

Brammer Standard Company, Inc.

Certificate of Analysis

BS 1982

Certified Reference Material¹ for Steel Alloy Number F-22
(UNS Number K21590)

	Certified Value ²	Estimate of Uncertainty ³	Certified Value ²	Estimate of Uncertainty ³
Analysis listed as percent by weight				
C	0.128	0.004	O	0.0017 0.0003
Mn	0.441	0.005	Sb	0.002 0.0006
P	0.012	0.0015	Sn	0.013 0.001
S	0.026	0.001	V	0.003 0.0006
Si	0.255	0.010		
Cu	0.177	0.003	Information Values⁴	
Ni	0.197	0.005	Nb	<0.003
Cr	2.09	0.02	Pb	0.0003
Mo	0.89	0.015	Ti	0.001
Al	0.021	0.002		
As	0.007	0.001		
Co	0.010	0.001		
N	0.0097	0.0004		

¹ 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)

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

³ 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.

⁴ Information values are not certified and are provided for information only.

See the following pages for more information.

Certificate Number 1982-071801p1

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BS 1982

Data listed as mass fraction expressed as percent.

1982-071801p2

Analysis	* C	* Mn	* P	* S	* Si	* Cu	* Ni	* Cr	* Mo
1	C 0.1244	AGD 0.435	MPH 0.0105	C 0.024	AIC 0.243	MCB 0.167	MND 0.190	AIC 2.060	AES 0.8676
2	AGA 0.126	MnP 0.437	MPN 0.0108	C 0.025	AIC 0.244	AES 0.171	AES 0.19	AIC 2.06	AA 0.874
3	C 0.127	AIC 0.437	AIC 0.0109	C 0.0256	GSi 0.247	AIC 0.173	AA 0.194	AGA 2.063	AIC 0.8749
4	C 0.1274	AIC 0.44	AIC 0.0115	C 0.0257	AES 0.254	ECS 0.1738	AIC 0.194	AIC 2.07	AIC 0.883
5	C 0.128	XRF 0.440	AES 0.0122	AGA 0.0262	MSi 0.255	AIC 0.175	AIC 0.195	AA 2.079	AES 0.885
6	C 0.128	AIC 0.44	AIC 0.0122	C 0.0262	AES 0.255	XRF 0.176	AES 0.197	TCr 2.08	AGA 0.889
7	CP 0.1286	MnP 0.4403	AIC 0.0124	C 0.0264	XRF 0.256	AES 0.176	AIC 0.198	AIC 2.10	AIC 0.89
8	C 0.1309	AIC 0.442	AGA 0.0126	CP 0.0269	IN 0.257	AGA 0.177	AGA 0.199	TCr 2.1017	AIC 0.89
9	C 0.132	AIC 0.442	AES 0.0128	C 0.0276	AGA 0.258	AIC 0.178	AIC 0.199	AES 2.11	XRF 0.896
10	C 0.132	AA 0.443	AIC 0.013		AIC 0.259	AIC 0.179	AIC 0.199	AIC 2.11	AIC 0.903
11		AES 0.444	XRF 0.014		AIC 0.260	AA 0.183	XRF 0.20	AES 2.113	AIC 0.911
12		MnP 0.445	AIC 0.014		GSi 0.2638	AIC 0.185	AIC 0.202	AIC 2.12	MMT 0.914
13		AES 0.445			AIC 0.269	AIC 0.185	GNi 0.205		
Average	0.1284	0.4408	0.0122	0.0260	0.2554	0.1768	0.1971	2.089	0.8898
Std Dev	0.0025	0.0031	0.0012	0.0011	0.0074	0.0053	0.0044	0.023	0.0144
Certified	0.128	0.441	0.012	0.026	0.255	0.177	0.197	2.09	0.89
t	2.2622	2.1788	2.201	2.306	2.1788	2.1788	2.1788	2.201	2.201
C(95%)	0.0018	0.0019	0.0007	0.0008	0.0045	0.0032	0.0027	0.014	0.0092

Analysis	* Al	* As	* Co	* N	* O	* Sb	* Sn	* V
1	AIC 0.019	AES 0.0058	AIC 0.0095	FU 0.0090	FU 0.00160	AES 0.0014	AES 0.0116	AIC 0.0029
2	AIC 0.0196	MAD 0.0060	AIC 0.0095	FU 0.0096	FU 0.0016	AAE 0.0019	AIC 0.0118	AIC 0.0029
3	AIC 0.020	AES 0.0064	AIC 0.0095	FU 0.0096	FU 0.0016	AAE 0.0020	AGA 0.0125	AES 0.003
4	AES 0.020	AIH 0.0064	AAA 0.0096	FU 0.0097	FU 0.0017	IN 0.0022	AAG 0.0126	IN 0.0030
5	AIC 0.0206	AES 0.0064	IN 0.0097	FU 0.0098	FU 0.0021	AIC 0.0024	AIM 0.013	AIC 0.003
6	AIC 0.0207	AAG 0.0070	AIH 0.0100	FU 0.0098		AIH 0.0024	AES 0.0130	AIC 0.0031
7	AES 0.0210	IN 0.0070	AAG 0.0101	FU 0.01004		MSM 0.0024	AIC 0.0132	MVE 0.0032
8	AGA 0.0214	AAH 0.0072	AIC 0.0103	FU 0.0102		AAG 0.0036	AIC 0.0135	AIC 0.0036
9	AIC 0.0218	AIC 0.0073	AES 0.0104				MSn 0.0136	AIC 0.0037
10	AAA 0.022	AAH 0.0073	AIC 0.0104				AES 0.0137	AES 0.0042
11	MCC 0.0234	AAH 0.0081	AES 0.0106				AIC 0.014	AES 0.0048
12			AES 0.011				AIC 0.014	
13							AIC 0.014	
Average	0.0209	0.0068	0.0101	0.00972	0.00172	0.0023	0.0131	0.0034
Std Dev	0.0012	0.0007	0.0005	0.00036	0.00022	0.0006	0.0008	0.0006
Certified	0.021	0.007	0.010	0.0097	0.0017	0.002	0.013	0.003
t	2.2281	2.2281	2.201	2.3646	2.7764	2.3646	2.1788	2.2281
C(95%)	0.0008	0.0005	0.0003	0.00030	0.00027	0.0005	0.0005	0.0004

Analysis	* Nb	* Pb	* Ti
1	AES <0.001	AAE 0.0002	AES 0.0004
2	AES 0.0012	AAE 0.0002	AIC 0.0005
3	AES 0.002	AIC 0.0005	AIC 0.0007
4			AIC 0.0010
5			AIC 0.001
6			AES 0.0012
7			AIC 0.0012
8			AES 0.0014
Average	0.0011	0.00030	0.00093
Std Dev	0.0010	0.00017	0.00036
Information	(<0.003)	(0.0003)	(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
AAE		Flame Atomic Absorption Spectrometry after extraction of antimony (III) iodide with TOPO/MIBK
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
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
MCC	Al	MAS - Chromazurol S photometric after separation with cupferron
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-butyl alcohol-trichloromethane extraction photometric
MSi	Si	MAS - Molybdenum blue photometric method (ASTM E350)
MSM	Sb	MAS - malachite green 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 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 1982 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	60	53	42	32
Grand Average	0.1265	0.0265	0.0100	0.0022
Standard Deviation	0.0047	0.0019	0.0004	0.0007

Optical Emission Spectrometric Analysis using ASTM Standard Test Method E 415

	C	Mn	P	S	Si	Cu	Ni	N
Number of Labs	69	78	75	73	76	78	76	10
Grand Average	0.1311	0.4442	0.0134	0.0260	0.2550	0.1810	0.1988	0.0105
Standard Deviation	0.0057	0.0125	0.0013	0.0020	0.0122	0.0077	0.0073	0.0012
	Cr	Mo	Al	Co	Sn	Ti	V	
Number of Labs	71	70	70	43	61	60	73	
Grand Average	2.0716	0.8826	0.0230	0.0105	0.0137	0.0020	0.0054	
Standard Deviation	0.0638	0.0297	0.0024	0.0007	0.0010	0.0008	0.0019	

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	7	6
Grand Average	0.4442	0.1801	0.2000	2.1081	0.8989	0.0032
Standard Deviation	0.0083	0.0027	0.0026	0.0225	0.0155	0.0014

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

	Mn	P	Si	Cu	Ni	Cr	Mo	Co	V
Number of Labs	7	4	6	7	6	6	8	4	5
Grand Average	0.4409	0.0145	0.2503	0.1765	0.1992	2.0551	0.8760	0.0124	0.0036
Standard Deviation	0.0125	0.0030	0.0089	0.0033	0.0050	0.0239	0.0176	0.0029	0.0008

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.

Certificate Number 1982-071801p4

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 certificate of analysis 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 39 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 1982-071801-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.

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 e-mail bramstan@netropolis.net
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Certified by: _____ on July 18, 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

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 Website: 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

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 1982-071801p6