

Brammer Standard Company, Inc.

Certificate of Analysis

BS 932G

Certified Reference Material for CDA Grade 932 Copper Alloy - UNS Number C93200

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³	Certified Value ¹	Estimate of Uncertainty ²
As	0.0096	0.0005	Pb	7.78	0.09
Co	0.0025	0.0003	S	0.035	0.005
Cu	82.0	0.2	Sb	0.173	0.007
Fe	0.028	0.002	Si	0.0014	0.0003
Ni	0.39	0.01	Sn	6.35	0.08
O	0.0014	0.0004	Zn	2.92	0.09
P	0.11	0.01			

	Certified Value ¹	Estimate of Uncertainty ²	Reference Values ^{3,4}	Certified Value ¹	Estimate of Uncertainty ²
C	0.011	0.007			

Informational Values^{3,5}

Al (0.002) Ca (0.00004) Cr (0.001) Mn (0.0005) N (0.001)

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 4 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 4 for more information on its calculation.

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

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.

Trace element information values for Ag, Au, B, Bi, Cd, Cl, Ga, Ge, In, Ir, Mg, Mo, Pd, Pt, Ru, Se, Te, Tl, and Zr 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.

Analysis	*	As	*	Co	*	Cu	*	Fe	*	Ni	*	O	*	P	*	Pb	*	S	*	Sb
1	5	0.008666667	4	0.002033333	16	[81.7]	12	0.022333333	4	0.36	2	0.00082	12	0.08935	17	7.29	1	0.0270	4	0.1593333
2	4	0.008933333	12	0.002266667	4	81.74333	12	0.025025	4	0.3629667	2	0.00096	12	0.090875	4	7.31593	1	0.02796667	12	0.159625
3	5	0.008966667	12	0.0022856	16	[81.9]	12	0.025525	12	0.3633333	2	0.000967	3	0.0925	10	7.336	1	0.0297	4	0.16
4	4	0.009	5	0.002293333	16	[81.99334]	12	0.025525	8	0.3773333	2	0.001196	12	0.0944	4	7.743	4	0.03066667	12	0.1600
5	12	0.009558625	12	0.002348075	13	82.02933	4	0.025666667	4	0.3806667	2	0.00121	10	0.097	4	7.75	12	0.032375	12	0.1602
6	3	0.0096	3	0.0024	16	[82.0933]	10	0.026	4	0.385	2	0.001353	5	0.10	4	7.75667	12	0.0326	4	0.1656667
7	12	0.009666667	12	0.00243015	17	82.09667	12	0.0261	10	0.385	1	0.00136	4	0.1005333	4	7.77467	12	0.0330	12	0.168025
8	4	0.009866667	4	0.002466667	4	82.155	17	0.026666667	4	0.3856667	16	0.00144	4	0.107	4	7.81333	1	0.03626667	12	0.168975
9	10	0.009893333	10	0.0025	4	82.18	4	0.0269	12	0.386325	3	0.00146	4	0.1102	4	7.85933	1	0.03746667	12	0.170725
10	12	0.00995805	4	0.0025	4	82.31073	12	0.027275	10	0.3883333	2	0.0018	4	0.1133333	12	7.86	4	0.03776667	12	0.1709
11	12	0.009985825	4	0.0025	10	82.349	12	0.0276	4	0.3953333	2	0.003767	4	0.1163333	4	7.87133	1	0.03793333	3	0.174
12	4	0.01	5	0.0027	16	[82.38667]	7	0.0278	12	0.39675	12	0.007858	4	0.1180667	4	7.89823	1	0.03856667	4	0.1770333
13	4	0.0106					4	0.0284	4	0.4018	12	0.008922	7	0.120	3	7.96	3	0.0392	10	0.1773333
14							4	0.0284	12	0.4022			4	0.1219333			12	0.0410	4	0.1776
15							3	0.0286	3	0.409			4	0.1266667			1	0.04153333	4	0.178
16							4	0.029666667	4	0.4095			17	0.13			1	0.042	4	0.1798667
17							4	0.029733333	5	0.4133333									4	0.180
18							10	0.030166667	12	0.414125									5	0.1833333
19							4	0.031	12	0.415075										
20							5	0.031	17	0.4166667										
21							4	0.031067												
Average		0.00961		0.00247		82.017		0.02806		0.3918		0.001379		0.1106		7.7774		0.035315		0.1728
Std Dev		0.00045		0.00017		0.046		0.00097		0.0044		0.000099		0.0024		0.0054		0.000079		0.0038
H		0.00075		0.00045		0.39		0.0012		0.0053607		0.00037		0.0025		0.047		0.0014		0.0032
U ₁		0.00088		0.00048		0.39		0.0016		0.0069		0.00039		0.0035		0.048		0.0014		0.0050
t-statistic		2.18		2.20		2.20		2.09		2.09		2.18		2.13		2.18		2.13		2.11
U ₂		0.0019		0.0011		0.85		0.0033		0.015		0.00084		0.0074		0.10		0.0029		0.011
U ₃		0.00053		0.00031		0.25		0.00073		0.0032		0.00023		0.0018		0.029		0.00073		0.0025
Certified		0.0096		0.0025		82.0		0.028		0.39		0.0014		0.11		7.78		0.035		0.173
Uncertainty		0.0005		0.0003		0.2		0.002		0.01		0.0004		0.01		0.09		0.005		0.007
Tolerance		0.0019		0.0011		0.9		0.006		0.03		0.0012		0.03		0.27		0.015		0.021

Analysis	*	Si	*	Sn	*	Zn
1	7	0.000126667	4	6.082666667	12	2.53185
2	4	0.000633333	4	6.273333333	12	2.5673
3	4	0.0013	4	6.277	12	2.58875
4	3	0.0016	12	6.30	4	2.894
5	4	0.0017	4	6.31	4	2.913333
6	4	0.002	4	6.354333333	17	2.946667
7	4	0.002033333	4	6.376633333	4	2.97
8	4	0.002066667	4	6.378666667	10	2.978667
9			3	6.38	4	2.988
10			4	6.399033333	4	2.996533
11			10	6.423	4	3.00
12			17	6.423333333	4	3.004
13			4	6.4319	4	3.023
14			10	6.459	10	3.045
15					1	3.0575
16					2	3.0725
17					4	3.117467
Average		0.00143		6.3517		2.9891
Std Dev		0.00011		0.0059		0.0070
H		0.00038		0.040		0.022
U ₁		0.00039		0.041		0.023
t-statistic		2.36		2.16		2.12
U ₂		0.00093		0.088		0.050
U ₃		0.00033		0.023		0.012
Certified		0.0014		6.35		2.92
Uncertainty		0.0003		0.08		0.09
Tolerance		0.0009		0.24		0.27

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.

BS 932G

* Code for analytical method

Trace analysis listed as mg/kg (ppm)

Analysis	*	Ag	*	Au	*	B	*	Bi	*	Cd	*	Cl	*	Ga	*	Ge	*	In	*	Ir
1	5	250	12	1.4	12	0.006	17	0.084	12	6.1	12	0.01	12	0.55	12	0.54	12	8.3	12	0.005
2	5	250	12	1.4			12	710	12	6.4	12	0.02	12	0.58	12	0.58	12	8.8	12	0.006
3	5	260	12	1.4			12	730	12	6.5	12	0.02	12	0.6	12	0.59	12	9.2	12	0.006
4	12	280					5	750												
5	12	280					5	760												
6	12	290					5	760												
7							12	770												
Analysis	*	Mg	*	Mo	*	Pd	*	Pt	*	Ru	*	Se	*	Te	*	Tl	*	Zr		
1	12	0.00442	12	0.187	12	0.43	12	0.1	12	0.4	12	39	12	12	12	0.09	12	0.000264		
2	12	6.7375			12	3.1	12	0.1	12	0.47	12	40	12	12	12	0.11	12	0.017		
3					12	3.4	12	0.12	12	0.48	12	40	12	12	12	0.11				
4													12	13						
5													12	13						
6													12	14						
7													12	17						
8													12	17						
9													12	18						

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	17025,17034
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025
LECO Corporation	St. Joseph, MI	A2LA	17025
NSL Analytical	Cleveland, OH	ACCLASS	17025
Dirats Laboratories	Westfield, MA	ACCLASS	17025
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
TUV Rheinland	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

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 a lathe 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: AR 147, 511, 645, 662, 892, 1653; BAM 222, 366; BAS 179/2, 183/4, 207/1, 309, 405/1; BS CE 012, CE 013, 836A-1, 863B, 932, 932A, 932E, 932F, 932M, 937B-1, 18150A; CKD 319; DSZU CA01a; IARM 80B, 90A, 91A, 91D, 91E; KMS LCSON-001; LECO 501-147, 501-402, 501-550, 501-676, 501-873, 501-953, 502-868; SRM 52A, 63B, 124D, 158A, 166B, 361, 400, 1112, 1113, 1114, 1413; Y 41340b.

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 405/1; BS CE 012, CE 013, 836A-1, 932, 932A, 932E, 932M, 937B-1; CKD 319; DSZU CA01a; KMS LCSON-001; LECO 501-676, 502-873; Y 41340b.

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 932G 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 National Bronze & Metals, Inc.; Lorain, OH.

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 932G-121517. 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 December 15, 2017.

Beau R. Brammer

President