Brammer Standard Company, Inc.

Certificate of Analysis
BS 642D

Certified Reference Material for Aluminum Silicon Bronze - UNS Number C64200

Certified Values[3]

	Certified Value[1]	Estimate of Uncertainty[2]		Certified Value[1]	Estimate of Uncertainty[2]
Ag	0.0011	0.0003	Ni	0.047	0.003
Al	6.73	0.09	O	0.0007	0.0002
C	0.0011	0.0002	P	0.0007	0.0002
Cr	0.0004	0.0002	Pb	0.0038	0.0004
Cu	91.2	0.2	Si	1.77	0.06
Fe	0.152	0.007	Sn	0.019	0.004
Mn	0.018	0.001	Zn	0.093	0.008

Informational Values[3,4]

As (0.002)	Co (0.0007)	Mg (0.0003)	N (0.0005)	S (0.0003)
Sb (0.001)	Zr (0.0001)			

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.

Trace element information values for Au, B, Be, Bi, Ca, Cd, Cl, Ga, Ge, Hf, In, Li, Mo, Na, Nb, Pd, Pt, Ru, Se, Te, Th, Ti, Tl, U, V, and W are shown on page 4.

The requirements of ISO Guides 30, 31, and 35 were followed for the preparation of this Certified Reference Material and certificate of analysis.

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* Code for method   Certified values listed as weight percent

Analysis	*	Ag	*	Al	*	C	*	Cr	*	Cu	*	Fe	*	Mn	*	Ni	*	O	*	P
1	5	0.0009	3	6.4773	1	0.00045333	4	0.0002	16	[91.045]	3	0.1357	4	0.011	15	0.04033	2	0.0004	12	0.0001686
2	5	0.000996667	4	6.5616667	1	0.00083333	12	0.00027333	16	[91.0496334]	4	0.13767	12	0.0115	4	0.0409	2	0.00049	12	0.0001844
3	17	0.001	3	6.58	3	0.0009	4	0.00033333	16	[91.06]	12	0.14	12	0.0118	4	0.042	2	0.00051	12	0.0001945
4	5	0.00103	10	6.59	1	0.00092333	5	0.00034667	15	91.07667	4	0.1400	12	0.0126	10	0.0435	2	0.00051	12	0.0005833
5	5	0.001133333	4	6.6003333	3	0.001	4	0.00046667	4	91.09	10	0.145	3	0.0177	10	0.04433	2	0.00052	4	0.0007
6	4	0.001166667	4	6.6866667	1	0.001	5	0.00054	16	[91.115]	10	0.1453	3	0.018	3	0.0445	2	0.00057	7	0.00079
7	12	0.0013	3	6.725	1	0.00106667	3	0.0007	16	[91.15334]	4	0.14753	4	0.0180333	4	0.04507	2	0.00069	4	0.0008
8			4	6.7596667	1	0.00113333	3	0.001	4	91.15667	12	0.1490	4	0.0181	12	0.04603	2	0.00091	3	0.0008
9			4	6.7906667	1	0.00123333			16	[91.2]	4	0.15	17	0.0182	8	0.0462	2	0.0010	4	0.0009333
10			10	6.7936667	1	0.00146667			18	91.26	12	0.15035	4	0.0182333	4	0.04637	2	0.00173	4	0.001
11			4	6.8003333	1	0.00173333			4	91.3	3	0.15133	5	0.0183333	10	0.04667			5	0.0014333
12			3	6.805					10	91.30667	4	0.15207	10	0.0185	4	0.04697				
13			4	6.8135333					16	[91.30667]	4	0.15233	4	0.0185333	17	0.047				
14			4	6.8433					3	91.35	12	0.15395	4	0.0186	5	0.047				
15			15	6.8433333					13	91.48667	12	0.15415	12	0.0186667	4	0.04707				
16			4	6.8433333							7	0.156	3	0.0187	12	0.04778				
17			4	6.94							5	0.15667	3	0.0188667	3	0.04787				
18											12	0.15683	5	0.0189	12	0.04793				
19											3	0.1585	4	0.0192	3	0.0488				
20											4	0.1587	4	0.0193	12	0.04925				
21											12	0.15995	10	0.0234	12	0.04935				
22											15	0.16	15	0.027	4	0.04957				
23											4	0.16003			4	0.05017				
24											3	0.164			12	0.0506				
25											10	0.16533			3	0.05135				
26															12	0.05633				
Average		0.001111		6.73		0.001068		0.000358		91.189		0.1518		0.01908		0.0455		0.00073		0.000690
Std Dev		0.000077		0.16		0.000095		0.000043		0.032		0.0028		0.00059		0.0013		0.00010		0.000095
H		0.00036		0.04		0.00035629		0.00027		0.42		0.0031		0.0011		0.0016		0.00032		0.00032
U_1		0.00037		0.17		0.00037		0.00027		0.42		0.0042		0.0012		0.0020		0.00034		0.00033
t-statistic		2.45		2.12		2.23		2.36		2.14		2.06		2.08		2.06		2.26		2.23
U_2		0.00090		0.36		0.00082		0.00064		0.91		0.0087		0.0025		0.0042		0.00076		0.00073
U_3		0.00034		0.087		0.00025		0.00023		0.23		0.0017		0.00053		0.0083		0.00024		0.00022
Certified		**0.0011**		**6.73**		**0.0011**		**0.0004**		**91.2**		**0.152**		**0.018**		**0.047**		**0.0007**		**0.0007**
Uncertainty		0.0003		0.09		0.0002		0.0002		0.2		0.007		0.001		0.003		0.0002		0.0002
Tolerance		0.0009		0.36		0.0008		0.0004		0.9		0.021		0.003		0.009		0.0007		0.0007

Analysis	*	Pb	*	Si	*	Sn	*	Zn
1	3	0.00305	10	1.6636	12	0.0120	3	0.0646
2	12	0.00305935	15	1.7166667	12	0.012275	12	0.082875
3	12	0.003141825	3	1.7421	12	0.013525	12	0.0834
4	5	0.003433333	4	1.7443333	12	0.013775	12	0.0851
5	5	0.00346	10	1.7466667	12	0.01545	12	0.085175
6	12	0.00358105	3	1.75	4	0.01566667	4	0.08766667
7	17	0.0036	4	1.754	12	0.01575	12	0.08795
8	12	0.0036081	3	1.76	12	0.01846667	12	0.088125
9	4	0.003633333	10	1.772	4	0.0185	4	0.0886
10	4	0.0039	4	1.775	3	0.0194	3	0.09125
11	4	0.004033333	4	1.78	5	0.01966667	10	0.0917
12	4	0.0041	19	1.7910667	5	0.01986667	8	0.09176667
13	12	0.004266667	4	1.7966667	10	0.0200	4	0.09246667
14	3	0.0043	4	1.7999333	4	0.0201	4	0.09313333
15	5	0.004333333	3	1.8	4	0.02016667	5	0.09333333
16	12	0.004377925	4	1.8000	4	0.02026667	4	0.09383333
17	12	0.004397375	4	1.8266667	3	0.021	10	0.09533333
18			4	1.8726667	17	0.022	4	0.09566667
19			6	1.8776667	15	0.02233333	4	0.10053333
20					10	0.02233333	17	0.1025
21					4	0.0225	3	0.1046
22					3	0.0228	15	0.113333
23					4	0.0229	3	0.114
24					4	0.024067	12	0.116667
25					3	0.0285		
Average		0.00380		1.7749		0.019332		0.093484
Std Dev		0.00015		0.0067		0.000063		0.000065
H		0.00054		0.015		0.0011		0.0024
U_1		0.00056		0.017		0.0011		0.0024
t-statistic		2.12		2.10		2.06		2.07
U_2		0.0012		0.035		0.0022		0.0049
U_3		0.00029		0.0081		0.00044		0.0010
Certified		**0.0038**		**1.77**		**0.019**		**0.093**
Uncertainty		0.0004		0.06		0.004		0.008
Tolerance		0.0012		0.18		0.012		0.024

BS 642D   * Code for method   Informational values listed as weight percent

Analysis	*	As	*	Co	*	Mg	*	N	*	S	*	Sb	*	Zr
1	5	0.0000933	5	0.00007	12	0.000062	2	0.0000267	1	0.00004	5	0.00006	12	0.0001033
2	5	0.00009667	12	0.00008	12	0.000066	2	0.0000273	12	0.0000871	5	0.00006	12	0.0001152
3	12	0.000131275	12	0.000081	12	0.0000701	2	0.0001	12	0.000088475	12	0.00008	12	0.000119
4	12	0.000139825	12	0.000082	4	0.0001	2	0.00046667	12	0.00009765	12	0.00009	12	0.0001488
5	12	0.000143333	12	0.000083	5	0.00013			1	0.0001	5	0.00009		
6	12	0.00014585	4	0.0001	4	0.00014667	12	0.0008711	1	0.0001	12	0.00009		
7	3	0.0013	5	0.0002267	12	0.00020333	12	0.00127993	12	0.0001466667	12	0.00010		
8	4	0.0023	4	0.0004	4	0.00056667			1	0.0001966667	5	0.0001		
9	4	0.004	4	0.0006	3	0.001595			1	0.0002333333	12	0.0001		
10	4	0.0041	4	0.0010333					1	0.0003466667	12	0.00011		
11	3	0.006	3	0.005					1	0.0007	12	0.00011		
12									3	0.00075	4	0.00017		
13									3	0.001	4	0.00047		
14											3	0.00225		
15											4	0.00507		
16											3	0.007		
Average		0.0017		0.0007		0.00033		0.00047		0.00030		0.0010		0.000122
Std Dev		0.0054		0.0012		0.00027		0.00067		0.00019		0.0018		0.000044
H		0.0004		0.0003		0.00026		0.00029		0.00026		0.0003		0.00022
U_1		0.0054		0.0012		0.00038		0.00073		0.00032		0.0019		0.00022
t-statistic		2.23		2.23		2.31		2.45		2.18		2.13		3.18
U_2		0.012		0.0027		0.00087		0.0018		0.00070		0.0039		0.00070
U_3		0.0037		0.00081		0.00029		0.00067		0.00019		0.0010		0.00035
Informational		(0.002)		(0.0007)		(0.0003)		(0.0005)		(0.0003)		(0.001)		(0.0001)

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. U_1 is the combined uncertainty from homogeneity and labs. U_2 is U_1 multiplied by the coverage factor (95 % t-statistic). U_3 is U_2 divided by the square root of the number of determinations (n). Thus:

$$C_L = \sqrt{S_L^2 + U_L^2} \qquad W_L = \frac{1}{C_L^2} \qquad A = \frac{\sum_{i=1}^{n} W_L M_L}{\sum_{i=1}^{n} W_L} \qquad S = \frac{1}{\sqrt{\sum_{i=1}^{n} W_L}} \qquad U_1 = \sqrt{H^2 + S^2} \qquad U_2 = t \times U_1 \qquad U_3 = \frac{U_2}{\sqrt{n}}$$

*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 U_3 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.

BS 642D   * Code for analytical method   Trace analysis listed as mg/kg   (ppm)

Analysis	*	Au	*	B	*	Be	*	Bi	*	Ca	*	Cd	*	Cl	*	Ga	*	Ge	*	Hf
1	12	0.03	12	2	12	80	12	0.15	12	0.1223	12	0.84	12	0.009	12	7.7	12	0.07	12	0.01
2	12	0.05	12	2.2	12	90	12	0.18	12	0.15	12	0.92	12	0.02	12	9.4	12	0.1	12	0.01
3	12	0.06	12	2.5	12	100	12	0.18	12	0.1525	12	0.94	12	0.04	12	9.6	12	0.13	12	0.01
4									12	0.1643										
5									12	0.17										
6									12	0.21										

Analysis	*	In	*	Li	*	Mo	*	Na	*	Nb	*	Pd	*	Pt	*	Ru	*	Se	*	Te
1	12	0.51	12	0.005	12	2	12	0.02	12	0.01	12	0.3	12	0.01	12	0.03	12	0.13	12	0.0543
2	12	0.57	12	0.008	12	2.1	12	0.02	12	0.01	12	0.45	12	0.02	12	0.03	12	0.13	12	0.0555
3	12	0.62	12	0.03	12	2.4	12	0.03	12	0.02	12	0.46			12	0.06	12	0.16	12	0.06
4																			12	0.0603
5																			12	0.0638
6																			12	0.0655
7																			12	0.07
8																			12	0.07
9																			12	0.0748

Analysis	*	Th	*	Ti	*	Tl	*	U	*	V	*	W
1	12	0.003	12	1.8	12	0.009	12	0.02	12	5	12	0.01
2	12	0.003	12	2.1	12	0.01	12	0.02	12	5.4	12	0.02
3	12	0.004	12	2.2	12	0.04	12	0.03	12	5.6	12	0.04

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	PIXE
4	ICP Atomic Emission	10	X-Ray Fluorescence	16	Difference
5	ICP Mass Spectrometry	11	GD Atomic Emission	17	Atomic Absorption
6	Gravimetric	12	GD Mass Spectrometry	18	Electrolytic
				19	Wet

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

Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, Guide 34
LECO Corporation	St. Joseph, MI	A2LA	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025
NSL Analytical	Cleveland, OH	ANAB	17025
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
Dirats Laboratories	Westfield,MA	ANAB	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
TUV Rheinland Pvt. Ltd.	Bangalore, India	NABL	17025
Evans Analytical Group	Liverpool, NY	A2LA	17025
Exova	Glendale Heights, Il	A2LA	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Exova	Santa Fe Springs, CA	A2LA	17025

A2LA = American Association for Laboratory Accreditation
ANAB = ANSI-ASQ National Accreditation Board
CNAS = China National Accreditation Service
PRI =Performance Review Institute

Analysis: Chemical analyses were made on solid pieces and chips prepared by an end mill from representative samples 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: 39X17873, 39XCTS; AR 147, 511, 645, 662, 892, 1653; BAM 222, 223, 224, 228, 361, 366; BAS 179/2, 183/3, 183/4, 207/1, 304/1, 390; BS 110B, 642, 642A, 642B, 642C, 863B, 903D, 929, 932C, 932D, 932E, 932F, 954A, 954B, 954C, 954D, 955B, 14500, 18150A; IARM 80B, 81A, 81B, 84B, 150A, 151A, 158C; IPT 10A, 15; LECO 501-147, 501-402, 501-550, 501-593, 501-953, 502-348, 502-868; SRM 124D, 158A, 166B, 394, 395, 400, 874, 1112, 1113, 1114 1413, 3128.

Homogeneity: This Certified Reference Material (CRM) was tested for homogeneity using ASTM Standard Method E826 and found acceptable. It was also examined by spark atomic emission spectrometry and found to be compatible with the following Reference Materials — BAM 228, 361; BAS 183/3, 304/1; BS 110B, 642, 642A, 642C, 903D, 929, 954A, 14500; IARM 81B; IPT 15; SRM 158A, 394, 395, 398, 874.

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 642D is valid indefinitely. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

Storage: This CRM must be stored in a cool, dry, non-corrosive environment.

Source: The bar stock for this CRM was produced by Eureka Metals; Los Angeles, CA.

Form: This CRM is machined in the form of a disc, approximately 38 mm in diameter and 19 mm thick by Brammer Standard Company, Inc.

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

Certified Area: The entire depth of the CRM may be used.

> Caution: As with any bar material, avoid spark atomic emission spectrometric burns in the center of the CRM (5 mm radius), as some segregation may be present.

Sample Preparation: For best analytical results, use the same method for preparing the analytical surface on all reference materials as used for production specimens. Avoid overheating the sample during surface preparation.

> Caution: CRM contains significant insoluble soft metal inclusions. Surface smearing may occur. Spark atomic emission spectrometers may require extended preburns to compensate.

Certificate Number: The unique identification number for this certificate of analysis is 642D-110717. 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 Co., Inc.	**Phone: (281) 440-9396**	**Web: www.brammerstandard.com**
14603 Benfer Road		
Houston, Texas 77069-2895 USA	**Fax: (281) 440-4432**	**Email: contact@brammerstandard.com**

Brammer Standard Company, Inc., is accredited by the American Association For Laboratory Accreditation (A2LA) to ISO Standard 17034 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 30:2015   Terms and definitions used in connection with reference materials + 2008 amendment

ISO Guide 31:2015   Reference materials - Contents of certificates and labels

ISO Guide 33:2015   Uses of certified reference materials

ISO Standard 17034:2016 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

NIST Special Publication 829, Use of NIST Standard Reference Materials for Decisions on Performance of Analytical Chemical Methods and Laboratories

Certified by: _____ on November 9, 2017.

Beau R. Brammer

President