

Brammer Standard Company, Inc.

Certificate of Analysis

BS 718E

Certified Reference Material for 718 Nickel Alloy - UNS Number N07718

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²
Al	0.47	0.02		Mo	0.06
B	0.0043	0.0004		N	0.0006
C	0.020	0.002		Nb	0.08
Co	0.21	0.01		Ni	0.6
Cr	17.7	0.3		O	0.0003
Cu	0.021	0.004		P	0.003
Fe	18.6	0.3		Si	0.009
H	0.0002	0.0001		Ti	0.05
Mg	0.0013	0.0005		V	0.001
Mn	0.039	0.004			
	Reference Value ¹	Estimate of Uncertainty ²	Reference Values^{3,4}	Reference Value ¹	Estimate of Uncertainty ²
S	0.0006	0.0005		W	0.009
Sn	0.0012	0.0008		Zr	<0.05
Ta	0.006	0.003			

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.

Trace element information values for As, Be, Ca, Ga, Ge, Hf, Pb, Re, Sb, U, and Zn are shown on page 4.

The requirements of ISO Guides 30, and Standards 33401 and 33405 were followed for the preparation of this Certified Reference Material and certificate of analysis.

Analysis	*	Al	*	B	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	H	*	Mg	*	Mn	
1	10	0.45	3	0.0038	3	0.0181	10	0.187	4	17.44	12	0.016333	10	18.25333	2	0.000056	12	0.00092333	10	0.0331	
2	4	0.454	12	0.0041	1	0.018567	4	0.1976667	10	17.466667	5	0.0171	13	18.44333	2	0.00013	4	0.00096667	4	0.033267	
3	3	0.457	4	0.0041667	1	0.019	5	0.200	4	17.4819	5	0.0177	10	18.45	2	0.0001333	4	0.0011	11	0.0344	
4	4	0.4600	5	0.0042	1	0.0200	3	0.2016667	3	17.523333	4	0.0179	11	18.45	2	0.0001333	11	0.0012	4	0.036	
5	3	0.46	4	0.0043	1	0.0200	3	0.203	10	17.57	5	0.018033	4	18.52	2	0.000175	14	0.0017	4	0.037	
6	3	0.461	5	0.00434	3	0.020	4	0.2066667	11	17.59	10	0.0191	14	18.56667	2	0.0002133	4	0.0017	4	0.0390	
7	4	0.466033	3	0.0043667	1	0.020	4	0.2076667	10	17.60	4	0.0192	4	18.57	2	0.00027			4	0.0394	
8	14	0.466667	14	0.0044	1	0.020033	4	0.2078333	14	17.6	10	0.020	4	18.58667	2	0.00032			5	0.0394	
9	11	0.47	3	0.0045	1	0.020133	3	0.21	4	17.621	3	0.020433	4	18.59773					10	0.040	
10	10	0.470	11	0.0045	1	0.020333	4	0.2100	4	17.666667	4	0.021	4	18.6088					3	0.040	
11	4	0.470333	4	0.0045333	1	0.020833	4	0.2120667	4	17.7000	4	0.021367	3	18.62333					4	0.040567	
12	4	0.4711	4	0.0046	11	0.0212	4	0.2143333	4	17.715133	3	0.0214	16	18.66397					14	0.040667	
13	4	0.472667	4	0.0050	1	0.0214	14	0.2156667	13	17.723333	14	0.021667	4	18.67467					4	0.041333	
14	4	0.475333	3	0.0051	1	0.021533	10	0.217	3	17.756667	4	0.021833	4	18.691					4	0.041567	
15	4	0.479333			1	0.021767	4	0.217	4	17.773333	11	0.0227	4	18.708					3	0.0416	
16	4	0.487			1	0.021967	11	0.223	4	17.806	3	0.024333	10	18.71					7	0.0418	
17	4	0.487333					4	0.2346667	4	17.877667	4	0.0245	3	18.71					12	0.043	
18									3	17.88	4	0.034667	3	18.71333							
Average		0.4692		0.00433		0.02027		0.2134		17.684		0.02147		18.59		0.000179		0.00127		0.0391	
Std Dev		0.0043		0.00014		0.00064		0.0034		0.026		0.00065		0.12		0.000085		0.00035		0.0012	
H		0.0071		0.00076		0.0015		0.0047		0.061		0.0015		0.063		0.00023		0.00047		0.0020	
U ₁		0.0083		0.00077		0.0016		0.0058		0.067		0.0017		0.063		0.00026		0.00048		0.0023	
t-statistic		2.12		2.16		2.13		2.12		2.11		2.11		2.11		2.36		2.57		2.12	
U ₂		0.018		0.0017		0.0034		0.012		0.14		0.0035		0.13		0.00061		0.0012		0.0049	
U ₃		0.0043		0.00045		0.00086		0.0030		0.033		0.00082		0.031		0.00022		0.00051		0.0012	
Certified		0.47		0.0043		0.020		0.21		17.7		0.021		18.6		0.0002		0.0013		0.039	
Uncertainty		0.02		0.0004		0.002		0.01		0.3		0.004		0.3		0.0001		0.0005		0.004	
Tolerance		0.06		0.0012		0.006		0.03		0.9		0.012		0.9		0.0001		0.0012		0.012	

Analysis	*	Mo	*	N	*	Nb	*	Ni	*	O	*	P	*	Si	*	Ti	*	V		
1	4	2.859333	2	0.0062	4	5.015	16	[53.4]	2	0.0008667	4	0.003793	12	0.050	10	0.9456667	3	0.0252		
2	11	2.89	2	0.0068233	4	5.053667	16	[53.428]	2	0.0009667	12	0.0052	4	0.052167	4	0.949	4	0.02696667		
3	3	2.903333	2	0.0070	10	5.08	16	[53.5]	2	0.0011667	5	0.0054	4	0.060967	4	0.957	3	0.02766667		
4	14	2.91	2	0.0070333	10	5.14	4	53.546	2	0.001275	3	0.006433	5	0.061667	4	0.9600	4	0.0277		
5	4	2.9100	2	0.0070667	11	5.16	16	[53.693867]	2	0.0013	5	0.006433	10	0.065	10	0.962	5	0.028		
6	4	2.913533	2	0.0073333	4	5.1600	16	[53.7]	2	0.0013233	4	0.0079	3	0.070333	3	0.9633333	10	0.028		
7	10	2.916667	2	0.0075333	4	5.160033	6	53.713333	2	0.0013667	4	0.0079	4	0.070367	14	0.9656667	4	0.0287		
8	4	2.919333	2	0.00755	3	5.163333	16	[53.719]	2	0.0015	10	0.008	3	0.0708	4	0.972	3	0.0288		
9	4	2.926667	2	0.0076	4	5.171	4	53.777433	2	0.0016833	4	0.008067	11	0.0709	3	0.973	4	0.02883333		
10	4	2.928	2	0.0077333	14	5.18	4	53.82	2	0.00169	3	0.008333	14	0.071333	4	0.973	4	0.0290		
11	10	2.93	2	0.008	3	5.18	4	53.823333			10	0.0088	4	0.073433	4	0.9736667	4	0.02903333		
12	3	2.93	2	0.0083933	4	5.181867	14	53.833333	4	0.0090	4	0.074533	11	0.983	14	0.0291				
13	4	2.950667			4	5.186667	3	53.886667	4	0.0093	4	0.0763	4	0.9845333	11	0.0292				
14	4	2.950667			4	5.189	16	[53.99]	14	0.0094	4	0.077	4	0.990	4	0.0293				
15	10	2.96			3	5.19	10	54.386667	11	0.0099			3	1.0063333	4	0.03033333				
16	3	2.98			4	5.210333	4	54.46	3	0.0102			7	1.0093333	10	0.03123333				
17	4	2.994333			10	5.22							4	1.0132	12	0.032				
18	4	2.9971			4	5.240							10	1.02						
Average		2.9341		0.00737		5.160		53.79		0.001260		0.0078		0.0675		0.978		0.02911		
Std Dev		0.0059		0.00026		0.057		0.30		0.000074		0.0018		0.0085		0.022		0.00095		
H		0.020		0.00095		0.028		0.13		0.00046		0.00097		0.0026		0.011		0.0018		
U ₁		0.021		0.00098		0.028		0.13		0.00047		0.00097		0.0026		0.011		0.0020		
t-statistic		2.11		2.20		2.11		2.13		2.26		2.13		2.16		2.11		2.12		
U ₂		0.044		0.0022		0.060		0.27		0.0011		0.0021		0.0057		0.023		0.0042		
U ₃		0.010		0.00062		0.014		0.068		0.00034		0.00052		0.0015		0.0053		0.0010		
Certified		2.93		0.0074		5.16		53.8		0.0013		0.008		0.067		0.98		0.029		
Uncertainty		0.06		0.0006		0.08		0.6		0.0003		0.003		0.009		0.05		0.001		
Tolerance		0.18		0.0018		0.24		1.8		0.0009		0.007		0.027		0.15		0.003		

Analysis	*	S	*	Sn	*	Ta	*	W	*	Zr
1	1	0.0001	12	0.0005667	14	0.0024	4	0.017	5	0.0003333
2	1	0.000155	5	0.0005667	4	0.0052	12	0.0236667	5	0.0003533
3	1	0.000267	5	0.00069	5	0.005433	4	0.0245333	5	0.0004333
4	1	0.00027	5	0.0007333	5	0.0056	3	0.0271667	12	0.0005667
5	1	0.00033	4	0.0013	12	0.005767	10	0.028	14	0.0029
6	1	0.000333	3	0.0013	5	0.006667	5	0.0286667	11	0.0029
7	1	0.0006	4	0.0015	4	0.0074	4	0.0297667	4	0.0029
8	1	0.000663	9	0.0015	4	0.0083	5	0.0321	4	0.0039
9	1	0.0014	5	0.0019667	4	0.0087	4	0.0344		
10	1	0.00213	4	0.0019667	3	0.0087	4	0.0360667		
11							3	0.0413333		
12							11	0.0414		
13							3	0.0416		
14							4	0.0420		
15							14	0.042		
16							4	0.0441667		
Average		0.00062		0.00121		0.00632		0.0334		0.000886
Std Dev		0.00065		0.00054		0.00029		0.0082		0.000048
H		0.00036		0.00045		0.00089		0.0019		0.0019
U ₁		0.00037		0.00046		0.00093		0.0019		0.0019
t-statistic		2.26		2.26		2.26		2.13		2.36
U ₂		0.00084		0.0010		0.0021		0.0040		0.0044
U ₃		0.00027		0.00033		0.00067		0.0010		0.0016
Reference		0.0006		0.0012		0.006		0.033		<0.05
Uncertainty		0.0005		0.0008		0.003		0.009		
Tolerance		0.0005		0.0011		0.005		0.027		

For each element, in accordance with the requirements of ISO 17034 and 33405, 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 Standard 33405:2024 section 10.

BS 718E

* Code for analytical method

Trace analysis listed as mg/kg (ppm)

Analysis	*	As	*	Be	*	Ca	*	Ga	*	Ge	*	Hf	*	Pb	*	Re	*	Sb	*	U
1	12	10	12	0.007	12	0.27	12	15	12	1.1	12	0.39	12	0.10	12	0.35	12	0.92	12	0.01
2	12	10	12	0.008	12	0.28	12	15	12	1.2	12	0.42	12	0.13	12	0.38	12	0.96	12	0.01
3	12	12	12	0.009	12	0.33	12	16	12	1.3	12	0.44	12	0.16	12	0.46	12	1.2	12	0.01
Analysis	*	Zn																		
1	12	3.1																		
2	12	3.2																		
3	12	3.2																		

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
NSL Analytical	Cleveland, OH	ANAB	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
Eurofins EAG Materials Science, LLC	Liverpool, NY	A2LA	17025
Vitkovice Testing Center	Hulvaky, Ostrava	Czech Accreditation Institute	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Luvak Inc.	Boylston, MA	PRI	17025
APL, Inc	Milwaukee, WI	A2LA	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
Laboratory Testing, Inc.	Hatfield, PA	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
 PCA = Polish Center For Accreditation
 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: 22X754D, 28X625M; AR 517C, 555, 637, 645, 647, 657, 659, 662, 668, 670, 673, 675, 869, 881, 961, 1647, 1650, 1652, 1653; BAS 351; BS C-2000, G30, H230, H230A, H2D, H3C, HON T, MP35N, 625F, 718A, 718B, 718C, 718D, 725, 825, 825D, 825E, 925A, 2023, 6255; DSZU CA031; IARM54B, 54H, 56A, 56B, 56C, 56G, 56H, 62E, 68C, 100C, 189A, 190A, 358A; LECO 501-529, 501-928, 502-060, 502-863, 502-903, 502-916, 502-918, 502-935, 502-938, 502-978, 503-514; SRM 50A, 349, 864, 866, 867, 882, 1208-2, 1249.

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 351; BS 718A, 718B, 718D; CT 991, 994; SRM 1208-2, 1249.

Validity statement: ISO Standard 33401 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 718E 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 ATI Specialty Materials; Richburg, SC.

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 Standard 33403 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 718E-071025. 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 17034:2016 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials (our current Certificate Number 656.02 expires 01/31/2027)

Brammer Standard Company's Chemical Laboratory is accredited by A2LA to ISO Standard 17025:2017. (Our current Certificate Number 656.01 expires 01/31/2027)

By current Certificate Number 10539 expiring 01/01/2027, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9001:2015 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 Standard 33401:2024 Reference materials - Contents of certificates, labels and accompanying documentation

ISO Standard 33403:2024 Reference materials – Requirements and recommendations for use

ISO Standard 17034:2016 General requirements for the competence of reference material producers

ISO Standard 33405:2024 Reference Materials – Approaches for characterization and assessment of homogeneity and stability

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 July 10, 2025.

Beau R. Brammer

President