

Brammer Standard Company, Inc.

# Certificate of Analysis

BS 1981

Certified Reference Material<sup>1</sup> for Steel Alloy Number F-11  
(UNS Number K11597)

	Certified Value <sup>2</sup>	Estimate of Uncertainty <sup>3</sup>		Certified Value <sup>2</sup>	Estimate of Ucertainty <sup>3</sup>
Analysis listed as percent by weight					
<b>C</b>	<b>0.142</b>	0.004	<b>N</b>	<b>0.0085</b>	0.0003
<b>Mn</b>	<b>0.490</b>	0.008	<b>Sn</b>	<b>0.007</b>	0.001
<b>P</b>	<b>0.008</b>	0.001	<b>Ti</b>	<b>0.0028</b>	0.0003
<b>S</b>	<b>0.016</b>	0.001	<b>V</b>	<b>0.004</b>	0.0006
<b>Si</b>	<b>0.666</b>	0.010			
<b>Cu</b>	<b>0.152</b>	0.005	<b>Information Values<sup>4</sup></b>		
<b>Ni</b>	<b>0.129</b>	0.006	<b>B</b>	0.0003	
<b>Cr</b>	<b>1.20</b>	0.02	<b>Nb</b>	0.002	
<b>Mo</b>	<b>0.470</b>	0.010	<b>O</b>	0.0020	
<b>Al</b>	<b>0.022</b>	0.002	<b>W</b>	<0.01	
<b>As</b>	<b>0.0048</b>	0.0010			
<b>Ca</b>	<b>0.0005</b>	0.00015 <sup>5</sup>			
<b>Co</b>	<b>0.009</b>	0.001			

<sup>1</sup> Brammer Standard Company, Inc. is accredited to ISO Guide 34 as a Reference Material Producer to produce Certified Reference Materials by A2LA (Certificate Number 656.02)

<sup>2</sup> The certified value listed is the present best estimate of the true value based on the results of an interlaboratory testing program.

<sup>3</sup> The uncertainties listed are based on value judgments of the material inhomogeneity and the 95% confidence interval. The half-width confidence interval C(95%) is shown on page 2.

<sup>4</sup> Information values are not certified and are provided for information only.

<sup>5</sup> Editorial Revision - The uncertainty for Ca was incorrectly listed as 0.0015% on the original certificate of analysis.

See the following pages for more information.

Certificate Number Rev1981-120508p1

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BS 1981

Data listed as mass fraction expressed as percent.

Rev1981-120508p2

Analysis	*	C	* Mn	* P	* S	* Si	* Cu	* Ni	* Cr	* Mo
1	C	0.138	MnP 0.481	AIC 0.0061	C 0.014	GSi 0.651	AES 0.145	AES 0.118	AIC 1.18	AES 0.4538
2	C	0.1394	AA 0.481	MPN 0.0069	C 0.0154	XRF 0.652	MCB 0.146	GNi 0.124	AGA 1.184	AES 0.4546
3	C	0.140	AIC 0.482	AIC 0.0070	C 0.0154	AIC 0.656	AIC 0.147	AES 0.124	AIC 1.188	AA 0.462
4	C	0.1406	AES 0.488	MPH 0.0076	C 0.0157	GSi 0.657	AES 0.150	AIC 0.126	AA 1.190	AGA 0.466
5	C	0.141	AGA 0.488	AES 0.008	C 0.016	AGA 0.658	ECS 0.151	MND 0.126	AES 1.196	AIC 0.468
6	C	0.141	AIC 0.49	AIC 0.008	C 0.0162	AIC 0.66	AGA 0.152	XRF 0.13	TCr 1.20	GMo 0.468
7	C	0.143	AIC 0.49	AIC 0.008	C 0.0165	AIC 0.66	XRF 0.152	AIC 0.131	TCr 1.20	AIC 0.471
8	C	0.1430	MnP 0.492	AIC 0.0083	AGA 0.0166	GSi 0.664	AIC 0.152	AIC 0.131	AIC 1.20	AIC 0.4719
9	CP	0.1434	XRF 0.492	AIC 0.0084	C 0.0167	AIC 0.667	IN 0.153	AIC 0.131	AIC 1.21	XRF 0.477
10	AGA	0.146	AES 0.492	AGA 0.0085	CP 0.0168	GSi 0.677	AIC 0.154	AGA 0.132	AES 1.21	AIC 0.48
11			MnP 0.496	AES 0.0085		AES 0.678	MCT 0.155	AA 0.133	XRF 1.218	AIC 0.48
12			AIC 0.498	XRF 0.0085		AES 0.685	AIC 0.160	AIC 0.133	AIC 1.24	AIC 0.482
13			AIC 0.500	AIC 0.009		AIC 0.687	AIC 0.160	AIC 0.141	AIC 1.24	MMT 0.482
Average		0.1415	0.4900	0.0079	0.0159	0.6655	0.1521	0.1292	1.204	0.470
Std Dev		0.0023	0.0061	0.0008	0.0009	0.0123	0.0046	0.0057	0.019	0.010
Certified		0.142	0.490	0.008	0.016	0.666	0.152	0.129	1.20	0.470
t		2.2622	2.1788	2.1788	2.2622	2.1788	2.1788	2.1788	2.1788	2.1788
C(95%)		0.0017	0.0037	0.0005	0.0006	0.0074	0.0028	0.0034	0.012	0.006

Analysis	*	Al	* As	* Ca	* Co	* N	* Sn	* Ti	* V
1	AIC	0.0192	AIM 0.0027	AES 0.00018	AIC 0.0086	FU 0.0081	AIM 0.0064	AES 0.0022	IN 0.0026
2	AIC	0.021	MAD 0.0036	AIC 0.0003	AIC 0.0086	FU 0.0082	AES 0.0064	AIC 0.0025	AIC 0.0031
3	AES	0.021	AIC 0.0044	AES 0.00039	AIC 0.0087	FU 0.0083	AES 0.0065	AES 0.0027	AIC 0.0035
4	AES	0.0214	AES 0.00465	AES 0.0004	AES 0.0089	FU 0.0086	AIC 0.0069	AIC 0.0028	AIC 0.0036
5	AIC	0.0214	AAH 0.0047	AIC 0.0004	AAA 0.009	FU 0.0086	AIC 0.007	AES 0.0029	MVE 0.0038
6	AES	0.022	AES 0.005	AIM 0.00044	AIC 0.0090	FU 0.0087	AIC 0.0072	AIC 0.0030	AIC 0.0038
7	AIC	0.022	AIH 0.0051	AES 0.00055	AES 0.009	FU 0.00876	AAG 0.0072	AIC 0.003	AIC 0.0038
8	AIC	0.0222	IN 0.0051	AIC 0.0006	IN 0.0091	FUP 0.0089	AIC 0.0073	AIC 0.0031	AES 0.004
9	AGA	0.0225	AAH 0.0053	AIC 0.0006	AAG 0.0092		MSn 0.0074		AES 0.004
10	AIC	0.0230	AES 0.0054	AIC 0.0006	AES 0.0095		AIC 0.008		AIC 0.004
11	MCC	0.0234	AES 0.0056	AIC 0.0006	AIH 0.0096		AGA 0.0080		AES 0.0041
12	AIC	0.028	AAG 0.0057		AIC 0.0098		AIC 0.008		AES 0.0043
13			AAH 0.0057		0.012		AES 0.00845		
Average		0.0223	0.00484	0.00046	0.0093	0.00852	0.0073	0.00278	0.0037
Std Dev		0.0021	0.00087	0.00014	0.0009	0.00029	0.0007	0.00030	0.0005
Certified		0.022	0.0048	0.0005	0.009	0.0085	0.007	0.0028	0.004
t		2.201	2.1788	2.2281	2.1788	2.3646	2.1788	2.3646	2.201
C(95%)		0.0013	0.00053	0.00010	0.0005	0.00024	0.0004	0.00025	0.0003

Analysis	*	B	* Nb	* O	* W
1	MBD	0.00011	AES 0.0015	FU 0.00166	AES <0.001
2	AIC	0.00027	XRF 0.002	FU 0.0018	AES <0.001
3	AIC	0.0003	AES 0.002	FU 0.0018	AES <0.01
4	AIC	0.0003		FU 0.0022	
5	AES	0.0003		FU 0.0023	
6	AES	0.00034			
7	AES	0.0004			
Average		0.00029	0.0018	0.00195	
Std Dev		0.00009	0.0003	0.00028	
Information		(0.0003)	(0.002)	(0.0020)	(<0.01)

Data in parentheses are not certified but are provided for information only.

\* Methods of analysis listed on page 3

$C(95\%) = (t \text{ } sd) / \sqrt{n}$  The half-width confidence interval, where  $t$  is the appropriate Student's  $t$  value,  $sd$  is the interlaboratory standard deviation, and  $n$  is the number of acceptable mean values. For further information regarding the confidence interval for the certified value see ISO Guide 35:1989 section 4.

## Methods of Analysis

Code	Element	Method
AA		Flame Atomic Absorption Spectrometry
AAA		Flame Atomic Absorption - standard addition method
AAG		Electro-thermal atomization (graphite furnace) Atomic Absorption Spectrometry
AAH		Flame Atomic Absorption Spectrometry with hydride generation
AES		AES - Spark Source Optical Emission Spectrometry
AGA		AES - Spark Source and Glow Discharge Spectrometry average
AIC		AES - ICP -Inductively Coupled Plasma Spectrometry
AIH		AES - ICP -Inductively Coupled Plasma Spectrometry after hydride generation
AIM		AES - ICP Mass Spectrometry addition method
C	C, S	Combustion-Infrared Absorption (ASTM E 1019) traceable to CRMs
CP	C, S	Combustion-Infrared Absorption traceable to pure substances
ECS	Cu	Sulphide precipitation, electro- deposition, gravimetric
FU	N, O	Inert gas Fusion Method (ASTM E 1019) traceable to CRMs
FUP	N	Inert gas Fusion Method traceable to pure substances
GMo	Mo	Gravimetry, Benzolnoxime
GNi	Ni	Dimethylglyoxime gravimetric
GSi	Si	Gravimetry with perchloric acid
IN		INAA - Neutron Activation Analysis
MAD	As	MAS - Molybdenum blue photometric after separation by distillation
MBD	B	MAS - Distillation separation-curcumin photometric
MCB	Cu	MAS - Bicyclohexane oxalyldihydrazone photometric
MCC	Al	MAS - Chromazurol S photometric after separation with cupferron
MCT	Cu	MAS - Tetraethylthiuram disulphide
MMT	Mo	MAS - Thiocyanate photometric
MND	Ni	MAS - Dimethylglyoxime photometric
MnP	Mn	MAS - Potassium periodate oxidation photometric
MPH	P	MAS - Heteropoly molybdenum blue spectrophotometry
MPN	P	MAS - n-butylol alcohol-trichloromethane extraction photometric
MSn	Sn	MAS - Phenylfluorone photometric
MVE	V	MAS - n-benzoyl phenylhydroxylamine extraction photometric
TCr	Cr	Perodisulphate oxidation titration
XRF		X-Ray Fluorescence spectrometry

AES = Atomic Emission Spectrometry

MAS = Molecular Absorption Spectrometry (photometric, spectrophotometric methods)

**Co-operating Laboratories:** The co-operating laboratories were:

### Laboratory

AK Steel Research, Middletown, Ohio  
ANAREM, Prague, Czech Republic  
Brammer Standard Co., Inc., Houston, Texas  
China National Analysis Center for Iron and Steel, Beijing, China  
Crucible Specialty Steel, Syracuse, New York  
J. Dirats and Co., Inc., Westfield, Massachusetts  
IncoTest, Huntington, West Virginia  
LECO Corporation, St. Joseph, Michigan  
Shiva Analyticals (India) Ltd., Hoskote, Bangalore, India  
VHG Laboratories, Inc., Manchester, New Hampshire

### Laboratory contact

Howard P. Vail  
Karel Bičovský  
Richard P. Beaumont  
Prof. Wang Haizhou  
William Mastroe  
Eric E. Dirats  
Melissa G. Staley  
Dennis Lawrenz  
Dr. T. V. Ramakrishna  
Julie M. McIntosh

**Additional analytical data:** This material was used as an unknown test specimen number 1981 in a nationally recognized Proficiency Testing Program (PTP) for low-alloy steel. Most of the participating laboratories used one or more of the ASTM Standard Test Methods E 322, E 415, E 1019, and E 1085. The PTP data was not used in calculating the certified values listed on pages 1 and 2. The data shown below are the results from the PTP.

Combustion Instrument Analysis using ASTM Standard Test Method E 1019

	C	S	N	O
Number of Labs	61	54	42	32
Grand Average	0.1426	0.0167	0.0088	0.0024
Standard Deviation	0.0052	0.0013	0.0004	0.0008

Optical Emission Spectrometric Analysis using ASTM Standard Test Method E 415

	C	Mn	P	S	Si	Cu	Ni	N
Number of Labs	70	76	75	74	76	77	77	10
Grand Average	0.1499	0.4894	0.0088	0.0168	0.6572	0.1539	0.1310	0.0092
Standard Deviation	0.0062	0.0091	0.0010	0.0014	0.0209	0.0061	0.0059	0.0009
	Cr	Mo	Al	Co	Sn	Ti	V	
Number of Labs	74	73	72	45	63	65	73	
Grand Average	1.1903	0.4712	0.0232	0.0093	0.0082	0.0034	0.0049	
Standard Deviation	0.0217	0.0143	0.0024	0.0008	0.0009	0.0009	0.0013	

X-ray Emission Spectrometric Analysis using ASTM Standard Test Method E 322

	Mn	Cu	Ni	Cr	Mo	V
Number of Labs	7	7	7	7	8	6
Grand Average	0.4909	0.1549	0.1310	1.2082	0.4745	0.0033
Standard Deviation	0.0094	0.0024	0.0033	0.0110	0.0098	0.0010

X-ray Emission Spectrometric Analysis using ASTM Standard Test Method E 1085

	Mn	P	Si	Cu	Ni	Cr	Mo	Co	V
Number of Labs	6	4	6	8	7	7	8	4	5
Grand Average	0.4839	0.0089	0.6574	0.1525	0.1312	1.1971	0.4641	0.0102	0.0040
Standard Deviation	0.0076	0.0019	0.0226	0.0034	0.0049	0.0259	0.0115	0.0026	0.0011

**Certification Process:** The requirements of ISO Guide 31, ISO Guide 34, ISO Guide 35, and ASTM Standard Guides E 1724 and E 1831 were followed for the preparation of this reference material and certificate of analysis. This is a Certified Reference Material as defined by ISO Guide 30.

**Analysis:** Chemical analyses were made on chips prepared by a lathe from the certified portion of the discs in accordance with ASTM Standard Practice E 1806. The laboratories participating in the testing normally followed the requirements of ISO Guide 25 and/or ISO Standard 17025. Individual values listed on page 2 are the average of each analyst's results. Methods of analysis used were a combination of ASTM Standard Test Method E 1019 and E 415 plus additional ICP and AA spectrometric methods.

**Outliers:** Some outlying data was excluded from the data listed on page 2 due to technical assessment of the cooperating laboratories and statistical evaluation.

**Traceability:** The following Certified Reference Materials were used to validate the analytical data listed on page 2: SRM 32b, 36a, 106b, 166b, 343a, 361, 362, 2165, 2166; ECRM 085-1, 088-1; CKD 180A through 189A.

**Homogeneity:** This Reference Material was tested for homogeneity using ASTM Standard Method E 826 and found acceptable. It was also examined by optical emission spectrometry using ASTM Standard Test Method E 415 and found to be compatible with the following Reference Materials: SRM C1173, 1261a, 1262a, 1263a, 1264a, 1265a, 1761, 1762, 1762, 1764, 1765, 1766, 1767; JSS 169-1, 170-6, 171-4; ECRM 186-1, 181-1; SS 457/1, 458/1.

**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. Whereas this material is in a solid form and stable, no expiration date is specified.

**Source:** This material was produced by Copperweld Steel Company, Warren, Michigan. It was melted by an electric arc furnace, vacuum degassed, aluminum killed, bottom poured into ingots, hot rolled into billets then bars, normalized (at 1750° for two hours) and annealed (at 1200° F for two hours).

**Form:** This Reference Material is in the form of a disc, approximately 38 mm in diameter and 19 mm thick.

**Use:** This Reference Material is intended for use in optical emission and x-ray spectrometric methods of analysis. Refer to ISO Guide 33 for information about the use of Reference Materials.

**Certified area:** The entire depth of the disc may be used.

**Caution:** As with any bar material, avoid optical emission spectrometric burns in the center of the disc (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 disc during surface preparation.

**Certificate Number:** The unique identification number for this certificate of analysis is Rev1981-120508-px, where x indicates the page number. Refer to future Brammer Standard Company catalogs for information on any revisions to this or other Brammer Standard reference materials. You may also obtain information on revisions of certificates from the internet at [brammerstandard.com](http://brammerstandard.com).

**Editorial Revision:** The uncertainty for Ca was incorrectly listed as 0.0015% on the original certificate of analysis.

**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	<a href="http://brammerstandard.com">brammerstandard.com</a>
14603 Benfer Road			
Houston, Texas 77069-2895 USA	Fax: (281) 440-4432	e-mail	<a href="mailto:contact@brammerstandard.com">contact@brammerstandard.com</a>

Certified by: \_\_\_\_\_ on December 5, 2008.  
Beau R. Brammer

**Brammer Standard Company, Inc., is accredited to ISO Guide 34 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials by A2LA (Certificate Number 656.02) The scope of accreditation is listed on the website: [www.brammerstandard.com](http://www.brammerstandard.com)**

**By Certificate Number 10539, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9002:1994 by National Quality Assurance, U.S.A.**

**Brammer Standard Company's Chemical Laboratory is accredited to ISO Guide 25 by A2LA. (Certificate Number 656.01)**

## **References:**

*ASTM documents available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, Telephone: 610-832-9500 Fax: 610-832-9555 e-mail: [service@astm.org](mailto:service@astm.org) Website: [www.astm.org](http://www.astm.org)*

E 322 - 96 Standard Test Method for X-Ray Emission Spectrometric Analysis of Low-Alloy Steels and Cast Irons

E 415 - 85 (Reapproved 1999) Standard Test Method for Optical Emission Vacuum Spectrometric Analysis of Carbon and Low-Alloy Steel

E 826 - 85 (Reapproved 1996) Standard Practice for Testing Homogeneity of Materials for the Development of Reference Materials

E 1019 - 2000 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel and in Iron, Nickel, and Cobalt Alloys

E 1085 - 95 Standard Test Method for X-Ray Emission Spectrometric Analysis of Low-Alloy Steels

E 1724 - 95 Standard Guide for Testing and Certification of Metal and Metal-Related Reference Materials

E 1806 - 96 Standard Practice for Sampling Steel and Iron for Determination of Chemical Composition

E 1831 - 96 Standard Guide for Preparing Certificates for Reference Materials Relating to Chemical Composition of Metals, Ores, and Related Materials.

*ISO Guides available from Global Engineering - [www.global.ihs.com](http://www.global.ihs.com)*

ISO Standard 17025 (First edition, 1999), General requirements for the competence of calibration and testing laboratories.

ISO Guide 25 (Third edition, 1990), General requirements for the competence of calibration and testing laboratories.

ISO Guide 30 (Second edition, 1991), Terms and definitions used in connection with reference materials.

ISO Guide 31 (Second edition, 2000), Reference materials -Contents of certificates and labels.

ISO Guide 33 (Second edition, 2000), Uses of certified reference materials.

ISO Guide 34 (Second edition, 2000), General requirements for the competence of reference material producers.

ISO Guide 35 (Second edition, 1989), Certification of reference materials - General and statistical principles.

*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

**Certificate Number Rev1981-120508p6**