

Certificate of Analysis

BS 0021

Certified Reference Material¹ for 410 Stainless Steel Alloy
(UNS Number S41000)

	Certified Value²	Estimate of Uncertainty³	Certified Value²	Estimate of Uncertainty³
Analysis listed as percent by weight				
C	0.128	0.003	V	0.029 0.002
Mn	0.420	0.006		
P	0.021	0.001		
S	0.008	0.001	Information Values⁴	
Si	0.354	0.008	As	0.004
Cu	0.040	0.002	B	<0.0002
Ni	0.100	0.004	Ca	0.0002
Cr	12.00	0.05	Nb	0.001
Mo	0.016	0.001	O	0.004
Al	0.008	0.001	Ti	0.003
Co	0.015	0.001	W	0.005
N	0.029	0.0015		
Sn	0.003	0.001		

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

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 0021-071801p1

BS 0021

Data listed as mass fraction expressed as percent.

0021-071801p2

Analysis	*	C	*	Mn	*	P	*	S	*	Si	*	Cu	*	Ni	*	Cr	*	Mo
1	C	0.125	XRF	0.411	AIC	0.0193	C	0.0068	XRF	0.343	AIC	0.037	AIC	0.0956	TCr	11.9405	AIC	0.014
2	C	0.126	MnP	0.4143	XRF	0.020	C	0.007	XRF	0.348	AGX	0.039	GNi	0.096	XRF	11.968	AES	0.0147
3	C	0.127	MnP	0.415	AIC	0.020	C	0.0073	AIC	0.348	XRF	0.039	XRF	0.097	XRF	11.97	AIC	0.0149
4	C	0.1275	AIC	0.415	AIC	0.0202	C	0.00753	GSi	0.3486	XRF	0.039	AIC	0.097	TCr	11.98	AGX	0.015
5	C	0.13	XRF	0.419	AIC	0.0202	C	0.0077	XRF	0.350	ECS	0.039	MND	0.0978	XRF	11.991	AIC	0.016
6	C	0.130	AIC	0.421	XRF	0.0204	C	0.008	GSi	0.352	AIC	0.040	XRF	0.099	AIC	12.00	XRF	0.016
7	C	0.1302	AGX	0.421	AES	0.0207	IC	0.0080	AGA	0.357	AES	0.0402	XRF	0.10	TCr	12.01	XRF	0.016
8			XRF	0.422	AGA	0.0210	C	0.0082	AIC	0.361	AIC	0.0413	AGA	0.101	AIC	12.04	GMo	0.0162
9			AA	0.423	AIC	0.0213	C	0.0086	GSi	0.364	AIC	0.0415	XRF	0.102	XRF	12.065	XRF	0.0165
10			AIC	0.424	MPH	0.022			GSi	0.368	MCB	0.0420	AIC	0.105	TCr	12.07	MMo	0.0165
11			AES	0.427	MPN	0.0222							XRF	0.044	AIC	0.106		
12			MnP	0.428														
Average		0.1280		0.4200		0.0207		0.0077		0.3540		0.0402		0.0997		12.003		0.0156
Std Dev		0.0021		0.0053		0.0009		0.0006		0.0081		0.0019		0.0035		0.043		0.0009
Certified		0.128		0.420		0.021		0.008		0.354		0.040		0.100		12.00		0.016
t		2.4469		2.201		2.2281		2.306		2.2622		2.2281		2.2281		2.2622		2.2622
C(95%)		0.0020		0.0034		0.0006		0.0004		0.0058		0.0013		0.0024		0.031		0.0006

Analysis	*	Al	*	Co	*	N	*	Sn	*	V
1	AIC	0.007	AIC	0.0140	FU	0.0266	AIC	0.0017	MVE	0.0262
2	AES	0.0075	AIC	0.014	TN	0.0290	AES	0.0018	AAA	0.027
3	AIC	0.0076	AIC	0.0141	FU	0.02926	MSn	0.0020	AIC	0.0280
4	AES	0.0079	AAA	0.0142	FU	0.0293	AIC	0.002	XRF	0.028
5	AES	0.008	XRF	0.0145	FU	0.0294	AIM	0.0021	XRF	0.028
6	AGA	0.008	AES	0.0149	FU	0.0295	AIC	0.0021	XRF	0.029
7	AAA	0.0084	AGX	0.015	FU	0.0302	AES	0.0036	AGX	0.029
8	AIC	0.0084	AIC	0.0154	FU	0.031	AAG	0.0036	AES	0.0291
9	AIC	0.009	XRF	0.016			AGA	0.004	AES	0.0305
10			M5	0.0164			AIH	0.0043	AIC	0.0319
11			XRF	0.017			AIM	0.0045	AIC	0.0331
12			AIC	0.0170						
13			XRF	0.017						
Average		0.0080		0.0153		0.0293		0.0029		0.0291
Std Dev		0.0006		0.0012		0.0013		0.0011		0.0021
Certified		0.008		0.015		0.029		0.003		0.029
t		2.306		2.1788		2.3646		2.2281		2.2281
C(95%)		0.0004		0.0007		0.0011		0.0007		0.0014

Analysis	*	As	*	B	*	Ca	*	Nb	*	O	*	Ti	*	W
1	AES	0.0039	AES	<0.0002	AIC	0.0001	XRF	0.001	FU	0.0031	AIC	0.0018	XRF	0.004
2	AAG	0.0040	AIC	0.0001	AES	0.00022	XRF	0.001	FU	0.00323	XRF	0.002	AES	0.004
3							AES	0.0015	FU	0.0034	AES	0.0026	MWC	0.0046
4							XRF	0.002	FU	0.0034	XRF	0.003	AIC	0.0048
5									FU	0.007	XRF	0.006	XRF	0.005
6													XRF	0.005
Average		0.0040				0.0002		0.0014		0.0040		0.0031		0.0050
Std Dev		0.0001				0.0001		0.0005		0.0017		0.0017		0.0013
Information		(0.004)		(<0.0002)		(0.0002)		(0.001)		(0.004)		(0.003)		(0.005)

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

* Methods of an analysis listed on page 3

C(95%) = (t x 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
AES		AES - Spark Source Optical Emission Spectrometry
AGA		AES - Spark Source and Glow Discharge Spectrometry average
AGX		Glow Discharge and X-Ray Fluorescence 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
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
IC	S	Ion chromatography
M5	Co	MAS - 5-Cl-PADAB spectrophotometric
MCB	Cu	MAS - Bicyclohexane oxalyldihydrazone photometric
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 photometric
MPN	P	MAS - n-butyl alcohol-trichloromethane extraction photometric
MSn	Sn	MAS - Phenylfluorone photometric
MVE	V	MAS - n-benzoyl phenylhydroxylamine extraction photometric
MWC	W	MAS - Chlorpromazine hydrochloride sodium thiocyanate - tri-chloromethane extraction
TCr	Cr	Persulfate oxidation, ferrous sulfate titrimetric
TN	N	Neutralization titrimetric after distillation separation
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
 Allvac, Monroe, North Carolina
 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 Herdlein
 Patrick M. Cole
 Karel Bišovsk
 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 0021 in a nationally recognized Proficiency Testing Program (PTP) for stainless steel. Most of the participating laboratories used one or more of the ASTM Standard Test Methods E 572, E 1019, and E 1086. 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	26	25	22	21
Grand Average	0.1279	0.0078	0.0299	0.0036
Standard Deviation	0.0049	0.0008	0.0009	0.0008

Optical Emission Spectrometric Analysis using ASTM Standard Test Method E 1086

	C	Mn	P	S	Si	Cu	Ni
Number of Labs	18	23	22	17	22	21	17
Grand Average	0.1320	0.4175	0.0209	0.0074	0.3568	0.0387	0.0994
Standard Deviation	0.0048	0.0093	0.0009	0.0010	0.0092	0.0047	0.0067

	Cr	Mo	Co	V	Al
Number of Labs	21	19	7	10	9
Grand Average	12.0566	0.0179	0.0156	0.0289	0.0085
Standard Deviation	0.0739	0.0033	0.0032	0.0040	0.0020

X-ray Emission Spectrometric Analysis using ASTM Standard Test Method E 572

	Mn	P	Si	Cu	Ni	Cr	Mo	V	Co
Number of Labs	16	8	10	14	17	17	17	9	16
Grand Average	0.4141	0.0205	0.3527	0.0385	0.0973	12.0322	0.0169	0.0297	0.0166
Standard Deviation	0.0069	0.0013	0.0100	0.0026	0.0054	0.0780	0.0021	0.0030	0.0033

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 are listed on page 3.

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 20f, 125b, 131f, 155, 2159, 2160, 3013a, 3107, 3109a, 3161a; ECRM 096-1, 289-1, 295-1; BCS 152/3, 338, 431/1.

Homogeneity: This Certified 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 1086 and found to be compatible with the following Reference Materials: SRM 1219, 1267, C1289, 1295; JSS 650-8; BS SS 4951, 91E, 410A.

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 the Gloria Heavy Industrial Corporation, Tainan Hsien, Taiwan. It was melted by an electric arc furnace, bottom poured into ingots, hot rolled, and finished with a normalized heat treatment.

Form: This Certified Reference Material is in the form of a disc, approximately 40 mm in diameter and 12 mm thick.

Use: This Certified 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 0021-071801-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 572 - 94 Standard Test Method for X-Ray Emission Spectrometric Analysis of Stainless 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 1086 - 94 Standard Test Method for Optical Emission Vacuum Spectrometric Analysis of Stainless Steel by the Point-to-Plane Excitation Technique

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 0021-071801p6