

Certificate of Analysis

BS 9812

Certified Reference Material¹ for Custom 450 Stainless Steel Alloy
(UNS Number S45000)

	Certified Value ²	Estimate of Uncertainty ³	Certified Value ²	Estimate of Ucertainty ³
Analysis listed as percent by weight				
C	0.031	0.002	Sn	0.004 0.0004
Mn	0.485	0.008	V	0.088 0.003
P	0.018	0.001	W	0.025 0.004
S	0.004	0.0005		
Si	0.43	0.012		
Cu	1.65	0.02		
Ni	6.61	0.04	Information Values⁴	
Cr	14.82	0.04	Al	0.002
Mo	0.76	0.012	As	0.005
Ca	0.0012	0.0002	B	0.0003
Co	0.110	0.004	O	0.007
N	0.0195	0.0008	Ti	0.005
Nb	0.645	0.012		

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.

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Analysis	*	C	* Mn	* P	* S	* Si	* Cu	* Ni	* Cr	
1	C	0.029	XRF 0.475	XRF 0.0165	C	0.003	AIC 0.407	AIC 1.62	AIC 6.560	TCr 14.75
2	C	0.029	AES 0.476	AIC 0.017	C	0.0034	XRF 0.411	AES 1.628	TNi 6.58	AIC 14.79
3	C	0.0296	XRF 0.477	XRF 0.017	C	0.00344	XRF 0.417	AIC 1.63	AIC 6.59	AES 14.798
4	C	0.0299	AA 0.481	AIC 0.0172	IC	0.0038	AES 0.421	AIC 1.634	GNI 6.601	TCr 14.80
5	C	0.0313	AIC 0.481	XRF 0.0176	C	0.0038	GSI 0.426	MCB 1.64	XRF 6.601	AES 14.80
6	C	0.033	AIC 0.481	AIC 0.0177	C	0.0039	AES 0.427	AES 1.65	AES 6.61	XRF 14.805
7	C	0.033	MnP 0.484	MPN 0.0178	C	0.0046	AIC 0.430	AA 1.651	AIC 6.62	AGA 14.81
8			MnP 0.485	AIC 0.0179			XRF 0.43	XRF 1.658	AES 6.623	TCr 14.84
9			AGX 0.485	XRF 0.018			GSI 0.432	AGX 1.66	GNI 6.63	XRF 14.85
10			AES 0.488	MPH 0.0184			AGA 0.432	XRF 1.661	AGA 6.64	XRF 14.861
11			AIC 0.489	AIC 0.0185			GSI 0.434	MCT 1.673	TNi 6.64	AIC 14.88
12			XRF 0.491	AGA 0.0186			AIC 0.437		XRF 6.65	XRF 14.88
13			MnP 0.4963	AES 0.0189						
14			XRF 0.497	AES 0.019						
Average		0.0307	0.4847	0.0179	0.0037	0.425	1.646	6.612	14.822	
Std Dev		0.0018	0.0069	0.0008	0.0005	0.009	0.017	0.027	0.040	
Certified		0.031	0.485	0.018	0.004	0.43	1.65	6.61	14.82	
t		2.4469	2.1604	2.1604	2.4469	2.201	2.2281	2.201	2.201	
C(95%)		0.0016	0.0040	0.0004	0.0005	0.006	0.011	0.017	0.025	

Analysis	*	Mo	* Ca	* Co	* N	* Nb	* Sn	* V	* W	
1	XRF	0.742	AIC 0.0008	AIC 0.101	TN	0.0184	XRF 0.626	AAG 0.0031	XRF 0.083	AIC 0.016
2	AIC	0.745	AES 0.00087	AIC 0.102	FU	0.0188	AIC 0.630	AES 0.0035	AES 0.085	XRF 0.018
3	AIC	0.747	AAA 0.0011	AAA 0.106	FU	0.0193	XRF 0.638	AIH 0.0036	AIC 0.0857	MWC 0.0197
4	AIC	0.748	AIC 0.0011	AA 0.107	FU	0.0193	AGX 0.639	AIM 0.0036	AGA 0.086	AIC 0.0201
5	AGX	0.752	AGA 0.0012	M5 0.108	FU	0.0194	AIC 0.642	AIC 0.004	XRF 0.086	AIC 0.0216
6	AES	0.755	AES 0.00128	AIC 0.110	FU	0.020	AIC 0.642	MSn 0.0040	AIC 0.0862	XRF 0.025
7	AES	0.755	AIC 0.0013	AIC 0.111	FU	0.0202	AIC 0.643	AGA 0.004	MVE 0.0862	XRF 0.025
8	XRF	0.756	AA 0.0013	AES 0.111	FU	0.0205	AES 0.644	AES 0.0043	XRF 0.0875	AES 0.027
9	XRF	0.758	AIC 0.0014	AGX 0.112			MNR 0.646	AIC 0.0043	AIC 0.0878	AIM 0.0271
10	AIC	0.768	AIC 0.0014	XRF 0.112			AES 0.646	AIM 0.0044	AES 0.088	AIC 0.028
11	AIC	0.772		XRF 0.113			MNA 0.6469	AIC 0.0045	XRF 0.089	AGA 0.028
12	MMT	0.783		AES 0.115			XRF 0.65	AES 0.00475	AAA 0.0916	AES 0.029
13				XRF 0.116			XRF 0.666		AIC 0.0955	XRF 0.031
14				XRF 0.117			AIC 0.668			AIC 0.033
Average		0.7568	0.00118	0.1101	0.01949	0.6448	0.0040	0.0875	0.0249	
Std Dev		0.0121	0.00021	0.0048	0.00071	0.0114	0.0005	0.0032	0.0051	
Certified		0.76	0.0012	0.110	0.0195	0.645	0.004	0.088	0.025	
t		2.201	2.2622	2.1604	2.3646	2.1604	2.201	2.1788	2.1604	
C(95%)		0.0077	0.00015	0.0028	0.00059	0.0066	0.0003	0.0019	0.0029	

Analysis	*	Al	* As	* B	* O	* Ti	
1	XRF	0.001	AAG 0.0035	AES 0.0002	FU	0.0060	AES 0.0038
2	XRF	0.002	AES 0.0052	AES 0.00028	FU	0.0060	XRF 0.004
3	AES	0.0024	AES 0.0055	AES 0.00031	FU	0.00606	AES 0.0052
4	AES	0.0035			FU	0.0064	XRF 0.0055
5					FU	0.009	XRF 0.007
Average		0.0022	0.00473	0.00026	0.0067	0.0051	
Std Dev		0.0010	0.00108	0.00006	0.0013	0.0013	
Certified		(0.002)	(0.005)	(0.0003)	(0.007)	(0.005)	

* 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 - 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
FU	N, O	Inert gas Fusion Method (ASTM E 1019) traceable to CRMs
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
MCT	Cu	MAS - Tetraethylthiuram disulfide
MMT	Mo	MAS - Thiocyanate photometric
MNA	Nb	MAS - Absorptionmetric determination method with 4-(2-pyridylazo)-Resorcinol
MnP	Mn	MAS - Periodate oxidation
MNR	Nb	MAS - PAR photometric
MPH	P	MAS - Heteropoly molybdenum blue photometric
MPN	P	MAS - 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
TNi	Ni	EDTA 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
 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 Bišovský
 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 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 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	25	19	18
Grand Average	0.0309	0.0038	0.0193	0.0070
Standard Deviation	0.0034	0.0005	0.0005	0.0009

Optical Emission Spectrometric Analysis using ASTM Standard Test Method E 1086

	C	Mn	P	S	Si	Cu	Ni
Number of Labs	18	16	19	15	17	17	16
Grand Average	0.0316	0.4902	0.0175	0.0039	0.4349	1.6654	6.6115
Standard Deviation	0.0031	0.0055	0.0020	0.0004	0.0210	0.0322	0.0412

	Cr	Mo	Co	V	Nb
Number of Labs	18	18	8	5	6
Grand Average	14.8296	0.7565	0.1136	0.0853	0.6622
Standard Deviation	0.0961	0.0185	0.0040	0.0026	0.0310

Optical Emission Spectrometric Analysis using ASTM Standard Test Method E 327

	Mn	Cu	Ni	Cr	Si
Number of Labs	4	4	3	4	4
Grand Average	0.4893	1.6838	6.6327	14.9033	0.4250
Standard Deviation	0.0062	0.0395	0.0814	0.1145	0.0088

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

	Mn	P	Si	Cu	Ni	Cr	Mo	V	Co	Nb
Number of Labs	14	7	6	13	14	14	14	7	14	13
Grand Average	0.4798	0.0179	0.4290	1.6558	6.6284	14.8374	0.7487	0.0899	0.1137	0.6528
Standard Deviation	0.0148	0.0012	0.0175	0.0227	0.0294	0.0915	0.0151	0.0058	0.0060	0.0121

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 15h, 32b, 126c, 131f, 166b, 343a, 345, 3103a, 3107, 3109a, 3161a; ECRM 284-1, 289-1, 295-1; BS CSN-1.

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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 C1151, 1219, C1289, C2400; BS 17-4PH, 95, 95A, 96.

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 Carpenter Technology Corporation, Reading, Pennsylvania. 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 50 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 9812-032701-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 March 27, 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 9812-032701p6