

Brammer Standard Company, Inc.

# Certificate of Analysis

BS CC-23

## Chill-cast Iron Reference Material

	Certified Value <sup>1,2</sup>	Estimate of Uncertainty <sup>3</sup>		Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>3</sup>
Analysis listed as percent by weight					
<b>C</b>	<b>2.96</b>	0.03	<b>La</b>	<b>&lt;0.002</b>	
<b>Mn</b>	<b>0.74</b>	0.015	<b>Mg</b>	<b>&lt;0.001</b>	
<b>P</b>	<b>0.53</b>	0.025	<b>Nb</b>	<b>&lt;0.003</b>	
<b>S</b>	<b>0.082</b>	0.003	<b>Pb</b>	<b>0.008</b>	0.001
<b>Si</b>	<b>0.43</b>	0.015	<b>Sb</b>	<b>0.17</b>	0.02
<b>Cu</b>	<b>0.31</b>	0.006	<b>Sn</b>	<b>0.052</b>	0.003
<b>Ni</b>	<b>0.56</b>	0.01	<b>Te</b>	<b>0.033</b>	0.004
<b>Cr</b>	<b>0.47</b>	0.015	<b>Ti</b>	<b>0.091</b>	0.003
<b>Mo</b>	<b>0.265</b>	0.004	<b>V</b>	<b>0.196</b>	0.008
<b>Al</b>	<b>0.059</b>	0.002	<b>W</b>	<b>&lt;0.01</b>	
<b>As</b>	<b>0.017</b>	0.003	<b>Zr</b>	<b>0.060</b>	0.002
<b>B</b>	<b>0.066</b>	0.004			
<b>Ce</b>	<b>&lt;0.002</b>			Provisional value	
<b>Co</b>	<b>0.090</b>	0.002	<b>N</b>	(0.008)	

<sup>1</sup> The certified value listed is the present best estimate of the true value based on the results of an interlaboratory testing program.

<sup>2</sup> Data in parentheses is not certified and is provided for information only.

<sup>3</sup> The uncertainties listed are based on value judgments of the material inhomogeneity and the 95% confidence interval. The half-width confidence interval C(95%) is shown on page 2.

See reverse side for more information.

**Certificate Number CC23-020700p1**

**Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895**  
**Telephone (281) 440-9396 Fax (281) 440-4432**

Analysis	* C	* Mn	* P	* S	* Si	* Cu	* Ni	* Cr	* Mo									
1	H	2.940	C	0.71	P1	0.496	H	0.07568	E	0.41	AA	0.3000	C	0.54	M1	0.4514	C	0.261
2	H	2.944	C	0.726	P1	0.498	H	0.078	B	0.414	C	0.30	X	0.5513	C	0.46	C	0.262
3	A	2.953	C	0.73	C	0.515	H	0.0795	E	0.42	R2	0.304	C	0.552	Z	0.462	C	0.262
4	H	2.9575	C	0.73	C	0.52	A	0.0810	C	0.421	B	0.306	S	0.553	C	0.47	W	0.262
5	H	2.96	C	0.730	L	0.538	H	0.081	J	0.422	C	0.306	B	0.553	M	0.470	C	0.265
6	H	2.96	B	0.732	C	0.54	B	0.0812	C	0.430	C	0.309	X1	0.554	C	0.472	B	0.265
7	H	2.97	N	0.740	P	0.545	H	0.0815	C	0.436	C	0.31	E	0.559	U	0.474	Z	0.267
8	H	2.97	N	0.748	B	0.552	H	0.0823	J	0.44	C	0.31	C	0.56	B	0.475	C	0.269
9	H	2.99	C	0.75	C	0.557	H	0.0825	J	0.441	E	0.311	C	0.568	B	0.478	C	0.269
10	H	2.994	E	0.752	A	0.557	H	0.0826	A	0.448	A	0.312	A	0.568	A	0.478	A	0.270
11			A	0.755	C	0.56	C	0.083	J	0.453	C	0.313	C	0.57	C	0.480		
12							H	0.085			R	0.316			C	0.489		
13							H	0.085										
14							H	0.0863										
Average		2.964		0.735		0.534		0.0818		0.430		0.308		0.557		0.472		0.2652
Std Dev		0.018		0.014		0.024		0.0028		0.014		0.005		0.009		0.010		0.0034
Certified		2.96		0.74		0.53		0.082		0.43		0.31		0.56		0.47		0.265
t		2.2622		2.2281		2.2281		2.1604		2.2281		2.201		2.2281		2.201		2.2622
C(95%)		0.013		0.0092		0.016		0.0016		0.010		0.003		0.006		0.006		0.0024

Analysis	* Al	* As	* B	* Ce	* Co	* La	* Mg	* Nb	* Pb									
1	C	0.056	N1	0.0143	A	0.0615	CM	<0.0005	Z	0.0883	C	<0.002	C	<0.0003	C	<0.002	SW	0.0070
2	C	0.0561	D	0.0146	T	0.062	C	<0.0005	C	0.089	CM	0.00003	AA	<0.0005	C	<0.002	C	0.0072
3	C	0.0562	B	0.015	C	0.0624	C	<0.0005	C	0.0892	C	0.0001	C	0.0002	IC	0.00044	C	0.0080
4	B	0.0578	Z	0.0151	B	0.0651	C	<0.002	B	0.0896	Z	0.0001	C	0.0002	CM	0.00060	CM	0.0081
5	A	0.058	C	0.016	C	0.066	C	<0.002	C	0.090	C	0.0002	CM	0.00046	C	0.0014	EE	0.0082
6	C	0.059	C	0.016	T	0.068	C	0.000015	C	0.091	C	0.0012	E	0.0005	C	0.0018	EE	0.0082
7	C	0.0596	C	0.0175	C	0.069	C	0.0006	C	0.0910			B	0.00053	A	0.002	C	0.0084
8	C	0.061	C	0.018	CE	0.070	Z	0.001	C	0.0911					B	0.002	A	0.009
9	C	0.0612	N2	0.0209	CE	0.072	B	0.001	A	0.0912					C	0.002	G	0.0092
10	AA	0.062	C	0.0212					AA	0.0931					CM	0.00213		
11															C	0.0026		
Average		0.0587		0.0169		0.0662			0.0904									0.0081
Std Dev		0.0022		0.0025		0.0038			0.0014									0.0007
Certified		0.059		0.017		0.066		<0.002	0.090		<0.002		<0.001		<0.003			0.008
t		2.2622		2.2622		2.306			2.2622									2.306
C(95%)		0.0016		0.0018		0.0029			0.0010									0.0006

Analysis	* Sb	* Sn	* Te	* Ti	* V	* W	* Zr	* N									
1	S1	0.152	T1	0.0466	C	0.029	C	0.086	C	0.188	C	<0.002	C	0.058	V	0.0076	
2	AA	0.1531	D	0.050	F	0.029	C	0.089	C	0.190	C	<0.002	C	0.058	V	0.0078	
3	C	0.161	C	0.050	AA	0.02931	B	0.089	C	0.190	C	<0.002	B	0.0585	V	0.00819	
4	F	0.175	B	0.0517	C	0.032	AA	0.09056	C	0.193	Z	0.0009	C	0.0589			
5	Z	0.1783	C	0.052	EE	0.034	A	0.0908	B	0.193	C	0.001	C	0.060			
6	A	0.179	C	0.053	B	0.035	C	0.0916	C	0.194	C	0.0011	C	0.0602			
7	C	0.180	A	0.053	CM	0.0360	C	0.0916	C	0.195	W	0.001699	C	0.0606			
8	C	0.184	C	0.0538	EE	0.036	C	0.092	AA	0.1985	B	0.0032	CM	0.0615			
9	B	0.192	C	0.055	C	0.0366	C	0.0923	C	0.200	C	0.0056	B	0.062			
10	C	0.193	AA	0.05519			C	0.0932	R1	0.202	C	0.007	C	0.0624			
11			C	0.056					A	0.205							
12									C	0.208							
Average		0.175		0.0524		0.0330		0.0906	0.1964				0.0600		0.0079		
Std Dev		0.015		0.0028		0.0032		0.0021	0.0063				0.0016		0.0003		
Certified		0.17		0.052		0.033		0.091	0.196		<0.01		0.060		(0.008)		
t		2.2622		2.22281		2.306		2.2622	2.201				2.2622		4.3027		
C(95%)		0.011		0.0019		0.0025		0.0015	0.0040				0.0012		0.0007		

\* Methods of analysis listed on page 3.

Data in parentheses is not certified but is provided for information only.

Data listed as mass fraction expressed as percent.

$C(95\%) = (t \times sd) / \sqrt{n}$  The half-width confidence interval, where  $t$  is the appropriate Student's  $t$  value,  $sd$  is the interlaboratory standard deviation, and  $n$  is the number of acceptable mean values. For further information regarding the confidence interval for the certified value see ISO Guide 35:1989 section 4.

**Code Element Method**

A	various	AES - Optical Emission - Glow Discharge
AA	various	AAS - Flame Atomic Absorption Spectrometry - standard addition method
B	various	AES - Optical Emission - Spark Source
C	various	AES - Inductively Coupled Plasma
CE	B	AES - Inductively Coupled Plasma after solvent extraction
CM	various	AES - Inductively Coupled Plasma Mass Spectrometry
D	various	AES- Inductively Coupled Plasma after hydride generation
E	various	AAS - Flame Atomic Absorption Spectrometry
EE	Pb, Te	AAS - Flame Atomic Absorption Spectrometry after solvent extraction
F	various	AAS - Flame Atomic Absorption Spectrometry after hydride generation
G	various	AAS - Electro-thermic atomization - graphite furnace
H	C, S	Combustion-Infrared Absorption (ASTM E 1019)
IC	Nb	Ion Chromatography
J	Si	Gravimetry, with perchloric acid
L	P	Titration, phosphomolybdate
M	Cr	Titration, ammonium persulphate oxidation, ferrous sulphate
M1	Cr	Titration, peroxodisulphate oxidation
N	Mn	MAS - periodate oxidation
N1	As	MAS - Standard addition method
N2	As	MAS - arsenic-bismuth-molybdenum blue
P	P	MAS - molybdivanadophosphoric acid
P1	P	MAS - bismuth phosphorus molybdenum blue
R	Cu	MAS - tetraethylthiuram disulphide
R1	V	MAS - photometric after N-benzoyl phenylhydroxylamine extraction
R2	Cu	MAS - bis-cyclohexanone oxalyldihydrazone
S1	Sb	MAS - malachite green benzene extraction
SW	Pb	Square-wave polarographic
T	B	MAS - distillation, curcumine
T1	Sn	MAS - Phenylfluorone
U	Cr	MAS - diphenylcarbazide
V	N	Inert gas Fusion Method (ASTM E 1019)
W	W, Mo	MAS - thiocyanate
X	Ni	Gravimetric - dimethylglyoxime
X1	Ni	MAS - dimethylglyoxime
Z	various	INAA - Instrumental Neutron Activation Analysis

AES = Atomic Emission Spectrometry

MAS = Molecular Absorption Spectrometry (photometric - spectrophotometer methods)

**Co-operating Laboratories:** The co-operating laboratories were:

**Laboratory**

ANAREM, Prague, Czech Republic  
 AK Steel Research, Middletown, Ohio  
 Brammer Standard Co., Inc., Houston, Texas  
 China National Analysis Center for Iron and Steel, Beijing, China  
 Crucible Specialty Steel, Syracuse, New York  
 J. Dirats and Co., Inc., Westfield, Massachusetts  
 IMR Test Labs, Lansing, New York  
 LECO Corporation, St. Joseph, Michigan  
 Shiva Technologies, Inc., Syracuse, New York  
 Shiva Analyticals (India) Ltd., Hoskote, Bangalore, India  
 VHG Laboratories, Inc., Manchester, New Hampshire

**Laboratory contact**

Karel Bičovský  
 Howard Vail  
 Richard P. Beaumont  
 Prof. Wang Haizhou  
 William Mastroe  
 Eric E. Dirats  
 Timothy J. McGrady and Terence C. O'Brien  
 Dennis Lawrenz  
 Don Shuman  
 Dr. T. V. Ramakrishna  
 Julie M. McIntosh

**Certification Process:** The requirements of ISO Guide 31, ISO Guide 34, ISO Guide 35, and ASTM Standard Guides E 1724 and E 1831 were followed for the preparation of this reference material and certificate of analysis. This is a reference material as defined by ISO Guide 30.

**Analysis:** Chemical analyses were made on chips prepared by a lathe from the certified portion of the discs in accordance with ASTM Standard Practice E 1806. The laboratories participating in the testing normally followed the requirements of ISO Guide 25. The individual values listed on page 2 are the average of each analyst's results. Methods of analysis used were a combination of ASTM Standard Test Methods E 350 and E 1019 plus additional ICP and AA spectrometric methods.

**Outliers:** Some outlying data was excluded from the data listed on page 2 due to technical assessment of the cooperating laboratories and statistical evaluation.

**Traceability:** The following Certified Reference Materials were used to validate the analytical data listed on page 2: NIST SRM 5L, 7f, 338, 363, 364, CC1173, 1761, 2166, C2423, C2424a, C2425; ECRM 471-1, 480-1, 481-1; CKD 215, 235, 238A, 239A, 241 - 249; CMSI 1530, 1533, 1551.

**Homogeneity:** This Reference Material was tested for homogeneity using ASTM Standard Method E 826 and found acceptable. It was also examined by optical emission spectrometry using ASTM Standard Test Method E 1999 and found to be compatible with the following Certified Reference Materials: NIST SRM C1145A, 1149.

**Validity statement:** ISO Guide 31 requires that a validity period statement be included in the certificate of analysis. This Reference Material is valid for 20 years from the certificate date.

**Source:** This material was melted and cast by American Centrifugal, Birmingham, Alabama, using an electric arc furnace. It was chill-cast into a mold on a copper chill-plate producing all discs simultaneously.

**Description and use:** This Reference Material is in the form of a disc, approximately 32 mm in diameter and 17 mm thick. It is intended for use in optical emission and x-ray spectrometric methods of analysis.

**Certified area:** The area certified of each disc is the portion extending upward 10 mm from the larger diameter surface.

**NOTE:** Shrinkage cavities may appear in the top portion of some discs. These cavities are normal and will not affect the certified portion of the disc.

**CAUTION:** The high phosphorus and sulfur content may interfere with proper sparking on an optical emission spectrometer. An increase in the preburn time may be required for proper spark excitation of the disc.

**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 disc during surface preparation.

**Certificate Number:** The unique identification number for this certificate of analysis is CC23-020700-px, where x indicates the page number. Refer to future Brammer Standard Company catalogs for information on any revisions to this or other Brammer Standard reference materials. You may also obtain information on revisions of certificates from the internet at [brammerstandard.com](http://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

Certified by: \_\_\_\_\_ on February 7, 2000.  
G. R. Brammer

**Certificate Number CC23-020700p4**

**By Certificate Number 10539, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9002:1994 by National Quality Assurance, U.S.A.**

**Brammer Standard Company's Chemical Laboratory is accredited to ISO Guide 25 by A2LA.  
(Certificate Number 656.01)**

## **References:**

*ASTM documents available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959,  
Telephone: 610-832-9500 Fax: 610-832-9555 e-mail: service@astm.org Website: www.astm.org*

E 350 - 90 Standard Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

E 826 - 85 (Reapproved 1990) Standard Practice for Testing Homogeneity of Materials for the Development of Reference Materials

E 1019 - 93 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel and in Iron, Nickel, and Cobalt Alloys

E 1724 - 95 Standard Guide for Testing and Certification of Metal and Metal-Related Reference Materials

E 1806 - 96 Standard Practice for Sampling Steel and Iron for Determination of Chemical Composition

E 1831 - 96 Standard Guide for Preparing Certificates for Reference Materials Relating to Chemical Composition of Metals, Ores, and Related Materials.

E 1999 - 99 Standard Test Method for Analysis of Cast Iron Using Optical Emission Spectrometry

*ISO Guides available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.*

ISO Guide 25 (Third edition, 1990), General requirements for the competence of calibration and testing laboratories.

ISO Guide 30 (Second edition, 1991), Terms and definitions used in connection with reference materials.

ISO Guide 31 (First edition, 1981), Contents of certificates of reference materials.

ISO Guide 33 (First edition, 1989), Uses of certified reference materials.

ISO Guide 34 (First edition, 1996), Quality system guidelines for the production of reference materials.

ISO Guide 35 (Second edition, 1989), Certification of reference materials - General and statistical principles.

*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

**Certificate Number CC23-020700p5**