

# Brammer Standard Company, Inc.

## Certificate of Analysis

### BS 43A

Certified Reference Material for AISI 6150 Low Alloy Steel - UNS Number G61500

	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	<b>Certified Values<sup>2,3,4</sup></b>		Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>C</b>	<b>0.49</b>	0.01		<b>Ni</b>	<b>0.24</b>	0.01
<b>Co</b>	<b>0.008</b>	0.001		<b>P</b>	<b>0.0074</b>	0.0006
<b>Cr</b>	<b>0.92</b>	0.01		<b>S</b>	<b>0.025</b>	0.001
<b>Cu</b>	<b>0.18</b>	0.01		<b>Si</b>	<b>0.252</b>	0.005
<b>Mn</b>	<b>0.82</b>	0.01		<b>Sn</b>	<b>0.011</b>	0.001
<b>Mo</b>	<b>0.059</b>	0.002		<b>V</b>	<b>0.145</b>	0.003
<b>N</b>	<b>0.0072</b>	0.0009				

	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	<b>Reference Values<sup>2,3,4,5</sup></b>		Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>Al</b>	<b>0.003</b>	0.001		<b>Ti</b>	<b>0.002</b>	0.001
<b>Nb</b>	<b>0.0017</b>	0.0007				

#### Informational Values<sup>4,6</sup>

As (0.005)	B (0.0002)	Ca (0.0006)	Fe [96.8]	Mg (0.0001)
O (0.003)	Sb (0.002)	W (0.005)	Zr (0.001)	

<sup>1</sup> This certificate is a revision. For more information on the nature and extent of the revision, see the revision statement on page 5.

<sup>2</sup> 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.

<sup>3</sup> 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.

<sup>4</sup> Values are given in weight percent. Values in brackets are reported by difference.

<sup>5</sup> Reference values not certified and are provided for information only.

<sup>6</sup> Values in parentheses are not certified and are provided for information only.

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

**BS 43A**

\* Code for method

Certified values listed as weight percent

Analysis	*	C	*	Co	*	Cr	*	Cu	*	Mn	*	Mo	*	N	*	Ni	*	P	*	S
1	11	0.484	4	0.004	3	0.9008	3	0.1712	4	0.79	11	0.0582	2	0.007	3	0.23	4	0.006	4	0.024
2	3	0.4868	3	0.0075	3	0.9036	3	0.1728	3	0.811	3	0.0584	2	0.00715	3	0.232	4	0.00675	1	0.02423
3	4	0.487	3	0.0079	3	0.9064	3	0.1728	4	0.813	4	0.059	2	0.0072	11	0.233	4	0.007	1	0.02483
4	3	0.4874	11	0.0079	3	0.9108	3	0.1728	3	0.816	11	0.0591	2	0.00727	11	0.233	3	0.007	11	0.0254
5	3	0.4878	4	0.008	4	0.915	3	0.18	4	0.81675	4	0.0593	2	0.00727	4	0.237	3	0.007	1	0.02543
6	3	0.488571	4	0.0088	3	0.916	4	0.18	11	0.818	3	0.0594	2	0.0075	4	0.24	3	0.0072	11	0.0256
7	11	0.489	11	0.0095	4	0.93	3	0.18	3	0.8208	3	0.0594	4	0.0075	3	0.2406	3	0.0074	3	0.0258
8	1	0.489333			11	0.93	11	0.184	3	0.8216	3	0.0594	2	0.0077	3	0.2408	3	0.008	1	0.0259
9	3	0.49			11	0.93	11	0.185	3	0.8218	4	0.05975			3	0.2412	3	0.008	1	0.026
10	3	0.491			4	0.93275	4	0.1885	11	0.822	3	0.0598			3	0.2428	11	0.0082	3	0.0262
11	1	0.4915			4	0.935	4	0.19	4	0.825	4	0.06			4	0.243	11	0.0083	1	0.027
12	1	0.49175			3	0.938	4	0.190	3	0.8254	4	0.060								
13	1	0.492667									4	0.06								
14	1	0.493																		
15	1	0.4965																		
16	1	0.497																		
17	1	0.4975																		
18	3	0.502																		
19	3	0.505																		
20	1	0.505333																		
21	3	0.505333																		
22	1	0.507333																		
Average		0.4951		0.00813		0.920696		0.1800		0.816779		0.0590		0.00719		0.237582		0.007350		0.0255
Std Dev		0.0050		0.00040		0.000091		0.0041		0.000091		0.0022		0.00058		0.000095		0.000095		0.0011
H		0.0073		0.0010		0.010		0.0043		0.0097		0.0025		0.0009		0.0050		0.00095		0.00165
U <sub>1</sub>		0.0089		0.0011		0.010		0.0059		0.0097		0.0033		0.0011		0.0050		0.00095		0.0020
t-statistic		2.08		2.45		2.20		2.20		2.20		2.18		2.36		2.23		2.23		2.23
U <sub>2</sub>		0.018		0.0026		0.023		0.013		0.021		0.0072		0.0026		0.011		0.0021		0.0044
U <sub>3</sub>		0.0039		0.0010		0.0066		0.0038		0.0061		0.0020		0.00092		0.0033		0.00064		0.0013
Certified		<b>0.49</b>		<b>0.008</b>		<b>0.92</b>		<b>0.18</b>		<b>0.82</b>		<b>0.059</b>		<b>0.0072</b>		<b>0.24</b>		<b>0.0074</b>		<b>0.025</b>
Uncertainty		0.01		0.001		0.01		0.01		0.01		0.002		0.0009		0.01		0.0006		0.001
Tolerance		0.03		0.003		0.03		0.03		0.03		0.007		0.0026		0.03		0.0021		0.004

Analysis	*	Si	*	Sn	*	V
1	3	0.248	11	0.0077	3	0.1414
2	4	0.249	4	0.0086	3	0.1426
3	4	0.25	4	0.0097	3	0.1426
4	4	0.25	4	0.01	3	0.143
5	3	0.251	3	0.0105	3	0.1436
6	11	0.253	3	0.0106	4	0.1445
7	11	0.254	3	0.011	11	0.145
8	3	0.2552	3	0.011	11	0.145
9	3	0.2568	3	0.0112	3	0.147
10	3	0.2574	3	0.0114	4	0.148
11	3	0.258	11	0.0116	4	0.15
12			4	0.0125	4	0.15
13			4	0.013		
Average		0.2522		0.01100		0.145225
Std Dev		0.0048		0.00041		0.000091
H		0.0051		0.0011		0.0038
U <sub>1</sub>		0.0070		0.0012		0.0038
t-statistic		2.23		2.18		2.20
U <sub>2</sub>		0.016		0.0026		0.0085
U <sub>3</sub>		0.0047		0.00073		0.0024
Certified		<b>0.252</b>		<b>0.011</b>		<b>0.145</b>
Uncertainty		0.005		0.001		0.003
Tolerance		0.016		0.003		0.009

**BS 43A** \* Code for method Reference values listed as weight percent

Analysis	*	Al	*	Nb	*	Ti
1	3	0.0019	4	0.001	4	0.0009
2	4	0.002	11	0.0017	4	0.001
3	4	0.002	11	0.0018	11	0.0011
4	11	0.0026	3	0.002	3	0.0012
5	3	0.0026	3	0.002	11	0.0014
6	4	0.0033			3	0.0015
7	3	0.0034			4	0.002
8	3	0.0036			4	0.003
9	3	0.0038			3	0.003
10	3	0.004			3	0.003
11	4	0.004			3	0.003
12	11	0.004			3	0.003
Average		0.003100		0.00170		0.0019
Std Dev		0.000091		0.00014		0.00022
H		0.00066		0.00052		0.000544
U <sub>1</sub>		0.00067		0.00054		0.00059
t-statistic		2.20		2.78		2.20
U <sub>2</sub>		0.0015		0.0015		0.0013
U <sub>3</sub>		0.00042		0.00067		0.00037
Reference		<b>0.003</b>		<b>0.0017</b>		<b>0.002</b>
Uncertainty		0.001		0.0007		0.001
Tolerance		0.002		0.0015		0.002

**BS 43A** \* Code for method Informational values listed as weight percent

Analysis	*	As	*	B	*	Ca	*	Fe	*	Mg	*	O	*	Sb	*	W	*	Zr
1	11	0.0041	11	0.000054	3	0.0005	16	[96.8]	3	0.000094	2	0.00273	3	0.0009	3	0.0003	11	0.0003
2	11	0.0052	3	0.0002	3	0.0005	16	[96.81]	11	0.0002	2	0.00285	11	0.0016	3	0.0014	3	0.0013
3	3	0.0062	11	0.0002	11	0.0006	16	[96.82]			2	0.00293	11	0.0019	11	0.0015	3	0.0013
4	3	0.0062	3	0.0002	11	0.0006	16	[96.84]			2	0.0032	3	0.0024	4	0.01	11	0.002
5															4	0.0125		
Average		0.005		0.000164		0.0006		96.818		0.000147		0.003		0.0017		0.005		0.0012
Std Dev		0.052		0.000089		0.0012		0.048		0.000098		0.022		0.0092		0.044		0.0053
H		0.001		0.00023		0.0004		0.19		0.00022		0.001		0.0005		0.001		0.0005
U <sub>1</sub>		0.052		0.00024		0.0012		0.20		0.00024		0.022		0.0092		0.044		0.0053
t-statistic		3.18		3.18		3.18		3.18		12.71		3.18		3.18		2.78		3.18
U <sub>2</sub>		0.17		0.00078		0.0039		0.62		0.0031		0.069		0.029		0.12		0.017
U <sub>3</sub>		0.083		0.00039		0.0020		0.31		0.0022		0.035		0.015		0.054		0.0084
Informational		(0.005)		(0.0002)		(0.0006)		[96.8]		(0.0001)		(0.003)		(0.002)		(0.005)		(0.001)

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<sub>L</sub>), calculated from its standard deviation (S<sub>L</sub>) and its uncertainty estimate (U<sub>L</sub>), is used as the weight (W<sub>L</sub>) for its mean (M<sub>L</sub>). The standard deviation (S) is calculated as the square root of the reciprocal of the sum of the weights. U<sub>1</sub> is the combined uncertainty from homogeneity and labs. U<sub>2</sub> is U<sub>1</sub> multiplied by the coverage factor (95 % t-statistic). U<sub>3</sub> is U<sub>2</sub> 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 U<sub>3</sub> 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.

**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     |                           |
| 6 Gravimetric             | 12 GD Mass Spectrometry   |                           |

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

Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, 17034
Copperweld Steel Company	Warren, OH		
LECO Corporation	St. Joseph, MI		
Crucible Specialty Metals	Syracuse, NY		
Dirats Laboratories	Westfield, MA		
Midstates Analytical Laboratories	Tulsa, OK		
Jones & Laughlin Steel Corporation	Pittsburgh, PA		
VHG Labs	Manchester, NH		

A2LA = American Association for Laboratory Accreditation

**Analysis:** Chemical analyses were made on solid pieces and chips prepared by end mill 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: 13X61500; BAS 483; BS 43A, 62A, 62B, 67B, 73B, 4130, 4140C, 8620C; CKD CZ2004A; DSZU CA013; JSS 514-3; SRM 361, 1162; YSBC 31901.

**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 — 3X61500; BAS 483; BS 43A, 62A, 62B, 67B, 73B, 4130, 4140C, 8620C; CKD CZ2004A; DSZU CA013; JSS 514-3; SRM 361, 1162; YSBC 31901.

**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 43A 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 Colt Industries Crucible, Inc., New York, NY.

**Form:** This CRM is machined in the form of a disc, approximately 41 mm in diameter and 19 mm 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 REV43A-102720. You may obtain information on revisions of certificates from the internet at [www.brammerstandard.com](http://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

Phone: (281) 440-9396 Web: [www.brammerstandard.com](http://www.brammerstandard.com)

Fax: (281) 440-4432

Email: [contact@brammerstandard.com](mailto:contact@brammerstandard.com)

**Revision:** This certified reference material was originally certified as a reference material on May 20, 1987. This certificate was revised on April 08, 1992 because it was tested by additional laboratories. It was again revised on December 4, 2009 to show uncertainties. A comprehensive homogeneity study, including additional information about its contribution to the uncertainty estimates, was performed. Al and Ti have been changed from certified to Reference. Revised values for all elements except Co and Si are presented. A reference value for Nb was provided. Informational values for As, B, Ca, Fe, Mg, O, Sb, W, and Zr are provided. All trace data are presented in mg/kg (ppm). Zn trace value 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](http://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 17025:2005 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 35:2006 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](http://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 October 27, 2020.

Beau R. Brammer  
President