

Brammer Standard Company, Inc.

Certificate of Analysis

BS 715C

Certified Reference Material for CDA 715 Copper Nickel - UNS Number C71500

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²	
C	0.0081	0.0008		P	0.0035	0.0005
Cu	67.4	0.2		S	0.0036	0.0007
Fe	0.59	0.01		Si	0.011	0.001
Mn	0.706	0.006		Sn	0.0040	0.0008
Ni	31.2	0.2		Zn	0.052	0.002
O	0.0020	0.0006				

	Reference Value ¹	Estimate of Uncertainty ²	Reference Values^{3,4}	Reference Value ¹	Estimate of Uncertainty ²	
Co	0.012	0.002		Pb	0.003	0.001

Informational Values^{3,5}

Al (0.004)	As (0.001)	Be (0.0002)	Ca (0.00005)	Cr (0.003)
Mg (0.005)	Sb (0.0014)	Zr (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. 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, Ga, Mo, N, Na, Nb, Se, Te, Ti, 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.

BS 715C * Code for method Certified values listed as weight percent

Analysis	*	C	*	Cu	*	Fe	*	Mn	*	Ni	*	O	*	P	*	S	*	Si	*	Sn
1	1	0.0076333	4	67.25	3	0.5665	11	0.6635	4	31.0341	2	0.00149	4	0.001433	1	0.002	3	0.00955	12	0.002467
2	2	0.007675	13	67.279	10	0.5783	4	0.6975	11	31.09	2	0.0015	5	0.00299	1	0.00226667	4	0.01007	5	0.003167
3	1	0.0077	16	[67.29]	4	0.57966667	4	0.7032	14	31.1	2	0.00178	4	0.0032	11	0.0023	14	0.01063	4	0.00360
4	1	0.0079	16	[67.3387]	4	0.58	10	0.70436667	4	31.1033	2	0.0020	11	0.00335	2	0.003375	4	0.01093	5	0.00367
5	1	0.00801	16	[67.39]	4	0.58253333	14	0.705	4	31.1377	2	0.00203	5	0.003833	1	0.0034	4	0.01107	5	0.004167
6	1	0.0080667	16	[67.430667]	4	0.5875	4	0.705	4	31.1547	2	0.00217	4	0.003933	1	0.00363333	11	0.0114	9	0.0042
7	1	0.0081967	16	[67.453333]	4	0.58933333	4	0.70766667	13	31.2503	2	0.00237	5	0.0040	1	0.004	4	0.01183	4	0.005033
8	1	0.0085667	4	67.475	4	0.58966667	4	0.70853333	6	31.2627	2	0.003	12	0.004367	1	0.00405	4	0.01233	3	0.00585
9	1	0.0093333	14	67.5	4	0.58966667	4	0.70933333	4	31.2675	2	0.0032	10	0.0044	12	0.00416667	10	0.01273		
10			16	[67.52]	14	0.59033333	3	0.7095	3	31.285					1	0.00423333				
11			4	67.548033	4	0.592	4	0.72433333	16	31.30					1	0.00423333				
12					11	0.61	4	0.72833333	4	31.3333					1	0.005				
Average		0.00812		67.406794		0.5854		0.7057		31.2273		0.00203		0.00350		0.003555		0.01135		0.00402
Std Dev		0.00011		0.000095		0.0048		0.0047		0.0015		0.00011		0.00014		0.000091		0.00066		0.00011
H		0.00099		0.15		0.0080		0.009		0.088		0.00056		0.00069		0.00070		0.0011		0.00074
U ₁		0.00099		0.15		0.0094		0.010		0.088		0.00057		0.00071		0.00071		0.0013		0.00074
t-statistic		2.31		2.23		2.20		2.20		2.20		2.31		2.31		2.20		2.31		2.36
U ₂		0.0023		0.33		0.021		0.022		0.19		0.0013		0.0016		0.0016		0.0030		0.0018
U ₃		0.00076		0.10		0.0059		0.0064		0.056		0.00044		0.00054		0.00045		0.0010		0.00062
Certified		0.0081		67.4		0.59		0.706		31.2		0.0020		0.0035		0.0036		0.011		0.0040
Uncertainty		0.0008		0.2		0.01		0.006		0.2		0.0006		0.0005		0.0007		0.001		0.0008
Tolerance		0.0023		0.6		0.03		0.022		0.6		0.0018		0.0016		0.0021		0.003		0.0024

Analysis	*	Zn																			
1	5	0.0467333																			
2	12	0.0496667																			
3	11	0.04995																			
4	4	0.0501333																			
5	4	0.0515333																			
6	4	0.0517333																			
7	4	0.053																			
8	14	0.0539																			
9	4	0.0539333																			
10	4	0.0539667																			
11	3	0.0551																			
12	10	0.057																			
Average		0.052221																			
Std Dev		0.000091																			
H		0.0023																			
U ₁		0.0023																			
t-statistic		2.20																			
U ₂		0.0051																			
U ₃		0.0015																			
Certified		0.052																			
Uncertainty		0.002																			
Tolerance		0.006																			

BS 715C * Code for method Reference values listed as weight percent

Analysis	*	Co	*	Pb																	
1	5	0.0090667	12	0.0016																	
2	4	0.0094767	5	0.0021																	
3	5	0.0099233	11	0.0022																	
4	5	0.011	5	0.0023333																	
5	3	0.0115	5	0.00234																	
6	4	0.012	9	0.0034333																	
7	10	0.0123	4	0.0039333																	
8	4	0.0123333	4	0.0039333																	
9	4	0.0139333	3	0.00435																	
10	14	0.0139667																			
11	11	0.0154																			
Average		0.011900		0.003056																	
Std Dev		0.000095		0.000099																	
H		0.0012		0.00066																	
U ₁		0.0012		0.00066																	
t-statistic		2.23		2.31																	
U ₂		0.0026		0.0015																	
U ₃		0.00079		0.00051																	
Reference		0.012		0.003																	
Uncertainty		0.002		0.001																	
Tolerance		0.006		0.002																	

BS 715C * Code for method Informational values listed as weight percent

Analysis	*	Al	*	As	*	Be	*	Ca	*	Cr	*	Mg	*	Sb	*	Zr
1	12	0.00031	5	0.00011	3	0.0000895	12	0.000011	12	0.0017	11	0.0002	12	0.00030	12	0.0000133
2	14	0.0009	12	0.0001167	11	0.00025	3	0.0000837	4	0.004	3	0.0002	5	0.000427	11	0.00035
3	5	0.0010633	5	0.00019					10	0.00443	12	0.0150	5	0.000463	3	0.0028
4	4	0.0049333	11	0.0012									4	0.001533		
5	11	0.0051	9	0.0020667									3	0.0019		
6	3	0.0055	4	0.0023333									4	0.001967		
7	4	0.006											9	0.002133		
8	4	0.0116											11	0.00275		
Average		0.004		0.0010		0.00017		0.0000466		0.003		0.005		0.001369		0.0011
Std Dev		0.028		0.0030		0.00014		0.0000059		0.031		0.056		0.000039		0.0047
H		0.001		0.0004		0.00023		0.00015		0.001		0.001		0.00048		0.0004
U ₁		0.028		0.0030		0.00027		0.00015		0.031		0.056		0.00048		0.0047
t-statistic		2.36		2.57		12.71		12.71		4.30		4.30		2.36		4.30
U ₂		0.066		0.0078		0.0034		0.0020		0.13		0.24		0.0011		0.020
U ₃		0.023		0.0032		0.0024		0.0014		0.077		0.14		0.00040		0.012
Informational		(0.004)		(0.001)		(0.0002)		(0.00005)		(0.003)		(0.005)		(0.0014)		(0.001)

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_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 715C * Code for analytical method Trace analysis listed as mg/kg (ppm)

Analysis	*	Ag	*	Au	*	B	*	Bi	*	Cd	*	Ga	*	Mo	*	N	*	Na	*	Nb
1	4	30	12	0.01	12	0.71	12	0.22	12	1.1	12	0.39	12	0.82	2	1.4	12	0.01	12	0.09
2	12	33	12	0.01	12	1.00	12	0.23	12	1.1	12	0.42	12	0.89	2	1.4	12	0.01	12	0.1
3	12	34	12	0.02	12	1.10	12	0.28	12	1.1	12	0.5	12	1.1	2	2	12	0.02	12	0.13
4	12	38													2	2				
5	4	40													2	2				
6	4	40													2	2.2				
7															2	2.2				
8															2	3.1				
9															2	3.1				
Analysis	*	Se	*	Te	*	Ti	*	V	*	W										
1	12	9.2	12	0.4	12	0.32	12	0.2	12	1.9										
2	12	9.5	12	0.41	12	0.36	12	0.22	12	2										
3	12	10	12	0.42	12	0.47	12	0.27	12	2.2										

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	
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
Dirats Laboratories	Westfield, MA	ANAB	17025
NSL Analytical	Cleveland, OH	ANAB	17025
Eurofins EAG Materials Science, LLC	Liverpool, NY	A2LA	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Luvak Inc.	Boylston, MA	PRI	17025
Element Materials Technology	Huntington Beach, CA	A2LA	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
 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: 36XCN6H, 39X17866AD; AR 141, 147, 149, 644, 645, 652, 659, 673, 882, 891, 892, 950, 1650, 1653; BAS 180/2, 183/4, 390; BS 110B, 464B, 630C, 706, 706A, 706B, 706C, 715, 863B, 883B, 903D, 903E, 929, 937C, 14500, 14500A; IARM 80B, 85A, 85C, 236A, 279A; LECO 501-501, 501-626, 501-675, 502-412, 502-712, 502-918; SRM 55D, 62, 62D, 157A, 158A, 361, 393, 396, 459, 3101A, 3105A, 3168A, 3169.

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 110B, 706, 706A, 706B, 715, 937C, 14500, 14500A; IARM 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 715C 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 Lebronze Industrial; Suippes, France.

Form: This CRM is machined in the form of a disc approximately 38mm 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 715C-081920. 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.
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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 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 17025:2017 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 35:2006 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 August 19, 2020.

Beau R. Brammer
President