

BRAMMER STANDARD COMPANY, INC.

Certificate of Analysis

BS 303

Certified Reference Material for Stainless Steel Grade 303 - UNS Number S30300

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²
Al	0.0019	0.0003		Nb	0.001
B	0.0013	0.0003		Ni	0.04
C	0.044	0.001		O	0.0004
Co	0.071	0.002		P	0.001
Cr	17.23	0.07		S	0.005
Cu	0.627	0.005		Si	0.006
Fe	[70.7]	0.3		Sn	0.0005
Mn	1.80	0.01		Ti	0.001
Mo	0.410	0.005		V	0.001
N	0.023	0.001		W	0.001

Informational Values^{3,5}

Ca (0.0015)

Sb (0.002)

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.

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 Ag, As, Bi, Cd, Cl, Ga, Ge, H, K, Mg, Na, Pb, Pt, Re, Ta, Zn, and Zr 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 303

* Code for method

Certified values listed as weight percent

Analysis	* AI	* B	* C	* Co	* Cr	* Cu	* Fe	* Mn
1	5 0.001467	5 0.000937	1 0.042333	14 0.067	4 17.12977	12 0.5250	16 70.63333	10 1.75
2	4 0.001533	12 0.0010	1 0.042475	3 0.0679	3 17.14	10 0.549667	13 70.67167	4 1.757333
3	10 0.0017	4 0.001233	1 0.043667	4 0.068067	10 17.14333	5 0.573333	16 70.69	3 1.76
4	5 0.001833	3 0.0013	1 0.043733	4 0.0697	4 17.18	4 0.598133	4 70.75	4 1.773767
5	14 0.001833	5 0.001467	1 0.043767	4 0.069933	4 17.20333	4 0.604667	16 70.75667	8 1.790667
6	3 0.001967	7 0.00155	1 0.0438	5 0.070333	3 17.23	8 0.607667	4 70.83333	7 1.792
7	3 0.002	4 0.0018	1 0.044167	5 0.0719	13 17.255	4 0.6162	4 70.84	4 1.7496
8	4 0.0021	4 0.001867	1 0.045367	8 0.072267	10 17.27	4 0.62	16 70.87667	4 1.803333
9	4 0.0024	4 0.001867	1 0.045367	5 0.0730	4 17.27333	14 0.621333	16 70.8976	4 1.813
10	4 0.002567		1 0.045567	4 0.073033	4 17.27667	4 0.625	3 71.25667	4 1.813
11			1 0.0458		13 17.28967	4 0.625613	10 71.30333	4 1.83
12			3 0.0458		14 17.29	3 0.631	10 71.93333	14 1.83
13						4 0.636667		4 1.84
14						4 0.639667		10 1.848
15						4 0.649667		
16						3 0.656		
17						3 0.671333		
18						10 0.673333		
Average	0.00193	0.001304	0.04368	0.0706	17.235	0.6272	70.71	1.805
Std dev	0.00018	0.000093	0.00098	0.0017	0.041	0.0067	0.13	0.016
H	0.00035	0.00031	0.0013	0.0017	0.10	0.0069	0.37	0.015
U ₁	0.00040	0.00033	0.0017	0.0024	0.11	0.0096	0.39	0.022
t-statistic	2.26	2.31	2.20	2.26	2.20	2.11	2.20	2.16
U ₂	0.00090	0.00075	0.0037	0.0055	0.23	0.020	0.87	0.048
U ₃	0.00028	0.00025	0.0011	0.0017	0.067	0.0048	0.25	0.013
Certified	0.0019	0.0013	0.044	0.071	17.23	0.627	[70.7]	1.80
Uncertainty	0.0003	0.0003	0.001	0.002	0.07	0.005	0.3	0.01
Tolerance	0.0009	0.0008	0.004	0.005	0.23	0.020	0.9	0.05

Analysis	* Mo	* N	* Nb	* Ni	* O	* P	* S	* Si
1	3 0.390333	2 0.0212	14 0.0066	3 8.043333	2 0.005133	4 0.023267	1 0.314333	4 0.4022
2	10 0.395	2 0.021467	5 0.0067	6 8.096667	2 0.005267	5 0.0234	3 0.317	12 0.4050
3	4 0.398	2 0.02191	5 0.006713	10 8.113333	2 0.005537	4 0.0247	1 0.321333	6 0.405333
4	4 0.40	2 0.021933	5 0.0070	13 8.122667	2 0.005567	10 0.025433	1 0.321667	4 0.406667
5	4 0.4013	2 0.022	4 0.007833	10 8.13	2 0.005767	12 0.0255	1 0.325667	4 0.411
6	4 0.403	2 0.02205	5 0.008233	4 8.138667	2 0.0059	3 0.026233	1 0.3280	10 0.413333
7	4 0.408767	2 0.022267	5 0.008933	4 8.1646	2 0.0065	4 0.026467	1 0.332333	4 0.417067
8	12 0.41	2 0.022767	10 0.009	3 8.17	2 0.00655	14 0.027	1 0.333667	4 0.417667
9	10 0.4100	2 0.0229	4 0.009	4 8.183333	2 0.006653	10 0.0272	1 0.3358	10 0.427
10	4 0.411	2 0.0230	10 0.0091	4 8.193333	2 0.006853	5 0.0273	1 0.336667	14 0.427333
11	14 0.415667	2 0.0233	3 0.0095	4 8.2006	2 0.0069	4 0.027467	1 0.339333	3 0.431
12	3 0.418	2 0.024033	4 0.010433	4 8.213		7 0.027733		10 0.431
13	7 0.418333	2 0.024225		4 8.213333		3 0.029		
14	4 0.42					4 0.030033		
15						4 0.031667		
Average	0.4104	0.02343	0.00836	8.173	0.00584	0.02857	0.3257	0.4153
Std dev	0.0062	0.00061	0.00026	0.030	0.00018	0.00085	0.0053	0.0073
H	0.0051	0.0010	0.00061	0.050	0.00053	0.0011	0.0044	0.0052
U ₁	0.0080	0.0012	0.00067	0.059	0.00056	0.0014	0.0069	0.0089
t-statistic	2.16	2.18	2.20	2.18	2.23	2.14	2.23	2.20
U ₂	0.017	0.0025	0.0015	0.13	0.0012	0.0030	0.015	0.020
U ₃	0.0046	0.0007	0.0004	0.035	0.00038	0.0008	0.0047	0.0057
Certified	0.410	0.023	0.008	8.17	0.0058	0.028	0.326	0.415
Uncertainty	0.005	0.001	0.001	0.04	0.0004	0.001	0.005	0.006
Tolerance	0.017	0.003	0.001	0.13	0.0012	0.003	0.015	0.020

BS 303 * Code for method Certified values listed as weight percent

Analysis	*	Sn	*	Ti	*	V	*	W
1	10	0.007333	5	0.009933	10	0.040667	12	0.0170
2	12	0.0074	12	0.0130	10	0.046067	4	0.0182
3	5	0.007567	4	0.0142	3	0.048167	5	0.0194
4	5	0.008633	5	0.014267	4	0.051033	10	0.020633
5	5	0.008967	3	0.0151	3	0.0514	4	0.021333
6	4	0.009	4	0.0152	12	0.0520	4	0.022067
7	5	0.009327	10	0.0154	5	0.054667	5	0.022333
8	5	0.0094	14	0.016567	10	0.055	5	0.022433
9	5	0.009567	4	0.016633	4	0.055	5	0.023567
10	3	0.010267	4	0.018	4	0.0552	4	0.024
11			10	0.0182	4	0.055333	10	0.026
12			3	0.0198	5	0.0581	3	0.0275
13			4	0.0219	14	0.059033	14	0.0281
14					7	0.059267	3	0.0282
15					4	0.059767	4	0.029167
16					4	0.059867	10	0.039
Average		0.00913		0.01704		0.0558		0.02372
Std dev		0.00036		0.00062		0.0010		0.00063
H		0.00064		0.0008		0.0015		0.0010
U ₁		0.00073		0.0010		0.0018		0.0012
t-statistic		2.26		2.18		2.13		2.13
U ₂		0.0017		0.0023		0.0039		0.0025
U ₃		0.00052		0.00063		0.0010		0.0006
Certified		0.0091		0.017		0.056		0.023
Uncertainty		0.0005		0.001		0.001		0.001
Tolerance		0.0017		0.002		0.004		0.003

BS 303 * Code for method Informational values listed as weight percent

Analysis	*	Ca	*	Sb
1	12	0.00046	5	0.0015
2	4	0.000667	5	0.001567
3	4	0.000987	12	0.0020
4	5	0.0010		
5	4	0.001067		
6	3	0.00109		
7	4	0.001633		
8	4	0.0017		
9	4	0.001867		
Average		0.001476		0.00154
Std dev		0.000046		0.00028
H		0.00032		0.00033
U ₁		0.00033		0.00043
t-statistic		2.31		4.30
U ₂		0.00076		0.0019
U ₃		0.00025		0.0011
(Informational)		(0.0015)		(0.002)

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. U₁ is the combined uncertainty from homogeneity and labs. U₂ is U₁ times 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 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 303		* Code for analytical method														Trace analysis listed as mg/kg (ppm)					
Analysis	*	Ag	*	As	*	Bi	*	Cd	*	Cl	*	Ga	*	Ge	*	H	*	K	*	Mg	
1	5	0.62	5	55	12	0.24	5	9.5	12	0.044	12	20	5	3.4	2	7	12	0.10	12	0.3	
2	5	0.64	5	68.33			5	9.6			5	24	5	3.5	2	7				5	0.6
3	5	0.64	12	74			5	9.6			5	24	5	3.6	2	7				5	0.76
4	5	0.8									5	24	5	11	2	7					
5	5	0.8											5	11	2	7					
6	5	0.9											5	11							
7	12	0.97											12	20							

BS 303		* Code for analytical method														Trace analysis listed as mg/kg (ppm)				
Analysis	*	Na	*	Pb	*	Pt	*	Re	*	Ta	*	Zn	*	Zr						
1	12	0.087	5	0.967	12	0.13	12	0.62	12	0.55	12	2.7	5	0.7						
2			5	1							5	5.4	14	42.67						
3			5	1							5	5.5	4	45.33						
4			5	1.0							5	5.5								
5			5	1.1																
6			5	1.1																
7			12	1.5																
8			3	2.5																
9			4	28.67																
10			14	29.67																

Analytical Method Codes:

- | | | |
|---------------------------|---------------------------|---------------------------|
| 1 Combustion (ASTM E1019) | 7 Photometric | 13 Titrimetric |
| 2 Fusion (ASTM E 1019) | 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

<u>Laboratory</u>	<u>Location</u>	<u>Registrar</u>	<u>Accreditation</u>
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, Guide 34
Dirats Laboratories	Westfield, MA	ACCLASS	17025
LECO Corporation	St. Joseph, MI	A2LA	17025
NSL Analytical	Cleveland, OH	ACCLASS	17025
Exova	Glendale Heights, IL	A2LA	17025
National Analysis Center For Iron And Steel Laboratory Testing, Inc.	Beijing, China	CNAS	17025
Northern Analytical Laboratory, Inc.	Hatfield, PA	PRI/Nadcap	17025
Elemental Analysis, Inc.	Londonderry, NH	PRI/Nadcap	17025
Evans Analytical Group	Lexington, KY	A2LA	17025
Luvak Inc.	Liverpool, NY	A2LA	17025
Instytut Metalurgii Zelaza	Boylston, MA	PRI/Nadcap	17025
	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 certified portion of the lot in accordance with ASTM Standard Practice E 1806. The laboratories participating in the testing followed the requirements of ISO Standard 17025. Methods of analysis used are those listed on pages 2-4.

Traceability: The following Certified Reference Materials were used to validate the analytical data listed on page 2-4 — 12X349, 12X356, 12X357, 24X07001, 24X07001B; 501-320, 501-449, 501-501, 501-502, 501-504, 501-644, 501-646, 501-991, 501-993, 502-102, 502-195, 502-280, 502-416, 502-449, 502-494; AR 657, 875, 956, 1652, 1656, 3040; BAS 152/2, 345, 464/1; BS 30D, 56H, 61G, 80C, 80D, 80F, 81G, 81N, 1030; CKD CZ 2026A; ECRM 85/7, 86/1, 87/1, 284/1, 285/1, 287/1; IARM 1C, 1D, 5E, 241B, 253A; IMZ 112; KMS HOCS-001; SRM 101C, 101E, 101G, 121D, 125A, 133A, 133B, 160B, 361, 362, 363, 862, 1246, 1249, 1263A, 3109A, 3162A, 3169.

Homogeneity: This Certified Reference Material (CRM) was tested for homogeneity using ASTM Standard Method E 826 and found acceptable. It was also examined by spark atomic emission spectrometry and found to be compatible with the following Reference Materials — 501-676; 502-416; AR 3040; BAS 431/1; BS 80C, 80D, 80F, 81G, 81N; ECRM 037/1, 284/1, 285/1, 287/1, 327/2; KMS HOCS-001.

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 303 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 Acciaierie Valbruna, Bolzano, Italy.

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 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 you use for production specimens. Avoid overheating the sample during surface preparation.

Certificate Number: The unique identification number for this certificate of analysis is 303-072814. 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**
14603 Benfer Road
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

- E 826 Standard Practice for Testing Homogeneity of a Metal Lot or Batch in Solid Form by Spark Atomic Emission Spectrometry
- E 1019 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques
- E 1806 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 July 28, 2014.

Beau R. Brammer