2LA	17025
Auburn Analytical Lab, Inc.	Auburn, MI		
Climax Research Services	Farmington Hills, MI		
Charles C. Kawn Company	Broadview, IL		
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, 17034

A2LA = American Association for Laboratory Accreditation
 ANAB = ANSI-ASQ National Accreditation Board

Analysis: Chemical analyses were made on solid pieces and chips prepared by a lathe from representative samples for the certified portion of the lot in accordance with ASTM Standard Practice E1806. The laboratories participating in the testing followed the requirements of ISO Standard 17025.

Traceability: The following Certified Reference Materials were used to validate the analytical data: BAM 031-3, 044-1; BAS 404/2, 454/1, 455/1, 458; BS LAS 1, 11A, 12, 13, 14A, 44, 50D, 208, 230, 232, 1763, 8620G; CKD 165D, 170H; ECRM 085-1, 088, 088-1, 096-1, 097-1, 184, 184-1, 194-1, 481--1; IMZ 1.22; SRM 11H, 13G, 19H, 32E, 50C, 125B, 291, 293, 361, 362, 363, 364, 365, 1270, 1763, 2165, 2166, 2168.

Homogeneity: This Certified Reference Material (CRM) was tested for homogeneity using ASTM Standard Method E826 and found acceptable. It was also examined by spark atomic emission spectrometry and found to be compatible with the following Reference Materials: BAS 454/1; BS 44, 208, 230, 232, 1763, 8620G; SRM 1763.

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 3952 is valid indefinitely. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

Storage: This CRM must be stored in a cool, dry, non-corrosive environment.

Source: The bar stock for this CRM was produced by Carpenter Technology Corporation; Reading, PA.

Form: This CRM is machined in the form of a disc, approximately 38mm in diameter and 19mm thick by Brammer Standard Company, Inc.

Use: This CRM is intended for use in spark atomic emission, glow discharge, and x-ray spectrometric methods of analysis. Refer to ISO Guide 33 for information about the use of Certified Reference Materials.

Certified Area: The entire depth of the CRM may be used.

Caution: As with any bar material, avoid spark atomic emission spectrometric burns in the center of the CRM (5 mm radius), as some segregation may be present.

Sample Preparation: For best analytical results, use the same method for preparing the analytical surface on all reference materials as used for production specimens. Avoid overheating the sample during surface preparation.

Caution: CRM contains significant insoluble soft metal inclusions. Surface smearing may occur. Spark atomic emission spectrometers may require extended preburns to compensate.

Certificate Number: The unique identification number for this certificate of analysis is REV3952-041123. You may obtain information on revisions of certificates from the internet at www.brammerstandard.com.

Safety Notice: A Safety Data Sheet (SDS) 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

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Fax: (281) 440-4432

Web: www.brammerstandard.com
Email: contact@brammerstandard.com

Revision: This certified reference material was originally certified as a reference material on June 26, 1996, before extensive homogeneity studies were employed. The elements B, Fe, Sb, and V have been added to the certified list. N has been changed from informational to certified. Revised values for all elements except Al are presented. Informational values for As, Ca, Co, Mg, Nb, Pb, Sn, Ta, Ti, W, and Zr are provided. All trace data are presented in mg/kg (ppm). One trace element has been added.

Brammer Standard Company, Inc., is accredited by the American Association For Laboratory Accreditation (A2LA) to ISO Standard 17034 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 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

E826 Standard Practice for Testing Homogeneity of a Metal Lot or Batch in Solid Form by Spark Atomic Emission Spectrometry

E1019 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques

E1806 Standard Practice for Sampling Steel and Iron for Determination of Chemical Composition

ISO Standard 17025:2017 General requirements for the competence of testing and calibration laboratories

ISO Standard 9001:2015 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 Standard 17034:2016 General requirements for the competence of reference material producers

ISO Guide 35:2017 Reference Materials - General and statistical principles for certification

ASTM documents available from ASTM, 100 Barr Harbor Dr., West Conshohocken, PA 19428.

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 April 11, 2023.

Beau R. Brammer

President