

BRAMMER STANDARD COMPANY, INC.

Certificate of Analysis

BS 304A

Certified Reference Material for Stainless Steel Grade 304L - UNS Number S30403

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³	Certified Value ¹	Estimate of Uncertainty ²
Al	0.0028	0.0007	Sn	0.0096	0.0005
C	0.019	0.001	V	0.067	0.001
Co	0.126	0.002	W	0.042	0.001
Cr	18.17	0.06			
Cu	0.548	0.004			
Fe	[70.1]	0.3			
Mn	1.706	0.009			
Mo	0.28	0.01			
N	0.072	0.002			
Nb	0.014	0.001			
Ni	8.20	0.04			
O	0.0061	0.0005			
P	0.0402	0.0009			
S	0.0188	0.0006			
Si	0.56	0.01			

Informational Values^{3,4}

As (0.007)	B (0.0005)	Mg (0.0001)	Pb (0.0001)	Sb (0.002)
Ti (0.0005)	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 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 Values in parentheses are not certified and are provided for information only.

Trace element information values for Bi, Ca, Ga, Ge, Re, Ta, and Zn are shown on page 4.

The requirements of ISO Guides 31, 34, and 35 were followed for the preparation of this Certified Reference Material and certificate of analysis. This is a Certified Reference Material as defined by ISO Guide 30.

BS 304A * Code for method Certified values listed as weight percent

Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895
Telephone: (281) 440-9396 Fax: (281) 440-4432 Website: www.brammerstandard.com
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Analysis	*	Al	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo
1	5	0.001253	1	0.0177	4	0.11333	10	18.03353	4	0.489667	16	[69.41]	10	1.67	4	0.26
2	3	0.00185	1	0.018	3	0.123	10	18.05	5	0.492367	16	[69.89]	3	1.68	14	0.260333
3	3	0.002	3	0.018	14	0.12367	13	18.085	10	0.4953	4	70.03667	4	1.68	12	0.2700
4	4	0.0027	1	0.018433	4	0.12367	3	18.10	10	0.521	16	[70.065]	4	1.681	4	0.276
5	14	0.003833	1	0.0186	3	0.124	3	18.10	3	0.53	14	70.08333	3	1.686667	3	0.279
6	4	0.004333	1	0.018967	3	0.125	10	18.13	3	0.533333	3	70.16667	4	1.6872	3	0.28
7	4	0.004567	1	0.019333	12	0.1250	13	18.13467	10	0.536	10	70.17667	10	1.69	4	0.283667
8			1	0.01991	4	0.125033	4	18.14143	4	0.536533	16	[70.19987]	3	1.695	4	0.28428
9			1	0.020037	3	0.1265	10	18.15333	4	0.53775	10	70.2	8	1.698667	4	0.286
10			1	0.0202	8	0.12667	4	18.155	4	0.539	13	70.216	4	1.703533	4	0.287067
11			1	0.020967	4	0.128	4	18.179	3	0.5434	16	[70.29667]	4	1.710	10	0.287333
12			3	0.02135	4	0.1283	3	18.2	4	0.545333			3	1.7125	7	0.287667
13			1	0.023267	10	0.13	3	18.24455	4	0.546667			10	1.716667	10	0.288
14					4	0.131667	4	18.25868	4	0.546667			10	1.749233	3	0.2925
15					4	0.13175	4	18.28333	8	0.551			4	1.753333	5	0.294367
16					5	0.1363	14	18.29	4	0.5535			14	1.78	3	0.2974
17					5	0.14343			3	0.5605					10	0.304333
18									10	0.571333						
Average		0.00282		0.01933		0.1259		18.170		0.5479		70.067		1.7061		0.2801
Std dev		0.00012		0.00074		0.0029		0.048		0.0049		0.057		0.0064		0.0040
H		0.00043		0.0009		0.00248		0.11		0.0064		0.43		0.015		0.0041
U ₁		0.00045		0.0012		0.0038		0.12		0.0080		0.43		0.016		0.0057
t-statistic		2.45		2.18		2.12		2.13		2.11		2.23		2.13		2.12
U ₂		0.0011		0.0026		0.0081		0.26		0.017		0.96		0.034		0.012
U ₃		0.00042		0.00070		0.0020		0.065		0.0040		0.29		0.0086		0.0030
Certified		0.0028		0.019		0.126		18.17		0.548		[70.1]		1.706		0.28
Uncertainty		0.0007		0.001		0.002		0.06		0.004		0.3		0.009		0.01
Tolerance		0.0011		0.003		0.008		0.26		0.017		1.0		0.034		0.01

Analysis	*	N	*	Nb	*	Ni	*	O	*	P	*	S	*	Si	*	Sn
1	2	0.068473	5	0.011967	3	8.02	2	0.005273	3	0.036167	3	0.016	6	0.505	9	0.008733
2	2	0.070967	4	0.012867	4	8.050333	2	0.005567	12	0.0365	1	0.0160	5	0.513433	3	0.009
3	2	0.07109	5	0.0129	10	8.08	2	0.005943	4	0.0366	1	0.016733	14	0.521333	12	0.0093
4	2	0.0713	4	0.013	10	8.137367	2	0.0062	5	0.036667	1	0.0168	10	0.527	4	0.009333
5	2	0.071867	5	0.013167	4	8.161233	2	0.006267	10	0.037	10	0.017	4	0.541733	5	0.0096
6	2	0.072533	3	0.0144	14	8.17	2	0.006277	10	0.0374	1	0.018917	4	0.542	4	0.009677
7	2	0.0727	4	0.014567	10	8.18	2	0.006833	4	0.038067	3	0.01895	4	0.545	3	0.00985
8	2	0.072967	4	0.0146	13	8.184333	2	0.00698	4	0.038333	1	0.019	4	0.546667	5	0.0102
9	2	0.0730	4	0.014933	4	8.19	2	0.007033	5	0.038967	1	0.0194	3	0.55	5	0.010267
10	2	0.073133	10	0.015	4	8.190667	3	0.039	3	0.039	1	0.0194	6	0.565	5	0.0103
11	2	0.073633	5	0.015067	4	8.203333	3	0.0394	3	0.0394	3	0.0195	10	0.565	4	0.010367
12	2	0.074	12	0.0160	3	8.233333			14	0.0402	1	0.019533	4	0.565333		
13					10	8.256667			4	0.04084	1	0.0196	4	0.566333		
14					3	8.26			4	0.040867	1	0.0205	4	0.56848		
15					3	8.2703			4	0.041033	1	0.020933	3	0.57438		
16					4	8.292333			7	0.0411	1	0.02128	3	0.574667		
17									10	0.0422			3	0.5765		
18									3	0.04465			10	0.578667		
Average		0.0722		0.01381		8.204		0.00613		0.0402		0.01881		0.5580		0.00957
Std dev		0.0020		0.00057		0.038		0.00022		0.0012		0.00063		0.0049		0.00038
H		0.0018		0.00079		0.054		0.00057		0.0013		0.0009		0.0065		0.00068
U ₁		0.0027		0.00098		0.066		0.00061		0.0018		0.0011		0.0081		0.00078
t-statistic		2.20		2.20		2.13		2.31		2.11		2.13		2.11		2.23
U ₂		0.0059		0.0021		0.14		0.0014		0.0037		0.0024		0.017		0.0017
U ₃		0.0017		0.00060		0.035		0.00047		0.00087		0.00059		0.0040		0.00052
Certified		0.072		0.014		8.20		0.0061		0.0402		0.0188		0.56		0.0096
Uncertainty		0.002		0.001		0.04		0.0005		0.0009		0.0006		0.01		0.0005
Tolerance		0.006		0.002		0.14		0.0014		0.0037		0.0024		0.02		0.0017

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* Code for method Certified values listed as weight percent

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Analysis	*	V	*	W
1	10	0.057667	12	0.0350
2	4	0.059967	4	0.0351
3	7	0.064233	3	0.036267
4	4	0.064433	10	0.037133
5	4	0.065167	5	0.038467
6	4	0.066667	4	0.04
7	3	0.0669	10	0.041
8	3	0.06705	5	0.041167
9	3	0.0675	4	0.041567
10	10	0.0676	4	0.0418
11	3	0.068	3	0.042
12	4	0.068033	4	0.0424
13	4	0.069	3	0.0428
14	14	0.0714	3	0.0440
15	5	0.071933	5	0.047933
16	12	0.0800	4	0.048267
17	10	0.0840	10	0.053433
Average		0.0672		0.0424
Std dev		0.0018		0.0014
H		0.0017		0.0014
U ₁		0.0025		0.0019
t-statistic		2.12		2.12
U ₂		0.0054		0.0041
U ₃		0.0013		0.0010
Certified		0.067		0.042
Uncertainty		0.001		0.001
Tolerance		0.005		0.004

BS 304A * Code for method Informational values listed as weight percent

Analysis	*	As	*	B	*	Mg	*	Pb	*	Sb	*	Ti	*	Zr
1	12	0.0062	5	0.000157	5	0.000042	5	0.000107	3	0.00135	5	0.000237	5	0.000107
2	5	0.0073	12	0.00020	12	0.000055	12	0.00012	12	0.0016	3	0.0003	3	0.00215
3			3	0.000635	3	0.000145			5	0.0020	12	0.00041		
4			3	0.001							3	0.00125		
Average		0.01		0.00050		0.000081		0.000113		0.002		0.0005		0.0011
Std dev		0.11		0.00094		0.000016		0.000046		0.011		0.0023		0.0066
H		0.00		0.00027		0.00021		0.00022		0.000		0.00027		0.0003
U ₁		0.11		0.00098		0.00021		0.00022		0.011		0.0023		0.0066
t-statistic		12.71		3.18		4.30		12.71		4.30		3.18		12.71
U ₂		1.40		0.0031		0.00092		0.0028		0.045		0.0074		0.083
U ₃		0.99		0.0016		0.00053		0.0020		0.026		0.0037		0.059
(Informational)		(0.007)		(0.0005)		(0.0001)		(0.0001)		(0.002)		(0.0005)		(0.001)

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. 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 Tolerance is the half width of the 95 % confidence interval for measurements 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.

For further information regarding the confidence interval for the certified value see ISO Guide 35:2006 section 6.

BS 304A

* Code for analytical method

Trace analysis listed as mg/kg (ppm)

Analysis *	Bi	* Ca	* Ga	* Ge	* Re	* Ta	* Zn
1	12 0.016	3 1.85	12 17	12 19	12 0.38	12 1.4	12 1.0

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

Laboratory

Location

Registrar

Accreditation

Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, Guide 34
LECO Corporation	St. Joseph, MI	A2LA	17025
NSL Analytical	Cleveland, OH	ACCLASS	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025
Dirats Laboratories	Westfield, MA	ACCLASS	17025
Luvak Inc.	Boylston, MA	PRI/Nadcap	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Exova	Glendale Heights, IL	A2LA	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	AB 554

A2LA = American Association for Laboratory Accreditation

ACCLASS = ANSI-ASQ National Accreditation Board

CNAS = China National Accreditation Service

Nadcap = National Aerospace and Defense Contractors Accreditation Program

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

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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: 12X356, 12X357, 12X3255, 12X43400, 12X72M24, 13X12855, 13X15035, 13X30403A, 13X43100, 13XNCS3, 13XNSA11, 215XHC3, 215XHC5; 501-147, 501-257, 501-320, 501-501, 501-502, 501-503, 501-504, 501-644, 501-646, 501-675, 501-676, 501-991, 501-993, 502-257, 502-402, 502-416; AR 644, 646, 654, 657, 869, 875, 878, 1656; BAS 55, 65, 317, 409, 431/1, 464/1; BS CA304-3, 81E, 81F, 81G, 81P, 81V-1, 192A, 303, 3951, 4829A; CKD 166A, 181; ECRM 85, 86, 87, 284/2; IARM 6G, 241B, 289A; IMZ 112, 124, 504; IPT 208; JK 37; JSS 655-13; NCS NS11022; SRM 55D, 101C, 101D, 101E, 101G, 121D, 160B, 343A, 361, 362, 363, 365, 1162, 1170B, 1225, 1246, 1249, 1261, 1263A, 1264A, 1413, 1763A.

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 — 501-676, 502-257, 502-416; BAS 431/1; BS CA304-3; 81E, 81G, 81P, 81V-1, 192A; ECRM 284-2; IARM 289A; NCS NS11022; SRM 101G.

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 304A is valid indefinitely. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

Source: The bar stock for this CRM was produced by Chandan Steel Limited; Mumbai, India.

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.

Certificate Number: The unique identification number for this certificate of analysis is 304A-030315. You may obtain information on revisions of certificates from the internet at www.brammerstandard.com.

Safety Notice: A Material Safety Data Sheet (MSDS) 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. Phone: (281) 440-9396 Web: www.brammerstandard.com
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Houston, Texas 77069-2895 USA Fax: (281) 440-4432 Email: contact@brammerstandard.com

Brammer Standard Company, Inc., is accredited by the American Association For Laboratory Accreditation (A2LA) to ISO Guide 34 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 30:1992 Terms and definitions used in connection with reference materials + 2008 amendment
- ISO Guide 31:2000 Reference materials - Contents of certificates and labels
- ISO Guide 33:2000 Uses of certified reference materials
- ISO Guide 34:2009 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, 1916 Race Street, Philadelphia, PA, 19103.

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 March 3, 2015.

Beau R. Brammer