

Brammer Standard Company, Inc.

Certificate of Analysis

BS 347C

Certified Reference Material for Stainless Steel Grade 347 - UNS Number S34700

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²	
B	0.0018	0.0003		Nb	0.58	0.02
C	0.051	0.002		Ni	10.08	0.06
Ca	0.0011	0.0004		O	0.0053	0.0006
Co	0.072	0.003		P	0.022	0.001
Cr	17.27	0.03		S	0.022	0.001
Cu	0.110	0.003		Si	0.677	0.008
Fe	69.1	0.2		Sn	0.0034	0.0007
Mn	1.67	0.01		V	0.097	0.002
Mo	0.27	0.01		W	0.013	0.001
N	0.039	0.002		Zr	0.0028	0.0007
	Reference Value ¹	Estimate of Uncertainty ²	Reference Values⁴	Reference Value ¹	Estimate of Uncertainty ²	
Al	0.003	0.001		Ti	0.004	0.001
As	0.003	0.001				

Informational Values^{3,5}

Mg (0.002)

Pb (0.0008)

Sb (0.002)

Ta (0.003)

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 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 Ce, Ga, Ge, Ir, La, Nd, Os, Pt, Re, Se, Sr, 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.

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Certificate Number 347C-111320 Page 1/7

Analysis	*	B	*	C	*	Ca	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo	*	N
1	14	0.0011333	1	0.04756667	12	0.000643	10	0.0667	3	17.103333	4	0.1	16	[68.88]	3	1.64	10	0.253	2	0.03757
2	12	0.0011333	1	0.0480	3	0.00077	4	0.066833	13	17.11	4	0.107	4	68.906667	3	1.64667	4	0.256333	2	0.0384
3	7	0.0015467	1	0.04963333	4	0.001	4	0.069367	4	17.23	4	0.1073	16	[68.92]	8	1.65	5	0.257467	2	0.03883
4	4	0.0016333	3	0.051	11	0.001	4	0.07	10	17.243333	10	0.107333	13	68.969667	4	1.65667	4	0.26	2	0.03953
5	4	0.0016333	3	0.0511	4	0.001067	3	0.071	3	17.245	3	0.108	16	[68.970573]	10	1.66	4	0.260433	2	0.03973
6	5	0.0017067	1	0.05123333	3	0.00115	14	0.0717	3	17.25	4	0.108333	16	[68.98]	3	1.66	4	0.262767	2	0.03997
7	4	0.0017333	1	0.0513	3	0.00117	11	0.07195	14	17.266667	3	0.1085	14	69	10	1.66	3	0.264	2	0.0400
8	3	0.001765	11	0.0514	4	0.00121	10	0.072	13	17.267	4	0.1086	16	[69.032667]	7	1.66133	3	0.264	2	0.0400
9	4	0.0017667	3	0.05165	14	0.001233	4	0.072033	3	17.27	5	0.109867	16	[69.05]	4	1.66287	3	0.265	2	0.04027
10	11	0.0018	3	0.052	3	0.0016	8	0.072367	10	17.27	8	0.11	3	69.096667	8	1.66933	11	0.2665	2	0.04033
11	3	0.0018	1	0.0520	4	0.002267	5	0.072433	3	17.275	10	0.110	16	[69.135]	4	1.66987	4	0.2677		
12	4	0.0018333	1	0.05203333			3	0.07245	17	17.286433	11	0.11025	16	[69.18333]	3	1.67	14	0.268		
13	4	0.0018667	1	0.052147			3	0.0728	4	17.287333	3	0.110333	4	69.2	14	1.67	4	0.268067		
14	3	0.0020	1	0.05317333			4	0.072933	8	17.29	4	0.1107	10	69.206667	4	1.67	4	0.268667		
15	3	0.002025	1	0.05342			8	0.073	4	17.296233	4	0.111333	4	69.366667	11	1.6725	10	0.27		
16	3	0.0021	1	0.054			3	0.07325	4	17.296667	3	0.112			4	1.67593	3	0.270		
17			1	0.05513333			4	0.0736	4	17.3	8	0.113			3	1.68	3	0.27175		
18			1	0.05566667			4	0.0747	3	17.3	4	0.113633			3	1.68	4	0.274667		
19							3	0.075367	11	17.3725	3	0.11375			4	1.68223	3	0.27875		
20							4	0.076633	4	17.405	14	0.117667			4	1.68833				
21											3	0.12								
Average		0.001777		0.0515		0.001059		0.072056		17.268225		0.110362		69.080		1.6728		0.2684		0.0393
Std Dev		0.000048		0.0014		0.000027		0.000071		0.000071		0.000069		0.043		0.0045		0.0032		0.0014
H		0.00053		0.0023		0.00044		0.0027		0.060		0.0033		0.15		0.014		0.0053		0.0020
U ₁		0.00053		0.0027		0.00044		0.0027		0.060		0.0033		0.16		0.015		0.0062		0.0025
t-statistic		2.13		2.11		2.23		2.09		2.09		2.09		2.14		2.09		2.10		2.26
U ₂		0.0011		0.0056		0.0010		0.0057		0.13		0.0070		0.34		0.032		0.013		0.0056
U ₃		0.00028		0.0013		0.00029		0.0013		0.028		0.0015		0.087		0.0071		0.0030		0.0018
Certified		0.0018		0.051		0.0011		0.072		17.27		0.110		69.1		1.67		0.27		0.039
Uncertainty		0.0003		0.002		0.0004		0.003		0.03		0.003		0.2		0.01		0.01		0.002
Tolerance		0.0011		0.006		0.0010		0.009		0.13		0.009		0.6		0.03		0.03		0.006

Analysis	*	Nb	*	Ni	*	O	*	P	*	S	*	Si	*	Sn	*	V	*	W	*	Zr
1	10	0.56	3	9.985	2	0.0044	12	0.0180	10	0.020	3	0.65	4	0.0018333	3	0.08945	3	0.009	4	0.0018
2	4	0.56	4	10.0203333	2	0.00452	3	0.019	2	0.0200	3	0.6575	5	0.0024	4	0.09157	4	0.009633	3	0.00218
3	10	0.5616667	17	10.0242333	2	0.0048	4	0.019033	3	0.0205	4	0.665	4	0.0029	10	0.096	4	0.011533	4	0.00243
4	4	0.5663333	4	10.0246667	2	0.0048	10	0.0196	1	0.0205267	4	0.6695	5	0.0029	10	0.0962	12	0.011667	11	0.00263
5	3	0.579	14	10.0333333	2	0.00488	4	0.0212	3	0.021	10	0.67	4	0.0030333	5	0.09643	4	0.0120	4	0.00303
6	3	0.58	10	10.0366667	2	0.004933	7	0.0217	1	0.0212667	14	0.670667	12	0.0031333	4	0.0966	5	0.0121	14	0.00313
7	4	0.5817667	3	10.04	2	0.005867	3	0.0218	1	0.02127	4	0.670833	5	0.0032	4	0.09693	3	0.01235	3	0.0033
8	4	0.5846667	10	10.07	2	0.00591	4	0.021933	1	0.0213333	6	0.671333	5	0.00321	3	0.097	5	0.012633	3	0.004
9	4	0.585	4	10.08	2	0.0076	4	0.021933	1	0.0214667	11	0.67475	3	0.003325	14	0.0971	4	0.0128		
10	11	0.585	11	10.085			11	0.02195	11	0.021775	3	0.6765	3	0.0034	4	0.09717	4	0.013467		
11	3	0.587	3	10.09			7	0.021967	1	0.0218	3	0.677	3	0.0041	11	0.09733	3	0.0135		
12	3	0.59	3	10.09			10	0.022	3	0.022	4	0.677	3	0.0044	4	0.09743	11	0.013525		
13	4	0.5901333	4	10.0993333			17	0.022	1	0.0226667	4	0.68	9	0.0047	3	0.0976	4	0.013633		
14	14	0.5906667	4	10.1			4	0.022	3	0.02275	3	0.68	4	0.0050333	3	0.0978	5	0.013967		
15	4	0.5912	4	10.1058333			5	0.022233	1	0.02278	3	0.682			4	0.0979	14	0.015333		
16	4	0.5956667	4	10.1196667			3	0.02225	1	0.0228033	17	0.683033			3	0.09887				
17	4	0.5983333	4	10.12			3	0.0226	1	0.02365	4	0.696667			8	0.099				
18			8	10.12			4	0.0227			17	0.70			4	0.09973				
19			3	10.14			3	0.023			4	0.706667			4	0.1				
20			3	10.1933333			4	0.023133							3	0.10138				
Average		0.581555		10.078870		0.00530		0.02220		0.02194		0.676761		0.00340		0.0973		0.012476		0.00281
Std Dev		0.000077		0.000071		0.00011		0.00067		0.00067		0.000073		0.00012		0.0020		0.000082		0.00011
H		0.0080		0.043		0.00082		0.0015		0.0015		0.0087		0.00069		0.0031		0.0012		0.00064
U ₁		0.0080		0.043		0.00083		0.0017		0.0017		0.0087		0.00070		0.0037		0.0012		0.00065
t-statistic		2.12		2.09		2.31		2.09		2.12		2.10		2.16		2.09		2.14		2.36
U ₂		0.017		0.089		0.0019		0.0035		0.0036		0.018		0.0015		0.0078		0.0026		0.0015
U ₃		0.0041		0.020		0.00064		0.00079		0.00086		0.0042		0.00040		0.0017		0.00066		0.00054
Certified		0.58		10.08		0.0053		0.022		0.022		0.677		0.0034		0.097		0.013		0.0028
Uncertainty		0.02		0.06		0.0006		0.001		0.001		0.008		0.0007		0.002		0.001		0.0007
Tolerance		0.06		0.18		0.0019		0.004		0.004		0.024		0.0021		0.008		0.003		0.0021

BS 347C

* Code for method

Reference values listed as weight percent

Analysis	*	Al	*	As	*	Ti
1	5	0.0017667	3	0.0014	12	0.001733
2	5	0.0021667	4	0.0017	4	0.002367
3	4	0.0022	4	0.00203333	5	0.002407
4	4	0.0030667	4	0.0020667	5	0.0028
5	4	0.0034	11	0.002225	5	0.002867
6	3	0.0035	3	0.002375	4	0.003093
7	4	0.0035333	3	0.002575	4	0.003367
8	14	0.0038667	12	0.00323333	3	0.00355
9	4	0.0040333	4	0.0035	11	0.00395
10	3	0.00425	5	0.0039667	4	0.003967
11	3	0.004275	15	0.00408333	3	0.004
12	11	0.004875	9	0.00416667	3	0.004
13			5	0.00426333	3	0.0042
14			5	0.0047	4	0.004267
15					4	0.004567
16					3	0.0046
17					14	0.005067
Average		0.003411		0.003021		0.003576
Std Dev		0.000091		0.000085		0.000077
H		0.00069		0.00065		0.00070
U ₁		0.00069		0.00066		0.00071
t-statistic		2.20		2.16		2.12
U ₂		0.0015		0.0014		0.0015
U ₃		0.00044		0.00038		0.00036
Reference		0.003		0.003		0.004
Uncertainty		0.001		0.001		0.001
Tolerance		0.002		0.002		0.003

BS 347C

* Code for method

Informational values listed as weight percent

Analysis	*	Mg	*	Pb	*	Sb	*	Ta
1	12	0.000087	5	0.0002	5	0.000577	12	0.0004
2	4	0.0036667	3	0.0002	5	0.0007	5	0.0004
3			5	0.00020333	5	0.0007	5	0.00044
4			12	0.00028667	12	0.000767	5	0.000467
5			9	0.0003	5	0.000793	4	0.004833
6			5	0.0003	3	0.0012	3	0.0049
7			5	0.00034333	9	0.001233	4	0.005
8			3	0.000575	4	0.004	3	0.00575
9			11	0.001025	4	0.0041	5	0.0086
10			4	0.0049	3	0.00475		
Average		0.002		0.0008		0.0019		0.003
Std Dev		0.015		0.0017		0.0069		0.018
H		0.001		0.0004		0.0005		0.001
U ₁		0.015		0.0017		0.0069		0.018
t-statistic		12.71		2.26		2.26		2.31
U ₂		0.19		0.0039		0.016		0.042
U ₃		0.14		0.0012		0.0049		0.014
Informational		(0.002)		(0.0008)		(0.002)		(0.003)

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.

BS 347C

* Code for analytical method

Trace analysis listed as mg/kg (ppm)

Analysis	*	Ce	*	Ga	*	Ge	*	Ir	*	La	*	Nd	*	Os	*	Pt	*	Re	*	Se
1	12	0.03	12	26	12	9	12	0.06	12	0.02	12	0.01	12	0.06	12	0.2	12	0.49	12	0.53
2	12	0.03	12	27	12	9.3	12	0.06	12	0.02	12	0.01	12	0.06	12	0.2	12	0.5	12	0.53
3	12	0.04	12	28	12	9.3	12	0.06	12	0.02	12	0.02	12	0.06	12	0.21	12	0.51	12	0.6
Analysis	*	Sr	*	Y	*	Zn														
1	12	0.07	12	0.02	12	0.8														
2	12	0.07	12	0.02	12	0.81														
3	12	0.07	12	0.02	12	0.81														

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
Element Materials Technology	Glendale Heights, IL	A2LA	17025
NSL Analytical	Cleveland, OH	ANAB	17025
Eurofins EAG Materials Science, LLC	Liverpool, NY	A2LA	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI	17025
Vitkovice Testing Center	Ostrava, Czech Republic	ILAC	17025
Shiva Analyticals	Hoskote, Bangalore	NABL	17025
Luvak Inc.	Boylston, MA	PRI	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	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: 12X12749W, 12X15259Q, 12X3490, 12X353E, 13X12853K, 13X14212, 13X14418A, 13X31603D, 13X32100, 13X32900A, 13X4100A, 13X42200; AR 165, 511, 614A, 654, 657, 662, 675, 882, 891, 892, 961; BAS 31, 333, 341, 386, 404/1, 406/2, 408/1, 409, 460, 464/1, 467; BS H-13, H1C, HiCaL-1, SS3951, 61G, 80F, 85D, 87C, 87E, 87F, 180A, 180B, 187D, 200-1, 200-2, 200-4, 200A, 304A, 304B, 316D, 316E, 347A, 347B, 800A, 2205, 2931A, 8620E, 9030E, 9325A, 9905A; CKD 184A, 186A, 189A; DSZU CA013; ECRM 085-1, 184-1, 284-1, 292-1, 292-1D; IARM 8B, 8I, 299A; IMZ 55/1A, 114A, 117, 123, 152A, 174; IPT 12A, 17/1, 17A; JK 37; JSS 169-5, 174-5, 175-7, 651-13, 655-13, 655-8; LECO 501-320, 501-502, 501-503, 501-677, 502-328, 502-717, 502-855, 502-868, 502-928; NCS NS11037, NS11042; SRM C1152, C1153, C1154, 16F, 101G, 123C, 160B, 361, 362, 363, 1154, 1172, 1762, 1765.

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 333, 386, 467; BS 87C, 87E, 347A, 347B; ECRM 284-1, 292-1D; DSZU CA013; JSS 655-8; NCS NS11043, NS11037.

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 347C 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 44mm 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 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 347C-111320. 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 35:2006 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 November 13, 2020.

Beau R. Brammer

President