

# Brammer Standard Company, Inc.

## Certificate of Analysis

### BS 42

Certified Reference Material for AISI Modified Grade 4150 Steel

	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	Certified Values <sup>3</sup>	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>Al</b>	<b>0.020</b>	0.002	<b>N</b>	<b>0.008</b>	0.001
<b>C</b>	<b>0.518</b>	0.009	<b>Ni</b>	<b>0.188</b>	0.008
<b>Cr</b>	<b>0.663</b>	0.009	<b>P</b>	<b>0.020</b>	0.001
<b>Cu</b>	<b>0.251</b>	0.006	<b>S</b>	<b>0.074</b>	0.004
<b>Fe</b>	<b>96.6</b>	0.2	<b>Si</b>	<b>0.234</b>	0.007
<b>Mn</b>	<b>1.22</b>	0.02	<b>Ti</b>	<b>0.0017</b>	0.0006
<b>Mo</b>	<b>0.191</b>	0.008	<b>V</b>	<b>0.0031</b>	0.0007

	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	Reference Values <sup>3,4</sup>	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>As</b>	<b>0.006</b>	0.002	<b>O</b>	<b>0.003</b>	0.001
<b>B</b>	<b>&lt;0.005</b>		<b>Pb</b>	<b>&lt;0.005</b>	
<b>Ca</b>	<b>&lt;0.005</b>		<b>Sn</b>	<b>0.011</b>	0.005
<b>Co</b>	<b>0.011</b>	0.003	<b>Ta</b>	<b>&lt;0.05</b>	
<b>Mg</b>	<b>&lt;0.005</b>		<b>W</b>	<b>&lt;0.005</b>	
<b>Nb</b>	<b>0.0012</b>	0.0006			

<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> 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.

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\* Code for method

Certified values listed as weight percent

Analysis	*	Al	*	C	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo	*	N	*	Ni	*	P	
1	3	0.0171	3	0.50575	4	0.65	11	0.246	16	[96.56]	11	1.2	3	0.185	2	0.00765	4	0.18	4	0.017	
2	11	0.0178	1	0.51	4	0.6600	11	0.246	16	[96.565]	11	1.21	11	0.186	2	0.00767	3	0.18675	3	0.0187	
3	11	0.0182	4	0.5100	11	0.662	4	0.25	16	[96.57]	3	1.22	11	0.187	2	0.0078	3	0.19	3	0.0189	
4	3	0.0186	3	0.513	11	0.663	4	0.2500	16	[96.6]	3	1.22	4	0.1900	2	0.0082	3	0.1900	11	0.0203	
5	4	0.019	4	0.517	3	0.667	3	0.251	16	[96.61]	3	1.2225	4	0.19	2	0.00823	11	0.19	4	0.0205	
6	3	0.02025	1	0.518667	3	0.668	3	0.252			4	1.2300	3	0.198			4	0.19	3	0.02075	
7	4	0.0220	3	0.519	3	0.672	3	0.25875			4	1.24	3	0.199			11	0.191	11	0.0208	
8	4	0.023	1	0.522																4	0.0210
9			1	0.523333																	
10			11	0.526																	
11			11	0.53																	
Average		0.01949		0.517705		0.66314		0.2508		96.581		1.22036		0.1910		0.0082		0.18825		0.01979	
Std Dev		0.00011		0.000095		0.00012		0.0046		0.043		0.00012		0.0042		0.0018		0.00012		0.00098	
H		0.0015		0.0075		0.0086		0.0051		0.19		0.012		0.0044		0.0010		0.0044		0.0015	
U <sub>1</sub>		0.0015		0.0075		0.0086		0.0069		0.19		0.012		0.0061		0.0021		0.0044		0.0018	
t-statistic		2.36		2.23		2.45		2.45		2.78		2.45		2.45		2.78		2.45		2.36	
U <sub>2</sub>		0.0035		0.017		0.021		0.017		0.54		0.030		0.015		0.0057		0.011		0.0042	
U <sub>3</sub>		0.0012		0.0050		0.0080		0.0064		0.24		0.011		0.0057		0.0026		0.0041		0.0015	
Certified		<b>0.020</b>		<b>0.518</b>		<b>0.663</b>		<b>0.251</b>		<b>96.6</b>		<b>1.22</b>		<b>0.191</b>		<b>0.008</b>		<b>0.188</b>		<b>0.020</b>	
Uncertainty		0.002		0.009		0.009		0.006		0.2		0.02		0.008		0.001		0.008		0.001	
Tolerance		0.006		0.027		0.027		0.018		0.5		0.06		0.024		0.003		0.024		0.004	

Analysis	*	S	*	Si	*	Ti	*	V													
1	4	0.0690	3	0.227	4	0.001	4	0.0026													
2	1	0.070133	4	0.2300	11	0.0011	11	0.0028													
3	1	0.072	4	0.231	3	0.0012	11	0.0029													
4	1	0.0728	3	0.232	3	0.0014	4	0.0030													
5	11	0.0738	3	0.234	11	0.0014	3	0.0035													
6	1	0.0745	4	0.238	3	0.004	3	0.0037													
7	4	0.075	11	0.24																	
8	11	0.0752	11	0.241																	
9	3	0.0768																			
10	3	0.0785																			
11	3	0.08																			
Average		0.074339		0.2344		0.00168		0.00308													
Std Dev		0.000095		0.0047		0.00013		0.00013													
H		0.0027		0.0049		0.00052		0.00066													
U <sub>1</sub>		0.0027		0.0068		0.00053		0.00067													
t-statistic		2.23		2.36		2.57		2.57													
U <sub>2</sub>		0.0061		0.016		0.0014		0.0017													
U <sub>3</sub>		0.0018		0.0057		0.00056		0.00071													
Certified		<b>0.074</b>		<b>0.234</b>		<b>0.0017</b>		<b>0.0031</b>													
Uncertainty		0.004		0.007		0.0006		0.0007													
Tolerance		0.012		0.021		0.0016		0.0021													

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\* Code for method

Reference values listed as weight percent

Analysis	*	As	*	B	*	Ca	*	Co	*	Mg	*	Nb	*	O	*	Pb	*	Sn	*	Ta
1	3	0.00625	4	0.0016	3	0.0001	4	0.0087	3	0.0002	11	0.000014	2	0.00235	4	0.0010	4	0.006	3	0.009
2	3	0.0063					11	0.0092			11	0.0008	2	0.00245			4	0.0100		
3	3	0.0064					11	0.0099			3	0.0009	2	0.0030			3	0.0127		
4							4	0.010			3	0.0013					3	0.0127		
5							3	0.0109			3	0.003					3	0.013		
6							3	0.0114			4	0.0030					4	0.014		
7							3	0.01275												
8							4	0.0160												
Average		0.00634		0.002		0.000100		0.01062		0.00020		0.00122		0.0030		0.0010		0.01140		0.009
Std Dev		0.00044		0.017		0.000055		0.00062		0.00010		0.00039		0.0013		0.0073		0.00013		0.010
H		0.00089		0.001		0.00019		0.0011		0.00024		0.00046		0.0007		0.0004		0.0011		0.001
U <sub>1</sub>		0.00099		0.017		0.00020		0.0013		0.00026		0.00061		0.0015		0.0074		0.0012		0.010
t-statistic		4.30		12.71		12.71		2.36		2.36		2.57		4.30		12.71		2.57		12.71
U <sub>2</sub>		0.0043		0.21		0.0026		0.0030		0.0033		0.0016		0.0063		0.093		0.0030		0.13
U <sub>3</sub>		0.0025		0.21		0.0026		0.0011		0.0033		0.00064		0.0036		0.093		0.0012		0.13
Reference		<b>0.006</b>		<b>&lt;0.005</b>		<b>&lt;0.005</b>		<b>0.011</b>		<b>&lt;0.005</b>		<b>0.0012</b>		<b>0.003</b>		<b>&lt;0.005</b>		<b>0.011</b>		<b>&lt;0.05</b>
Uncertainty		0.002						0.003		0.006		0.0006		0.001		0.005		0.005		0.005
Tolerance		0.005						0.009		0.009		0.0011		0.002		0.010		0.010		0.010



Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, 17034
Allegheny Ludlum	Lockport, NY		
Midstates Analytical Laboratories, Inc.	Tulsa, OK		
LECO Corporation	St. Joseph, MI	A2LA	17025
Crucible Specialty Metals	Syracuse, NY		
Hoesch Stahl AG	Dortmund, Germany		
VHG Labs	Manchester, NH	A2LA	17025, Guide 34

A2LA = American Association for Laboratory Accreditation

**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: BAS 410/2, 453/1, 455; BS CSN 2-2, 42A, 59A, 66A, 4140C, 8822; ECRM 096-1D; JSM M402-4; JSS 501-3; NCS NS20035b; SRM 8J, 1269; TS N004; USS K; YSBC 41340b.

**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 453/1; BS 42A, 59A, 66A, 4140C, 8822; ECRM 096-1D; JSS 501-3; SRM 1269; USS K.

**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 42 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 Earle M. Jorgensen Co.; Houston, TX.

**Form:** This CRM is machined in the form of a disc, approximately 44mm 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 42-051723. 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 March 20, 1992, before extensive homogeneity studies were employed. A comprehensive homogeneity study, including additional information about its contribution to the uncertainty estimates, was performed and the certificate revised on December 4, 2009 as a reference material. Another comprehensive homogeneity study was performed and this became a certified reference material on May 17, 2023. The revision supplies uncertainty estimates for all certified elements. The element Fe has been added to the certified list. Ti has been changed from informational to certified. Co and Sn have been changed from certified to reference. Revised values for all elements except Al are presented. Reference values for B, Ca, Mg, O, Pb, and Ta are provided.

**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 35:2017 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](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 May 17, 2023.

Beau R. Brammer

President