

# Brammer Standard Company, Inc.

## Certificate of Analysis

### BS 73D

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

	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	Certified Values <sup>3</sup>	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>Al</b>	<b>0.015</b>	0.002	<b>Ni</b>	<b>0.420</b>	0.009
<b>As</b>	<b>0.0052</b>	0.0008	<b>O</b>	<b>0.0022</b>	0.0006
<b>C</b>	<b>0.202</b>	0.009	<b>P</b>	<b>0.018</b>	0.002
<b>Ca</b>	<b>0.0004</b>	0.0002	<b>Pb</b>	<b>0.18</b>	0.02
<b>Co</b>	<b>0.0123</b>	0.0009	<b>S</b>	<b>0.027</b>	0.003
<b>Cr</b>	<b>0.47</b>	0.02	<b>Si</b>	<b>0.287</b>	0.009
<b>Cu</b>	<b>0.240</b>	0.009	<b>Sn</b>	<b>0.021</b>	0.002
<b>Fe</b>	<b>97.1</b>	0.3	<b>Ti</b>	<b>0.0012</b>	0.0003
<b>Mn</b>	<b>0.834</b>	0.009	<b>V</b>	<b>0.0028</b>	0.0007
<b>Mo</b>	<b>0.162</b>	0.008	<b>W</b>	<b>0.0107</b>	0.0009
<b>N</b>	<b>0.0101</b>	0.0007			

  

	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	Reference Values <sup>3,4</sup>	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>B</b>	<b>0.0004</b>	0.0003	<b>Nb</b>	<b>0.0014</b>	0.0009
<b>H</b>	<b>&lt;0.005</b>		<b>Sb</b>	<b>0.0021</b>	0.0008
<b>Mg</b>	<b>&lt;0.005</b>		<b>Zr</b>	<b>&lt;0.05</b>	

<sup>1</sup> 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.

<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 4 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> Reference values are not certified and are provided for information only.

Trace element information values for Cl, Ga, Ge, Ir, Na, Os, Re, 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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\* Code for method

Certified values listed as weight percent

Analysis	*	Al	*	As	*	C	*	Ca	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo		
1	3	0.0124	9	0.00426667	1	0.19	12	0.000052	3	0.011	4	0.4508	3	0.2293333	16	[97.01633]	4	0.8216667	4	0.1540667		
2	11	0.0127	4	0.00456667	1	0.1941333	4	0.0004	4	0.0112	3	0.4576667	10	0.23	16	[97.03]	4	0.8236667	4	0.1546667		
3	12	0.0133333	5	0.0046	1	0.195	3	0.0004	3	0.0115	10	0.46	4	0.2323333	16	[97.0469667]	4	0.825	4	0.1576667		
4	5	0.0134333	4	0.00495	1	0.1951	4	0.0004	4	0.01171	4	0.4603333	10	0.2346667	4	97.0633333	4	0.8275	14	0.1586667		
5	3	0.0139	4	0.00496667	1	0.1976	11	0.0004	3	0.012	4	0.4656667	4	0.2352333	4	97.0666667	4	0.8296	4	0.1599667		
6	4	0.0139333	4	0.0050	1	0.198	4	0.0006	10	0.012	4	0.4681333	11	0.236	16	[97.0880667]	10	0.83	4	0.16		
7	3	0.014	4	0.0052	1	0.198			5	0.0121	3	0.469	4	0.236	16	[97.1]	10	0.83	10	0.1600		
8	3	0.014	3	0.0052	1	0.1994			5	0.0121667	3	0.469	4	0.2363333	10	97.1033333	4	0.8300	4	0.1601667		
9	4	0.0142	5	0.00532333	1	0.20			4	0.0123	11	0.469	14	0.2363333	16	[97.11]	14	0.8303333	4	0.1616		
10	4	0.0144667	15	0.00543333	1	0.200			11	0.0124	14	0.4693333	4	0.238	14	97.1166667	4	0.8313333	3	0.162		
11	4	0.0149067	5	0.00563333	3	0.2			4	0.0124333	4	0.4693667	4	0.2387	3	97.12	3	0.833	10	0.1623333		
12	4	0.015	3	0.006	1	0.2004333			4	0.0125	4	0.4696667	4	0.2396667	16	[97.1275334]	4	0.8353333	4	0.1626667		
13	4	0.0150	3	0.006	1	0.2013333			14	0.0125333	4	0.47	4	0.24	16	[97.2]	4	0.8362333	3	0.163		
14	5	0.0151	5	0.00603333	11	0.204			3	0.0126	4	0.47	3	0.24	13	97.3716667	4	0.8362333	11	0.163		
15	4	0.0153333	12	0.00736667	1	0.2056667			4	0.0126	13	0.470	10	0.240	4	97.3933333	4	0.837	4	0.1656667		
16	10	0.0156			3	0.2093			12	0.0126667	10	0.4700	4	0.2403333				11	0.843	3	0.166	
17	14	0.0156333			1	0.2133333			4	0.0129667	4	0.4704	3	0.242				3	0.843	4	0.166	
18	4	0.0156333							4	0.013	3	0.478	4	0.2423333				10	0.8433333	7	0.1666667	
19	4	0.0163333										4	0.4883333	4	0.2436667				3	0.848	3	0.167
20												10	0.4956667	8	0.2466667				4	0.853	10	0.17
21												5	0.504667	5	0.246667						10	0.17
22												4	0.507333								4	0.170333
Average		0.01446		0.00515		0.2018		0.0004001		0.01232		0.4730		0.2398		97.127		0.834362		0.1624		
Std Dev		0.00046		0.00018		0.0031		0.0000051		0.00043		0.0036		0.0030		0.029		0.000071		0.0025		
H		0.0013		0.00081		0.0045		0.00031		0.0012		0.0071		0.0050		0.19		0.0098		0.0041		
U <sub>1</sub>		0.0014		0.00083		0.0055		0.00031		0.0013		0.0080		0.0058		0.19		0.0098		0.0048		
t-statistic		2.10		2.14		2.12		2.57		2.11		2.08		2.09		2.14		2.09		2.08		
U <sub>2</sub>		0.0028		0.0018		0.012		0.00079		0.0027		0.017		0.012		0.41		0.020		0.010		
U <sub>3</sub>		0.00065		0.00046		0.0028		0.00032		0.00063		0.0035		0.0026		0.11		0.0046		0.0021		
Certified		<b>0.015</b>		<b>0.0052</b>		<b>0.202</b>		<b>0.0004</b>		<b>0.0123</b>		<b>0.47</b>		<b>0.240</b>		<b>97.1</b>		<b>0.834</b>		<b>0.162</b>		
Uncertainty		0.002		0.0008		0.009		0.0002		0.0009		0.02		0.009		0.3		0.009		0.008		
Tolerance		0.006		0.0024		0.027		0.0003		0.0027		0.06		0.027		0.9		0.027		0.024		

Analysis	*	N	*	Ni	*	O	*	P	*	Pb	*	S	*	Si	*	Sn	*	Ti	*	V
1	2	0.00928	10	0.404	2	0.0014567	4	0.013	10	0.1583333	12	0.0123333	4	0.2741667	3	0.018233333	4	0.0008667	4	0.0019
2	2	0.0096667	10	0.41	2	0.0016333	5	0.01693333	3	0.159	1	0.0226667	5	0.2746667	4	0.0188	4	0.0009	12	0.0020
3	2	0.0097	10	0.41	2	0.0016667	4	0.01703333	4	0.1686667	4	0.0257333	6	0.28	10	0.02	3	0.0010	4	0.0022333
4	2	0.010	3	0.41233333	2	0.00171	3	0.0176	4	0.1706667	1	0.0259	10	0.2813333	10	0.020333333	4	0.001	4	0.0026333
5	2	0.0100	4	0.413	2	0.0018	14	0.01766667	4	0.1723333	3	0.026	3	0.282	4	0.020666667	4	0.0010	5	0.00264
6	2	0.010	11	0.417	2	0.0019	4	0.01783333	4	0.173	10	0.026	3	0.282	3	0.0208	5	0.0011267	14	0.0026667
7	2	0.0101	14	0.4186667	2	0.002	4	0.0179	4	0.1734667	11	0.0263	4	0.2827667	9	0.0209	12	0.0011333	5	0.0027
8	2	0.010275	4	0.419	2	0.0020667	4	0.01793333	11	0.175	1	0.0265333	3	0.284	4	0.0210	5	0.0011933	4	0.0027
9	2	0.0102933	4	0.41933333	2	0.0021	4	0.01793333	4	0.1766667	1	0.0265667	4	0.2856667	4	0.021366667	11	0.0012	10	0.003
10	2	0.0103	4	0.4200	2	0.0022	3	0.018	4	0.1775333	1	0.027	4	0.2863333	4	0.0215	5	0.0012	4	0.0030
11	2	0.0103333	7	0.42	2	0.0036467	13	0.018	5	0.1783333	7	0.0270333	14	0.2873333	5	0.021766667	4	0.0012733	4	0.0030667
12	2	0.010425	4	0.4205	2	0.004	10	0.018	3	0.179	1	0.0273967	4	0.289	4	0.0218	14	0.0013667	4	0.0031
13	2	0.0104667	4	0.4226			11	0.0181	4	0.1842333	1	0.0274	4	0.2897667	5	0.0218	4	0.0014667	3	0.0031
14	2	0.0106333	4	0.4233333	7	0.0182	4	0.0182	4	0.1843333	1	0.0275333	10	0.29	5	0.021833333	4	0.0015	11	0.0033
15			4	0.42376667	4	0.0184	9	0.186	1	0.028	3	0.29	3	0.29	3	0.022			4	0.0034
16			3	0.424	10	0.01983333	10	0.19	4	0.028	4	0.2900	3	0.29	3	0.022				
17			4	0.42416667	3	0.02006667	4	0.1900	1	0.02946	11	0.291	4	0.2922						
18			3	0.427	4	0.02073333	4	0.1901	1	0.0296333	7	0.2916667	4	0.293						
19			3	0.427	3	0.021	3	0.204	1	0.0296667	4	0.2923333	5	0.2936667						
20			4	0.42733333					3	0.033	4	0.297								
21			5	0.435667							4	0.301667								
Average		0.01015		0.419938		0.002182		0.018114		0.178456		0.026608		0.286795		0.021261		0.001159		0.002763
Std Dev		0.00036		0.000069		0.000091		0.000073		0.000073		0.000071		0.000069		0.000073		0.000085		0.000082
H		0.0011		0.0067		0.00057		0.0014		0.0043		0.0017		0.0055		0.0015		0.0004503		0.00063
U <sub>1</sub>		0.0011		0.0067		0.00058		0.0014		0.0043		0.0017		0.0055		0.0015		0.00046		0.00064
t-statistic		2.16		2.09		2.20		2.10		2.10		2.09		2.09		2.10		2.16		2.14
U <sub>2</sub>		0.0025		0.014		0.0013		0.0030		0.0090		0.0035		0.011		0.0032		0.00099		0.0014
U <sub>3</sub>		0.00066		0.0031		0.00037		0.00068		0.0021		0.00079		0.0025		0.00073		0.00026		0.00035
Certified		<b>0.0101</b>		<b>0.420</b>		<b>0.0022</b>		<b>0.018</b>		<b>0.18</b>		<b>0.027</b>		<b>0.287</b>		<b>0.021</b>		<b>0.0012</b>		<b>0.0028</b>
Uncertainty		0.0007		0.009		0.0006		0.002		0.02		0.003		0.009		0.002		0.0003		0.0007
Tolerance		0.0025		0.027		0.0018		0.006		0.06		0.009		0.027		0.006		0.0010		0.0021



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 its 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.

**BS 73D** \* Code for analytical method Trace analysis listed as mg/kg (ppm)

Analysis	*	Cl	*	Ga	*	Ge	*	Ir	*	Na	*	Os	*	Re	*	Zn				
1	12	0.01	12	8.2	12	11	12	0.01	12	0.01	12	0.01	12	0.28	12	1.4				
2			12	8.4	12	11	12	0.01	12	0.01	12	0.01	12	0.29	12	1.4				
3			12	8.8	12	12	12	0.01	12	0.02	12	0.01	12	0.29	12	1.5				
4																8	1.5			
5																8	1.9			
6																8	1.9			

### 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

Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, 17034
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
NSL Analytical	Cleveland, OH	ANAB	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
Vitkovice Testing Center	Hulvaky, Ostrava	Czech Accreditation Institute	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Shiva Analyticals Private Limited	Hoskote, Bangalore	NABL	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
Eurofins EAG Materials Science, LLC	Liverpool, NY	A2LA	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Luvak Inc.	Boylston, MA	PRI	17025
Laboratory Testing, Inc.	Hatfield, PA	A2LA	17025
Raghavendra Spectro Metallurgical Laboratory	Karnataka, India	NABL	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	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: AR 546, 612A, 614A, 641, 644, 655, 657, 662, 668, 673, 870, 872, 884, 895, 960, 1650, 1652; BAS 409, 410/2, 458, 464/1, 493; BS HON T, 61S, 70A, 70B, 73A, 73B, 73C, 75G, 166B, 1030A, 1951, 2022, 2991, 4002, 4340A, 8620A, 8620C, 8620E, 8822A; DSZU CA01a; ECRM 85-1, 86-1, 87-1; IARM 30C, 32D, 182B; IMZ 111, 112, 132; IPT 12A, 17A; JSS GS-1D, GS-6b; LECO 501-503, 501-677, 502-916, 502-990, 762-747; NCS NS11078, NS11079; SRM 32E, 111B, 132A, 160B, 293, 361, 362, 363, 364.

**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: BS 61D, 70A, 70B, 73A, 73B, 1951, 2022, 2991, 4002, 8620A.

**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 73D 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 Sidenor Aceros Especiales; Basauri, Spain.

**Form:** This CRM is machined in the form of a disc, approximately 38mm 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 73D-011724. 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)**

The scopes of accreditation and ISO certificates 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 17025:2017 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 35:2017 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 January 17, 2024.

Beau R. Brammer

President