Brammer Standard Company, Inc.

Certificate of Analysis

B.S. 4C

Chill-cast Iron

	Certified Value[1]	Estimate of Uncertainty[2]		Certified Value[1]	Estimate of Uncertainty[2]
		Analysis listed as percent by weight			
C	**3.82**	0.03	**Ca**	**0.0013**	0.0002
Mn	**0.21**	0.01	**Ce**	**0.010**	0.002
P	**0.003**	0.001	**Co**	**0.014**	0.002
S	**0.001**	0.0005	**La**	**0.002**	0.0005
Si	**0.52**	0.02	**Mg**	**0.0002**	0.0001
Cu	**0.014**	0.002	**N**	**0.008**	0.001
Ni	**0.068**	0.002	**Sb**	**0.0012**	0.0005
Cr	**0.111**	0.005	**Te**	**0.0011**	0.0004
Mo	**0.105**	0.005	**Ti**	**0.002**	0.0005
Al	**0.003**	0.0006	**V**	**0.0005**	0.0001
As	**0.007**	0.002	**Zr**	**0.010**	0.002
B	**0.0002**	0.00005			

Informational Values

Bi	<0.00001	Pb	0.0004
Cd	<0.00005	Se	<0.00005
Hg	<0.00002	Sn	0.0004
Nb	0.0005	W	0.006
O	0.004	Zn	<0.0003

[1] The certified value listed is the present best estimate of the true value.

[2] The uncertainties listed are based on value judgments of the material inhomogeneity and possible bias in the determined analytical values.

See reverse side for more information. Certificate Number 4C-092293

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

BS 4C — Certificate number 4C-092293

Analysis	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al
1	3.79	0.18	0.0020	0.0003	0.503	0.012	0.0646	0.106	0.097	0.0030
2	3.80	0.204	0.0022	0.0007	0.519	0.0125	0.067	0.108	0.101	0.003
3	3.817	0.205	0.0023	0.001	0.519	0.013	0.067	0.109	0.103	0.0030
4	3.82	0.205	0.0029	0.0010	0.528	0.013	0.068	0.113	0.105	0.003
5	3.823	0.206	0.003	0.001	0.532	0.0146	0.0685	0.115	0.107	0.003
6	3.829	0.208	0.004	0.0011		0.015	0.069	0.116	0.107	0.003
7	3.83	0.210		0.0012		0.015	0.069		0.108	0.0036
8	3.84	0.21		0.0015		0.015	0.069		0.109	0.0038
9	3.855	0.22								
10		0.22								
Average	3.823	0.207	0.0027	0.0010	0.520	0.0138	0.0678	0.1112	0.1046	0.0032
Std Dev	0.020	0.011	0.0007	0.0004	0.011	0.0013	0.0015	0.0041	0.0041	0.0003
Certified	3.82	0.21	0.003	0.001	0.52	0.014	0.068	0.111	0.105	0.003

Analysis	As	B	Ca	Ce	Co	La	Mg	N	Nb	O
1	0.0046	0.0001	0.0009	0.007	0.012	0.0013	0.0001	0.0073	0.0002	0.0022
2	0.005	0.00011	0.0012	0.0078	0.012	0.0013	0.0001	0.0074	0.0004	0.0042
3	0.0055	0.00016	0.0012	0.010	0.012	0.0020	0.00015	0.0077	0.0005	0.0045
4	0.006	0.0002	0.0013	0.010	0.013	0.0021	0.0002	0.0079	0.0005	
5	0.007	0.0002	0.00135	0.0105	0.013	0.0022	0.0002	0.0081	0.0007	
6	0.0070		0.0014	0.0122	0.0137	0.0025	0.00024	0.0088		
7	0.0077		0.0015	0.0128	0.0144		0.0003	0.0095		
8	0.0078		0.0015		0.0145		0.0003	0.0097		
9	0.0078		0.0015		0.0155		0.0004			
10	0.0081				0.016					
11					0.0162					
Average	0.0067	0.00015	0.00132	0.0100	0.0138	0.0019	0.00022	0.0083	0.0005	0.0036
Std Dev	0.0013	0.00005	0.00020	0.0021	0.0016	0.0005	0.00010	0.0009	0.0002	0.0013
Certified	0.007	0.0002	0.0013	0.010	0.014	0.002	0.0002	0.008	(0.0005)	(0.004)

Analysis	Pb	Sb	Sn	Te	Ti	V	W	Zn	Zr
1	0.00016	0.0006	0.00005	0.0006	0.001	0.0003	0.003	<0.0001	0.0075
2	0.0003	0.0006	0.0002	0.0008	0.001	0.0005	0.0040	0.00015	0.0100
3	0.0003	0.0006	0.00029	0.0009	0.0011	0.0005	0.005	0.0002	0.010
4	0.00035	0.0012	0.0003	0.0011	0.0018	0.0005	0.0060		0.0110
5	0.0005	0.0012	0.0004	0.0014	0.0018	0.0006	0.0082		0.0112
6	0.0007	0.0013	0.0005	0.0014	0.002	0.0006	0.0088		
7		0.0014	0.0007	0.0015	0.0020		0.009		
8		0.0014	0.0009		0.0021				
9		0.0018							
10		0.0021							
Average	0.00039	0.00122	0.00042	0.00110	0.0016	0.00050	0.0063		0.0099
Std Dev	0.00019	0.00051	0.00028	0.00035	0.0005	0.00011	0.0024		0.0015
Certified	(0.0004)	0.0012	(0.0004)	0.0011	0.002	0.0005	(0.006)	(<0.0003)	0.010

Analysis produced by glow-discharge mass spectrometers

Lab	Bi	Cd	Hg	Se
1	---	0.00009	<0.00001	<0.00005
2	<0.000001	<0.000005	<0.00001	---
3	<0.00001	<0.00005	<0.00002	---

Analysis: Chemical analyses were made on chips prepared by a lathe from the certified portion of the discs. The individual values listed above are the average of each analyst's results. Methods of analysis used were a combination of ASTM Standard Methods E 351, E 1019, plus additional ICP, and AA spectrometric methods and Glow-Discharge Mass Spectrometers. The Certified Reference Materials used to validate the analytical data are listed on the last page of this certificate.

Co-operating Laboratories: Some of the co-operating laboratories were:
Analytical Associates Inc., Detroit, Michigan
Analytika Co., Ltd., Prague, Czechoslovakia
Brammer Standard Co., Inc., Houston, Texas
Crucible Specialty Metals, Syracuse, New York
J. Dirats and Co., Inc., Westfield, Massachusetts
Northern Analytical Laboratory, Inc., Merrimack, New Hampshire
Shiva Technologies, Inc., Cicero, New York
VHG Laboratories, Inc., Manchester, New Hampshire

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 and found to be compatible with the following Certified Reference Materials: NIST SRM C1145A, C1146A, 1147, C1150A, C2424; CKD 241 through 249.

Source: This material was melted and cast by American Centrifugal, Birmingham, Alabama, using an electric arc furnace. It was chill-cast into a water-cooled sample mold producing 648 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.

Preparation: Use the same method for preparing the analytical surface on all reference materials and specimens for best results. Avoid overheating the disc during surface preparation.

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. Phone: (281) 440-9396
14603 Benfer Road
Houston, Texas 77069-2895 USA Fax: (281) 440-4432

Certified by: _____ on September 22, 1993.
G. R. Brammer

Certificate Number 4C-092293

Methods of analysis - Certified Reference Materials used for validation of the results for BS 4C.

Al BY GFAAS- ECRM 184-1 BY AAS- 476-2, 481-1
BY ICP- NIST SRM 125B, 361 - 363, ECRM 096-1, 184-1, 481-1

As BY GFAAS- NIST SRM 364; ECRM 481-1 BY HYDRIDE AAS- 476-2
BY ICP- NIST SRM 361 - 364; ECRM 184-1, 481-1;

B BY ICP- NIST SRM 361 - 365
BY DISTILLATION AND PHOTOMETRY- NIST SRM 361, 362, 364

C BY COMBUSTION- NIST SRM 5L, 122g, 333, 342a, 890, 891; ECRM 481-1, 486-1, 487-1
BY COMBUSTION- Barium carbonate

Ca BY AAS- ECRM 088-1, 096-1
BY ICP- NIST SRM 361 - 364; ECRM 096-1

Ce BY ICP- JSS 190-1 through 191-5; CMSI 1551
BY ICP- NIST SRM 361 - 364

Co BY AAS- ECRM 088-1, 481-1, ASMW 23/6
BY ICP- NIST SRM 361 - 365, 1270; ECRM 085-1, 184-1; CMSI 1551

Cr BY AAS- NIST SRM 363, 364, 476-2, 481-1
BY SPECTROPHOTOMETRY- ECRM 476-2, 481-1
BY ICP- NIST SRM 125B, 361 - 365, 1270; ECRM 088-1, 096-1, 184-1, 481-1; CMSI 1551

Cu BY AAS- NIST SRM 363; ECRM 096-1, ECRM 476-2, 481-1; ASMW 23/6
BY SPECTROPHOTOMETRY - DIETHYLTHIURAMDISULPHIDE- ECRM 476-2, 481-1
BY ICP- NIST SRM 125B, 361 - 365, 1270; ECRM 085-1, 096-1, 184-1, 481-1; CMSI 1551

Mg BY AAS- NIST SRM 362, 363
BY ICP- NIST SRM 361 - 364; ECRM 481-1; CMSI 1551

Mn BY AAS- NIST SRM 363, 364; ECRM 476-2, 481-1
BY SPECTROPHOTOMETRY - PERIODATE- ECRM 476-1, 481-1
BY ICP- NIST SRM 125B, 361 - 365; ECRM 085-1, 088-1, 096-1, 184-1, 481-1; CMSI 1551

Mo BY AAS- NIST SRM 362; ECRM 184-1
BY ICP- NIST SRM 125B, 361 - 365, 1270; ECRM481-1; CMSI 1551
BY SPECTROPHOTOMETRY - THIOCYANATE EXTRACTED TO BUTYLACETATE- 476-2, 481-1; ASMW 23/6

N BY THERMO-EVOLUTION-HELIUM CARRIER- ECRM 476-2

Nb BY ICP- NIST SRM 361 - 364; ECRM 096-1
BY SPECTROPHOTOMETRY SULPHOCHLOROPHENOLE-S-EXTRACTION- ASMW 23/6

Ni BY GRAVIMETRIC DMG- ECRM 476-2, 481-1
BY AAS- NIST SRM 361, BAM 044-1; ECRM 476-2, 481-1; ASMW 23/6
BY ICP- NIST SRM 125B, 361 - 365, 1270; ECRM 088-1, 096-1, 184-1, 481-1; CMSI 1551

P BY SPECTROPHOTOMETRY, PVM EXTRACTED TO MIBK- ECRM 476-2, 481-1
BY ICP- NIST SRM 125B, 361 - 365, 1270; ECRM 085-1, 088-1, 096-1, 184-1, 481-1; CMSI 1551

Pb BY GF AAS- BCS 456/1, 458/1; BY AAS AFTER TOPO EXTRACTION TO MIBK- ASMW 23/6
BY GFAAS- NIST SRM 362; BCS 455/1
BY ICP- NIST SRM 361 - 365; ECRM 085-1

S BY COMBUSTION- NIST SRM 5L, 122g, 333, 342a, 890, 891; ECRM 476-2, 481-1, 486-1, 487-1

Sb BY AAS- ECRM 184-1; BCS 458-1 BY AAS AFTER TOPO EXTRACTION TO MIBK- ASMW 23/6
BY ICP- NIST SRM 361 - 364; ECRM 085-1

Si GRAVIMETRIC- NIST SRM 5L; ECRM 476-2, 481-1; ASMW 23/6
BY AAS- ECRM 481-1, 458/1
BY ICP- NIST SRM 125B, 361 - 365, 1270; ECRM 085-1, 088-1, 096-1, 184-1, 481-1; CMSI 1551

Sn BY GFAAS- NIST SRM 363; BAM 039-2; BY AAS AFTER TOPO EXTRACTION TO MIBK- ASMW 23/6
BY ICP- NIST SRM 125B, 361 - 364; ECRM 184-1

Te BY GFAAS- NIST SRM 361
BY ICP- JSS 190-1 through 191-5; CMSI 1551

Ti BY GFAAS- NIST SRM 361
BY SPECTROPHOTOMETRY WITH DIANTIPYRYLMETHANE- ECRM 476-2
BY ICP- NIST SRM 361 - 364; CMSI 1551

V BY GFAAS- NBS SRM 362, 364, 365; ECRM 085-1
BY SPECTROPHOTOMETRY AND N-BENZOYL N-PHENYL HYDROXILAMINE EXTRACTION- ECRM 476-2; ASMW 23/6
BY ICP- NIST SRM 361 - 365, 1270; ECRM 085-1, 088-1, 096-1, 184-1; CMSI 1551

W BY ICP- NIST SRM 361 - 364

Zn BY ICP- NIST SRM 362; ECRM 085-1

Zr BY ICP- NIST SRM 125B, 361 - 365; ECRM 085-1, 088-1, 096-1, 184-1, 481-1; CMSI 1551
BY SPECTROPHOTOMETRY WITH ARSENAZO III AFTER TOPO EXTRACTION- Pure metal