

# Brammer Standard Company, Inc.

## Certificate of Analysis

### BS 73C

Certified Reference Material for Steel Grade 86L20 - UNS Number G86200

	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	<b>Certified Values<sup>3</sup></b>	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	
<b>Al</b>	<b>0.028</b>	0.002		<b>N</b>	<b>0.0040</b>	0.0004
<b>As</b>	<b>0.0035</b>	0.0005		<b>Ni</b>	<b>0.56</b>	0.03
<b>C</b>	<b>0.206</b>	0.004		<b>O</b>	<b>0.0013</b>	0.0005
<b>Co</b>	<b>0.0028</b>	0.0005		<b>P</b>	<b>0.0111</b>	0.0009
<b>Cr</b>	<b>0.574</b>	0.008		<b>Pb</b>	<b>0.21</b>	0.01
<b>Cu</b>	<b>0.025</b>	0.002		<b>S</b>	<b>0.031</b>	0.003
<b>Fe</b>	<b>[97.0]</b>	0.3		<b>Si</b>	<b>0.280</b>	0.008
<b>Mn</b>	<b>0.86</b>	0.02		<b>Ti</b>	<b>0.0024</b>	0.0006
<b>Mo</b>	<b>0.180</b>	0.005		<b>V</b>	<b>0.0031</b>	0.0005

### Informational Values<sup>3,4</sup>

B (0.0002)	Ca (0.0005)	Mg (0.0001)	Nb (0.002)	Sb (0.002)
Sn (0.002)	W (0.006)	Zr (0.0011)		

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.

<sup>2</sup> 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.

<sup>3</sup> Values are given in weight percent. Values in brackets are reported by difference.

<sup>4</sup> Values in parentheses are not certified and are provided for information only.

Trace element information values for Ag, Bi, Cl, F, Ga, Ge, Re, Ta, 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.

Analysis	*	Al	*	As	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo	*	N
1	3	0.0216	4	0.00293333	1	0.2	12	0.0016	4	0.56	5	0.0217	10	96.933333	8	0.8086667	4	0.17	2	0.0031
2	10	0.0236	15	0.00305	1	0.2	3	0.001925	10	0.5618	3	0.02268	16	[96.95]	4	0.8313333	10	0.1742	2	0.004
3	5	0.02747	5	0.0031	3	0.2	5	0.0023	4	0.56633	4	0.02327	16	[96.955]	4	0.8393333	4	0.17533	2	0.00416
4	4	0.02797	5	0.0031	1	0.2023333	5	0.0023333	10	0.567	4	0.02353	16	[96.9815]	4	0.8399	4	0.17713	2	0.00423
5	4	0.02803	12	0.0033	1	0.203	5	0.00235	4	0.56763	8	0.02363	16	[96.99]	4	0.8536667	4	0.17833	2	0.00425
6	4	0.02893	3	0.003525	1	0.2033	8	0.0025733	10	0.56947	4	0.0246	16	[97.02]	4	0.8546667	4	0.17833	2	0.00427
7	4	0.02937	3	0.003725	1	0.2051033	4	0.0028667	4	0.571	4	0.02483	4	97.046667	4	0.8593333	4	0.17867	2	0.0043
8	10	0.0295	4	0.00376667	4	0.2052	3	0.002875	4	0.573	10	0.02503	16	[97.0625]	10	0.86	4	0.17897	2	0.0043
9	4	0.0295	3	0.004025	10	0.2053	5	0.0029333	3	0.5733	4	0.02513	13	97.246	4	0.86	3	0.1791	2	0.00433
10	4	0.02963			3	0.2055	4	0.0030333	10	0.57567	10	0.02557			4	0.8602333	10	0.17991	2	0.00434
11	4	0.0298			1	0.206	10	0.0031	3	0.57575	4	0.02577			10	0.8629	10	0.18	2	0.0054
12	3	0.02985			3	0.20825	3	0.00365	17	0.5796	10	0.026			3	0.86375	7	0.18067		
13	3	0.03028			3	0.2088	4	0.0039	3	0.57975	3	0.02788			3	0.8704	10	0.18167		
14	3	0.0316			1	0.2113333	3	0.0043	3	0.581	3	0.02808			10	0.871	4	0.1827		
15					1	0.2136667			4	0.5837	4	0.0287			10	0.8716667	3	0.1845		
16					1	0.2197333			4	0.58817					4	0.877	3	0.18475		
17					1	0.2206667									3	0.89	3	0.1875		
18																	5	0.188		
Average		0.02845		0.00353		0.2058		0.002839		0.5741		0.02505		97.003		0.8595		0.1799		0.00397
Std Dev		0.00085		0.00016		0.0030		0.000085		0.0039		0.00093		0.037		0.0046		0.0026		0.00017
H		0.0014		0.00058		0.0039		0.00053		0.0073		0.0013		0.33		0.009		0.0036		0.00060
U <sub>1</sub>		0.0016		0.00060		0.0049		0.00054		0.0082		0.0016		0.33		0.010		0.0045		0.00063
t-statistic		2.16		2.31		2.12		2.16		2.13		2.14		2.31		2.12		2.11		2.23
U <sub>2</sub>		0.0035		0.0014		0.010		0.0012		0.018		0.0035		0.77		0.022		0.0094		0.0014
U <sub>3</sub>		0.0010		0.00046		0.0025		0.00031		0.0044		0.00089		0.26		0.0054		0.0022		0.00042
Certified		<b>0.028</b>		<b>0.0035</b>		<b>0.206</b>		<b>0.0028</b>		<b>0.574</b>		<b>0.025</b>		<b>[97.0]</b>		<b>0.86</b>		<b>0.180</b>		<b>0.0040</b>
Uncertainty		0.002		0.0005		0.004		0.0005		0.008		0.002		0.3		0.02		0.005		0.0004
Tolerance		0.006		0.0014		0.012		0.0015		0.024		0.006		0.8		0.06		0.015		0.0014

Analysis	*	Ni	*	O	*	P	*	Pb	*	S	*	Si	*	Ti	*	V				
1	4	0.52567	2	0.00069067	4	0.0089333	10	0.1955	2	0.028	4	0.2413	10	0.0016	5	0.0024233				
2	8	0.53933	2	0.00086667	3	0.009025	4	0.1963333	1	0.02837	4	0.275	5	0.0018333	5	0.0024667				
3	4	0.54	2	0.00093333	7	0.0102	4	0.2	1	0.02893	4	0.27687	4	0.0018667	5	0.0025667				
4	10	0.55	2	0.001	4	0.0102	3	0.202	10	0.029	3	0.277	5	0.0018667	4	0.0027333				
5	4	0.55233	2	0.00107667	12	0.0102	10	0.2023	10	0.02917	3	0.277	5	0.0021	4	0.0027333				
6	4	0.556	2	0.0012	5	0.0104333	3	0.203	1	0.02967	10	0.278	4	0.0023	3	0.002775				
7	3	0.5573	2	0.00142067	3	0.0106	4	0.2038	1	0.02993	4	0.2781	4	0.0023333	3	0.002775				
8	4	0.5629	2	0.00176667	7	0.0106667	4	0.2085	1	0.03043	10	0.27833	10	0.0024667	10	0.0028667				
9	10	0.56367	2	0.0025	4	0.0108667	3	0.20875	1	0.03067	6	0.28	3	0.002475	3	0.003075				
10	10	0.5657	2	0.00283333	10	0.011	4	0.2099	3	0.0308	10	0.28067	3	0.0026	4	0.0031667				
11	4	0.567			4	0.0110333	4	0.2183333	1	0.03088	4	0.28067	4	0.0028	10	0.0032				
12	10	0.5733			10	0.0111667	4	0.2186667	1	0.0314	3	0.2815	4	0.003	4	0.0034				
13	4	0.57767			3	0.01165	4	0.2207	3	0.03156	4	0.28533	3	0.003125	4	0.0036				
14	3	0.5785			4	0.0119	10	0.222	3	0.03175	3	0.2882			10	0.0042				
15	4	0.58793			10	0.0129667	3	0.22475	4	0.0321	5	0.28833			3	0.0046				
16	4	0.5897			4	0.0147	10	0.2266667	12	0.03233	10	0.2999								
17	3	0.594					10	0.227	3	0.03235	12	0.34								
18	3	0.5945					5	0.237	1	0.038	4	0.35								
Average		0.5709		0.00126		0.01109		0.2116		0.03078		0.2798		0.002422		0.003105				
Std Dev		0.0036		0.00018		0.00039		0.0031		0.00097		0.0036		0.000064		0.000082				
H		0.0072		0.00040		0.00091		0.0040		0.0015		0.0047		0.0005034		0.00055				
U <sub>1</sub>		0.0081		0.00044		0.0010		0.0051		0.0017		0.0059		0.00051		0.00056				
t-statistic		2.11		2.26		2.13		2.11		2.11		2.11		2.18		2.14				
U <sub>2</sub>		0.017		0.0010		0.0021		0.011		0.0037		0.013		0.0011		0.0012				
U <sub>3</sub>		0.0040		0.00031		0.00053		0.0025		0.00087		0.0030		0.00031		0.00031				
Certified		<b>0.56</b>		<b>0.0013</b>		<b>0.0111</b>		<b>0.21</b>		<b>0.031</b>		<b>0.280</b>		<b>0.0024</b>		<b>0.0031</b>				
Uncertainty		0.03		0.0005		0.0009		0.01		0.003		0.008		0.0006		0.0005				
Tolerance		0.09		0.0012		0.0027		0.03		0.009		0.024		0.0018		0.0015				

Analysis	*	B	*	Ca	*	Mg	*	Nb	*	Sb	*	Sn	*	W	*	Zr
1	3	0.0001	12	0.000006	12	0.000043	12	0.0001267	5	0.00071	3	0.0003	12	0.0019	12	0.000023
2	7	0.00016	3	0.0000775	3	0.000065	5	0.0002967	12	0.00091	12	0.00049	10	0.002	5	0.000027
3	12	0.00019	4	0.0003	3	0.00007	5	0.0003167	5	0.00091	3	0.00055	5	0.00401	5	0.0001
4	4	0.0002	3	0.0003475	5	0.0001	5	0.0004	5	0.0011	5	0.00088	5	0.0045333	4	0.0009
5	4	0.0002	4	0.0016	3	0.0001625	10	0.0008	5	0.00117	5	0.001	5	0.0046333	3	0.0016
6	3	0.00022			4	0.0003233	4	0.002	4	0.00133	5	0.0011	3	0.0055	10	0.0018
7	3	0.00023					4	0.0025	4	0.00197	5	0.00118	4	0.0066667	4	0.0018667
8	3	0.00043					10	0.003	4	0.0028	4	0.00163	4	0.0068333	3	0.0021
9							3	0.0031	3	0.00338	4	0.00173	3	0.00735		
10							3	0.0036	3	0.00358	10	0.00177	4	0.008		
11							4	0.0049			10	0.0018	3	0.0083		
12							3	0.006125			4	0.00383	4	0.0094333		
13											3	0.00515				
14											3	0.00553				
15											4	0.0075				
Average		0.00022		0.00047		0.000127		0.0023		0.0018		0.0023		0.006		0.0011
Std Dev		0.00012		0.00076		0.000040		0.0084		0.0063		0.0077		0.033		0.0028
H		0.00025		0.00030		0.00022		0.0005		0.0005		0.0005		0.001		0.0004
U <sub>1</sub>		0.00027		0.00082		0.00022		0.0085		0.0063		0.0077		0.033		0.0029
t-statistic		2.36		2.78		2.57		2.20		2.26		2.14		2.20		2.36
U <sub>2</sub>		0.00065		0.0023		0.00057		0.019		0.014		0.017		0.072		0.0068
U <sub>3</sub>		0.00023		0.0010		0.00023		0.0054		0.0045		0.0043		0.021		0.0024
Informational		(0.0002)		(0.0005)		(0.0001)		(0.002)		(0.002)		(0.002)		(0.006)		(0.0011)

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<sub>L</sub>), calculated from its standard deviation (S<sub>L</sub>) and its uncertainty estimate (U<sub>L</sub>), is used as the weight (W<sub>L</sub>) for it's mean (M<sub>L</sub>). The standard deviation (S) is calculated as the square root of the reciprocal of the sum of the weights. U<sub>1</sub> is the combined uncertainty from homogeneity and labs. U<sub>2</sub> is U<sub>1</sub> multiplied by the coverage factor (95 % t-statistic). U<sub>3</sub> is U<sub>2</sub> 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<sub>3</sub> 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	*	Ag	*	Bi	*	Cl	*	F	*	Ga	*	Ge	*	Re	*	Ta	*	Zn
1	12	0.12	12	0.13	12	0.03	12	0.06	12	4.9	12	20	12	0.03	3	34	12	13
2	12	0.16	12	0.13	12	0.03			12	4.9	12	20	12	0.04			12	13
3	12	0.19	12	0.14	12	0.06			12	5	12	20	12	0.08			12	13

**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 AAS
6 Gravimetric	12 GD Mass Spectrometry	

ICP = Inductively Coupled Plasma      GF = Graphite Furnace      GD = Glow Discharge  
 DCP = Direct Current Plasma      HG = Hydride Generation      AAS = Atomic Absorption Spectrometry

Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, Guide 34
LECO Corporation	St. Joseph, MI	A2LA	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025
NSL Analytical	Cleveland, OH	ANAB	17025
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
TUV Rheinland Pvt. Ltd.	Bangalore, India	NABL	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	AB 554
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Exova	Santa Fe Springs, CA	A2LA	17025
Evans Analytical Group	Liverpool, NY	A2LA	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: 12X349D, 12XLA2; AR 612B, 645, 654, 657, 875, 882, 1648, 1650, 1652, 1653, 8620; BAS 206/3, 342, 406, 408, 434, 451, 451/1, 456/2, 458/2, 459, 460, 464/1; BS CSN 2-1, CSN 4, D-6, 54E, 56H, 61B, 61G, 68E, 71A, 72A, 72B, 73A, 73B, 75V, 75D, 75F, 75G, 300, 1026, 2931A, 8620B, 8620C, 8620E; CKD 167A, 168A; CMSI 5010; ECRM 037-1, 85-1, 86-1, 87-1; IARM 14D, 19F, 28E, 28H, 28I, 32B, 32D, 73A, 182B, 182C, 210C; IMZ 74A, 112, 114, 124, 132; LECO 501-320, 501-501, 501-503, 501-504, 501-505, 501-644, 501-646, 501-675, 501-676, 501-677, 501-991, 501-993, 502-197, 502-348, 502-855, 502-856, 502-870, 502-873, 502-874, 502-894, 502-895, 502-916, 502-918, 504-646; NCS NS 11019; SRM 30F, 72F, 291, 293, 361, 362, 363, 364, 365, 1162, 1261A, 1262A, 1264A, 1269, 1762; Y 41340b.

**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 8620; BAS 451/1, 456/2, 458/2; BS CSN 2-1, CSN 4, 54E, 61B, 61G, 71A, 72A, 72B, 73A, 73B, 75C, 75D, 75F, 75G, 8620B, 8620C; CMSI 5010; ECRM 037-1, 086-1; LECO 501-676, 502-873, 502-874; NCS NS 11019; SRM 30F, 291, 293, 1162, 1262A, 1269.

**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 73C 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.

**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 73C-080218. You may obtain information on revisions of certificates from the internet at [www.brammerstandard.com](http://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](http://www.brammerstandard.com)

**Fax: (281) 440-4432** Email: [contact@brammerstandard.com](mailto: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](http://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 9001:2015 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](http://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 August 2, 2018.

Beau R. Brammer  
President