Brammer Standard Company, Inc.

Certificate of Analysis

BS 836A-4

Certified Reference Material for Bronze CDA Grade 836- UNS Number C83600

Certified Values[3]

	Certified Value[1]	Estimate of Uncertainty[2]		Certified Value[1]	Estimate of Uncertainty[2]
Ag	**0.023**	0.001			
As	**0.008**	0.001			
Cu	**84.7**	0.4			
Fe	**0.026**	0.002			
Ni	**0.46**	0.01			
P	**0.086**	0.002			
Pb	**5.31**	0.04			
S	**0.041**	0.001			
Sb	**0.068**	0.001			
Sn	**4.58**	0.04			
Zn	**4.64**	0.03			

Reference Values[3,4]

Al	**0.0013**	0.0004
Si	**0.0019**	0.0005

Informational Values[3,5]

C (0.002) **Mn** (0.001)

[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.

[4] Reference values are not certified and are provided for information only.

[5] 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.

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BS 836A-4 * Code for method Certified values listed as weight percent

Analysis	*	Ag	*	As	*	Cu	*	Fe	*	Ni	*	P	*	Pb	*	S
1	4	0.0214	3	0.0073	6	84.03	4	0.023	17	0.447	7	0.08085	16	5.22	4	0.039
2	7	0.022	3	0.008	13	84.41	4	0.0243	16	0.454	4	0.0815	4	5.24	3	0.040
3	16	0.0223	3	0.008	3	84.51495	16	0.025	3	0.457	7	0.082	3	5.30	1	0.040067
4	3	0.023	4	0.0082	16	84.64	3	0.0262	4	0.457	4	0.0828	3	5.32	16	0.0406
5	8	0.0235	16	0.0086	3	84.64	3	0.029	3	0.46	3	0.0837	3	5.33	3	0.042
6	3	0.0239	3	0.009	3	84.75			3	0.46	3	0.084	4	5.33	3	0.042
7					3	84.75			4	0.461	4	0.086	16	5.35	3	0.0423
8					4	84.81			3	0.463	3	0.087	4	5.37	4	0.0427
9					3	85.10					4	0.0874			1	0.0435
10											16	0.0886				
11											16	0.091				
12											3	0.093				
Average		0.0227		0.00818		84.71		0.0256		0.4571		0.0865		5.308		0.04142
Std dev		0.0011		0.00049		0.15		0.0010		0.0047		0.0016		0.024		0.00098
H		0.0008		0.00051		0.55		0.0009		0.0051		0.0017		0.036		0.0011
U_1		0.0013		0.00071		0.57		0.0014		0.0070		0.0024		0.044		0.0015
t-statistic		2.57		2.57		2.31		2.78		2.36		2.20		2.36		2.31
U_2		0.0035		0.0018		1.30		0.0038		0.016		0.0052		0.10		0.0035
U_3		0.0014		0.00075		0.43		0.0017		0.0058		0.0015		0.036		0.0012
Certified		**0.023**		**0.008**		**84.7**		**0.026**		**0.46**		**0.086**		**5.31**		**0.041**
Uncertainty		**0.001**		**0.001**		**0.4**		**0.002**		**0.01**		**0.002**		**0.04**		**0.001**
Tolerance		0.003		0.0018		1.3		0.004		0.016		0.005		0.10		0.003

Analysis	*	Sb	*	Sn	*	Zn
1	3	0.0649	3	4.54	16	4.60
2	4	0.0657	16	4.57	16	4.61
3	8	0.067	3	4.58	3	4.62
4	17	0.0673	4	4.59	4	4.63
5	7	0.068	3	4.59	3	4.64
6	3	0.068	4	4.60	4	4.64
7	16	0.069	3	4.60	3	4.64
8	3	0.070			13	4.645
9	4	0.0703			3	4.66
10	3	0.071			4	4.66
11					16	4.6685
Average		0.0681		4.581		4.637
Std dev		0.0014		0.022		0.021
H		0.0015		0.032		0.032
U_1		0.0021		0.039		0.038
t-statistic		2.26		2.45		2.23
U_2		0.0046		0.094		0.085
U_3		0.0015		0.036		0.026
Certified		**0.068**		**4.58**		**4.64**
Uncertainty		**0.001**		**0.04**		**0.03**
Tolerance		0.005		0.09		0.09

BS 836A-4 * Code for method Reference values listed as weight percent

Analysis	*	Al	*	Si
1	4	0.0008	4	0.0011
2	3	0.0009	4	0.0011
3	4	0.001	3	0.002
4	3	0.002	3	0.003
5	3	0.002	3	0.003
Average		0.00134		0.00192
Std dev		0.00018		0.00025
H		0.00027		0.00030
U_1		0.00032		0.00039
t-statistic		2.78		2.78
U_2		0.00089		0.0011
U_3		0.00040		0.00048
Reference		**0.0013**		**0.0019**
Uncertainty		**0.0004**		**0.0005**
Tolerance		0.0009		0.0011

BS 836A-4 * Code for method Informational values listed as weight percent

Analysis	*	C	*	Mn
1	3	0.0026	3	0.0005
2			3	0.001
3			4	0.0010
4			3	0.001
5				
Average		0.00260		0.00087
Std dev		0.00037		0.00016
H		0.00033		0.00023
U_1		0.00049		0.00028
t-statistic		12.71		3.18
U_2		0.0063		0.00090
U_3		0.0063		0.00045
(Informational)		**(0.002)**		**(0.001)**

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 times 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 Tolerance is the half width of the 95 % confidence interval for measurements 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.

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 E 1019)	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	Atomic Absorbtion Spectroscopy
5	ICP Mass Spectrometry	11	GD Atomic Emission	17	Instrumental Neutron Activation Analysis
6	Gravimetric	12	GD Mass Spectrometry		

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

Laboratory	Location	Registrar	Accreditation
Advanced Analytical Services and Reference	Czech Republic		
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, Guide 34
National Analysis Center For Iron And Steel	Beijing, China		
Dirats Laboratories	Westfield,MA		
Laboratory Testing, Inc.	Hatfield, PA		
LECO Corporation	St. Joseph, MI		
Shiva Technologies	Syracuse, NY		
VHG Labs	Manchester, NH		

A2LA = American Association for Laboratory Accreditation

Analysis: Chemical analyses were made on solid pieces and chips prepared from representative samples for the certified portion of the lot in accordance with ASTM Standard Practice E 1806. The laboratories participating in the testing followed the requirements of ISO Standard 17025. Methods of analysis used were a those listed on page 2.

Traceability: The following Certified Reference Materials were used to validate the analytical data listed on pages 2-3 — SRM C83600, 872; IARM 86A, 86B.

Homogeneity: This Certified Reference Material (CRM) was tested for homogeneity using ASTM Standard Method E 826 and found acceptable. It was also examined by spark atomic emission spectrometry and found to be compatible with the following Reference Materials — BS CC137, 510A, 544, 836, 903, 903B, 922A, 932M.

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 836A-4 is valid indefinitely. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

Source: The bar stock for this CRM was produced by Western Reserve Manufacturing Company, Inc., Lorain, OH.

Form: This CRM is machined in the form of a disc, approximately 40 mm in diameter and 15 mm thick by Brammer Standard Company, Inc.

Use: This CRM is intended for use in spark atomic emission 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.

Certificate Number: The unique identification number for this certificate of analysis is 836A-4-082813. You may obtain information on revisions of certificates from the internet at **www.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. **Phone: (281) 440-9396** **Web: www.brammerstandard.com**
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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 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

E 826 Standard Practice for Testing Homogeneity of a Metal Lot or Batch in Solid Form by Spark Atomic Emission Spectrometry

E 1019 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques

E 1806 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, 1916 Race Street, Philadelphia, PA, 19103.

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 August 28, 2013.**

Beau R. Brammer