Brammer Standard Company, Inc.

Certificate of Analysis

BS 304B

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

Certified Values[3]

	Certified Value[1]	Estimate of Uncertainty[2]		Certified Value[1]	Estimate of Uncertainty[2]
Al	**0.0036**	0.0008	**N**	**0.081**	0.003
As	**0.0051**	0.0006	**Nb**	**0.074**	0.003
C	**0.017**	0.001	**Ni**	**8.68**	0.08
Ca	**0.0009**	0.0003	**O**	**0.0038**	0.0007
Co	**0.220**	0.003	**P**	**0.022**	0.002
Cr	**18.3**	0.1	**S**	**0.023**	0.001
Cu	**0.257**	0.007	**Si**	**0.540**	0.004
Fe	**69.6**	0.2	**Sn**	**0.0057**	0.0004
Mn	**1.72**	0.02	**V**	**0.097**	0.003
Mo	**0.42**	0.01			

Informational Values[3,4]

B (0.0004) Mg (0.0002) Pb (0.0008) Ti (0.0018) W (0.01)
Zr (0.001)

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] Values in parentheses are not certified and are provided for information only.

Trace element information values for Ag, Ce, Cl, Ga, Ge, In, Ir, La, Na, Os, Pd, Pt,Re, Ru, Sb, Sr, Y, and Zn 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 304B * Code for method Certified values listed as weight percent

Analysis	*	Al	*	As	*	C	*	Ca	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo
1	12	0.00092	4	0.0040667	1	0.014933333	12	0.00037	12	0.19	4	18.12	10	0.23867	4	68.993333	4	1.68667	4	0.40533
2	3	0.0028	12	0.0041	1	0.016	12	0.0007933	10	0.202	18	18.143333	10	0.241	16	[69.41667]	4	1.698	3	0.40733
3	14	0.00293333	3	0.0045	1	0.016066667	3	0.00081	10	0.21333	10	18.154	8	0.24933	14	69.466667	4	1.70	4	0.41
4	4	0.00306667	5	0.0046433	1	0.016533333	4	0.00083	4	0.21367	3	18.18	4	0.25	16	[69.4833]	3	1.70	4	0.41
5	4	0.0031	12	0.0047	1	0.016566667	4	0.0009	3	0.217	4	18.1833	3	0.25	4	69.492433	4	1.7033	10	0.41067
6	3	0.0037	4	0.0049333	1	0.016633333	14	0.0009	10	0.217	17	18.1902	4	0.2513	13	69.534667	10	1.70333	4	0.41317
7	4	0.00383333	9	0.0050	1	0.016666667	3	0.00093	4	0.2173	13	18.196333	4	0.25233	18	69.58	3	1.70333	4	0.414
8	3	0.004	3	0.0052	1	0.016946667	5	0.0030667	4	0.21807	3	18.23	3	0.255	16	[69.6]	4	1.70947	10	0.414
9	4	0.00416667	4	0.0055	3	0.017			3	0.21833	3	18.25	10	0.256	3	69.61	3	1.71	4	0.415
10	4	0.0049	5	0.0056333	1	0.017			3	0.219	10	18.28	4	0.2565	3	69.62	3	1.71	3	0.416
11	4	0.005	5	0.0060333	1	0.018			8	0.21967	3	18.28	4	0.2579	3	69.628	4	1.71367	4	0.41633
12	4	0.00586667			3	0.018			10	0.220	13	18.283333	4	0.25867	10	69.633333	3	1.72	4	0.41643
13					1	0.0184			4	0.220	10	18.286667	10	0.259	4	69.64	10	1.72	3	0.418
14					1	0.018433333			3	0.22	14	18.3	3	0.259	3	69.66	14	1.72	3	0.419
15					3	0.019			14	0.22	4	18.306667	4	0.25997	4	69.806667	8	1.721	18	0.42
16					3	0.0195			4	0.22	4	18.344667	4	0.26	10	69.83	4	1.72567	4	0.42027
17					12	0.0200			4	0.22017	3	18.351	4	0.26033	4	69.8462	4	1.72567	14	0.42033
18					1	0.0206			4	0.22063	4	18.36	4	0.26067	16	[70.0533]	10	1.72667	7	0.423
19									4	0.22667	4	18.373333	3	0.261			4	1.73	4	0.4267
20									4	0.2302	4	18.373333	14	0.26167			10	1.735	4	0.4360
21									5	0.24223	10	18.375	18	0.26333			4	1.73667		
22									4	0.24667			5	0.26697			4	1.7788		
23									12	0.2500							18	1.79667		
Average		0.00363		0.00508		0.01742		0.000874		0.2203		18.3566		0.2566		69.601		1.7243		0.4169
Std Dev		0.00013		0.00022		0.00061		0.000094		0.0029		0.0022		0.0028		0.045		0.0049		0.0033
H		0.00047		0.00053		0.0009		0.00030		0.0036		0.107689		0.00396		0.38		0.1495		0.0054
U_1		0.00049		0.00058		0.0011		0.00031		0.0046		0.11		0.0048		0.39		0.016		0.0064
t-statistic		2.20		2.23		2.11		2.36		2.07		2.09		2.08		2.11		2.07		2.09
U_2		0.0011		0.0013		0.0023		0.00074		0.0096		0.22		0.010		0.82		0.0033		0.013
U_3		0.00031		0.00039		0.00054		0.00026		0.0020		0.049		0.0021		0.19		0.0068		0.0030
Certified		**0.0036**		**0.0051**		**0.017**		**0.0009**		**0.220**		**18.3**		**0.257**		**69.6**		**1.72**		**0.42**
Uncertainty		0.0008		0.0006		0.001		0.0003		0.003		0.1		0.007		0.2		0.02		0.01
Tolerance		0.0024		0.0018		0.003		0.0007		0.010		0.6		0.021		0.8		0.06		0.03

Analysis	*	N	*	Nb	*	Ni	*	O	*	P	*	S	*	Si	*	Sn	*	V
1	2	0.0769	4	0.0646667	13	8.567666667	2	0.0028	12	0.016	1	0.0206667	4	0.5345	12	0.0045	12	0.0610
2	2	0.07815	4	0.0675333	4	8.5700	2	0.0032667	5	0.01847	1	0.0215	10	0.53533	4	0.005	3	0.092
3	2	0.07846667	10	0.0678333	4	8.578333333	2	0.00334	4	0.01933	1	0.0218	4	0.53667	12	0.0052333	4	0.093
4	2	0.07846667	3	0.068	4	8.603333333	2	0.00349	10	0.0197	1	0.0219	3	0.537	4	0.0054333	10	0.094
5	2	0.079	12	0.0696667	10	8.62	2	0.004	4	0.0199	1	0.022	6	0.53767	5	0.0054333	4	0.09443
6	2	0.07981667	4	0.0713333	10	8.628	2	0.004	4	0.02013	1	0.022	3	0.538	4	0.0054667	10	0.09477
7	4	0.08016667	5	0.0716667	4	8.6364	2	0.0041167	10	0.02167	1	0.0221	4	0.5399	9	0.0056333	3	0.095
8	2	0.08018667	10	0.072	3	8.643	2	0.0043	3	0.022	3	0.023	10	0.54	10	0.0056667	3	0.0959
9	2	0.08053333	3	0.073	3	8.646666667	2	0.0044333	4	0.0222	1	0.0231333	4	0.54	4	0.0057	3	0.09623
10	2	0.08066667	4	0.0737	3	8.65	2	0.004469	4	0.02223	3	0.0236	3	0.54	5	0.0057867	10	0.09667
11	2	0.0837	3	0.074	18	8.656666667	2	0.0046533	12	0.02267	1	0.0238	4	0.54007	3	0.006	4	0.09697
12	2	0.0933	10	0.0746667	10	8.66	2	0.0047667	10	0.023	1	0.024	14	0.54233	5	0.0061333	4	0.09707
13	2	0.09493333	10	0.075	4	8.673	2	0.0051	3	0.023	12	0.0240	3	0.543	3	0.0062	14	0.09717
14			4	0.0751667	14	8.68			4	0.02327	3	0.0244	4	0.543	4	0.0062667	10	0.098
15			4	0.0753667	4	8.698333333			3	0.0237	1	0.0244	18	0.54333	3	0.0064	4	0.0981
16			4	0.0785	3	8.71			14	0.0239	10	0.025	4	0.54333			4	0.0982
17			7	0.0790333	3	8.71			7	0.02397	3	0.025	4	0.54533			3	0.0986
18			4	0.0827667	4	8.717			4	0.024	1	0.0256667	3	0.547			4	0.09913
19			14	0.0828667	4	8.723333333			3	0.02417			4	0.54867			4	0.09943
20					4	8.769333333			4	0.02453							5	0.1017
21					10	8.794			3	0.0248							7	0.10243
22					4	8.8266674			4	0.0257							18	0.10667
23					4	8.84											12	0.1100
24																	4	0.11
Average		0.0814		0.073514		8.6858		0.00381		0.02242		0.02338		0.5403		0.00573		0.0969
Std Dev		0.0021		0.000073		0.0035		0.00013		0.00068		0.00075		0.0039		0.00017		0.0020
H		0.0020		0.0019		0.05546		0.00048		0.00102		0.0010		0.00647		0.00056		0.0022
U_1		0.0029		0.0019		0.056		0.00050		0.0012		0.0013		0.0075		0.00059		0.0030
t-statistic		2.18		2.10		2.07		2.18		2.08		2.11		2.10		2.14		2.07
U_2		0.0063		0.0039		0.12		0.0011		0.0025		0.0027		0.016		0.0013		0.0061
U_3		0.0017		0.00091		0.024		0.00030		0.00054		0.00064		0.0036		0.00032		0.0013
Certified		**0.081**		**0.074**		**8.68**		**0.0038**		**0.022**		**0.023**		**0.540**		**0.0057**		**0.097**
Uncertainty		0.003		0.003		0.08		0.0007		0.002		0.001		0.004		0.0004		0.003
Tolerance		0.009		0.009		0.24		0.0021		0.006		0.003		0.016		0.0013		0.009

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

Analysis	*	B	*	Mg	*	Pb	*	Ti	*	W	*	Zr
1	5	0.0000367	12	0.000065	12	0.00000167	12	0.00037	3	0.009	5	0.00002
2	12	0.0000653	4	0.0001	12	0.000002	5	0.0004333	4	0.0093	5	0.0001
3	12	0.000067	12	0.0001117	3	0.0002	12	0.0007067	12	0.0099	12	0.00020
4	7	0.00021667	4	0.0002	9	0.0003	5	0.0007967	7	0.0109	12	0.000327
5	3	0.00055	3	0.0002	4	0.001633333	4	0.0008667	5	0.01107	4	0.0017
6	3	0.00057	3	0.00027	3	0.0017	5	0.0011333	4	0.01117	4	0.0023333
7	4	0.0006	4	0.0003833	3	0.002	4	0.0014	5	0.0113	3	0.0026
8	4	0.0006					3	0.002	3	0.0115	4	0.0026
9	3	0.001					4	0.0022667	4	0.0130	3	0.0026
10							10	0.0024	4	0.01393		
11							4	0.0028333	12	0.0140		
12							3	0.003	5	0.01413		
13							3	0.003	4	0.01427		
14							4	0.0031	10	0.016		
15							14	0.0034333	4	0.01613		
16									4	0.0171		
17									14	0.01717		
Average		0.00041		0.000190		0.0008		0.001849		0.013		0.0014
Std Dev		0.00044		0.000095		0.0020		0.000082		0.073		0.0043
H		0.00025		0.00021		0.0003		0.0003743		0.001		0.0003
U_1		0.00051		0.00023		0.0020		0.00038		0.073		0.0044
t-statistic		2.31		2.45		2.45		2.14		2.12		2.31
U_2		0.0012		0.00057		0.0049		0.00082		0.16		0.010
U_3		0.00039		0.00022		0.0019		0.00021		0.038		0.0034
Informational		(0.0004)		(0.0002)		(0.0008)		(0.0018)		(0.01)		(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 it's 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:

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

*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.

BS 304B * Code for analytical method Trace analysis listed as mg/kg (ppm)

Analysis	*	Ag	*	Ce	*	Cl	*	Ga	*	Ge	*	In	*	Ir	*	La	*	Na	*	Os
1	12	0.41	12	0.01	12	0.01	12	27	12	45	12	0.2	12	0.08	12	0.04	12	0.01	12	0.07
2	12	0.43	12	0.02			12	27	12	45	12	0.22	12	0.08	12	0.04			12	0.08
3	12	0.44	12	0.02			12	28	12	46	12	0.24	12	0.08	12	0.04			12	0.08
Analysis	*	Pd	*	Pt	*	Re	*	Ru	*	Sb	*	Sr	*	Y	*	Zn				
1	12	0.18	12	0.41	12	0.57	12	0.15	12	13	12	0.04	12	0.008	12	0.15				
2	12	0.18	12	0.41	12	0.59	12	0.15	12	14	12	0.08	12	0.009	12	0.16				
3	12	0.2	12	0.41	12	0.6	12	0.22	12	14	12	0.09	12	0.01	12	0.18				

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	18	PIXE

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, Guide 34
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
NSL Analytical	Cleveland, OH	ACLASS	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025
Dirats Laboratories	Westfield,MA	ACLASS	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	AB 554
Evans Analytical Group	Liverpool, NY	A2LA	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
Luvak Inc.	Boylston, MA	PRI/Nadcap	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Exova	Santa Fe Springs, CA	A2LA	17025
Exova	Glendale Heights, Il	A2LA	17025
TUVRheinland	Bangalore, India	NABL	17025

A2LA = American Association for Laboratory Accreditation
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: 13X12534, 13X12853, 28X6255; AR 612B, 646, 654, 657, 670, 673, 875, 892, 911A, 950, 1648, 1652, 1653, 3040; BAS 55, 206/3, 245, 334, 335, 409, 410/2, 433, 451, 459, 463, 464/1; BS CA304-2, H-13, HON-T, SS39451, 30D, 48B, 50E, 61G, 81D, 81G, 81P, 81T, 93F, 192, 199B, 200-4, 304, 304-3, 304A, 316E, 410C, 718C, 718D, 750C, 1026, 1030, 8620E, 9722, 9932P; ECRM 85-1, 86-1, 87-1; IARM 2C, 2D, 2E, 2G, 4B, 5G, 6H, 16C, 21C, 62B, 62E, 241A, 241B; IMZ 1.7/4, 73, 74, 111, 112, 184; JK 37; LECO 501-320, 501-501, 501-502, 501-503, 501-504, 501-644, 501-646, 501-674, 501-676, 501-993, 502-197, 502-257, 502-416, 502-868; NCS NS110022, NS21006; SRM 72F, 72G, 90, 101C, 101E, 121D, 160B, 1095, 1152, 1244, 1264A, 1269, 1413, 1763, 1766, 2159, 3128.

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 — AR 3040; BAS 410/2, 463; BS CA304-2, CA304-3, HON-T, 50E, 55G, 81G, 81P, 192, 304, 304A, 9722, 9932P; LECO 501-676, 502-257; NCS NS11022, NS21006; SRM 72G, 1763, 1766, 2159.

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 304B 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 Carpenter Technology Corporation; Reading, PA.

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 304B-120517. 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 9001:2008 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 30:2015 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 December 5, 2017.

Beau R. Brammer

President