

# Certificate of Analysis

## BS 2001

Certified Reference Material<sup>1</sup> for AISI Steel Alloy Number 1018  
(UNS Number G10180)

	Certified Value <sup>2</sup>	Estimate of Uncertainty <sup>3</sup>	Certified Value <sup>2</sup>	Estimate of Uncertainty <sup>3</sup>
Analysis listed as percent by weight				
<b>C</b>	<b>0.168</b>	0.004	<b>N</b>	<b>0.0090</b> 0.0004
<b>Mn</b>	<b>0.67</b>	0.01	<b>Sn</b>	<b>0.012</b> 0.001
<b>P</b>	<b>0.005</b>	0.0005	<b>V</b>	<b>0.0006</b> 0.0002
<b>S</b>	<b>0.030</b>	0.0015		
<b>Si</b>	<b>0.22</b>	0.008		
<b>Cu</b>	<b>0.305</b>	0.008	<b>Information Values<sup>4</sup></b>	
<b>Ni</b>	<b>0.083</b>	0.003	<b>B</b>	<0.0003
<b>Cr</b>	<b>0.071</b>	0.003	<b>Nb</b>	<0.002
<b>Mo</b>	<b>0.019</b>	0.002	<b>O</b>	0.0061
<b>Al</b>	<b>0.002</b>	0.0005	<b>Pb</b>	0.0014
<b>As</b>	<b>0.006</b>	0.001	<b>Ti</b>	<0.002
<b>Ca</b>	<b>0.0018</b>	0.0002	<b>W</b>	<0.01
<b>Co</b>	<b>0.008</b>	0.001	<b>Zr</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.

See the following pages for more information.

**Certificate Number 2001-043001p1**

Analysis	* C	* Mn	* P	* S	* Si	* Cu	* Ni	* Cr	* Mo
1	C 0.166	AIC 0.66	MPH 0.00405	C 0.0282	GSi 0.212	XRF 0.296	IN 0.0773	XRF 0.0665	AIC 0.0180
2	C 0.167	AIC 0.66	MPN 0.0045	C 0.0286	AIC 0.212	MCB 0.298	AIC 0.080	AIC 0.0672	AIC 0.018
3	C 0.167	MnP 0.6605	AES 0.0045	C 0.0289	XRF 0.213	AIC 0.30	AIC 0.081	MCS 0.0700	AIC 0.018
4	C 0.1671	XRF 0.661	AIC 0.0045	C 0.029	AGD 0.215	AIC 0.30	AIC 0.0811	AIC 0.0704	IN 0.0183
5	C 0.1673	MnP 0.662	AIC 0.0045	C 0.0296	MSi 0.218	AIC 0.301	MND 0.0814	AIC 0.071	GMO 0.0186
6	C 0.1676	AGA 0.669	AIC 0.0048	C 0.030	AIC 0.219	AIC 0.302	AGA 0.082	AIC 0.071	AIC 0.0186
7	CP 0.1678	AA 0.670	AIC 0.005	C 0.0307	AES 0.219	MCT 0.306	AIC 0.082	AIC 0.072	AGA 0.019
8	AGA 0.169	AIC 0.671	AIC 0.005	AGA 0.0313	GSi 0.221	IN 0.308	XRF 0.085	IN 0.0721	AES 0.019
9	C 0.171	AIC 0.674	AIC 0.005	CP 0.0314	AIC 0.224	AGA 0.309	AES 0.0851	AIC 0.073	MMo 0.0192
10	C 0.171	AES 0.675	AIC 0.0050	C 0.0316	AIC 0.224	AES 0.316	GNI 0.0859	AGA 0.073	AIC 0.0192
11		AES 0.679	AGA 0.0050		AES 0.228	ECS 0.3172	AES 0.086	TCr 0.0738	XRF 0.0195
12		MnP 0.681			GSi 0.23		AIC 0.0863	AES 0.074	AIC 0.020
13		AIC 0.688			AIC 0.231		AIC 0.087	AES 0.0741	AES 0.0206
Average	0.1681	0.670	0.0047	0.0299	0.220	0.3048	0.0831	0.0714	0.0189
Std Dev	0.0017	0.009	0.0003	0.0013	0.007	0.0071	0.0030	0.0024	0.0008
Certified	0.168	0.67	0.005	0.030	0.22	0.305	0.083	0.071	0.019
t	2.2622	2.1788	2.2281	2.2622	2.1788	2.2281	2.1788	2.1788	2.1788
C(95%)	0.0012	0.006	0.0002	0.0009	0.004	0.0048	0.0018	0.0015	0.0005

Analysis	* Al	* As	* Ca	* Co	* N	* Sn	* V
1	AIC 0.0011	AIM 0.0024	AIC 0.0015	AAA 0.00705	FU 0.0085	AAG 0.0104	AIC 0.0004
2	AIC 0.0018	MAD 0.0053	AIC 0.0016	AIC 0.0071	FU 0.0086	AIM 0.0106	AIC 0.0005
3	AAA 0.0018	AIC 0.0053	AIC 0.0017	AIC 0.0071	FU 0.0087	AGA 0.0107	IN 0.0005
4	AIC 0.002	AIC 0.0059	AIC 0.0017	AIC 0.0072	FU 0.0089	AIC 0.0110	AIC 0.0005
5	AES 0.002	AES 0.0059	AIC 0.0017	AIC 0.0074	FU 0.0091	AES 0.0114	MVE 0.0006
6	AIC 0.002	AES 0.006	AES 0.00171	IN 0.0075	FU 0.0093	AIC 0.0123	AES 0.0007
7	AIC 0.002	AAH 0.0062	AES 0.00179	AAG 0.0076	FU 0.00932	AES 0.0124	AIC 0.0008
8	AES 0.0024	AIH 0.0067	AIC 0.0018	AES 0.0077	FUP 0.0096	AIC 0.0126	AIC 0.0009
9	AIC 0.0025	AES 0.0068	AES 0.0018	AIC 0.0078		AES 0.0127	
10	AIC 0.0030	IN 0.0068	AIC 0.0022	AIC 0.008		AIC 0.013	
11	AGA 0.0032	AAH 0.0069		AES 0.0083		AIC 0.013	
12	AES 0.0038	AES 0.0070		AES 0.009		AIC 0.013	
13		AAH 0.0070		XRF 0.0105		MSn 0.0133	
Average	0.0023	0.0060	0.00175	0.0079	0.00900	0.0120	0.00061
Std Dev	0.0007	0.0012	0.00018	0.0010	0.00039	0.0011	0.00017
Certified	0.002	0.006	0.0018	0.008	0.0090	0.012	0.0006
t	2.201	2.1788	2.2622	2.1788	2.3646	2.1788	2.3646
C(95%)	0.0005	0.0008	0.00013	0.0006	0.00033	0.0006	0.00014

Analysis	* B	* Nb	* O	* Pb	* Ti	* W	* Zr
1	AES <0.0003	AES <0.0001	FU 0.0055	AES 0.0012	AIC <0.001	AES <0.01	AES 0.0005
2	AES 0.00005	AES <0.002	FU 0.00577	AES 0.0015	AES <0.0010	AES 0.003	AES 0.0013
3		AES 0.0019	FU 0.0059		AIC 0.0005	AES 0.0045	
4			FU 0.0061		AIC 0.0005		
5			FU 0.0071		AIC 0.0010		
6					AIC 0.0012		
7					AES 0.0014		
8					AES 0.0015		
Average			0.00607	0.00135			0.00090
Std Dev			0.00061	0.00021			0.00057
Information	(<0.0003)	(<0.002)	(0.0061)	(0.0014)	(<0.002)	(<0.01)	(0.001)

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

\* Methods of analysis listed on page 3

$C(95\%) = (t \times sd) / n$  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 - 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
AGD		AES - GD - Glow Discharge Spectrometry
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
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 - Potassium periodate oxidation photometric
MPH	P	MAS - Heteropoly molybdenum blue spectrophotometry
MPN	P	MAS - n-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
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

Allvac, Lockport, New York  
Analytical Associates, Detroit, Michigan  
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

Thomas A. Herdlein  
Charles Deak (retired)  
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 2001 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	55	49	40	31
Grand Average	0.1678	0.0316	0.0091	0.0066
Standard Deviation	0.0040	0.0022	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	63	69	72	67	62	69	69	28
Grand Average	0.1724	0.6698	0.0060	0.0321	0.2227	0.3059	0.0841	0.0090
Standard Deviation	0.0057	0.0097	0.0009	0.0026	0.0075	0.0084	0.0036	0.0010

  

	Cr	Mo	Al	Co	Sn	Ca
Number of Labs	67	69	63	35	58	43
Grand Average	0.0695	0.0198	0.0028	0.0075	0.0125	0.0018
Standard Deviation	0.0029	0.0018	0.0012	0.0008	0.0012	0.0003

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

	Mn	Cu	Ni	Cr	Mo
Number of Labs	5	6	5	6	6
Grand Average	0.6748	0.3089	0.0850	0.0685	0.0202
Standard Deviation	0.0097	0.0108	0.0000	0.0027	0.0013

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

	Mn	P	S	Si	Cu	Ni	Cr	Mo	Co	Ca
Number of Labs	12	10	4	10	11	11	11	11	4	1
Grand Average	0.6677	0.0066	0.0308	0.2196	0.3066	0.0839	0.0672	0.0187	0.0085	0.0019
Standard Deviation	0.0071	0.0019	0.0054	0.0162	0.0089	0.0046	0.0042	0.0021	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 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 1228, 1262a, 1269, 1765, 1767; JSS 169-1, 170-6; BS 3941.

**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 Nucor Cold Finish, Brigham City, Utah. It was melted by an electric arc furnace, aluminum killed, bottom poured into ingots, hot rolled into billets, and cold drawn .

**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 2001-043001-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:

Brammer Standard Co., Inc.  
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 30, 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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