

BRAMMER STANDARD COMPANY, INC.

Certificate of Analysis

BS SiMn-1

Certified Reference Material for Silicomanganese Powder

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³
C	1.80	0.06	
Cr	0.019	0.001	
Fe	8.2	0.3	
Mn	73.2	0.3	
P	0.278	0.008	
S	0.016	0.001	
Si	16.0	0.4	

Informational Values^{3,4}

Al (0.028)	As (0.010)	B (0.014)	Ba (0.002)	Bi (0.00001)
Ca (0.05)	Ce (0.00006)	Co (0.051)	Cu (0.042)	Ga (0.0012)
Ge (0.0003)	K (0.0025)	La (0.00004)	Mg (0.009)	Mo (0.007)
N (0.004)	Na (0.0015)	Nb (0.0006)	Nd (0.00006)	Ni (0.083)
O (0.37)	Pb (0.0005)	Sb (0.002)	Se (0.0003)	Sn (0.0003)
Sr (0.0005)	Ti (0.19)	V (0.04)	W (0.004)	Zn (0.0022)
Zr (0.0007)				

¹ 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 3 for more information on its calculation.

² For each element, the uncertainty listed is based on a statistical evaluation of the contributions of homogeneity and the interlaboratory testing program. See page 3 for more information on its calculation.

³ Values are given in weight percent. Values in brackets are reported by difference.

⁴ 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 SiMn-1 * Code for method Certified values listed as weight percent

Analysis	*	C	*	Cr	*	Fe	*	Mn	*	P	*	S	*	Si
1	1	1.72	4	0.015	4	7.782	13	71.99333	4	0.243667	1	0.0091	4	15.0
2	1	1.785	5	0.016667	4	7.816567	13	72.46067	5	0.263333	1	0.011733	4	15.21667
3	1	1.814833	5	0.017767	4	8.018333	4	72.75667	5	0.2710	1	0.014963	4	15.97767
4	1	1.817667	4	0.018167	13	8.305	16	[73.12333]	4	0.2723	1	0.017133	6	16.23333
5	1	1.8194	5	0.0193	4	8.346667	16	[73.29637]	4	0.289	1	0.019267	17	16.25333
6	1	1.827967	4	0.019333	4	8.523333	4	73.80667	5	0.2904	1	0.019333	6	16.30667
7	1	1.8476	4	0.027767	4	8.603333	4	74.96667	4	0.2927	1	0.02125	6	16.396
8			4	0.0286					4	0.296667			6	16.52667
9									4	0.300				
Average		1.803		0.01937		8.18		73.20		0.2775		0.01554		15.99
Std dev		0.068		0.00079		0.31		0.10		0.0096		0.00068		0.050
H		0.015275		0.001024		0.049441		0.345597		0.004314		0.000926		0.086927
U ₁		0.070		0.0013		0.31		0.36		0.010		0.0011		0.51
t-statistic		2.45		2.36		2.45		2.45		2.31		2.45		2.36
U ₂		0.017		0.0031		0.77		0.88		0.024		0.0028		1.20
U ₃		0.065		0.0011		0.29		0.33		0.0079		0.0011		0.42
Certified		1.80		0.019		8.2		73.2		0.278		0.016		16.0
Uncertainty		0.06		0.001		0.3		0.3		0.008		0.001		0.4
Tolerance		0.17		0.003		0.8		0.9		0.024		0.003		1.2

BS SiMn-1 * Code for method Informational values listed as weight percent

Analysis	*	Al	*	As	*	B	*	Ba	*	Bi	*	Ca	*	Ce	*	Co
1	4	0.025833	5	0.008733	5	0.0116	5	0.0020	5	0.0000113	4	0.046167	5	0.0000623	4	0.049767
2	5	0.0305	5	0.01	4	0.014533	5	0.0021			5	0.050			5	0.0510
3			4	0.011267	5	0.0150									5	0.052633
Average		0.03		0.01		0.01		0.002		0.00001130		0.05		0.000062		0.05
Std dev		0.46		0.13		0.19		0.018		0.00000030		0.71		0.000017		0.61
H		0.001259		0.000765		0.000765		0.000419		0.000173		0.001628		0.000194		0.001628
U ₁		0.46		0.13		0.19		0.018		0.00017		0.71		0.00019		0.61
t-statistic		12.71		4.30		4.30		12.71		12.71		12.71		12.71		4.30
U ₂		5.87		0.56		0.80		0.22		0.0022		9.070		0.0025		2.62
U ₃		4.15		0.32		0.46		0.16		0.0022		6.41		0.0025		1.51
		(0.028)		(0.010)		(0.014)		(0.002)		(0.00001)		(0.05)		(0.00006)		(0.051)

Analysis	*	Cu	*	Ga	*	Ge	*	K	*	La	*	Mg	*	Mo	*	N
1	4	0.0415	5	0.0011	5	0.0002	5	0.0025	5	0.00004	5	0.0076	5	0.005567	2	0.00447
2	5	0.042	5	0.0014	5	0.00045					5	0.0080	5	0.006067		
3	5	0.043367									4	0.0103	4	0.0092		
Average		0.04		0.0012		0.00034		0.002		0.0000437		0.01		0.007		0.004
Std dev		0.53		0.0077		0.00064		0.033		0.0000067		0.11		0.083		0.080
H		0.001452		0.000358		0.000259		0.000419		0.000187		0.000765		0.00066		0.000533
U ₁		0.53		0.0077		0.00037		0.033		0.00019		0.11		0.083		0.080
t-statistic		4.30		12.71		12.71		12.71		12.71		4.30		4.30		12.71
U ₂		2.28		0.098		0.0087		0.43		0.0024		0.47		0.36		1.020
U ₃		1.31		0.069		0.0062		0.43		0.0024		0.27		0.21		1.020
(Informational)		(0.042)		(0.0012)		(0.0003)		(0.0025)		(0.00004)		(0.009)		(0.007)		(0.004)

BS SiMn-1 * Code for method Informational values listed as weight percent

Analysis	*	Na	*	Nb	*	Nd	*	Ni	*	O	*	Pb	*	Sb	*	Se
1	5	0.00153	4	0.000333	5	0.000055	5	0.079633	2	0.369	5	0.00046	5	0.00085	5	0.000277
2			5	0.0007			4	0.082133			5	0.0005	5	0.001067		
3			5	0.00082			5	0.0870					4	0.003333		
Average		0.002		0.0006		0.000055		0.08		0.37		0.0005		0.002		0.00028
Std dev		0.015		0.0017		0.000012		0.84		2.56		0.0013		0.011		0.00058
H		0.000419		0.000296		0.000192		0.00209		0.005168		0.000283		0.000419		0.000248
U ₁		0.015		0.0017		0.00019		0.84		2.56		0.0013		0.011		0.00063
t-statistic		12.71		4.30		12.71		4.30		12.71		12.71		4.30		12.71
U ₂		0.20		0.0075		0.0024		3.60		32.59		0.017		0.048		0.0080
U ₃		0.20		0.0043		0.0024		2.080		32.59		0.012		0.028		0.0080
(Informational)		(0.0015)		(0.0006)		(0.00006)		(0.083)		(0.37)		(0.0005)		(0.002)		(0.0003)

Analysis	*	Sn	*	Sr	*	Ti	*	V	*	W	*	Zn	*	Zr
1	5	0.0003	5	0.0004	4	0.1858	5	0.038667	5	0.0036	5	0.0018	5	0.0007
2	5	0.000313	5	0.0005233	5	0.1868	5	0.0399	4	0.0042	5	0.0025333	5	0.000707
3					5	0.196667	4	0.0426	5	0.0047				
Average		0.00031		0.0005		0.19		0.04		0.004		0.002		0.0007
Std dev		0.00051		0.0012		0.58		0.51		0.042		0.019		0.0027
H		0.000254		0.000283		0.003426		0.001452		0.000533		0.000419		0.000308
U ₁		0.00057		0.0012		0.58		0.51		0.042		0.019		0.0027
t-statistic		12.71		12.71		4.30		4.30		4.30		12.71		12.71
U ₂		0.0072		0.015		2.48		2.20		0.18		0.25		0.035
U ₃		0.0051		0.011		1.43		1.27		0.10		0.17		0.024
(Informational)		(0.0003)		(0.0005)		(0.19)		(0.04)		(0.004)		(0.0022)		(0.0007)

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_L), calculated from its standard deviation (S_L) and its uncertainty estimate (U_L), is used as the weight (W_L) for it's mean (M_L). The standard deviation (S) is calculated as the square root of the reciprocal of the sum of the weights. U₁ is the combined uncertainty from homogeneity and labs. U₂ is U₁ multiplied by the coverage factor (95 % t-statistic). U₃ is U₂ 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 U₃ 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 Uncertainty is a measure of the quality of the **Certified** value.

The Tolerance is a measure of the expected performance of an analysis. This involves further expanding the sample uncertainty to include instrument and operator uncertainty, for those without access to such calculations.

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 E1019) | 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 Difference |
| 5 ICP Mass Spectrometry | 11 GD Atomic Emission | 17 Wet |
| 6 Gravimetric | 12 GD Mass Spectrometry | |

ICP = Inductively Coupled Plasma GF = Graphite Furnace GD = Glow Discharge
 DCP = Direct Current Plasma HG = Hydride Generation

<u>Laboratory</u>	<u>Location</u>	<u>Registrar</u>	<u>Accreditation</u>
Evans Analytical Group	Liverpool, NY	A2LA	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
NSL Analytical	Cleveland, OH	ANAB	17025
National Analysis Center for Iron & Steel	Beijing, China	CNAS	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	AB 554
Exova	Gelndale Heights, IL	A2LA	17025
Northern Analytical Laboratory, Inc.	Londonderry, NH	PRI/Nadcap	17025

A2LA = American Association for Laboratory Accreditation
 ANAB = ANSI-ASQ National Accreditation Board
 CNAS = China National Accreditation Service
 Nadcap = National Aerospace and Defense Contractors Accreditation Program
 PCA = Polish Center For Accreditation
 PRI = Performance Review Institute

Analysis: Chemical analyses were made on samples taken from the bulk material for the certified portion of the lot in accordance with ASTM Standard Practice E1806. The laboratories participating in the testing followed the requirements of ISO Standard 17025.

Traceability: The following Certified Reference Materials were used to validate the analytical data: 501-320, 501-501, 501-504, 501-550, 501-644, 501-676, 501-677, 501-993, ; AR 642, 872, 875; BAS 208/2, 464/1; IARM 296A; JK 37; NCS HC11603; SRM 16F, 66A, 160B, 361, 363.

Homogeneity: This Certified Reference Material (CRM) was tested for homogeneity using ASTM Standard Method E826 and found acceptable.

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 SiMn-1 is valid 20 years. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

Source: The bulk stock for this CRM was produced by Felamn Production, LLC; Letart, WV.

Form: This CRM is available in the form of minus 100 mesh powder in 100 gram containers by Brammer Standard Company, Inc.

Use: This CRM is intended for use in x-ray spectrometric and solution methods of analysis. Refer to ISO Guide 33 for information about the use of Certified Reference Materials.

Sample Preparation: For best analytical results, use the same method for preparing all reference materials as used for production specimens.

Certificate Number: The unique identification number for this certificate of analysis is SiMn-1-063016. You may obtain information on revisions of certificates from the internet at www.brammerstandard.com.

Safety Notice: A Safety Data Sheet (SDS) 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 Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895
Telephone: (281) 440-9396 Fax: (281) 440-4432 Website: www.brammerstandard.com
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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

References:

Versions used were those available at the time of testing and characterization

- E826 Standard Practice for Testing Homogeneity of a Metal Lot or Batch in Solid Form by Spark Atomic Emission Spectrometry
- E1019 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques
- E1806 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, 100 Barr Harbor Dr., West Conshohocken, Pa 19428.

ISO Guides and Standards available from Global Engineering - 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

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Certified by: _____ on June 30, 2016.

Beau R. Brammer