Brammer Standard Company, Inc.

Certificate of Analysis

BS CC-21

Chill-cast Iron Reference Material

	Certified Value[1,2]	Estimate of Uncertainty[3]		Certified Value[1]	Estimate of Uncertainty[3]
		Analysis listed as percent by weight			
C	**2.66**	0.02	**La**	**<0.002**	
Mn	**1.37**	0.02	**Mg**	**0.0005**	0.0002
P	**0.85**	0.025	**Pb**	**0.004**	0.0005
S	**0.006**	0.001	**Sn**	**0.006**	0.0015
Si	**2.32**	0.04	**Ti**	**0.085**	0.002
Cu	**0.013**	0.001	**V**	**0.051**	0.002
Ni	**0.026**	0.003	**W**	**<0.002**	
Cr	**2.68**	0.04	**Zr**	**0.025**	0.003
Mo	**0.13**	0.01			
Al	**0.031**	0.003	Provisional values		
As	**0.045**	0.006	N	(0.013)	
B	**0.020**	0.003	Nb	(0.001)	
Ce	**<0.002**		Sb	(0.004)	
Co	**0.012**	0.001	Te	(0.009)	

[1] The certified value listed is the present best estimate of the true value based on the results of an interlaboratory testing program.

[2] Data in parentheses are not certified and are provided for information only.

[3] 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 CC21-020700p1

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	A	2.634	C	1.35	P1	0.8136	H	0.0057	J	2.26	C	0.012	X	0.0209	A	2.64	C	0.115
2	H	2.641	N	1.351	B	0.82	H	0.0058	J	2.274	C	0.0124	E	0.0232	E	2.651	A	0.127
3	H	2.645	E	1.351	C	0.83	H	0.006	A	2.282	R	0.0127	A	0.025	Z	2.652	C	0.130
4	H	2.66	C	1.36	C	0.832	H	0.006	J	2.289	C	0.013	C	0.026	M1	2.6549	C	0.131
5	H	2.66	A	1.37	C	0.850	H	0.0061	J	2.333	C	0.013	C	0.0262	C	2.66	C	0.131
6	H	2.66	E	1.376	A	0.851	H	0.00627	E	2.34	A	0.0131	C	0.0263	C	2.66	B	0.132
7	H	2.66	N	1.38	P	0.863	C	0.0063	B	2.36	C	0.0135	C	0.027	C	2.67	C	0.134
8	H	2.66	C	1.385	I	0.868	A	0.0064	E	2.37	E	0.0136	E	0.027	C	2.679	C	0.14
9	H	2.66	C	1.39	C	0.87	H	0.0068	C	2.37	E	0.0138	C	0.028	M	2.68	C	0.140
10	H	2.6604	C	1.39	C	0.87	H	0.007			AA	0.01415			C	2.73	Z	0.143
11	B	2.67			C	0.88	H	0.0071							M	2.77	W	0.150
12	H	2.68																
13	H	2.369																
Average		2.660		1.370		0.850		0.0063		2.320		0.0133		0.0255		2.677		0.1339
Std Dev		0.015		0.016		0.023		0.0005		0.044		0.0006		0.0022		0.039		0.0093
Certified		2.66		1.37		0.85		0.006		2.32		0.013		0.026		2.68		0.13
t		2.1788		2.2622		2.2281		2.2281		2.306		2.2622		2.306		2.2281		2.2281
C(95%)		0.009		0.012		0.015		0.0003		0.034		0.0005		0.0017		0.026		0.006

Analysis		Al		As		B		Ce		Co		La		Mg	*	Pb
1	C	0.0278	C	0.037	C	0.0160	C	<0.0005	C	0.0097	C	<0.0001	C	0.0002	C	0.0035
2	A	0.029	B	0.038	T	0.0173	C	<0.0005	C	0.010	C	<0.0002	C	0.0002	SW	0.0038
3	C	0.0294	D	0.0395	B	0.0173	C	<0.002	C	0.011	C	<0.0002	C	0.0003	A	0.004
4	C	0.030	Z	0.0405	T	0.0180	C	<0.002	C	0.011	CM	<0.0005	C	0.0003	C	0.0041
5	B	0.0303	C	0.0412	C	0.0194	C	0.001013	C	0.0116	C	<0.002	E	0.0005	G	0.0042
6	C	0.0314	C	0.042	A	0.0197	Z	0.001	Z	0.0115			C	0.0005	EE	0.0047
7	C	0.0318	C	0.042	T	0.021	CM	0.0011	E	0.0116			CM	0.00062	C	0.0047
8	C	0.032	N1	0.0473	C	0.022	C	0.0017	C	0.0118			E	0.00072		
9	C	0.032	C	0.054	C	0.023			C	0.0120			B	0.00083		
10	C	0.035	N2	0.0546	CE	0.025			B	0.0124						
11	AA	0.0369	C	0.0547	CE	0.025			AA	0.0126						
12									A	0.0126						
Average		0.0314		0.0446		0.0202				0.0115				0.00046		0.0041
Std Dev		0.0026		0.0068		0.0030				0.0009				0.00023		0.0004
Certified		0.031		0.045		0.020		<0.002		0.012		<0.002		0.0005		0.004
t		2.2281		2.2281		2.2281				2.201				2.306		2.4469
C(95%)		0.0018		0.0046		0.002				0.0006				0.0002		0.0004

Analysis	*	Sn	*	Ti	*	V	*	W	*	Zr		N	*	Nb	*	Sb	*	Te
1	B	0.0041	C	0.081	AA	0.04877	B	<0.0001	C	0.0255	V	0.0128	B	0.0001	C	0.003	C	0.005
2	AA	0.00412	A	0.0830	C	0.049	C	<0.002	C	0.0228	V	0.0129	C	0.0004	S1	0.0032	AA	0.005242
3	A	0.005	C	0.0834	C	0.050	C	<0.002	B	0.023	V	0.01362	CM	0.000554	Z	0.0036	F	0.007
4	C	0.006	C	0.0843	C	0.0500	C	<0.002	C	0.023			CM	0.00056	F	0.0038	C	0.008
5	D	0.006	C	0.0847	B	0.0502	W	0.00162	C	0.0233			IC	0.00061	C	0.004	B	0.009
6	C	0.006	C	0.085	C	0.051			C	0.0252			A	0.002	A	0.005	C	0.009
7	T1	0.0065	C	0.086	A	0.051			C	0.026			C	0.002	AA	0.0065	CM	0.0098
8	C	0.0068	C	0.087	C	0.052			C	0.026			C	0.0026	B	0.0072	EE	0.0116
9	C	0.007	C	0.0876	C	0.0532			B	0.027							EE	0.0119
10	C	0.007							C	0.028							C	0.0126
Average		0.0059		0.0847		0.0506				0.0247		0.0131		0.0011		0.0045		0.0089
Std Dev		0.0011		0.0021		0.0014				0.0020		0.0004		0.0009		0.0016		0.0027
Certified		0.006		0.085		0.051		<0.002		0.025		(0.013)		(0.001)		(0.004)		(0.009)
t		2.2622		2.306		2.306				2.2622		4.3027		2.3646		2.3646		2.2622
C(95%)		0.0008		0.0016		0.0011				0.0014		0.0011		0.0008		0.0013		0.0019

* Methods of analysis listed on page 3.

Data in parentheses are not certified but are provided for information only.
Data listed as mass fraction expressed as percent.

C(95%) = (t x sd)/√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.

Methods of analysis **Certificate Number CC21-020700p3**

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)
I	S	Gravimetry, barium sulfate
IC	Nb	Ion Chromotography
J	Si	Gravimetry, with perchloric acid
M	Cr	Titration, ammonium persulphate oxidation, ferrous sulphate
M1	Cr	Titration, peroxidisulphate oxidation
N	Mn	MAS - periodate oxidation
N1	As	MAS - Standard addition method
N2	As	MAS - arsenic-bismuth-molybdenumblue
P	P	MAS - molybdivanadophosphoric acid
P1	P	MAS - bismuth phosphorus molybdenum blue
R	Cu	MAS - tetraethylthiuram disulphide
S1	Sb	MAS - malachite green benzene extraction
SW	Pb	Square-wave polarographic
T	B	MAS - distillation, curcumine
T1	Sn	MAS - Phenylfluorone
V	N	Inert gas Fusion Method (ASTM E 1019)
W	W, Mo	MAS - thiocyanate
X	Ni	Gravimetric - 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	Laboratory contact
ANAREM, Prague, Czech Republic	Karel Bičovský
AK Steel Research, Middletown, Ohio	Howard Vail
Brammer Standard Co., Inc., Houston, Texas	Richard P. Beaumont
China National Analysis Center for Iron and Steel, Beijing, China	Prof. Wang Haizhou
Crucible Specialty Steel, Syracuse, New York	William Mastroe
J. Dirats and Co., Inc., Westfield, Massachusetts	Eric E. Dirats
IMR Test Labs, Lansing, New York	Timothe J. McGrady and Terence C. sO'Brien
LECO Corporation, St. Joseph, Michigan	Dennis Lawrenz
Shiva Technologies, Inc., Syracuse, New York	Don Shuman
Shiva Analyticals (India) Ltd., Hoskote, Bangalore, India	Dr. T. V. Ramakrishna
VHG Laboratories, Inc., Manchester, New Hampshire	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 5j, 7f, 338, 363, 364, CC1173, 1761, 2166, C2423, C2424a, C2425; ECRM 471-1, 480-1, 482-1; CKD 230, 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 C1291, CKD 246.

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 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 CC21-020700-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.

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 CC21-020700p4

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