

Certificate of Analysis

BS 0022 (REVISION OF BS XDDF)

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

	Certified Value ²	Estimate of Uncertainty ³	Certified Value ²	Estimate of Uncertainty ³
Analysis listed as percent by weight				
C	0.050	0.002	N	0.033 0.001
Mn	0.41	0.01	Nb	0.007 0.001
P	0.018	0.001	Sn	0.004 0.001
S	0.011	0.0015	Ti	0.002 0.0005
Si	0.62	0.02	V	0.034 0.0004
Cu	0.036	0.005	Information Values⁴	
Ni	0.23	0.01	Mg	<0.0005
Cr	12.36	0.04	O	0.002
Mo	0.117	0.006	Pb	0.0006
Al	0.078	0.005	Sb	0.0004
As	0.003	0.001	W	0.008
B	0.0007	0.0002	Zn	<0.002
Co	0.017	0.002	Zr	<0.003

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 0022-050301p1

Analysis	* C	* Mn	* P	* S	* Si	* Cu	* Ni	* Cr	* Mo
1	C 0.0475	XRF 0.386	XRF 0.0175	C 0.0100	AIC 0.564	AIC 0.029	GNi 0.219	TCr 12.30	AIC 0.108
2	C 0.0481	AA 0.397	AIC 0.0179	C 0.0108	XRF 0.57	MCT 0.030	AIC 0.224	AES 12.30	AIC 0.112
3	C 0.0489	AES 0.40	AIC 0.0180	C 0.0109	AIC 0.596	AES 0.03	AIC 0.226	AES 12.31	AIC 0.113
4	C 0.0498	MnP 0.404	AES 0.018	C 0.0109	AIC 0.61	AA 0.033	AIC 0.227	AES 12.34	AIC 0.114
5	C 0.050	AIC 0.406	XRF 0.018	C 0.0110	GSi 0.616	ECS 0.033	AIC 0.228	AIC 12.34	XRF 0.114
6	C 0.0502	XRF 0.406	AIC 0.018	C 0.0113	GSi 0.616	XRF 0.033	AES 0.229	XRF 12.342	AA 0.114
7	C 0.0502	AA 0.407	AES 0.018	C 0.0116	AGA 0.622	AA 0.034	XRF 0.23	AIC 12.35	AES 0.1148
8	C 0.0510	AIC 0.408	AIC 0.0182	C 0.012	GSi 0.6267	AIC 0.036	XRF 0.23	AIC 12.35	XRF 0.115
9	C 0.0521	AGX 0.409	AES 0.0183	C 0.0135	XRF 0.63	AGX 0.036	AIC 0.23	XRF 12.37	AGX 0.115
10		XRF 0.41	AGA 0.0185		AES 0.63	AIC 0.0367	XRF 0.23	AA 12.38	XRF 0.117
11		AIC 0.410	AIC 0.019		XRF 0.638	AES 0.0373	AGA 0.232	XRF 12.39	AIC 0.117
12		AIC 0.414	AIC 0.019		AIC 0.643	XRF 0.038	XRF 0.235	AIC 12.40	AIC 0.117
13		XRF 0.416			AES 0.644	AIC 0.0415	AIC 0.236	TCr 12.41	GMo 0.1174
14		AES 0.419			XRF 0.648	XRF 0.042	AA 0.238	AIC 12.42	AES 0.12
15		AIC 0.43			AIC 0.661	AIC 0.043	AES 0.241		AIC 0.12
16		AIC 0.443					AIC 0.246		AES 0.123
17									XRF 0.123
18									AIC 0.131
Average	0.0498	0.410	0.0182	0.0113	0.621	0.0355	0.2313	12.357	0.1170
Std Dev	0.0014	0.013	0.0004	0.0010	0.027	0.0044	0.0067	0.039	0.0051
Certified	0.050	0.41	0.018	0.011	0.62	0.036	0.23	12.36	0.117
t	2.306	2.1315	2.201	2.306	2.1448	2.1448	2.1315	2.1604	2.1098
C(95%)	0.0011	0.0069	0.0003	0.0008	0.0151	0.0024	0.0035	0.023	0.0026
BS XDDF	0.050	0.41	0.019	0.012	0.62	(0.04)	0.23	12.35	0.117

Analysis	* Al	* As	* B	* Co	* N	* Nb	* Sn	* Ti	* V
1	AA 0.069	AIC 0.0021	AIC 0.0003	XRF 0.014	FU 0.0320	MNA 0.0061	AIC 0.0024	AIC 0.0012	AAA 0.029
2	AIC 0.0731	AIC 0.0024	AIC 0.0005	AIC 0.015	FU 0.0320	AIC 0.0062	AA 0.0024	AIC 0.0016	AIC 0.030
3	AIC 0.075	AIH 0.0025	AES 0.0006	AIC 0.0155	FU 0.0326	AIC 0.0067	AIC 0.0027	AES 0.002	AA 0.032
4	AES 0.0753	AGA 0.003	AIC 0.0006	AAA 0.0159	FU 0.0333	AIC 0.007	AIC 0.0028	XRF 0.002	AIC 0.0323
5	AES 0.076	AIH 0.0033	AES 0.0006	AIC 0.016	FU 0.0341	XRF 0.007	AGA 0.003	XRF 0.002	XRF 0.033
6	AGA 0.076	AA 0.0033	AGA 0.0007	XRF 0.016		AIC 0.0071	AES 0.003	AES 0.0024	AIC 0.033
7	AES 0.079	AIC 0.0038	AIC 0.0008	AA 0.017		AIC 0.0075	AIC 0.003		AES 0.0337
8	AIC 0.080	AIC 0.004	AES 0.0008	AGX 0.017		AES 0.008	AAG 0.0032		XRF 0.034
9	AIC 0.08	AAG 0.0045	AIC 0.0008	AIC 0.018		XRF 0.008	AIC 0.0035		XRF 0.034
10	AIC 0.081	AES 0.0047	AES 0.00083	AES 0.0181		AIC 0.008	AES 0.0036		AGX 0.034
11	AES 0.082		AIC 0.0009	AIC 0.0182		AGX 0.008	AIH 0.0038		AIC 0.035
12	AIC 0.082			XRF 0.020		AIC 0.008	AIM 0.0045		AIC 0.0370
13	AIC 0.082			AIC 0.0209			AES 0.0048		AES 0.038
14	AAA 0.083						AIC 0.005		AIC 0.0387
15							AES 0.006		AES 0.041
16									XRF 0.044
Average	0.0781	0.0034	0.00068	0.0170	0.03280	0.0073	0.0036	0.0019	0.0338
Std Dev	0.0041	0.0009	0.00018	0.0020	0.00090	0.0007	0.0011	0.0004	0.0027
Certified	0.078	0.003	0.0007	0.017	0.033	0.007	0.004	0.002	0.034
t	2.1604	2.2622	2.2281	2.1788	2.7764	2.201	2.1448	2.5706	2.1604
C(95%)	0.0024	0.0006	0.00012	0.0012	0.00112	0.0005	0.0006	0.0004	0.0016
BS XDDF	(0.08)	(0.003)	0.0005	0.018	0.033	0.007	0.003	(0.002)	0.032

Analysis	* Mg	* O	* Pb	* Sb	* W	* Zn	* Zr
1	AIC <0.0005	FU 0.00150	AIC 0.00012	AA 0.0003	XRF 0.002	AIC <0.0001	AIC <0.002
2	AES <0.0005	FU 0.0018	AA 0.00014	AIC 0.00038	AIC 0.002	AIC <0.002	AES 0.0006
3		FU 0.0026	AIC 0.0004	AIC 0.0005	AIC 0.0022		XRF 0.002
4			AES 0.0008		XRF 0.0025		
5			AES 0.001		AES 0.0073		
6			AES 0.0010		AIM 0.0089		
7					AGA 0.010		
8					AIC 0.0115		
9					AIC 0.012		
10					AIC 0.012		
11					AES 0.018		
Average	<0.0005	0.0020	0.0006	0.0004	0.0080		
Std Dev		0.0006	0.0004	0.0001	0.0053		
Information (<0.0005)		(0.002)	(0.0006)	(0.0004)	(0.008)	(<0.002)	(<0.003)
BS XDDF		0.0021	(0.00013)	(0.0004)			(<0.002)

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
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, Benzolnoxime
GNi	Ni	Dimethylglyoxime gravimetric
GSi	Si	Gravimetry with perchloric acid
MCT	Cu	MAS - Tetraethylthiuram disulphide
MNA	Nb	MAS - Absorptionmetric determination method with 4-(2-pyridylazo)-Resorcinol
MnP	Mn	MAS - Periodate oxidation
TCr	Cr	Persulfate oxidation, ferrous sulfate titrimetric
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 0022 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 327, 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	26	22	21
Grand Average	0.0500	0.0114	0.0328	0.0026
Standard Deviation	0.0020	0.0008	0.0011	0.0012

Optical Emission Spectrometric Analysis using ASTM Standard Test Method E 1086

	C	Mn	P	S	Si	Cu	Ni
Number of Labs	17	23	23	17	22	21	18
Grand Average	0.0509	0.4090	0.0183	0.0110	0.5978	0.0355	0.2284
Standard Deviation	0.0025	0.0070	0.0009	0.0010	0.0217	0.0050	0.0071

	Cr	Mo	Co	V	Al
Number of Labs	20	22	6	10	9
Grand Average	12.3807	0.1150	0.0177	0.0308	0.0770
Standard Deviation	0.0541	0.0112	0.0013	0.0048	0.0166

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	9	10	15	17	17	17	9	15
Grand Average	0.4099	0.0189	0.6119	0.0347	0.2292	12.3756	0.1146	0.0348	0.0180
Standard Deviation	0.0069	0.0009	0.0105	0.0044	0.0040	0.0817	0.0021	0.0027	0.0034

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, 401A.

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 United States Steel Corporation, Pittsburgh, Pennsylvania. It was melted by an electric arc furnace, bottom poured into ingots, hot rolled, and finished with a normalized heat treatment. The material was originally certified as USS Standard Number DDF in 1974.

Form: This Certified Reference Material is in the form of a disc, approximately 38 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 0022-050301-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.

Revision information: A new interlaboratory testing program (ITP) was initiated for this material when a replacement was tested. There were no dramatic changes in the analyses originally certified. The original values certified on January 5, 1994, are listed on page 2 at the bottom of each table. The original part number was BS XDDF with certificate number XDDF-010594.

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 May 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

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 327 - 94 Standard Test Method for Optical Emission Spectrometric Analysis of Stainless Type 18-8 Steels by the Point-to-Plane Technique

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 0022-050301p6