

# BRAMMER STANDARD COMPANY, INC.

## Certificate of Analysis

### BS 291CD

Certified Reference Material for Chill-cast Iron

	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>B</b>	<b>0.0009</b>	0.0002			
<b>C</b>	<b>3.11</b>	0.02			
<b>Cr</b>	<b>0.040</b>	0.001			
<b>Cu</b>	<b>0.211</b>	0.003			
<b>Mg</b>	<b>0.042</b>	0.001			
<b>Mn</b>	<b>0.527</b>	0.005			
<b>Mo</b>	<b>0.0044</b>	0.0004			
<b>Ni</b>	<b>0.259</b>	0.003			
<b>P</b>	<b>0.0266</b>	0.0008			
<b>S</b>	<b>0.0182</b>	0.0006			
<b>Si</b>	<b>2.40</b>	0.02			
<b>Sn</b>	<b>0.131</b>	0.002			
<b>Ti</b>	<b>0.0173</b>	0.0007			
<b>V</b>	<b>0.0081</b>	0.0005			

### Informational Values<sup>3,4</sup>

Al (0.01)	As (0.004)	Ca (0.001)	Co (0.005)	Fe [93.2]
Nb (0.003)	Pb (0.001)	Sb (0.01)	W (0.005)	Zr (0.002)

<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 4 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 4 for more information on its calculation.

<sup>3</sup> Values are given in weight percent.

<sup>4</sup> 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 291CD

\* Code for method

Certified values listed as weight percent

Analysis	*	B	*	C	*	Cr	*	Cu	*	Mg	*	Mn	*	Mo	*	Ni
1	3	0.0006	1	3.0882	4	0.03845	4	0.198	3	0.0415	3	0.51	4	0.00325	4	0.25075
2	4	0.00079	1	3.09525	4	0.038725	8	0.2085	3	0.0415	4	0.52275	4	0.003425	3	0.251
3	4	0.000865	1	3.1045	7	0.038975	4	0.209	3	0.041567	8	0.523	4	0.00426	7	0.25375
4	4	0.00091	1	3.10675	13	0.04035	4	0.2095	3	0.041567	8	0.527	3	0.0044	4	0.259
5	4	0.000913	1	3.116	3	0.042	3	0.211	3	0.041567	4	0.5325	4	0.004788	4	0.261
6	4	0.000998	3	3.12	13	0.042	4	0.211	3	0.0416	4	0.5325	4	0.005	4	0.26225
7	4	0.001045	1	3.120	4	0.0421	16	0.212	3	0.0416	16	0.53475	4	0.00535	7	0.2625
8			1	3.12125	13	0.0432	4	0.21675	3	0.0416	8	0.53725			4	0.2665
9			1	3.12475					3	0.041633						
10									3	0.0417						
11									3	0.041717						
12									3	0.041733						
13									3	0.041733						
14									3	0.041733						
15									3	0.041767						
16									3	0.041767						
17									3	0.0418						
18									3	0.0418						
19									3	0.0418						
20									3	0.0418						
21									3	0.041833						
22									3	0.041833						
23									3	0.041833						
24									3	0.041867						
25									3	0.0419						
26									3	0.0419						
27									3	0.0419						
28									3	0.041933						
29									3	0.041963						
30									3	0.0420						
31									3	0.0420						
32									3	0.042067						
33									3	0.042067						
34									3	0.0421						
35									3	0.0421						
36									3	0.042113						
37									3	0.042133						
38									3	0.042142						
39									3	0.0422						
40									3	0.042267						
41									3	0.0423						
42									3	0.042333						
43									3	0.042367						
44									3	0.042433						
45									3	0.042433						
46									3	0.042467						
47									3	0.042467						
Average		0.000889		3.1112		0.04029		0.2112		0.04192		0.5272		0.00438		0.2588
Std dev		0.000069		0.0074		0.00052		0.0016		0.00048		0.0030		0.00017		0.0018
H		0.00024		0.023		0.0011		0.0030		0.0011		0.0057		0.00040		0.0034
U <sub>1</sub>		0.00025		0.024		0.0012		0.0034		0.0012		0.0064		0.00043		0.0039
t-statistic		2.45		2.31		2.36		2.36		2.01		2.36		2.45		2.36
U <sub>2</sub>		0.00060		0.055		0.0029		0.0081		0.0025		0.015		0.0011		0.0092
U <sub>3</sub>		0.00023		0.018		0.0010		0.0029		0.00036		0.0054		0.00040		0.0032
<b>Certified</b>		<b>0.0009</b>		<b>3.11</b>		<b>0.040</b>		<b>0.211</b>		<b>0.042</b>		<b>0.527</b>		<b>0.0044</b>		<b>0.259</b>
<b>Uncertainty</b>		<b>0.0002</b>		<b>0.02</b>		<b>0.001</b>		<b>0.003</b>		<b>0.001</b>		<b>0.005</b>		<b>0.0004</b>		<b>0.003</b>
Tolerance		0.0006		0.06		0.003		0.008		0.002		0.015		0.0011		0.009

Analysis	*	P	*	S	*	Si	*	Sn	*	Ti	*	V
1	4	0.025025	1	0.017425	6	2.37525	3	0.124	7	0.0159	3	0.0071
2	7	0.02585	1	0.01785	6	2.379	4	0.1255	3	0.0164	4	0.00745
3	4	0.026025	1	0.01795	6	2.39275	4	0.12675	7	0.01685	4	0.00780
4	17	0.0263	1	0.0180	6	2.39725	4	0.1295	4	0.01695	4	0.007875
5	17	0.027	1	0.018	6	2.411	4	0.13025	4	0.0173	4	0.0080
6	4	0.0272	1	0.018075	6	2.4175	4	0.132	4	0.017425	4	0.008208
7	7	0.027525	1	0.01825	3	2.42	4	0.137	4	0.0180	4	0.00855
8	3	0.0296	1	0.01865	6	2.429	4	0.138	4	0.018625	13	0.00883
9			3	0.0196								
Average		0.02659		0.01817		2.4001		0.1305		0.01726		0.00808
Std dev		0.00044		0.00031		0.0069		0.0014		0.00030		0.00019
H		0.0009		0.00074		0.018		0.0022		0.00072		0.00051
U <sub>1</sub>		0.0010		0.00080		0.020		0.0026		0.00079		0.00055
t-statistic		2.36		2.31		2.36		2.36		2.36		2.36
U <sub>2</sub>		0.0024		0.0019		0.046		0.0062		0.0019		0.0013
U <sub>3</sub>		0.00083		0.00062		0.016		0.0022		0.00066		0.00046
<b>Certified</b>		<b>0.0266</b>		<b>0.0182</b>		<b>2.40</b>		<b>0.131</b>		<b>0.0173</b>		<b>0.0081</b>
<b>Uncertainty</b>		<b>0.0008</b>		<b>0.0006</b>		<b>0.02</b>		<b>0.002</b>		<b>0.0007</b>		<b>0.0005</b>
Tolerance		0.0024		0.0019		0.05		0.006		0.0019		0.0013

**BS 291CD** \* Code for method Informational values listed as weight percent

Analysis	*	Al	*	As	*	Ca	*	Co	*	Fe	*	Nb	*	Pb	*	Sb
1	3	0.0082	3	0.0036	3	0.00068	3	0.0046	3	93.17	3	0.0025	3	0.0011	3	0.0068
Average		0.0082		0.0036		0.00068		0.0046		93.17		0.00250		0.00110		0.0068
Std dev		0.0016		0.0011		0.00028		0.0013		0.46		0.00052		0.00053		0.0016
H		0.0005		0.0004		0.00022		0.0004		0.60		0.00033		0.00025		0.0005
U <sub>1</sub>		0.0017		0.0012		0.00035		0.0013		0.76		0.00061		0.00058		0.0017
t-statistic		12.71		12.71		12.71		12.71		12.71		12.71		12.71		12.71
U <sub>2</sub>		0.021		0.015		0.0045		0.017		9.66		0.0078		0.0074		0.022
U <sub>3</sub>		0.021		0.015		0.0045		0.017		9.66		0.0078		0.0074		0.022
<b>(Informational)</b>		<b>(0.01)</b>		<b>(0.004)</b>		<b>(0.001)</b>		<b>(0.005)</b>		<b>[93.2]</b>		<b>(0.003)</b>		<b>(0.001)</b>		<b>(0.01)</b>

Analysis	*	W	*	Zr
1	3	0.0047	3	0.0017
Average		0.0047		0.00170
Std dev		0.0013		0.00070
H		0.00041		0.00029
U <sub>1</sub>		0.0014		0.00075
t-statistic		12.71		12.71
U <sub>2</sub>		0.017		0.010
U <sub>3</sub>		0.017		0.010
<b>(Informational)</b>		<b>(0.005)</b>		<b>(0.002)</b>

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<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> times 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 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:**

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 Atomic Absorption Spectrometry
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

<b><u>Laboratory</u></b>	<b><u>Location</u></b>	<b><u>Registrar</u></b>	<b><u>Accreditation</u></b>
Benxi Iron & Steel Group Co., Ltd.	Benxi, China	CNAS	17025
Chongqing Iron & Steel (Group) Co., Ltd.	Chongqing, China	CNAS	17025
Shanghai Research Institute of Materials	Shanghai, China	CNAS	17025
Zhengzhou Machinery Research Institution	Zhengzhou, CHina	CNAS	17025
Shijiazhuang Trump Scientific Co., LTD.	Shijiazhuang, China	CNAS	17025
Shandong Province Metallurgy Scientific	Jinan, China	CNAS	17025
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, Guide 34

A2LA = American Association for Laboratory Accreditation

CNAS = China National Accreditation Service

**Analysis:** Chemical analyses were made on solid pieces and chips from representative samples for the certified portion of the lot in accordance with ASTM Standard Practice E 1806. The laboratories participating in the testing followed the requirements of ISO Standard 17025. Methods of analysis used were a those listed on page 2.

**Traceability:** The following Certified Reference Materials were used to validate the analytical data listed on page 2 — SRM C2424A, 891; BS CC-8, CSN 2-1, 2A, 6A, 8, 29, 284C, 291A; ECRM 480-1.

**Homogeneity:** This Certified Reference Material (CRM) was tested for homogeneity using ASTM Standard Method E 826 and found acceptable. It was also examined by spark atomic emission spectrometry and found to be compatible with the following Reference Materials — GBW 01131A-01137a, GSB 03-1813-2005.

**Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895**  
**Telephone: (281) 440-9396      Fax: (281) 440-4432      Website: [www.brammerstandard.com](http://www.brammerstandard.com)**  
 Certificate Number 291CD-100413 Page 4/6

**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 291CD is valid indefinitely. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

**Source:** The cast stock for this CRM was produced by Shijiazhuang Trump Scientific Co, LTD.

**Form:** This CRM is machined in the form of a disc, approximately 35 mm in diameter and ~ 30 mm thick by Brammer Standard Company, Inc.

**Use:** This CRM is intended for use in spark atomic emission 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 upward 25 mm from the analytical surface.

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

**Certificate Number:** The unique identification number for this certificate of analysis is 291CD-100413. You may obtain information on revisions of certificates from the internet at [www.brammerstandard.com](http://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**

**Fax: (281) 440-4432**

**Web: [www.brammerstandard.com](http://www.brammerstandard.com)**

**Email: [contact@brammerstandard.com](mailto: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](http://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 30:1992 Terms and definitions used in connection with reference materials + 2008 amendment
- ISO Guide 31:2000 Reference materials - Contents of certificates and labels
- ISO Guide 33:2000 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](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 04, 2013.

Beau R. Brammer