

Brammer Standard Company, Inc.

Certificate of Analysis

BS 706C

Certified Reference Material for CDA Grade 706 Copper Alloy - UNS Number C70600

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³	Certified Value ¹	Estimate of Uncertainty ²
Cu	87.9	0.2	Pb	0.0033	0.0004
Fe	1.68	0.05	S	0.0014	0.0005
Mn	0.60	0.02	Si	0.0018	0.0003
Ni	9.7	0.2	Zn	0.084	0.006
O	0.0016	0.0003			

Informational Values^{3,4}

Al (0.001)	As (0.001)	C (0.004)	Co (0.003)	Cr (0.0006)
Mg (0.000003)	N (0.0005)	P (0.007)	Sb (0.0006)	Sn (0.0070)
Zr (0.0000002)				

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 Ag, Au, B, Bi, Ca, Cd, Cl, Ga, Ge, In, Mo, Nb, Pd, Se, Te, Ti, Tl, V, and W 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	*	Cu	*	Fe	*	Mn	*	Ni	*	O	*	Pb	*	S	*	Si	*	Zn
1	10	87.60666667	11	1.5298	4	0.52	3	9.45	1	0.0009703	11	0.0027509	1	0.0005	11	0.000762	4	0.0735
2	11	87.73755	4	1.60006667	10	0.55991	17	9.47	2	0.0011	12	0.00283545	1	0.00073	11	0.000797	11	0.0773
3	16	[87.78]	3	1.63	3	0.57341	4	9.56333333	3	0.0013	11	0.0028434	1	0.0008666667	11	0.000891	11	0.077725
4	4	87.80443333	14	1.63666667	4	0.58333	10	9.584	16	0.00136	4	0.0029	11	0.000938775	12	0.001063	11	0.078325
5	3	87.88	4	1.63766667	4	0.587	11	9.588325	2	0.0014265	11	0.0029485	11	0.00098665	4	0.001667	11	0.078425
6	6	87.88333333	4	1.64933333	4	0.58866667	3	9.648	5	0.0016	4	0.0031	11	0.001181725	3	0.0019	11	0.078575
7	4	87.9	11	1.6530	17	0.59	3	9.65	1	0.00165	5	0.0031333333	1	0.0013333333	4	0.0019	11	0.079125
8	3	87.9	4	1.66	3	0.59866667	4	9.651	16	0.00189	5	0.0031333333	1	0.0015666667	14	0.001967	14	0.081633
9	16	[87.98333]	4	1.68	4	0.59883333	4	9.68803333	4	0.0020333	11	0.00320305	1	0.0016666667	4	0.003533	4	0.084733
10	4	88.07666667	4	1.69	4	0.60	11	9.76695	4	0.0023209	11	0.0032065	12	0.0018	4	0.0039	4	0.088667
11	12	88.09163	3	1.70628	10	0.610	4	9.8114			12	0.003281	1	0.002			3	0.0903
12	10	88.0947	10	1.71	3	0.613	4	9.82			12	0.003358	4	0.0024			3	0.090833
13	17	88.11333	4	1.712667	4	0.628733	12	9.8447			12	0.003725	3	0.00243			17	0.092333
14	3	88.19333	17	1.716667	14	0.658667	4	9.846667			12	0.003732					12	0.092667
15			3	1.73	4	0.660267	10	9.93			12	0.003798					10	0.099133
16			12	1.730425							3	0.0038					4	0.099333
17			4	1.743333							12	0.003939						
18			10	1.74744														
19			12	1.771675														
Average		87.916		1.6796		0.597892		9.6888		0.001371		0.00346		0.001415		0.00184		0.0843
Std Dev		0.030		0.0052		0.000085		0.0046		0.000064		0.00016		0.000088		0.00010		0.0020
H		0.41		0.015		0.0073		0.058		0.00038		0.00052		0.00039		0.00042		0.0022
U ₁		0.41		0.016		0.0073		0.058		0.00039		0.00055		0.00040		0.00043		0.0030
t-statistic		2.16		2.10		2.14		2.14		2.26		2.12		2.18		2.26		2.11
U ₂		0.88		0.033		0.016		0.12		0.00088		0.0012		0.00087		0.0010		0.0063
U ₃		0.24		0.0076		0.0040		0.032		0.00028		0.00028		0.00024		0.00031		0.0015
Certified		87.9		1.68		0.60		9.7		0.0016		0.0033		0.0014		0.0018		0.084
Uncertainty		0.2		0.05		0.02		0.2		0.0003		0.0004		0.0005		0.0003		0.006
Tolerance		0.9		0.15		0.06		0.6		0.0009		0.0015		0.0009		0.0010		0.018

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* Code for method

Informational values listed as weight percent

Analysis	*	Al	*	As	*	C	*	Co	*	Cr	*	Mg	*	N	*	P	*	Sb	*	Sn	*	Zr
1	12	0.0000107	5	0.0000533	1	0.0010	12	0.00166667	12	0.000283	11	0.000000312	11	0.00017235	11	0.002776	5	0.00007	4	0.005	11	0.0000001274
2	11	0.00001688	4	0.0001	1	0.0011	11	0.00169925	4	0.000667	11	0.000000397	11	0.00027575	11	0.002933	12	0.00009	4	0.00527	11	0.0000002019
3	11	0.00001758	11	0.0001081	1	0.00166667	11	0.00175973	4	0.0009	12	0.000000967	2	0.00046666667	11	0.003786	5	0.0001	11	0.00531	11	0.0000002395
4	11	0.00001778	11	0.00011065	1	0.002	11	0.001836			11	0.000007516	11	0.0004797	4	0.00547	11	0.0001	12	0.00537		
5	5	0.00008333	12	0.00011667	1	0.00226667	5	0.00213333			4	0.0012	14	0.006567	11	0.0001	11	0.0001	11	0.00547		
6	4	0.0019	11	0.0001216	11	0.00238098	3	0.00224					5	0.0068	11	0.0001	11	0.0001	11	0.00604		
7	3	0.00195	5	0.0002	1	0.0025	5	0.0025					3	0.0072	11	0.0001	11	0.0001	11	0.00620		
8	4	0.002133333	4	0.0007	3	0.00326	14	0.0025					10	0.007833	11	0.0001	11	0.0001	11	0.00664		
9	14	0.002233333	4	0.004	1	0.0036	4	0.00293333					3	0.0088	11	0.0002	11	0.0002	11	0.00682		
10	3	0.0025	9	0.0051	11	0.00368963	4	0.00296667					3	0.00892	4	0.0003	4	0.0003	4	0.00773		
11													4	0.009033	3	0.0007	4	0.0007	4	0.008033		
12													4	0.009833	9	0.004467	5	0.0082				
13													5	0.010567					5	0.008533		
14																			4	0.0090		
15																			14	0.009033		
16																			3	0.0094		
Average		0.0011		0.0011		0.004		0.0025		0.0006		0.0000025		0.00052		0.007		0.00055		0.007004		0.000000200
Std Dev		0.0027		0.0026		0.016		0.0095		0.0017		0.0000000		0.00095		0.042		0.00069		0.000079		0.000000047
H		0.0004		0.0004		0.001		0.0005		0.0003		0.00018		0.00029		0.001		0.00030		0.00068		0.00025
U ₁		0.0027		0.0026		0.016		0.0095		0.0017		0.00018		0.00099		0.042		0.00075		0.00069		0.00025
t-statistic		2.26		2.26		2.14		2.18		4.30		3.18		2.78		2.16		2.20		2.13		4.30
U ₂		0.0061		0.0059		0.034		0.021		0.0075		0.00056		0.0028		0.091		0.0016		0.0015		0.0011
U ₃		0.0019		0.0019		0.0088		0.0057		0.0043		0.0002800		0.0012		0.024		0.00048		0.00037		0.00061
Informational		(0.001)		(0.001)		(0.004)		(0.003)		(0.0006)		(0.000003)		(0.0005)		(0.007)		(0.0006)		(0.0070)		(0.0000002)

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 its 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.

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* Code for analytical method

Trace analysis listed as mg/kg (ppm)

Analysis	*	Ag	*	Au	*	B	*	Bi	*	Ca	*	Cd	*	Cl	*	Ga	*	Ge	*	In
1	12	13	12	0.02	12	0.05	12	0.1	12	0.0042	12	0.14	12	0.02	12	0.19	12	0.12	12	0.15
2	12	13	12	0.03	12	0.07	12	0.11	12	0.0067	12	0.18	12	0.04	12	0.2	12	0.14	12	0.17
3	12	15	12	0.03	12	0.07	12	0.14	12	0.0077	12	0.24	12	0.06	12	0.2	12	0.15	12	0.17
4	3	18.1																		
Analysis	*	Mo	*	Nb	*	Pd	*	Se	*	Te	*	Ti	*	Tl	*	V	*	W		
1	12	0.51	3	61.9	12	0.03	12	6.5	12	0.01	12	0.002	12	0.007	12	0.02	12	0.06		
2	12	0.54			12	0.08	12	6.7	12	0.078	12	0.004	12	0.009	12	0.03	12	0.07		
3	12	0.56			12	0.1	12	7.3	12	0.078	12	0.006	12	0.01	12	0.04	12	0.08		
4									12	0.08										
5									12	0.088										
6									12	0.09										
7									12	0.090										
8									12	0.097										
9									12	0.099										

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 PIXE |
| 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, Guide 34
NSL Analytical	Cleveland, OH	ANAB	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025
Exova	Glendale Heights, IL	A2LA	17025
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
TUV Rheinland Pvt. Ltd.	Bangalore, India	NABL	17025
Luvak Inc.	Boylston, MA	PRI/Nadcap	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
Evans Analytical Group	Liverpool, NY	A2LA	17025

A2LA = American Association for Laboratory Accreditation

ANAB = ANSI-ASQ National Accreditation Board

NABL = National Accreditation Board for Testing and Calibration Laboratories

PRI = Performance Review Institute

Analysis: Chemical analyses were made on solid pieces and chips prepared by 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: 39X17869AC; AR 147, 148, 673, 892, 946, 1652, 1653; BAM 222, 367; BAS 180/2, 183/4, 390; BS 110B, 405C, 510B, 544B, 630C, 675B, 706, 706A, 706C, 929, 18150A; CTIF 1362, 1366, 1368; IARM 71B, 80B, 84A, 84C, 158B, 226A, 279A; IPT 15; LECO 501-147, 501-402, 501-502, 501-992, 502-416, 502-874; SRM C1107, 19F, 55D, 62, 62D, 157, 158A, 164A, 400, 459, 875, 1112, 1113, 1114, 1275, 1276A, 1413.

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 367; BS 110B, 544B, 706, 706A, 929; CTIF 1367; IARM 279A; IPT 15; SRM 1275.

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 706C 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 Le Bronze Industrial; Suippes, France.

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 706C-090517. 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.
14603 Benfer Road
Houston, Texas 77069-2895 USA

Phone: (281) 440-9396 Web: www.brammerstandard.com

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 September 05, 2017.

Beau R. Brammer
President