

# Certificate of Analysis

## BS 3993

Certified Reference Material<sup>1</sup> for AISI Steel Alloy Number 1117  
(UNS Number G11170)

	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>0.152</b>	0.003	<b>N</b>	<b>0.0071</b>	0.0003
<b>Mn</b>	<b>1.16</b>	0.015	<b>Sn</b>	<b>0.006</b>	0.0005
<b>P</b>	<b>0.012</b>	0.001	<b>V</b>	<b>0.002</b>	0.0005
<b>S</b>	<b>0.094</b>	0.003			
<b>Si</b>	<b>0.260</b>	0.005			
<b>Cu</b>	<b>0.111</b>	0.004			
<b>Ni</b>	<b>0.045</b>	0.002			
<b>Cr</b>	<b>0.072</b>	0.002	<b>Information Values<sup>4</sup></b>		
<b>Mo</b>	<b>0.010</b>	0.001	<b>Ca</b>	0.0002	
<b>Al</b>	<b>0.002</b>	0.0008	<b>O</b>	0.0030	
<b>As</b>	<b>0.004</b>	0.001	<b>Ti</b>	0.0008	
<b>Co</b>	<b>0.006</b>	0.0005			

<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.

See the following pages for more information.

**Certificate Number 3993-040301p1**

Analysis	*	C	* Mn	* P	* S	* Si	* Cu	* Ni	* Cr
1	C	0.148	AIC 1.14	AIC 0.0097	C 0.087	AIC 0.248	ECS 0.0998	IN 0.0405	AIC 0.0665
2	C	0.151	AIC 1.14	MPN 0.0104	C 0.0871	AIC 0.255	AIC 0.106	AIC 0.043	MCS 0.0708
3	C	0.151	AIC 1.14	AIC 0.0107	C 0.088	GSi 0.256	MCB 0.106	AGA 0.044	AIC 0.071
4	C	0.152	MnP 1.1432	AIC 0.011	C 0.094	MSi 0.259	IN 0.110	AIC 0.044	AIC 0.071
5	C	0.152	AIC 1.15	AIC 0.012	CP 0.0953	AIC 0.260	AIC 0.110	AIC 0.044	AIC 0.0713
6	C	0.152	AIC 1.150	AIC 0.0125	AES 0.0955	AGA 0.260	AIC 0.111	GNi 0.04412	TCr 0.07184
7	C	0.1535	MnP 1.16	AIC 0.0127	AES 0.096	AIC 0.261	MCT 0.111	AIC 0.0442	AIC 0.073
8	CP	0.1540	AES 1.17	AGA 0.0128	AGA 0.096	GSi 0.262	AIC 0.112	MND 0.0446	AES 0.0732
9	AGA	0.155	MnP 1.176	AES 0.013	C 0.0961	AIC 0.262	AGA 0.113	AIC 0.046	IN 0.0736
10			AGA 1.178	AIC 0.013	C 0.0963	AES 0.263	AIC 0.113	AIC 0.0461	AES 0.074
11			AA 1.184	AES 0.0143	C 0.0982	AES 0.264	AES 0.115	AES 0.047	AIC 0.074
12			AES 1.19	MPH 0.0145		GSi 0.2695	AES 0.120	AES 0.0471	AGA 0.075
Average		0.1521	1.160	0.0122	0.0936	0.2600	0.1106	0.0446	0.0721
Std Dev		0.0020	0.019	0.0015	0.0041	0.0053	0.0051	0.0018	0.0023
Certified		0.152	1.16	0.012	0.094	0.260	0.111	0.045	0.072
t		2.306	2.201	2.201	2.2281	2.201	2.201	2.201	2.201
C(95%)		0.0016	0.0119	0.0010	0.0028	0.0034	0.0032	0.0012	0.0014

Analysis	*	Mo	* Al	* As	* Co	* N	* Sn	* V
1	AIC	0.009	AAG 0.0007	AIM 0.0023	AIC 0.0058	FU 0.0066	AIC 0.0058	AIC 0.0015
2	AIC	0.009	AIC 0.0011	MAD 0.0032	AIC 0.0058	FU 0.0070	AES 0.0058	AIC 0.0015
3	AIC	0.0094	AIC 0.0013	AIC 0.0038	AIC 0.0061	FU 0.007	AIM 0.006	MVE 0.0016
4	IN	0.0099	AES 0.0014	AAH 0.0040	AAA 0.0061	FU 0.0071	AIC 0.006	AES 0.0018
5	AES	0.0100	AES 0.0015	AAH 0.0042	AIC 0.0062	FU 0.0072	AIC 0.006	AIC 0.0020
6	AES	0.0103	AIC 0.0021	AAG 0.0046	AAG 0.0064	FU 0.0074	MSn 0.0061	AIC 0.002
7	AGA	0.0105	AIC 0.0026	AAH 0.0046	IN 0.0065		AES 0.0061	AIC 0.0020
8	GMo	0.0106	AAA 0.0029	AES 0.005	AAG 0.0066		AIC 0.0062	AIC 0.0024
9	AIC	0.0107	AGA 0.0030	AIH 0.0051	AES 0.0066		AIC 0.0064	IN 0.0027
10	AIC	0.0108		AES 0.0051	AIC 0.0068		AAG 0.0064	AES 0.003
11	AIC	0.011		IN 0.0052	AES 0.0068		AAG 0.0068	
12	MMo	0.0112					AGA 0.0070	
Average		0.0102	0.00184	0.0043	0.0063	0.00705	0.0062	0.0021
Std Dev		0.0007	0.00083	0.0009	0.0004	0.00027	0.0004	0.0005
Certified		0.010	0.002	0.004	0.006	0.0071	0.006	0.002
t		2.201	2.306	2.2281	2.2281	2.5706	2.201	2.2622
C(95%)		0.0005	0.0006	0.0006	0.0002	0.00028	0.0002	0.0004

Analysis	*	Ca	* O	* Ti
1	AES	0.00004	FU 0.0029	AIC 0.0003
2	AIC	0.0002	FU 0.0030	AIC 0.0003
3	AIC	0.0002	FU 0.0030	AIC 0.0008
4			FU 0.0032	AIC 0.0011
5				AES 0.0013
Average		0.00015	0.00303	0.00076
Std Dev		0.00009	0.00013	0.00046
Information		(0.0002)	(0.0030)	(0.0008)

\* Methods of analysis listed on page 3

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

$C(95\%) = (t \times sd) / n$  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 Spectrometry - standard additions 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
GMo	Mo	Gravimetry, Benzoinoxime
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
MCB	Cu	MAS - Bicyclohexane oxalyldihydrazone photometric
MCS	Cr	MAS - Diphenyl carbazide photometric after separation with Na <sub>2</sub> CO <sub>3</sub>
MCT	Cu	MAS - Tetraethylthiuram disulphide
MMo	Mo	MAS - Thiocyanate after extraction with butyl acetate
MND	Ni	MAS - Dimethylglyoxime photometric
MnP	Mn	MAS - Periodate oxidation
MPH	P	MAS - Heteropoly molybdenum blue spectrophotometry
MPN	P	MAS - Butyl alcohol-trichloromethane extraction photometric
MSi	Si	MAS - Molybdenum blue photometric method (ASTM E350)
MSn	Sn	MAS - Phenylfluorone photometric
MVE	V	MAS - n-benzoyl phenylhydroxylamine extraction photometric
TCr	Cr	Perodisulphate oxidation titration

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 Bi ovsk  
 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 3993 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	25	33	25	20
Grand Average	0.1504	0.0951	0.0072	0.0035
Standard Deviation	0.0054	0.0051	0.0003	0.0005

Optical Emission Spectrometric Analysis using ASTM Standard Test Method E 415

	C	Mn	P	S	Si	Cu	Ni	N
Number of Labs	41	42	41	9	42	42	42	12
Grand Average	0.1540	1.1917	0.0136	0.0984	0.2598	0.1130	0.0468	0.0071
Standard Deviation	0.0055	0.0296	0.0012	0.0082	0.0110	0.0047	0.0044	0.0008

	Cr	Mo	Al	Co	Sn
Number of Labs	41	37	5	25	35
Grand Average	0.0727	0.0110	0.0035	0.0065	0.0067
Standard Deviation	0.0042	0.0028	0.0028	0.0012	0.0008

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

	Mn	Cu	Ni	Cr	Mo
Number of Labs	5	5	5	5	5
Grand Average	1.1574	0.1132	0.0481	0.0699	0.0116
Standard Deviation	0.0074	0.0066	0.0052	0.0034	0.0017

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

	Mn	Si	Cu	Ni	Cr	Mo
Number of Labs	5	5	5	4	5	5
Grand Average	1.1669	0.2583	0.1145	0.0456	0.0678	0.0105
Standard Deviation	0.0071	0.0096	0.0015	0.0028	0.0039	0.0010

**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 36a, 106b, 166b, 343a, 361, 362, 368, 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 1136, C 1221; SS 433/1, 434/1; BS 42A, 66B, 3942, CSN-2D.

**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 Bliss & Laughlin Industries, Inc., Batavia, Illinois. It was melted by an electric arc furnace, poured into ingots, hot rolled, and cold finished .

**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:**
- (1) 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.
  - (2) Sulfur tends to form MnS inclusions that will disrupt optical emission spectrometric burns. Both Mn and S will give high readings when this happens. Preburn conditions must be adjusted to compensate for this effect. Special curve or correction factor adjustments may be necessary.

**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 3993-040301-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).

**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:

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14603 Benfer Road  
Houston, Texas 77069-2895 USA

Phone: (281) 440-9396  
Fax: (281) 440-4432

web [brammerstandard.com](http://brammerstandard.com)  
e-mail [bramstan@netropolis.net](mailto:bramstan@netropolis.net)

Certified by: \_\_\_\_\_ on April 3, 2001.  
G. 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

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