Brammer Standard Company, Inc.

Certificate of Analysis

BS CC-24

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 [4]	**4.48**	0.05	**Nb**	**<0.005**	
Mn	**0.215**	0.004	**Pb**	**0.004**	0.001
P	**0.016**	0.003	**Sb**	**0.29**	0.02
S	**0.018**	0.001	**Sn**	**0.11**	0.008
Si	**0.23**	0.015	**Te**	**0.023**	0.003
Cu	**0.076**	0.003	**Ti**	**0.190**	0.005
Ni	**0.26**	0.01	**V**	**0.42**	0.01
Cr	**0.23**	0.01	**W**	**0.15**	0.015
Mo	**1.61**	0.03	**Zr**	**0.046**	0.005
Al	**0.159**	0.005	Provisional values		
As	**0.16**	0.015	B	(0.0005)	
Ce	**<0.005**		Bi	(0.010)	
Co	**0.009**	0.001	La	(0.0004)	
Mg	**0.013**	0.001	N	(0.0045)	

[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.

[4] The high carbon content will cause the disc to crack when severe machining is used for surface preparation. See page 4 **Caution** section.

See reverse side for more information.

Certificate Number CC24-020700p1

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Analysis	*	C	*	Mn	*	P	*	S	*	Si	*	Cu	*	Ni	*	Cr	*	Mo
1	H	4.42	N	0.209	C	0.012	H	0.01606	C	0.220	C	0.0732	C	0.246	U	0.216	C	1.565
2	H	4.428	N	0.213	C	0.012	H	0.0168	E	0.22	R	0.0733	E	0.252	Z	0.217	C	1.58
3	H	4.436	C	0.214	C	0.013	H	0.017	C	0.22	C	0.074	X1	0.253	A	0.221	A	1.59
4	H	4.45	A	0.214	P1	0.0138	C	0.017	J	0.222	C	0.0740	A	0.256	M	0.225	C	1.61
5	B	4.46	C	0.215	C	0.0152	A	0.0171	E	0.23	A	0.0744	S	0.258	B	0.227	C	1.62
6	H	4.486	C	0.215	F1	0.016	C	0.0171	C	0.234	C	0.075	C	0.262	C	0.235	C	1.62
7	A	4.49	E	0.216	A	0.0170	H	0.0174	C	0.245	E	0.0755	C	0.266	C	0.235	W	1.63
8	H	4.50	C	0.218	B	0.0171	H	0.0178	A	0.245	C	0.076	C	0.27	C	0.241	AA	1.631
9	H	4.52	C	0.221	P	0.0182	H	0.018	A	0.248	C	0.078	C	0.270	C	0.242	B	1.64
10	H	4.52			C	0.0183	H	0.0181	J	0.250	B	0.0782	C	0.272	C	0.242		
11	H	4.55			C	0.0184	H	0.0190			AA	0.07975						
12							B	0.0190										
13							B	0.0192										
Average		4.478		0.2150		0.0155		0.0177		0.2334		0.0756		0.261		0.230		1.610
Std Dev		0.043		0.0033		0.0025		0.0010		0.0126		0.0022		0.009		0.010		0.026
Certified		4.48		0.215		0.016		0.018		0.23		0.076		0.26		0.23		1.61
t		2.2281		2.306		2.2281		2.1788		2.2622		2.2281		2.2622		2.2622		2.306
C(95%)		0.029		0.0025		0.0017		0.0006		0.0090		0.0015		0.006		0.007		0.020

Analysis	*	Al	*	As	*	Ce	*	Co	*	Mg	*	Nb	*	Pb	*	Sb	*	Sn
1	C	0.152	N1	0.143	CM	<0.0005	A	0.0080	C	0.012	C	<0.0005	CM	0.0015	C	0.258	A	0.102
2	C	0.155	B	0.149	B	0.001	Z	0.0084	C	0.0122	C	<0.002	C	0.0028	A	0.28	E	0.104
3	C	0.156	C	0.152	C	0.0018	C	0.009	E	0.0127	C	<0.002	C	0.0030	E	0.287	C	0.107
4	C	0.156	D	0.157	C	0.002	C	0.009	C	0.0128	IC	0.00022	C	0.0032	C	0.291	AA	0.1075
5	A	0.157	Z	0.1583	C	0.0021	C	0.0092	A	0.013	CM	0.00040	G	0.0036	Z	0.2925	T1	0.110
6	B	0.157	C	0.17	C	0.0023	C	0.0092	E	0.0135	A	0.0005	EE	0.0038	C	0.30	B	0.111
7	C	0.158	C	0.170	C	0.0037	E	0.0098	C	0.0136	C	0.002	EE	0.0038	C	0.310	C	0.119
8	C	0.160	C	0.175	C	0.004	C	0.010	CM	0.0144	C	0.0034	A	0.004	C	0.31	C	0.119
9	C	0.160	C	0.179			C	0.0100			C	0.0043	SW	0.0063			C	0.120
10	AA	0.164	B	0.185			AA	0.0101									C	0.121
11	C	0.170																
Average		0.1586		0.1638				0.0093		0.0130				0.0036		0.2911		0.1121
Std Dev		0.0049		0.0139				0.0007		0.0008				0.0013		0.0170		0.0071
Certified		0.159		0.16		<0.005		0.009		0.013		<0.005		0.004		0.29		0.11
t		2.2281		2.2622				2.2622		2.3646				2.306		2.3646		2.2622
C(95%)		0.0032		0.0100				0.0005		0.0007				0.0010		0.0142		0.0051

Analysis	*	Te	*	Ti	*	V	*	W	*	Zr	*	B	*	Bi	*	La	*	N
1	AA	0.01604	A	0.185	C	0.406	C	0.132	B	0.0411	T	0.00027	G	0.0089	C	0.0002	V	0.0041
2	C	0.019	AA	0.1867	C	0.407	C	0.139	C	0.04164	C	0.0003	C	0.0097	C	0.0002	V	0.0042
3	C	0.0218	C	0.1880	C	0.408	Z	0.1395	C	0.0426	CE	0.0003	B	0.01	C	0.0002	V	0.00528
4	EE	0.022	C	0.1884	C	0.41	C	0.143	C	0.0432	C	0.0004			CM	0.00030		
5	EE	0.023	C	0.189	C	0.413	B	0.146	B	0.044	CE	0.0004			Z	0.0004		
6	C	0.023	C	0.190	A	0.414	C	0.148	C	0.044	C	0.0004			C	0.0004		
7	CM	0.0240	B	0.191	C	0.42	C	0.151	C	0.048	T	0.00047			B	0.001		
8	C	0.025	C	0.194	W	0.4215	W	0.154	C	0.0486	B	0.00053						
9	C	0.025	C	0.195	C	0.423	B	0.163	C	0.0499	A	0.0008						
10	B	0.028	C	0.196	C	0.423	C	0.179	C	0.050	C	0.0009						
11					B	0.424			C	0.052								
12					R1	0.439			C	0.052								
Average		0.0227		0.1903		0.4175		0.1495		0.0465		0.0005		0.0095		0.0004		0.0045
Std Dev		0.0033		0.0037		0.0095		0.0135		0.0042		0.0002		0.0006		0.0003		0.0007
Certified		0.022		0.190		0.42		0.15		0.046		(0.0005)		(0.010)		(0.0004)		(0.0045)
t		2.2622		2.2622		2.201		2.2622		2.2281		2.2622		4.3027		2.4469		4.3027
C(95%)		0.0024		0.0026		0.0060		0.0097		0.0028		0.0002		0.0014		0.0003		0.0016

* 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 CC24-020700p3**

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
G	various	AAS - Electro-thermic atomization - graphite furnace
H	C, S	Combustion-Infrared Absorption (ASTM E 1019)
IC	Nb	Ion Chromotography
J	Si	Gravimetry, with perchloric acid
M	Cr	Titration, ammonium persulphate oxidation, ferrous sulphate
N	Mn	MAS - periodate oxidation
N1	As	MAS - Standard addition method
P	P	MAS - molybdivanadophosphoric acid
P1	P	MAS - bismuth phosphorus molybdenum blue
R	Cu	MAS - tetraethylthiuram disulphide
R1	V	MAS - photometric after N-benzoyl phenylhydroxlamine extraction
S	Ni	MAS - diacethyldioxime, iodine
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
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	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	Timothy J. McGrady and Terence C. O'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 5L, 7f, 338, 363, 364, CC1173, 1761, 2166, C2423, C2424a, C2425; ECRM 471-1, 480-1, 481-1; CKD 215, 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 1141A, C2424A, C2425.

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 carbon will cause surface cracks if the disc is subjected to severe machine surface preparation. Use a coolant during surface preparation and remove small amounts of material during each machining.

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 CC24-020700-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 CC24-020700p4

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