

BRAMMER STANDARD COMPANY, INC.

Certificate of Analysis

BS 75G

Certified Reference Material for Lead Steel Grade 11L17 - UNS Number G11170

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²
Al	0.0016	0.0003		Ni	0.001
As	0.0028	0.0003		O	0.0008
C	0.161	0.003		P	0.0006
Co	0.0031	0.0004		Pb	0.006
Cr	0.079	0.002		S	0.002
Cu	0.0300	0.0009		Si	0.001
Mn	1.08	0.01		Sn	0.0003
Mo	0.0174	0.0007		V	0.0002
N	0.0030	0.0003		W	0.0002

	Reference Value ¹	Estimate of Uncertainty ²	Reference Values^{3,4}	Reference Value ¹	Estimate of Uncertainty ²
Nb	0.0003	0.0002			

Informational Values^{3,5}

B (0.0002)

Ca (0.0002)

Fe [98.2]

Ti (0.0004)

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 Bi, Ga, Ge, Mg, Na, Sb, 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.

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* Code for method Certified values listed as weight percent

Analysis	*	Al	*	As	*	C	*	Co	*	Cr	*	Cu	*	Mn	*	Mo
1	5	0.001333	5	0.0023	1	0.154333	15	0.0024	12	0.0750	4	0.0279	4	1.057767	14	0.015467
2	4	0.0017	5	0.002363	1	0.1568	4	0.0026	14	0.077533	12	0.0280	4	1.062333	4	0.015833
3	14	0.0018	4	0.0026	1	0.157433	4	0.00275	3	0.07865	5	0.028467	14	1.069333	4	0.015867
4	3	0.00215	5	0.0027	1	0.158333	5	0.00286	4	0.0788	4	0.028533	4	1.0725	12	0.0160
5	12	0.0022	15	0.0028	1	0.158667	4	0.003067	4	0.0791	10	0.029267	4	1.076667	4	0.016033
6	4	0.002233	12	0.0029	1	0.159	12	0.0034	10	0.0794	4	0.029267	3	1.0775	4	0.0167
7	4	0.0024	5	0.0030	1	0.160667	5	0.0034	4	0.080	14	0.030033	4	1.08	4	0.017033
8			9	0.003323	1	0.162167	5	0.0035	4	0.080267	4	0.030067	4	1.090033	5	0.017367
9			4	0.0034	1	0.163667	4	0.003567	4	0.081867	4	0.0301	4	1.104	4	0.017667
10					1	0.164333			5	0.084667	4	0.0301			3	0.01775
11					3	0.1655			5	0.085133	3	0.03035			5	0.0180
12											5	0.0323				
Average		0.00155		0.00280		0.1611		0.00311		0.0794		0.02999		1.078		0.01743
Std dev		0.00018		0.00021		0.0030		0.00020		0.0019		0.00081		0.011		0.00063
H		0.00033		0.00040		0.0028		0.00042		0.0019		0.0011		0.010		0.0009
U ₁		0.00037		0.00045		0.0041		0.00046		0.0026		0.0014		0.015		0.0011
t-statistic		2.45		2.31		2.23		2.31		2.23		2.20		2.31		2.23
U ₂		0.00091		0.0010		0.0092		0.0011		0.0059		0.0030		0.035		0.0024
U ₃		0.00035		0.00035		0.0028		0.00036		0.0018		0.00087		0.012		0.00071
Certified		0.0016		0.0028		0.161		0.0031		0.079		0.0300		1.08		0.0174
Uncertainty		0.0003		0.0003		0.003		0.0004		0.002		0.0009		0.01		0.0007
Tolerance		0.0009		0.0010		0.009		0.0011		0.006		0.0030		0.03		0.0024

Analysis	*	N	*	Ni	*	O	*	P [#]	*	Pb	*	S	*	Si
1	2	0.0023	10	0.043433	2	0.014667	4	0.007167	4	0.235	1	0.107667	4	0.0094
2	2	0.00255	14	0.0436	2	0.016	5	0.007567	4	0.23875	1	0.108	4	0.009633
3	2	0.002668	12	0.0440	2	0.016067	12	0.0081	4	0.246233	1	0.110333	12	0.0102
4	2	0.00276	4	0.0446	2	0.0161	4	0.0085	14	0.253	1	0.111	14	0.0129
5	2	0.0028	3	0.0450	2	0.017367	4	0.0085	4	0.257333	1	0.1126	4	0.013633
6	2	0.002933	4	0.045133	2	0.0176	4	0.0086	4	0.257867	1	0.113	3	0.013825
7	2	0.002967	5	0.0472	2	0.018025	4	0.008667	4	0.262	1	0.115	10	0.013933
8	2	0.002967	4	0.0476	2	0.018325	4	0.0088	17	0.2645	1	0.116	5	0.0151
9	2	0.003	5	0.048133			4	0.00885			1	0.116267		
10	2	0.0030	4	0.048733			3	0.00925			3	0.1175		
11	2	0.003225	4	0.0507			4	0.0093						
12	2	0.00351												
Average		0.00296		0.0451		0.01547		0.00848		0.2472		0.1139		0.0114
Std dev		0.00016		0.0012		0.00049		0.00065		0.0058		0.0025		0.0010
H		0.00041		0.0014		0.00081		0.00062		0.0037		0.0023		0.0007
U ₁		0.00044		0.0018		0.00094		0.00090		0.0069		0.0034		0.0013
t-statistic		2.20		2.23		2.36		2.23		2.36		2.26		2.36
U ₂		0.0010		0.0040		0.0022		0.0020		0.016		0.0076		0.0030
U ₃		0.00028		0.0012		0.00079		0.00060		0.0057		0.0024		0.0011
Certified		0.0030		0.045		0.0155		0.0085		0.247		0.114		0.011
Uncertainty		0.0003		0.001		0.0008		0.0006		0.006		0.002		0.001
Tolerance		0.0010		0.004		0.0022		0.0020		0.016		0.008		0.003

Unweighted mean and standard deviation were used to calculate Phosphorus. The weighted mean is 0.00787 and standard deviation is 0.00038. The weighted certified value is 0.0079 with an uncertainty of 0.0005 and tolerance of 0.0016.

BS 75G * Code for method Certified values listed as weight percent

Analysis	*	Sn	*	V	*	W
1	12	0.0010	4	0.00034	5	0.000267
2	5	0.0012	5	0.000483	5	0.000313
3	5	0.00125	12	0.00050	5	0.00035
4	4	0.001333	5	0.0005	4	0.000367
5	5	0.0014	4	0.000567	12	0.00040
6	5	0.001433	5	0.000677	5	0.0004
7	5	0.0018	4	0.0008	4	0.003533
8	9	0.0026	14	0.001033	3	0.003625
9					4	0.004433
10					14	0.005567
Average		0.00140		0.000546		0.000426
Std dev		0.00013		0.000065		0.000073
H		0.00032		0.00024		0.00023
U ₁		0.00035		0.00025		0.00024
t-statistic		2.36		2.36		2.26
U ₂		0.00082		0.00060		0.00055
U ₃		0.00029		0.00021		0.00017
Certified		0.0014		0.0005		0.0004
Uncertainty		0.0003		0.0002		0.0002
Tolerance		0.0008		0.0005		0.0004

BS 75G * Code for method Reference values listed as weight percent

Analysis	*	Nb
1	12	0.00010
2	5	0.000183
3	3	0.0003
4	4	0.0003
5	4	0.00075
6	4	0.001267
Average		0.000340
Std dev		0.000058
H		0.00022
U ₁		0.00023
t-statistic		2.57
U ₂		0.00058
U ₃		0.00024
Reference		0.0003
Uncertainty		0.0002
Tolerance		0.0003

BS 75G * Code for method Informational values listed as weight percent

Analysis	*	B	*	Ca	*	Fe	*	Ti
1	12	0.00001	4	0.00005	16	98.16	5	0.0000833
2	3	0.00008	4	0.000107	4	98.16	12	0.00010
3	4	0.000167	12	0.00020	16	98.17333	4	0.00022
4	4	0.00085	4	0.0003	16	98.19867	5	0.000227
5					16	98.205	4	0.0004
6					10	98.22	4	0.0015
7							3	0.001575
8							14	0.002167
Average		0.000157		0.000155		98.19		0.00038
Std dev		0.000030		0.000016		0.79		0.00009
H		0.00019		0.00019		0.52		0.00023
U ₁		0.00019		0.00019		0.94		0.00024
t-statistic		3.18		3.18		2.57		2.36
U ₂		0.00061		0.00060		2.42		0.00057
U ₃		0.00030		0.00030		0.99		0.00020
(Informational)		(0.0002)		(0.0002)		[98.2]		(0.0004)

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 75G

* Code for analytical method

Trace analysis listed as mg/kg (ppm)

Analysis *	Bi	* Ga	* Ge	* Mg	* Na	* Sb	* Zn	* Zr
1	12 0.061	12 6.0	5 16	12 0.2	12 0.35	5 4.67	12 1.0	4 3
2		5 8.0	5 17	4 0.9		5 5	5 1.7	
3		5 8.0	5 17			12 7.0	5 1.8	
4		5 8.0	12 35				5 1.8	

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

Laboratory

Location

Registrar

Accreditation

Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, Guide 34
Dirats Laboratories	Westfield, MA	ACLASS	17025
LECO Corporation	St. Joseph, MI	A2LA	17025
NSL Analytical	Cleveland, OH	ACLASS	17025
Exova	Glendale Heights, IL	A2LA	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025
Northern Analytical Laboratory, Inc.	Londonderry, NH	PRI/Nadcap	17025
Luvak Inc.	Boylston, MA	PRI/Nadcap	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	AB 554

A2LA = American Association for Laboratory Accreditation

ACLASS = 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 were a 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; 501-147, 501-280, 501-320, 501-501, 501-502, 501-503, 501-644, 501-646, 501-676, 501-991, 501-993, 502-280, 502-416, 502-449; AR 659, 660, 875, 896, 897, 1117, 1648, 1651, 1653, 1656; BAS 039/1, 180/1, 212, 212/1, 464/1; BS 30D, 56H, 61G, 65A, 65B, 74C, 74E, 75B, 75D, 75F, 1030; CMSI 1159; ECRM 085/1, 086/1, 087/1, 088/1, 096/1, 097/1, 184/1, 284/1; IARM 183C, 199A, 242A; IMZ 1.6/4, 112, 124; IPT 41A; JSS 003; KMS HOSC-001; SRM 8J, 55D, 75G, 84J, 101C, 106, 125B, 129C, 130, 160B, 361, 362, 363, 364, 365, 368, 862, 1263A, 1270, 3109A, 3113, 3137.

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; AR 1117; BS 65A, 65B, 74C, 74E, 75B, 75D, 75F; CMSI 1159; ECRM 184-1, 284-1; KMS HOCS-001; SRM 84J, 129C.

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 75G is valid indefinitely. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

Form: This CRM is machined in the form of a disc, approximately 41 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.

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 75G-070814. 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 08, 2014.

Beau R. Brammer