

Brammer Standard Company, Inc.

Certificate of Analysis

BS 183B

Certified Reference Material for Greek Ascology - UNS Number S41800

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²
Al	0.0009	0.0003		Ni	0.02
C	0.181	0.009		P	0.002
Co	0.032	0.002		S	0.0008
Cr	12.45	0.09		Sb	0.0003
Cu	0.074	0.005		Si	0.02
Fe	80.4	0.2		Sn	0.0005
Mn	0.344	0.006		V	0.005
Mo	0.33	0.01		W	0.1
N	0.044	0.002			
	Reference Value ¹	Estimate of Uncertainty ²	Reference Values^{3,4}	Reference Value ¹	Estimate of Uncertainty ²
As	0.005	0.002		Nb	0.0025

Informational Values^{3,5}

B (0.0007)	Ca (0.0003)	Mg (0.0002)	O (0.0054)	Pb (0.0003)
Ta (0.004)	Ti (0.0016)	Zr (0.0009)		

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 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 Ce, Ga, Ge, Ir, Na, Os, Re, Y, and Zn 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	*	Al	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo	*	N	*	Ni	
1	4	0.0006	1	0.172633	4	0.0285	13	12.29	5	0.0667	10	80.133333	8	0.33	10	0.31	2	0.0381	10	1.92	
2	12	0.000617	1	0.172633	10	0.0296667	10	12.30	4	0.066825	3	80.253333	3	0.333	11	0.318	2	0.0403	4	1.936	
3	5	0.000773	1	0.176333	7	0.0298	4	12.355	10	0.06886667	13	80.262333	4	0.339333	11	0.319	2	0.0425	4	1.93867	
4	3	0.0008	3	0.179	11	0.03	3	12.38	3	0.06973333	4	80.266667	11	0.34	4	0.31975	13	0.04257	3	1.94	
5	4	0.000837	1	0.18	11	0.0304	3	12.40	11	0.0699	16	[80.33551]	10	0.34	4	0.324	2	0.04257	4	1.9455	
6	4	0.000837	1	0.180	4	0.0307333	3	12.42	11	0.0699	16	[80.351167]	3	0.34	4	0.325867	2	0.04293	3	1.95	
7	5	0.0010	1	0.1807	3	0.031	4	12.4256	4	0.07033333	16	[80.41]	4	0.340	4	0.325867	2	0.04343	4	1.9633	
8	11	0.001	1	0.181667	3	0.0313	4	12.4256	4	0.07073333	16	[80.42334]	11	0.34	4	0.328867	2	0.0435	4	1.96553	
9	4	0.0012	1	0.1822	3	0.0314	13	12.42733	3	0.071	14	80.466667	4	0.342333	3	0.329	2	0.0437	4	1.96553	
10			1	0.182667	8	0.0316	4	12.43	4	0.0715	4	80.5463	3	0.344	4	0.329667	2	0.0440	3	1.97	
11			3	0.183	4	0.0318333	14	12.43333	8	0.0724	4	80.5463	4	0.345	3	0.33	2	0.0449	4	1.97	
12			1	0.185	14	0.0318667	4	12.44533	4	0.07353333	16	[80.58]	4	0.345	3	0.33	2	0.04967	11	1.97	
13			3	0.185	4	0.0319	17	12.45	3	0.074	4	80.6525	4	0.345667	14	0.330667	2	0.04967	14	1.97	
14			1	0.185523	4	0.0324667	4	12.4689	4	0.07406667	16	[80.75]	4	0.345667	7	0.332333			4	1.975	
15			1	0.187467	5	0.0327667	4	12.47	8	0.075	7	0.345667	4	0.335467					4	1.97967	
16			11	0.188	8	0.033	3	12.5	4	0.07781	4	0.34725	4	0.337667					11	1.98	
17			11	0.189	4	0.0331	4	12.51333	10	0.078	3	0.35	3	0.338333					17	1.99	
18					4	0.0331667	11	12.52	3	0.0786	14	0.350667	3	0.339					13	1.99333	
19					4	0.0331667	11	12.53	4	0.07926667	3	0.354333	8	0.34					4	1.9959	
20					3	0.0341667	3	12.53	14	0.08033333	4	0.354567	4	0.343					10	1.99667	
21					4	0.0345	17	12.54577	3	0.0805	10	0.354667	5	0.346667							
22							10	12.54667	4	0.081033											
Average		0.00085		0.1811		0.03170		12.4689		0.073638		80.424		0.3438		0.3288		0.0444		1.9647	
Std Dev		0.00011		0.0029		0.00081		0.0039		0.00067		0.038		0.0034		0.0033		0.0013		0.0045	
H		0.00040		0.0043		0.0018		0.049		0.0027		0.17		0.0060		0.0059		0.0021		0.016	
U ₁		0.00041		0.0052		0.0020		0.049		0.0027		0.17		0.0069		0.0067		0.0025		0.017	
t-statistic		2.31		2.12		2.09		2.08		2.08		2.16		2.09		2.09		2.18		2.09	
U ₂		0.0010		0.011		0.0042		0.10		0.0057		0.37		0.014		0.014		0.0055		0.035	
U ₃		0.00032		0.0027		0.00091		0.022		0.0012		0.10		0.0031		0.0031		0.0015		0.0077	
Certified		0.0009		0.181		0.032		12.45		0.074		80.4		0.344		0.33		0.044		1.96	
Uncertainty		0.0003		0.009		0.002		0.09		0.005		0.2		0.006		0.01		0.002		0.02	
Tolerance		0.0009		0.027		0.006		0.27		0.015		0.6		0.018		0.03		0.005		0.06	

Analysis	*	P	*	S	*	Sb	*	Si	*	Sn	*	V	*	W
1	10	0.015067	11	0.0032	11	0.0004	4	0.394333	4	0.00413333	4	0.1526667	8	3.394
2	4	0.0157	10	0.0034	5	0.00054	3	0.397	4	0.00413333	10	0.155	4	3.409
3	4	0.015733	1	0.0034	5	0.0006	4	0.397	9	0.00436667	10	0.16	4	3.416733
4	12	0.016333	3	0.0035	12	0.0006833	3	0.40	3	0.0044	3	0.16	4	3.416733
5	3	0.017067	12	0.00360	5	0.0008133	3	0.401	12	0.00453333	4	0.1615	14	3.423333
6	4	0.0174	1	0.0038	9	0.0009	3	0.406	3	0.0046	3	0.1627	4	3.432833
7	13	0.017467	1	0.003867	3	0.0009	13	0.4069	5	0.00466667	4	0.1630667	8	3.463
8	13	0.017467	1	0.0039	5	0.0009333	13	0.4069	11	0.0047	5	0.1646667	16	3.48
9	3	0.0177	1	0.00391	4	0.0011667	4	0.4089	4	0.00476667	4	0.165	11	3.49
10	17	0.018	1	0.004067	4	0.0011667	10	0.41	11	0.0049	3	0.166	11	3.49
11	3	0.018	1	0.004407	4	0.0014	4	0.411	4	0.00496667	3	0.1663333	3	3.50
12	4	0.018033	1	0.004433			10	0.411	5	0.00514	4	0.1672333	4	3.515333
13	4	0.0181	3	0.0046			14	0.412333	5	0.00536667	4	0.1687	3	3.52
14	11	0.0183	1	0.0048			4	0.412667			4	0.1687	10	3.55
15	11	0.0183	1	0.004933			4	0.41325			14	0.1693333	4	3.598967
16	5	0.018433	1	0.004933			4	0.418			11	0.17	10	3.60
17	4	0.018633	11	0.005			17	0.42			3	0.17	4	3.606667
18	3	0.019	1	0.0051			3	0.427333			8	0.17	4	3.62625
19	10	0.0190	1	0.0051			11	0.434			11	0.171	4	3.63
20	3	0.019					11	0.434					4	3.659
21	4	0.0193					21	0.439433						
Average		0.01804		0.004208		0.000864		0.4100		0.00456		0.164837		3.526599
Std Dev		0.00055		0.000073		0.000095		0.0039		0.00014		0.000073		0.000067
H		0.0014		0.00075		0.00040		0.0066		0.00077		0.0041		0.022
U ₁		0.0015		0.00075		0.00041		0.0077		0.00079		0.0041		0.022
t-statistic		2.09		2.10		2.23		2.09		2.18		2.10		2.08
U ₂		0.0032		0.0016		0.00092		0.016		0.0017		0.0086		0.047
U ₃		0.00069		0.00036		0.00028		0.0035		0.00048		0.0020		0.010
Certified		0.018		0.0042		0.0009		0.41		0.0046		0.165		3.5
Uncertainty		0.002		0.0008		0.0003		0.02		0.0005		0.005		0.1
Tolerance		0.006		0.0024		0.0009		0.06		0.0017		0.015		0.3

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* Code for method

Reference values listed as weight percent

Analysis	*	As	*	Nb
1	5	0.003067	12	0.004533
2	5	0.003267	3	0.005
3	5	0.0033	4	0.005977
4	12	0.0033	5	0.006
5	3	0.004	5	0.00627
6	15	0.00404	5	0.006367
7	5	0.004147	4	0.0084
8	4	0.004167	4	0.008533
9	11	0.0042	4	0.008533
10	11	0.0042	3	0.0089
11	4	0.004767	4	0.0093
12	4	0.004767	14	0.009367
13	9	0.005133	10	0.0097
14	4	0.0067		
15	3	0.007		
16	4	0.007833		
Average		0.004618		0.007452
Std Dev		0.000079		0.000088
H		0.00078		0.00095
U ₁		0.00078		0.00096
t-statistic		2.13		2.18
U ₂		0.0017		0.0021
U ₃		0.00042		0.00058
Reference		0.005		0.0075
Uncertainty		0.002		0.0025
Tolerance		0.004		0.0060

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* Code for method

Informational values listed as weight percent

Analysis	*	B	*	Ca	*	Mg	*	O	*	Pb	*	Ta	*	Ti	*	Zr
1	12	0.00018	12	0.000115	12	0.000047	2	0.003867	5	0.00004	3	0.003	12	0.00028	12	0.000193
2	11	0.0002	11	0.0002	4	0.00005	2	0.00457	12	0.0000423	4	0.0033333	5	0.00042	11	0.0005
3	5	0.000257	4	0.0002	4	0.0002	2	0.0046	3	0.000079	4	0.0033333	5	0.000583	4	0.0008
4	3	0.00027	4	0.0002	4	0.0002033	2	0.004667	5	0.0001	4	0.0034	5	0.000633	4	0.001067
5	4	0.0005	11	0.0002	4	0.0002267	2	0.004977	11	0.0004	4	0.0076667	4	0.001167	4	0.001067
6	3	0.0005	4	0.000363	4	0.0002267	2	0.005167	4	0.00045			4	0.0019	3	0.0015
7	3	0.0005	4	0.000363			2	0.005467	4	0.00055			4	0.002033		
8	3	0.00069	3	0.00039			2	0.005533	4	0.00055			4	0.002033		
9	14	0.001033	3	0.0005			2	0.0066	9	0.0006			14	0.002067		
10	4	0.0012					2	0.0086					3	0.0023		
11	4	0.0012					2	0.014033					11	0.0024		
12	7	0.001363					2	0.014033					3	0.0025		
13	4	0.0015											4	0.002567		
14	11	0.005														
Average		0.000723		0.00028		0.000159		0.00541		0.00031		0.004		0.001606		0.0009
Std Dev		0.000088		0.00020		0.000068		0.00010		0.00025		0.032		0.000088		0.0022
H		0.00038		0.00027		0.00022		0.00083		0.00028		0.001		0.00051		0.0004
U ₁		0.00039		0.00034		0.00023		0.00084		0.00037		0.032		0.00052		0.0023
t-statistic		2.16		2.31		2.57		2.20		2.31		2.78		2.18		2.57
U ₂		0.00084		0.00077		0.00060		0.0018		0.00086		0.090		0.0011		0.0059
U ₃		0.00022		0.00026		0.00025		0.00053		0.00029		0.040		0.00031		0.0024
Informational		(0.0007)		(0.0003)		(0.0002)		(0.0054)		(0.0003)		(0.004)		(0.0016)		(0.0009)

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. U_1 is the combined uncertainty from homogeneity and labs. U_2 is U_1 multiplied by the coverage factor (95 % t-statistic). U_3 is U_2 divided by the square root of the number of determinations (n). Thus:

$$C_L = \sqrt{S_L^2 + U_L^2} \quad W_L = \frac{1}{C_L^2} \quad A = \frac{\sum_{i=1}^n W_L M_L}{\sum_{i=1}^n W_L} \quad S = \frac{1}{\sqrt{\sum_{i=1}^n W_L}} \quad U_1 = \sqrt{H^2 + S^2} \quad U_2 = t \times U_1 \quad U_3 = \frac{U_2}{\sqrt{n}}$$

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_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 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	*	Ce	*	Ga	*	Ge	*	Ir	*	Na	*	Os	*	Re	*	Y	*	Zn		
1	12	0.007	12	13	12	10	12	0.05	12	0.01	12	0.04	12	0.73	12	0.008	12	1.6		
2	12	0.007	12	14	12	11	12	0.05			12	0.04	12	0.77	12	0.009	12	1.7		
3	12	0.009	12	15	12	11	12	0.05			12	0.05	12	0.81	12	0.009	12	1.8		

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
NSL Analytical	Cleveland, OH	ANAB	17025
Eurofins EAG Materials Science, LLC	Liverpool, NY	A2LA	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Luvak Inc.	Boylston, MA	PRI	17025
Vitkovice Testing Center	Ostrava, Czech Republic	ILAC	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Shiva Analyticals	Hoskote, Bangalore	NABL	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025

A2LA = American Association for Laboratory Accreditation
ANAB = ANSI-ASQ National Accreditation Board
CNAS = China National Accreditation Service
ILAC = International Laboratory Accreditation Cooperation
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: 12X15259Q, 12X3490, 12X4330A, 13X12853K, 13X14212, 13X14212L, 13X14215L, 13X14418A, 13X14775S, 13X31603D, 13X32100, 13X32900, 13X32900A, 13X4100A, 13X41800, 13X41800A, 13X42200, 14X93603A, 23X80010; AR 165, 641, 654, 659, 662, 675, 871, 882, 892, 960, 1648, 1650, 1652, 1653; BAS 69, 72, 342, 386, 424, 435, 451, 464/1, 469; BS CSN-2, H-13, H-19, H1C, 17-4PHA, 50G, 97, 183, 185A, 186A, 187C, 187D, 200-1, 200-2, 200-4, 200A, 316D, 431, 800A, 4340A, 9905A; CKD 186A; DSZU CA013; ECRM 085-1, 179-1, 179-2, 184-1, 288-1; IARM 20A, 20C, 22B, 90B, 91B, 205B; IMN BB1; IMZ 123, 161, 162, 196; IPT 12A, 17A; JK 37; JSS 169-5, 174-5, 175-7; LECO 501-503, 501-506, 501-644, 501-646, 501-673, 502-257, 502-712, 502-868, 502-916, 502-921; APL 16A; SRM 33D, 121D, 126C, 132, 132B, 133B, 134A, 139B, 160B, 293, 343A, 344, 345, 346A, 348, 348A, 361, 362, 363, 866, 1219, 1261, 1295, 1761, 1762, 3155.

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: 13X41800; BAS 386, 424, 451; BS CSN-2, H-19, 97, 183; DSZU CA013; ECRM 179-1, 179-2, 184-1, 288-1; IARM 20A, 20C, 205B; IMZ 161, 196; JK 37; LECO 502-257; SRM 121D, 126C, 132B, 134A, 160B, 293, 344, 345, 346A, 348, 348A, 362, 866, 1219, 1295.

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 183B 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 Crucible Specialty Metals; Syracuse, New York.

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 183B-123120. 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 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 35:2017 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

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 31, 2020.

Beau R. Brammer

President