

# Brammer Standard Company, Inc.

## Certificate of Analysis

### BS 9325B

Certified Reference Material for Low Alloy Steel

	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	<b>Certified Values<sup>3</sup></b>	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>Al</b>	<b>0.027</b>	0.003		<b>Ni</b>	0.05
<b>As</b>	<b>0.0033</b>	0.0008		<b>O</b>	0.001
<b>C</b>	<b>0.254</b>	0.005		<b>P</b>	0.003
<b>Co</b>	<b>0.0073</b>	0.0009		<b>Pb</b>	0.0006
<b>Cr</b>	<b>1.22</b>	0.02		<b>S</b>	0.0009
<b>Cu</b>	<b>0.166</b>	0.008		<b>Si</b>	0.02
<b>Fe</b>	<b>94.0</b>	0.1		<b>Ti</b>	0.0006
<b>Mn</b>	<b>0.504</b>	0.009		<b>V</b>	0.0005
<b>Mo</b>	<b>0.203</b>	0.009		<b>W</b>	0.0006
<b>N</b>	<b>0.0112</b>	0.0009		<b>Zr</b>	0.0004

	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	<b>Reference Values<sup>3,4</sup></b>	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>B</b>	<b>0.0003</b>	0.0002		<b>Nb</b>	0.001
<b>Ca</b>	<b>0.004</b>	0.002		<b>Sb</b>	<0.05
<b>H</b>	<b>0.0002</b>	0.0001		<b>Sn</b>	0.001
<b>Mg</b>	<b>&lt;0.005</b>			<b>Ta</b>	0.001

<sup>1</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>2</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>3</sup> Values are given in weight percent. Values in brackets are reported by difference.

<sup>4</sup> Reference values are not certified and are provided for information only.

Trace element information values for Zn are shown on page 3.

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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Analysis	*	Al	*	As	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo	*	N
1	4	0.0216333	3	0.002	1	0.2405	5	0.005767	11	1.19	3	0.154333	13	93.8406667	4	0.486	5	0.187333	2	0.010733
2	14	0.0221667	15	0.002433	1	0.249567	11	0.0059	4	1.200367	4	0.156667	3	93.95	4	0.494667	4	0.195333	2	0.0109
3	5	0.0237	5	0.002523	1	0.249667	5	0.0064	4	1.203667	4	0.157233	10	93.9766667	4	0.4956	4	0.198667	2	0.0112
4	3	0.0245333	5	0.002567	3	0.25	4	0.006894	4	1.203733	4	0.160067	16	[93.98]	4	0.49668	10	0.199333	2	0.0112
5	4	0.026	5	0.0026	11	0.25	3	0.007	4	1.208	4	0.1605	16	[93.99]	4	0.499167	3	0.199667	2	0.011233
6	4	0.0264	4	0.0027	3	0.25	4	0.007	3	1.22	5	0.164	16	[93.9925334]	3	0.50	4	0.199933	2	0.011333
7	4	0.0264814	10	0.003	4	0.2521	4	0.0070	4	1.222754	14	0.164667	16	[94.02]	4	0.5	4	0.200039	2	0.011333
8	3	0.027	9	0.003233	4	0.253268	8	0.00701	3	1.223333	4	0.1653	16	[94.036334]	3	0.501	4	0.2008	2	0.0115
9	11	0.0274	10	0.003567	1	0.254667	4	0.007033	4	1.223333	3	0.165667	4	94.0953667	4	0.502233	4	0.200933	2	0.011767
10	4	0.0277667	4	0.003733	4	0.254667	4	0.007097	4	1.224667	3	0.166	4	94.1	14	0.502667	14	0.201667		
11	4	0.0278333	4	0.004067	1	0.255	14	0.0073	10	1.229	10	0.166333	14	94.1	8	0.503333	3	0.202		
12	4	0.0280	4	0.0041	3	0.255667	4	0.007533	3	1.23	4	0.167667	16	[94.31333]	7	0.504333	4	0.2028		
13	3	0.0283333	4	0.004824	1	0.257667	5	0.007553	14	1.23	4	0.169			11	0.508	11	0.205		
14	3	0.0302	11	0.0051	1	0.259	3	0.008	4	1.234733	4	0.169333			3	0.508667	4	0.205667		
15	4	0.0307			1	0.259	4	0.0087	4	1.237433	4	0.169467			10	0.509667	4	0.208		
16					1	0.271	10	0.0088	4	1.238333	3	0.17			10	0.51	10	0.209		
17							3	0.009367	10	1.24	10	0.17			4	0.512667	3	0.21		
18									3	1.243333	11	0.171			3	0.514667	3	0.223333		
19											8	0.174333			4	0.517333				
20											7	0.174667								
Average		0.02678		0.003318		0.2541		0.00728		1.222372		0.165812		94.038		0.503509		0.202750		0.01118
Std Dev		0.00088		0.000085		0.0034		0.00024		0.000075		0.000071		0.033		0.000073		0.000075		0.00045
H		0.0016855		0.00068		0.005128		0.000943		0.012112		0.004108		0.18564721		0.007394		0.004558		0.001136
U <sub>1</sub>		0.0019		0.00069		0.0061		0.00097		0.012		0.0041		0.19		0.012		0.0046		0.0012
t-statistic		2.1447867		2.160369		2.13145		2.119905		2.109816		2.093024		2.20098516		2.100922		2.109816		2.306004
U <sub>2</sub>		0.0041		0.0015		0.013		0.0021		0.026		0.0086		0.42		0.016		0.0096		0.0028
U <sub>3</sub>		0.0011		0.00040		0.0033		0.00050		0.0060		0.0019		0.12		0.0036		0.0023		0.00094
Certified		<b>0.027</b>		<b>0.0033</b>		<b>0.254</b>		<b>0.0073</b>		<b>1.22</b>		<b>0.166</b>		<b>94.0</b>		<b>0.504</b>		<b>0.203</b>		<b>0.0112</b>
Uncertainty		0.003		0.0008		0.005		0.0009		0.02		0.008		0.1		0.009		0.009		0.0009
Tolerance		0.009		0.0024		0.015		0.0027		0.06		0.024		0.4		0.027		0.027		0.0028

Analysis	*	Ni	*	O	*	P	*	Pb	*	S	*	Si	*	Ti	*	V	*	W	*	Zr	
1	4	3.0633333	2	0.010167	4	0.027733	3	0.0011	1	0.004	4	0.343333	4	0.0011480	4	0.006919	11	0.003	5	0.000253	
2	4	3.0992667	2	0.010433	5	0.029033	11	0.0014	1	0.005	4	0.348082	14	0.00136667	4	0.007533	4	0.003033	4	0.001033	
3	4	3.1002	2	0.010625	4	0.029263	4	0.001833	1	0.005967	3	0.36	5	0.00163333	10	0.007533	4	0.003067	4	0.001033	
4	4	3.102	2	0.010633	3	0.0309	4	0.001933	3	0.006	5	0.369	5	0.00180	4	0.007623	3	0.0031	11	0.0011	
5	4	3.1029333	2	0.010667	3	0.030933	4	0.0020	1	0.006	14	0.371	4	0.00186667	5	0.0077	4	0.0035	3	0.0012	
6	4	3.117	2	0.0109	4	0.0310	5	0.0020	1	0.006033	4	0.379333	4	0.0020	4	0.007767	5	0.0036	4	0.0016	
7	14	3.1233333	2	0.0110	4	0.031267	5	0.0021	1	0.006467	4	0.380	3	0.00206667	4	0.0079	5	0.003643			
8	3	3.13	2	0.011877	3	0.031667	5	0.002177	1	0.006725	4	0.3800	4	0.00206667	3	0.007967	10	0.004			
9	11	3.14	2	0.0124	11	0.0322	3	0.002267	1	0.006733	6	0.380967	5	0.00206667	3	0.008	5	0.004167			
10	4	3.1432333			4	0.032533	5	0.002267	1	0.007	4	0.384667	3	0.0021	10	0.0080	3	0.004567			
11	3	3.15			3	0.033	9	0.0023	3	0.007133	10	0.386667	11	0.0021	4	0.008					
12	3	3.15			10	0.033	4	0.003087	11	0.0072	3	0.388	4	0.0023	4	0.0081					
13	4	3.1540083			4	0.033067			1	0.007393	3	0.39	3	0.0024	4	0.008133					
14	10	3.16			4	0.0332			3	0.0074	4	0.391733			3	0.0083					
15	10	3.17			4	0.033667			1	0.007533	11	0.393			14	0.008367					
16	4	3.177			10	0.0339			10	0.008	10	0.397			11	0.0087					
17	3	3.2033333			3	0.0346			4	0.009194	4	0.398333									
18											3	0.405									
Average		3.134450		0.01125		0.0316		0.001915		0.006693		0.380340		0.002004		0.00804		0.00357		0.001046	
Std Dev		0.000077		0.00048		0.0011		0.000063		0.000077		0.000075		0.000061		0.00027		0.00010		0.000048	
H		0.0209472		0.001139		0.001821		0.000546		0.00091		0.006353		0.0005588		0.000984		0.00070		0.00070	
U <sub>1</sub>		0.021		0.0012		0.0021		0.00055		0.00091		0.0064		0.00056		0.0010		0.00071		0.00070	
t-statistic		2.1199053		2.306004		2.119905		2.200985		2.119905		2.109816		2.17881283		2.13145		2.26		2.570582	
U <sub>2</sub>		0.044		0.0029		0.0045		0.0012		0.0019		0.013		0.0012		0.0022		0.0016		0.0018	
U <sub>3</sub>		0.011		0.00095		0.0011		0.00035		0.00047		0.0032		0.00034		0.00054		0.00051		0.00074	
Certified		<b>3.13</b>		<b>0.011</b>		<b>0.032</b>		<b>0.0019</b>		<b>0.0067</b>		<b>0.38</b>		<b>0.0020</b>		<b>0.0080</b>		<b>0.0036</b>		<b>0.0010</b>	
Uncertainty		0.05		0.001		0.003		0.0006		0.0009		0.02		0.0006		0.0005		0.0006		0.0004	
Tolerance		0.15		0.003		0.009		0.0018		0.0027		0.06		0.0018		0.0022		0.0018		0.0009	

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\* Code for method

Reference values listed as weight percent

Analysis	*	B	*	Ca	*	H	*	Mg	*	Nb	*	Sb	*	Sn	*	Ta
1	11	0.0002	4	0.001367	2	0.000039	3	0.0001	5	0.00102	5	0.00042	5	0.00058667	5	0.00191
2	4	0.0002	4	0.00246	2	0.000087	4	0.00018	5	0.00103	5	0.000437	5	0.00066667	5	0.001967
3	3	0.0003	4	0.0027	2	0.000167	5	0.000733	3	0.0014	5	0.0005	4	0.00102626	5	0.002367
4	7	0.0003467	11	0.0028	2	0.000167			11	0.0018	9	0.0012	3	0.00103333	5	0.0031
5	3	0.0005	4	0.003033	2	0.000247			4	0.001933	11	0.0016	3	0.002	3	0.0036
6	3	0.0006	4	0.0031	2	0.000355			4	0.001933	4	0.002933	5	0.0021	4	0.004
7			3	0.0031	2	0.0004			4	0.003133	4	0.003033	9	0.0032	11	0.0040
8			4	0.004735	2	0.000433					3	0.0047	4	0.00383333	4	0.004033
9			5	0.004967									4	0.00393333		
10			4	0.006933												
Average		0.000342		0.00352		0.00024		0.00034		0.00175		0.00149		0.00204		0.00312
Std Dev		0.000047		0.00010		0.00014		0.00051		0.00012		0.00012		0.00011		0.00011
H		0.0002901		0.000696		0.000257		0.000289		0.000527		0.000495		0.00055978		0.000663
U <sub>1</sub>		0.00029		0.00070		0.00030		0.00058		0.00054		0.00051		0.00057		0.00067
t-statistic		2.5705818		2.262157		2.364624		4.302653		2.446912		2.364624		2.30600413		2.364624
U <sub>2</sub>		0.00076		0.0016		0.00070		0.0025		0.0013		0.0012		0.0013		0.0016
U <sub>3</sub>		0.00031		0.00050		0.00025		0.0015		0.00050		0.00043		0.00044		0.00056
Reference		<b>0.0003</b>		<b>0.004</b>		<b>0.0002</b>		<b>&lt;0.005</b>		<b>0.002</b>		<b>&lt;0.05</b>		<b>0.002</b>		<b>0.003</b>
Uncertainty		0.0002		0.002		0.0001				0.001				0.001		0.001
Tolerance		0.0002		0.003		0.0001				0.001				0.001		0.002

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.

**BS 9325B**

\* Code for analytical method

Trace analysis listed as mg/kg (ppm)

Analysis	*	Zn
1	5	4.9
2	5	5
3	5	5.4

**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
Shijiazhuang Trump Scientific Co., LTD.	Shijiazhuang, China	CNAS	17025
NSL Analytical	Cleveland, OH	ANAB	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
Luvak Inc.	Boylston, MA	PRI	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI	17025
Shiva Analyticals Private Limited	Hoskote, Bangalore	NABL	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
APL, Inc	Milwaukee, WI	A2LA	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025

A2LA = American Association for Laboratory Accreditation  
 ANAB = ANSI-ASQ National Accreditation Board  
 CNAS = China National Accreditation Service  
 NABL = National Accreditation Board for Testing and Calibration Laboratories  
 PCA = Polish Center For Accreditation  
 PRI = Performance Review Institute

**Analysis:** Chemical analyses were made on solid pieces and chips prepared by an 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: 12X835M30A, 12X93106A; AR 546, 558, 614A, 641, 645, 657, 659, 668, 675, 868, 872, 892, 960, 961, 1650, 1651, 1653; BAS 181, 331, 386, 409, 409/1, 409/2, 434, 464/1, 614/1; BS HON T, 55G, 58C, 58D, 58E, 61G, 1009, 1018, 1762, 2931A, 3310, 4130, 4142Se, 4340A, 4820A, 4992, 8620E, 8630, 9325A; CKD CZ2006A, 186A; DSZU CA013; ECRM 85, 86, 87; IARM30C, 156B, 156C, 169B, 9310; IMZ 112; JSM M402-4; JSS GS-1D; LECO 501-502, 501-503, 502-712, 502-856, 502-913, 502-916; NCS HC13203, NS11079; SRM C1146A, 16F, 72G, 73A, 139B, 160B, 361, 363, 1765, 2165.

**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 409, 409/2, 614/1; BS 58C, 58D, 58E, 4992, 9325A.

**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 9325B 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 cast stock for this CRM was produced by Jey Swen Enterprise Co.; Kaohsiung, Taiwan.

**Form:** This CRM is machined in the form of a disc, approximately 38mm in diameter and 30mm 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 certified area of each disc is the portion extending several mm inward from each surface.

Note: Shrinkage cavities may appear in the horizontal center of some discs. These cavities are normal and will not affect the certified portions of the disc.

**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 9325B-110622. 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)

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 17025:2017 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](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 December 6, 2022.

Beau R. Brammer

President