

Brammer Standard Company, Inc.

Certificate of Analysis

BS 309

Certified Reference Material for Stainless Steel Grade 309 - UNS Number S30900

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³	Certified Value ¹	Estimate of Uncertainty ²
As	0.0048	0.0008	Nb	0.0090	0.0007
C	0.062	0.002	Ni	12.16	0.08
Ca	0.0010	0.0003	O	0.0027	0.0006
Co	0.200	0.006	P	0.028	0.002
Cr	22.40	0.09	S	0.0011	0.0004
Cu	0.349	0.006	Si	0.24	0.01
Fe	62.6	0.2	Sn	0.0089	0.0006
Mn	1.61	0.01	Ti	0.0020	0.0003
Mo	0.193	0.007	V	0.075	0.002
N	0.073	0.003			

	Reference Value ¹	Estimate of Uncertainty ²	Reference Values ^{3,4}	Reference Value ¹	Estimate of Uncertainty ²
Al	0.0025	0.0015	Sb	0.0017	0.0011
B	0.0004	0.0002	W	0.031	0.009
Mg	0.0002	0.0001	Zr	<0.005	
Pb	<0.005				

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 Ce, Ga, Ge, Ir, La, Os, Pt, Re, Ta, 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.

Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895 USA
Telephone: (281) 440-9396 Fax (281) 440-4432 Website: www.brammerstandard.com

Certificate Number 309-041921 Page 1/6

Analysis	*	As	*	C	*	Ca	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo	*	N
1	10	0.0039333	1	0.057	12	0.0006767	4	0.173166667	4	22.228333	3	0.337	16	62.377733	10	1.5966667	4	0.18625	2	0.0695667
2	5	0.0040	1	0.0582	14	0.0009	4	0.185333333	3	22.24	4	0.339667	3	62.383333	3	1.60	10	0.19	2	0.0704333
3	3	0.0041	3	0.061	3	0.001	10	0.194	17	22.31	3	0.343	16	62.49	3	1.6	15	0.19	2	0.0723333
4	4	0.0045667	1	0.0610667	4	0.001	4	0.197666667	10	22.313333	8	0.344667	16	62.5	4	1.6056667	2	0.190433	2	0.0729667
5	12	0.0046	1	0.0611333	4	0.0010967	8	0.199	3	22.35	4	0.345867	14	62.5	4	1.6093333	4	0.1905	2	0.073075
6	4	0.0046333	1	0.06135	4	0.0012	11	0.2	10	22.36	4	0.346	16	62.555867	4	1.6099667	1	0.191417	2	0.0733667
7	9	0.0052333	1	0.06137	11	0.0012	3	0.200	14	22.4	10	0.346333	16	62.56	11	1.61	4	0.191667	2	0.0734333
8	15	0.0052733	1	0.0614667	4	0.00126	3	0.20	4	22.400667	14	0.347333	4	62.583333	7	1.6103333	3	0.192	2	0.0734333
9	5	0.0053733	3	0.0616667	4	0.0015	4	0.201	4	22.403067	3	0.349333	10	62.69	4	1.6108	3	0.192333	2	0.0739667
10	5	0.0054333	11	0.0622	14	0.00166667	4	0.20166667	4	22.4125	4	0.3494	16	62.69	10	1.611	11	0.193	2	0.074
11	5	0.006	1	0.0623333	4	0.00196667	4	0.20196667	4	22.414933	11	0.35	16	62.716667	3	1.612	8	0.193	2	0.074025
12			1	0.0623667	10	0.202	3	22.443333	3	0.35	13	62.789333	3	1.6133333	1	0.193333	2	0.0743333		
13			3	0.0627	8	0.202	11	22.46	4	0.3502	4	0.3502	4	62.8125	14	1.6133333	10	0.194333	2	0.0755
14			1	0.0629	3	0.203	13	22.462333	5	0.350667					4	1.6145667	2	0.195333	2	0.0765333
15			1	0.0636667	3	0.20366667	4	22.463333	4	0.35199					3	1.6166667	1	0.195767		
16			1	0.0646333	4	0.20566667	3	22.48	8	0.352					8	1.62	6	0.196		
17					4	0.21125	17	22.5125	3	0.353333					4	1.6236667	3	0.198333		
18					5	0.22066667	3	22.55	7	0.355					4	1.6266667	5	0.200		
19									4	0.355333					4	1.6305	2	0.202333		
20									10	0.356					4	1.6342				
Average		0.00478		0.0619		0.001035		0.200114		22.4017		0.3486		62.587		1.6107		0.1935		0.0734
Std Dev		0.00020		0.0018		0.000035		0.000075		0.0021		0.0039		0.053		0.0056		0.0033		0.0020
H		0.00079		0.0025		0.00043		0.0045		0.071		0.0061		0.14		0.014		0.0044		0.0027
U ₁		0.00081		0.0031		0.00043		0.0045		0.071		0.0072		0.15		0.015		0.0056		0.0034
t-statistic		2.23		2.13		2.31		2.11		2.11		2.09		2.18		2.09		2.10		2.16
U ₂		0.0018		0.0066		0.0010		0.010		0.15		0.015		0.33		0.032		0.012		0.0073
U ₃		0.00055		0.0016		0.00033		0.0023		0.035		0.0034		0.091		0.0071		0.0027		0.0019
Certified		0.0048		0.062		0.0010		0.200		22.40		0.349		62.6		1.61		0.193		0.073
Uncertainty		0.0008		0.002		0.0003		0.006		0.09		0.006		0.2		0.01		0.007		0.003
Tolerance		0.0024		0.007		0.0009		0.018		0.27		0.018		0.6		0.03		0.021		0.009

Analysis	*	Nb	*	Ni	*	O	*	P	*	S	*	Si	*	Sn	*	Ti	*	V
1	11	0.0066	10	12.06	2	0.0021	3	0.0255	1	0.0006333	3	0.205	11	0.0074	5	0.0008867	4	0.0708
2	12	0.0079333	4	12.08	2	0.0022	12	0.027666667	1	0.0006667	17	0.21	10	0.0077667	5	0.0011133	10	0.072
3	14	0.0083333	10	12.09667	2	0.0022675	4	0.027766667	1	0.0007333	4	0.226803	12	0.0082667	3	0.0017	3	0.0726
4	3	0.0084667	11	12.12	2	0.0023533	4	0.027833333	12	0.00075	3	0.228333	4	0.0083133	14	0.0019333	4	0.072967
5	4	0.0085967	4	12.139667	2	0.00244	4	0.027966667	1	0.0008	4	0.230667	5	0.0086	11	0.002	14	0.073067
6	5	0.0088333	6	12.141333	2	0.0025	4	0.028	1	0.0008333	5	0.232	3	0.0087	10	0.0020	11	0.0733
7	4	0.0090333	6	12.146667	2	0.002775	11	0.028	1	0.001	3	0.236	3	0.0087	4	0.0020667	3	0.073333
8	5	0.0090933	4	12.15	2	0.0029333	5	0.028066667	1	0.0010767	17	0.237333	3	0.0088	4	0.0022	3	0.074
9	4	0.0092333	4	12.152567	2	0.0030233	4	0.0281	3	0.0011	4	0.239433	4	0.0088667	3	0.0022667	10	0.0743
10	4	0.0096	4	12.17	2	0.0033	10	0.0281	1	0.0011333	4	0.24125	5	0.0088667	4	0.0023	3	0.0744
11	5	0.0096667	4	12.1706	2	0.0033667	3	0.028333333	1	0.0011667	3	0.246667	4	0.0090333	4	0.0023467	4	0.0746
12	10	0.010	4	12.175	2	0.0034333	17	0.029	1	0.00117	4	0.250133	4	0.0091	4	0.0025	4	0.0756
13	3	0.0106	3	12.18	3	0.029	1	0.0013	14	0.251333	5	0.0096667	3	0.003	5	0.076233		
14			3	12.183333	4	0.029033333	11	0.0017	4	0.252667	5	0.0098333			4	0.076267		
15			4	12.187367	3	0.029233333	3	0.0018333	10	0.255					3	0.0773		
16			14	12.2	7	0.029566667			4	0.259					4	0.077637		
17			8	12.20	4	0.0299			3	0.26					4	0.0786		
18			3	12.2	3	0.0304												
19			4	12.203667	10	0.0315												
20			3	12.236667														
21			3	12.27														
Average		0.00897		12.1614		0.002724		0.0284		0.001060		0.238919		0.00892		0.002024		0.0749
Std Dev		0.00038		0.0028		0.000091		0.0010		0.000082		0.000077		0.00032		0.000088		0.0019
H		0.0010		0.048		0.00063		0.0017		0.00044		0.0050		0.0010		0.0005581		0.0028
U ₁		0.0011		0.048		0.00063		0.0020		0.00044		0.0050		0.0011		0.00056		0.0033
t-statistic		2.18		2.09		2.20		2.10		2.14		2.12		2.16		2.18		2.12
U ₂		0.0024		0.10		0.0014		0.0042		0.0010		0.011		0.023		0.0012		0.0071
U ₃		0.00066		0.022		0.00040		0.0010		0.00025		0.0026		0.00062		0.00034		0.0017
Certified		0.0090		12.16		0.0027		0.028		0.0011		0.24		0.0089		0.0020		0.075
Uncertainty		0.0007		0.08		0.0006		0.002		0.0004		0.01		0.0006		0.0003		0.002
Tolerance		0.0024		0.24		0.0018		0.006		0.0010		0.03		0.0023		0.0009		0.007

Analysis	*	Al	*	B	*	Mg	*	Pb	*	Sb	*	W	*	Zr
1	5	0.0010	12	0.00013	5	0.0001	5	0.000006	5	0.0011	12	0.021667	4	0.00001
2	5	0.0012	7	0.0002	12	0.0001633	12	0.00000767	9	0.0012333	4	0.024933	12	0.000207
3	5	0.0015	5	0.0002	3	0.0002	3	0.0005	12	0.0012667	3	0.027	11	0.0017
4	3	0.0021667	3	0.0003	11	0.0003	11	0.0005	5	0.0013	4	0.027433	4	0.001767
5	3	0.0022	11	0.0006	4	0.0003	9	0.002233333	5	0.0013	4	0.0275	4	0.002067
6	4	0.0025	4	0.0006333					5	0.0014333	5	0.0275	10	0.002167
7	4	0.003							3	0.0028	4	0.028333	3	0.0025
8	14	0.0031333							10	0.003	10	0.0301	4	0.00317
9	11	0.0032									4	0.0302		
10	4	0.0036667									14	0.030733		
11	4	0.0042667									11	0.0309		
12											3	0.0321		
13											3	0.033033		
14											4	0.033467		
15											10	0.034433		
16											3	0.0378		
17											4	0.04377		
Average		0.002530		0.000253		0.000202		0.0006		0.00168		0.030641		0.002483
Std Dev		0.000095		0.000063		0.000054		0.0015		0.00011		0.000077		0.000062
H		0.00061		0.00026		0.00024		0.0004		0.00052		0.0018		0.00061
U ₁		0.00062		0.00027		0.00025		0.0015		0.00053		0.0018		0.00061
t-statistic		2.23		2.57		2.78		2.78		2.36		2.12		2.36
U ₂		0.0014		0.00069		0.00069		0.0042		0.0013		0.0038		0.0014
U ₃		0.00041		0.00028		0.00031		0.0019		0.00044		0.00092		0.00051
Reference		0.0025		0.0004		0.0002		<0.005		0.0017		0.031		<0.005
Uncertainty		0.0015		0.0002		0.0001		0.0011		0.0011		0.009		0.009
Tolerance		0.0024		0.0003		0.0001		0.0016		0.0016		0.027		0.027

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.

Analysis	*	Ce	*	Ga	*	Ge	*	Ir	*	La	*	Os	*	Pt	*	Re	*	Ta	*	Y
1	12	0.01	12	32	12	7	12	0.08	12	0.006	12	0.07	12	0.21	12	0.4	4	0.8	12	0.01
2	12	0.01	12	32	12	8	12	0.09	12	0.007	12	0.08	12	0.24	12	0.41	4	0.8	12	0.02
3	12	0.02	12	33	12	8	12	0.09	12	0.008	12	0.08	12	0.25	12	0.41	4	0.9	12	0.02
4																	4	1.8		
5																	4	2.1		
6																	4	3.8		
7																	5	42		
8																	5	46		
9																	5	47		
Analysis	*	Zn																		
1	12	0.55																		
2	12	0.56																		
3	12	0.56																		

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
Eurofins EAG Materials Science, LLC	Liverpool, NY	A2LA	17025
NSL Analytical	Cleveland, OH	ANAB	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Luvak Inc.	Boylston, MA	PRI	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
LECO Corporation	St. Joseph, MI	A2LA	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Analytical Process Laboratories	Milwaukee, WI	A2LA	17025
Vitkovice Testing Center	Ostrava, Czech	ILAC	17025
Element Materials Technology	Huntington Beach, CA	A2LA	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	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 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: 12XLA90, 13X12536, 13X125370, 13X14934, 13X14935, 23X80030; AR 414B, 612B, 644, 654, 659, 662, 663, 668, 673, 675, 676, 870, 872, 881, 882, 892, 1650, 1653; BAS 72, 261, 342, 346A, 406/2, 461, 464/1, 474; BS CA316-1, CSN-1, 17-4PHA, 80F, 81G, 82A, 82B, 82C, 82D, 85D, 180B, 181B, 253, 302A; CT 689; DSZU CA013; ECRM 085-1, 184-1, 195-1; IARM 3E, 4A, 5E, 15-5, 20A, 21A, 189A, 190A; IMZ 83A, 123, 158; IPT 12A, 17A; JK 37; JSS 652-5, 653-8, 654-5; LECO 501-501, 501-503, 501-644, 501-646, 501-676, 502-328, 502-414, 502-415, 502-416, 502-449, 502-702, 502-712, 502-855, 502-856, 502-868, 502-903, 502-904, 502-916; NCS NS20035B; SRM 101G, 160B, 344, 349A, 361, 363, 659, 897, 898, 899, 1155.

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 474; BS CA316-1, CSN-1, 82A, 82B, 82C, 82D, 253; CSZU CA013; IARM 5E, 20A; JSS 653-8; LECO 502-416, 502-916; NCS NS20035B.

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 309 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 Outokumpu Stainless Bar, LLC; Richburg, SC.

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 309-041921. 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 April 19, 2021.

Beau R. Brammer
President