

# Brammer Standard Company, Inc.

## Certificate of Analysis

### BS 624

Certified Reference Material for Aluminum Bronze - UNS Number C62400

	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	<b>Certified Values<sup>3</sup></b>	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>Al</b>	<b>10.2</b>	0.2		<b>Mn</b>	0.01
<b>C</b>	<b>0.0041</b>	0.0008		<b>Ni</b>	0.002
<b>Cu</b>	<b>86.5</b>	0.1		<b>Si</b>	0.002
<b>Fe</b>	<b>3.02</b>	0.04			

	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	<b>Reference Values<sup>3,4</sup></b>	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>As</b>	<b>&lt;0.01</b>			<b>Sb</b>	
<b>P</b>	<b>&lt;0.005</b>			<b>Sn</b>	0.004
<b>Pb</b>	<b>&lt;0.005</b>			<b>Zn</b>	0.003
<b>S</b>	<b>&lt;0.005</b>				

### Informational Values<sup>3,5</sup>

O (0.0005)

<sup>1</sup> 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.

<sup>2</sup> 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.

<sup>3</sup> Values are given in weight percent. Values in brackets are reported by difference.

<sup>4</sup> Reference values are not certified and are provided for information only.

<sup>5</sup> Values in parentheses are not certified and are provided for information only.

Trace element information values for Ag, Au, Be, Bi, Ca, Ce, Co, Cr, Ga, Ge, Hf, La, Mg, Mo, Na, Nb, Se, Th, Ti, U, V, and Zr are shown on page 3.

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	*	Al	*	C	*	Cu	*	Fe	*	Mn	*	Ni	*	Si
1	4	9.95133333	1	0.00303333	10	86.256667	4	2.89166667	5	0.146	5	0.0461333	4	0.0160867
2	11	9.98	1	0.00313333	13	86.257333	3	2.98333333	4	0.14775	4	0.0476	4	0.0173
3	11	10	1	0.00316667	3	86.293333	4	2.99633333	3	0.149	3	0.0488	5	0.0173333
4	4	10.03	1	0.00338667	4	86.3575	10	3.002	3	0.15	3	0.0494	10	0.018
5	11	10.09	11	0.0035	16	86.38	4	3.00723333	10	0.150	8	0.050	4	0.0186333
6	3	10.11	11	0.0036	16	86.39	4	3.009	3	0.153	3	0.05	17	0.0186333
7	4	10.183	1	0.0037	16	86.4	11	3.01	4	0.1544	11	0.0505	4	0.0190667
8	4	10.1963333	1	0.00386667	16	86.415	3	3.01	4	0.155	14	0.0506333	3	0.0191
9	14	10.2	1	0.004	4	86.444967	11	3.01	3	0.158	10	0.0509	14	0.0191667
10	4	10.2012667	1	0.00411333	14	86.5	11	3.01	4	0.1588933	4	0.0509333	3	0.0192
11	10	10.204	11	0.00425	10	86.54	14	3.02	4	0.1596667	11	0.0511	4	0.0193
12	4	10.2276667	3	0.0043	16	86.556667	4	3.0205	10	0.160	4	0.0516333	3	0.0195
13	8	10.24	1	0.00473333	16	86.575	3	3.04	3	0.1666667	3	0.0521	3	0.0203333
14	4	10.2647333	1	0.0048	16	86.587044	10	3.04	4	0.1702333	3	0.0526333	4	0.0204333
15	3	10.305	1	0.00518	4	86.643333	3	3.04	8	0.174	10	0.0527	11	0.0206
16	3	10.31	3	0.006	16	86.68	3	3.04	11	0.183	11	0.0536	11	0.0207
17	3	10.31	1	0.0063225	16	86.7	4	3.04416667			8	0.0540333	11	0.0207
18	4	10.338					4	3.0515			4	0.0544667		
19	10	10.36					10	3.05666667			4	0.0549667		
20	10	10.3933333					4	3.07376667			4	0.0557767		
21	3	10.39667					4	3.08666667			4	0.0558		
22	4	10.44525									3	0.0650		
Average		10.2048		0.00411		86.469226		3.0249		0.158476		0.0519		0.01902
Std Dev		0.0030		0.00014		0.000077		0.0057		0.000079		0.0012		0.00076
H		0.043		0.00074		0.18		0.021		0.0040		0.0023		0.0014
U <sub>1</sub>		0.043		0.00076		0.18		0.021		0.0040		0.0026		0.0016
t-statistic		2.08		2.12		2.12		2.09		2.13		2.08		2.12
U <sub>2</sub>		0.090		0.0016		0.37		0.044		0.0086		0.0054		0.0035
U <sub>3</sub>		0.019		0.00039		0.090		0.010		0.0021		0.0011		0.00084
Certified		<b>10.2</b>		<b>0.0041</b>		<b>86.5</b>		<b>3.02</b>		<b>0.16</b>		<b>0.052</b>		<b>0.019</b>
Uncertainty		0.2		0.0008		0.1		0.04		0.01		0.002		0.002
Tolerance		0.6		0.0024		0.4		0.16		0.03		0.006		0.006

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\* Code for method

Reference values listed as weight percent

Analysis	*	As	*	P	*	Pb	*	S	*	Sb	*	Sn	*	Zn
1	9	0.000054	5	0.0007	5	0.0002967	1	0.0001	5	0.00006	3	0.0102	3	0.0021333
2	5	0.0000867	5	0.00089667	5	0.0003367	1	0.00010667	5	0.000073	3	0.0104	5	0.0045
3	5	0.0001	7	0.00090333	5	0.0004	1	0.00012	12	0.000090	5	0.0123	4	0.0047267
4	5	0.0001	12	0.00096333	12	0.0005133	1	0.00013333	5	0.0003	5	0.0139667	5	0.0058333
5	12	0.00012	4	0.00203333	3	0.0013	1	0.00016667	3	0.00135	5	0.0144333	5	0.0059333
6	10	0.00123333	11	0.00205	3	0.0013	1	0.0002	4	0.00148	4	0.0153	8	0.0065
7	3	0.00395	11	0.0021	3	0.0014	1	0.0003	3	0.002	4	0.0163333	4	0.0066533
8	9	0.0047	11	0.0021	3	0.0017333	1	0.00033333	3	0.0021	9	0.0167667	3	0.0067
9	3	0.0048	3	0.00293333	10	0.0019	11	0.0009	10	0.0036333	10	0.017	3	0.0068
10	3	0.005	4	0.00303333	4	0.002	11	0.0009	4	0.004	8	0.017	4	0.0071667
11	4	0.0050	3	0.00326667	14	0.0023667	11	0.00095	9	0.0044	4	0.0170667	3	0.0076
12	10	0.0051	3	0.0033	11	0.0024	1	0.001	11	0.0062	12	0.0176667	11	0.0083
13	11	0.00535	14	0.0034	11	0.0025	3	0.00136667	11	0.0062	4	0.018	11	0.0086
14	11	0.0059	3	0.0038	11	0.00265	3	0.0019	11	0.00655	3	0.0183333	12	0.0088667
15	11	0.006	3	0.0039	4	0.0036667	3	0.0026			11	0.0199	14	0.0096667
16	4	0.0062					3	0.0028			11	0.0202	11	0.00975
17											11	0.0213	4	0.0111
Average		0.003356		0.002359		0.001205		0.000686		0.001880		0.016245		0.007108
Std Dev		0.000079		0.000082		0.000054		0.000028		0.000080		0.000077		0.000077
H		0.00068		0.00059		0.00046		0.00037		0.00054		0.0013		0.00093
U <sub>1</sub>		0.00069		0.00060		0.00046		0.00037		0.00055		0.0013		0.00094
t-statistic		2.13		2.14		2.14		2.13		2.16		2.12		2.12
U <sub>2</sub>		0.0015		0.0013		0.0010		0.00079		0.0012		0.0028		0.0020
U <sub>3</sub>		0.00037		0.00033		0.00025		0.00020		0.00032		0.00069		0.00048
Reference		<b>&lt;0.01</b>		<b>&lt;0.005</b>		<b>&lt;0.005</b>		<b>&lt;0.005</b>		<b>&lt;0.01</b>		<b>0.016</b>		<b>0.007</b>
Uncertainty												0.004		0.003
Tolerance												0.012		0.006

Analysis	*	O
1	2	0.00012667
2	2	0.00016667
3	2	0.00023333
4	2	0.00025
5	2	0.00027833
6	2	0.00033333
7	2	0.00033333
8	2	0.00043333
9	2	0.00043333
10	2	0.00058
11	2	0.00203333
Average		0.00047
Std Dev		0.00053
H		0.00032
U <sub>1</sub>		0.00062
t-statistic		2.23
U <sub>2</sub>		0.0014
U <sub>3</sub>		0.00042
Informational		(0.0005)

For each element, in accordance with the requirements of ISO 17034 and Guide 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<sub>L</sub>), calculated from its standard deviation (S<sub>L</sub>) and its uncertainty estimate (U<sub>L</sub>), is used as the weight (W<sub>L</sub>) for its mean (M<sub>L</sub>). The standard deviation (S) is calculated as the square root of the reciprocal of the sum of the weights. U<sub>1</sub> is the combined uncertainty from homogeneity and labs. U<sub>2</sub> is U<sub>1</sub> multiplied by the coverage factor (95 % t-statistic). U<sub>3</sub> is U<sub>2</sub> 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 U<sub>3</sub> 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.

Analysis	*	Ag	*	Au	*	Be	*	Bi	*	Ca	*	Ce	*	Co	*	Cr	*	Ga	*	Ge
1	12	14	12	0.02	12	0.03	12	0.2	12	0.16	12	0.01	12	2.3	12	12	12	11	12	0.4
2	12	15	12	0.03	12	0.03	12	0.21	12	0.16	12	0.01	12	2.3	12	12	12	11	12	0.4
3	12	15	12	0.03	12	0.03	12	0.23	12	0.2			12	2.4	12	13	12	12	12	0.4
4													3	8						
5													3	8						
6													3	9						
Analysis	*	Hf	*	La	*	Mg	*	Mo	*	Na	*	Nb	*	Se	*	Th	*	Ti	*	U
1	12	0.02	12	0.01	12	1.8	12	0.73	12	0.02	12	0.01	12	0.1	12	0.004	12	4.9	12	0.03
2	12	0.02	12	0.01	12	1.9	12	0.76	12	0.02	12	0.01	12	0.11	12	0.004	12	5	12	0.03
3	12	0.02	12	0.01	12	2	12	0.81	12	0.03	12	0.01			12	0.005	12	5.2	12	0.04
Analysis	*	V	*	Zr																
1	12	14	12	0.7																
2	12	14	12	0.71																
3	12	15	12	0.78																

**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

Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, 17034
Eurofins EAG Materials Science, LLC	Liverpool, NY	A2LA	17025
NSL Analytical	Cleveland, OH	ANAB	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
LECO Corporation	St. Joseph, MI	A2LA	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Analytical Process Laboratories	Milwaukee, WI	A2LA	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Luvak Inc.	Boylston, MA	PRI	17025
Vitkovice Testing Center	Ostrava, Czech	ILAC	17025
Element Materials Technology	Santa Fe Spring, CA	A2LA	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025

A2LA = American Association for Laboratory Accreditation

ANAB = ANSI-ASQ National Accreditation Board

CNAS = China National Accreditation Service

NABL = National Accreditation Board for Testing and Calibration Laboratories

PCA = Polish Center For Accreditation

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: 31XWAB40, 31XWAB60, 32XALB60, 32XALB9A, 32XB12, 32XSEB5, 33XGM50, 33XGM4, 33XGM5, 39XCT6; AR 115C, 141, 147, 149, 644, 668, 673, 871, 881, 882, 891, 892, 911A, 917B, 946, 1650, 1651, 1653; BAS 180/2, 183/4, 304/1, 346A, 390; BS 88A, 94A, 110A, 110B, 464B, 510B, 623A, 624, 630B, 630C, 642A, 929, 954A, 954B, 954C, 14500, 14500A; IARM 80B, 80D, 81B, 93B, 94A, 188A, 189A, 190A, 279A; IPT 10A, 14/3, 16/3B, 17/3, 18/3, 20/3; LECO 501-147, 501-501, 501-675, 501-676, 501-953, 502-412, 502-702, 502-712, 502-916, 502-918; SRM 158A, 164A, 361.

**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: BAS 180/2; BS CC954, 110B, 623A, 642A, 929, 954A, 954B, 954C, 14500, 14500A; IARM 81B, 279A.

**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 624 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 Bolton Aerospace Limited; Suffolk, England.

**Form:** This CRM is machined in the form of a disc, approximately 44mm in diameter and 19mm 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 624-031121. You may obtain information on revisions of certificates from the internet at [www.brammerstandard.com](http://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.**  
14603 Benfer Road  
Houston, Texas 77069-2895 USA

Phone: (281) 440-9396 Web: [www.brammerstandard.com](http://www.brammerstandard.com)

Fax: (281) 440-4432 Email: [contact@brammerstandard.com](mailto: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 by National Quality Assurance (NQA), U.S.A.**

The scopes of accreditation are listed on the website: [www.brammerstandard.com](http://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 17025:2017 General requirements for the competence of testing and calibration laboratories

ISO Standard 9001:2015 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 35:2017 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](http://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 March 11, 2021.

Beau R. Brammer  
President