Brammer Standard Company, Inc.

Certificate of Analysis

BS XCCS-1

Certified Reference Material for Carbon Steel

Certified Values[3]

	Certified Value[1]	Estimate of Uncertainty[2]		Certified Value[1]	Estimate of Uncertainty[2]
Al	**0.061**	0.001	**Sn**	**0.0002**	0.0001
As	**0.0024**	0.0002	**Ti**	**0.0015**	0.0002
C	**0.0441**	0.0009	**V**	**0.0012**	0.0002
Ca	**0.0024**	0.0006	**Zr**	**0.0006**	0.0002
Co	**0.0017**	0.0002			
Cr	**0.0288**	0.0007			
Cu	**0.0143**	0.0005			
Fe	**99.2**	0.4			
Mn	**0.356**	0.003			
Mo	**0.0060**	0.0003			
N	**0.0052**	0.0005			
Ni	**0.0132**	0.0004			
P	**0.0068**	0.0003			
S	**0.0022**	0.0002			
Si	**0.292**	0.008			

Informational Values[3,4]

B (0.0004) Mg (0.0003) Nb (0.001) Pb (0.0006) Sb (0.0005)
W (0.003)

[1] For each element, the certified value listed is the present best estimate of the true value based on the mean of the weighted results of an interlaboratory testing program. See page 4 for more information on its calculation.

[2] For each element, the uncertainty listed is based on a statistical evaluation of the contributions of homogeneity and the interlaboratory testing program. See page 4 for more information on its calculation.

[3] Values are given in weight percent. Values in brackets are reported by difference.

[4] Values in parentheses are not certified and are provided for information only.

Trace element information values for O are shown on page 4.

The requirements of ISO Guides 31, 34, and 35 were followed for the preparation of this Certified Reference Material and certificate of analysis. This is a Certified Reference Material as defined by ISO Guide 30.

Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895
Telephone: (281) 440-9396 Fax: (281) 440-4432 Website: www.brammerstandard.com

BS XCCS-1 * Code for method Certified values listed as weight percent

Analysis	*	Al	*	As	*	C	*	Ca[#]	*	Co	*	Cr	*	Cu	*	Fe
1	4	0.0526	5	0.001333	1	0.033467	4	0.0017	5	0.0014	10	0.025667	4	0.0090	16	[99.15823]
2	4	0.055333	5	0.0014	1	0.0392	4	0.0017	3	0.0015	3	0.026	3	0.012467	16	[99.16]
3	3	0.055567	4	0.001533	1	0.0408	4	0.002033	4	0.00158	4	0.026033	4	0.012825	16	[99.17]
4	7	0.06030	3	0.0016	1	0.0418	4	0.002153	5	0.001623	10	0.027	4	0.0129	16	[99.17]
5	5	0.060375	4	0.001633	3	0.0422	4	0.002233	4	0.001633	4	0.027333	4	0.0133	3	99.18
6	7	0.06060	9	0.001867	1	0.043467	4	0.002233	4	0.001653	3	0.0274	5	0.0135	14	99.2
7	3	0.061	10	0.0020	1	0.044137	3	0.0024	4	0.001653	4	0.027967	4	0.0136	4	99.20
8	4	0.061767	15	0.002047	1	0.044225	4	0.00252	4	0.001675	14	0.0280	3	0.0138	10	99.21
9	3	0.0622	4	0.002408	1	0.0443	4	0.002898	4	0.00169	4	0.028275	4	0.013875	13	99.24467
10	7	0.0623	4	0.002443	1	0.044575	4	0.002898	4	0.001723	3	0.0283	10	0.0144		
11	14	0.0623	4	0.00245	17	0.04475	4	0.0029	4	0.00174	13	0.028325	8	0.01445		
12	4	0.062533	4	0.002503	1	0.044925	4	0.002933	4	0.0019	5	0.028467	7	0.014467		
13	5	0.0631	4	0.002513	1	0.044925	18	0.002978	4	0.0023	4	0.028833	18	0.0147		
14	4	0.06325	4	0.002525	3	0.045			5	0.0025	13	0.02895	8	0.014867		
15	7	0.06335	5	0.002533	1	0.045					7	0.0290	4	0.01495		
16	4	0.065367			1	0.0453					4	0.02905	4	0.015		
17					1	0.048233					4	0.0294	4	0.015067		
18											4	0.03025	14	0.016333		
19													3	0.0165		
Average		0.0611		0.002403		0.0441		0.002702		0.001669		0.02875		0.01428		99.184
Std dev		0.0016		0.000065		0.0012		0.000067		0.000063		0.00088		0.00045		0.036
H		0.0017		0.000408		0.0014		0.000425		0.000362		0.001146		0.000823		0.55
U_1		0.0023		0.00041		0.0018		0.00043		0.00037		0.0014		0.00094		0.55
t-statistic		2.13		2.14		2.12		2.18		2.16		2.11		2.10		2.31
U_2		0.0049		0.00089		0.0039		0.00094		0.00079		0.0030		0.0020		1.27
U_3		0.0012		0.00023		0.0001		0.00026		0.00021		0.00072		0.00045		0.42
Certified		**0.061**		**0.0024**		**0.0441**		**0.0024**		**0.0017**		**0.0288**		**0.0143**		**99.2**
Uncertainty		**0.001**		**0.0002**		**0.0009**		**0.0006**		**0.0002**		**0.0007**		**0.0005**		**0.4**
Tolerance		0.005		0.0009		0.0039		0.0015		0.0008		0.0030		0.0020		1.3

[#] Unweighted mean and standard deviation were used to calculate Calcium. The weighted mean is 0.002702 and standard deviation is 0.000067. The weighted certified value is 0.0027 with an uncertainty of 0.0003 and a tolerance of 0.0009.

BS XCCS-1 * Code for method Certified values listed as weight percent

Analysis	*	Mn	*	Mo	*	N	*	Ni	*	P	*	S	*	Si	*	Sn
1	10	0.327667	3	0.0043	13	0.004998	4	0.0102	4	0.0041	1	0.001633	10	0.27	5	0.0001
2	4	0.349	14	0.0043	13	0.005033	4	0.0112	10	0.0047	1	0.00172	6	0.275667	4	0.00018
3	4	0.3495	3	0.0046	13	0.00516	10	0.0112	3	0.0056	1	0.0018	5	0.276	5	0.0002
4	8	0.34975	4	0.004667	13	0.005175	4	0.0116	4	0.0057	1	0.001867	4	0.27633	4	0.00023
5	4	0.351	4	0.004667	13	0.005248	8	0.011933	3	0.005767		0.001983	3	0.28	5	0.00028
6	7	0.3525	5	0.004733	13	0.00529	18	0.01205	14	0.0058		0.002075	4	0.28033	4	0.00031
7	14	0.354667	10	0.0049	13	0.00551	4	0.012533	7	0.00585		0.002083	3	0.285	5	0.00032
8	3	0.355	5	0.0050			3	0.0130	5	0.006333	3	0.0021	4	0.2865	4	0.000325
9	10	0.355	3	0.005033			10	0.0131	4	0.006843	1	0.002167	7	0.2865	4	0.000325
10	4	0.355433	4	0.005333			4	0.0131	4	0.006953	1	0.002183	7	0.2895	4	0.000413
11	7	0.355667	4	0.00560			4	0.013233	10	0.0070		0.002355	4	0.289967	3	0.0005
12	3	0.357	4	0.005743			4	0.013275	4	0.00708		0.002365	4	0.291967	4	0.0005
13	3	0.358	4	0.0059			4	0.0135	4	0.00718	1	0.002433	3	0.292		
14	4	0.358267	4	0.00615			3	0.0135	19	0.007195	1	0.002433	14	0.293667		
15	4	0.359	4	0.00667			4	0.0135	4	0.0072	1	0.002467	7	0.29375		
16	5	0.362667	4	0.00680			14	0.0136	7	0.007295		0.002483	4	0.301		
17	18	0.365	4	0.00720			5	0.0138	4	0.00734			4	0.302		
18	4	0.3655					4	0.0139	4	0.008067			7	0.302333		
19	4	0.365667											10	0.302333		
20	8	0.371667														
Average		0.3564		0.0059		0.00520		0.01317		0.00680		0.002162		0.2921		0.000228
Std dev		0.0033		0.00017		0.00017		0.00042		0.00020		0.000045		0.0033		0.000026
H		0.004895		0.00057		0.000539		0.0008		0.000599		0.000394		0.0043		0.000221
U_1		0.0059		0.00060		0.00056		0.00090		0.00063		0.00040		0.0054		0.00022
t-statistic		2.09		2.12		2.45		2.11		2.11		2.13		2.10		2.20
U_2		0.012		0.0013		0.0014		0.0019		0.0013		0.00084		0.011		0.00049
U_3		0.0028		0.00031		0.00052		0.00045		0.00031		0.00021		0.0026		0.00014
Certified		**0.356**		**0.0060**		**0.0052**		**0.0132**		**0.0068**		**0.0022**		**0.292**		**0.0002**
Uncertainty		**0.003**		**0.0003**		**0.0005**		**0.0004**		**0.0003**		**0.0002**		**0.008**		**0.0001**
Tolerance		0.012		0.0013		0.0014		0.0019		0.0013		0.0008		0.027		0.0002

Analysis	*	Ti	*	V	*	Zr
1	5	0.000857	5	0.0001967	4	0.000325
2	5	0.00092	5	0.0004	4	0.000525
3	5	0.000967	5	0.000477	4	0.00065
4	4	0.0012	4	0.000633	4	0.00075
5	14	0.001267	10	0.0009	5	0.0008
6	4	0.0013	3	0.0009	4	0.000833
7	3	0.0013	14	0.0009	4	0.0009
8	4	0.001367	4	0.0010	3	0.0009
9	3	0.0014	13	0.001025	10	0.0009
10	4	0.00155	4	0.001208	4	0.000925
11	4	0.001693	4	0.001213		
12	4	0.001695	4	0.001325		
13	4	0.001833	4	0.001358		
14	4	0.002063	4	0.001358		
Average		0.001521		0.001179		0.000608
Std dev		0.000058		0.000018		0.000055
H		0.000352		0.000326		0.000273
U_1		0.00036		0.00033		0.00028
t-statistic		2.16		2.16		2.26
U_2		0.00077		0.00071		0.00063
U_3		0.00021		0.00019		0.00020
Certified		**0.0015**		**0.0012**		**0.0006**
Uncertainty		**0.0002**		**0.0002**		**0.0002**
Tolerance		0.0008		0.0007		0.0006

BS XCCS-1 * Code for method Informational values listed as weight percent

Analysis	*	B	*	Mg	*	Nb	*	Pb	*	Sb	*	W
1	4	0.0001	4	0.000127	5	0.0000733	5	0.0000533	4	0.000195	4	0.000367
2	7	0.00068	3	0.00015	10	0.00009	3	0.0002	4	0.000255	5	0.000483
3			5	0.000233	5	0.0001067	4	0.00023	4	0.000413	5	0.00063
4			5	0.000293	4	0.0002333	10	0.0003	4	0.000688	14	0.003167
5			4	0.00066	7	0.00159	5	0.0003	4	0.000778	4	0.0032
6					4	0.0016075	9	0.0003633			3	0.0032
7					7	0.0016325	4	0.0006825			5	0.0069
8					4	0.0016975	4	0.000755				
9					4	0.0018225	4	0.00096				
10					4	0.001925	4	0.00102				
11							4	0.001065				
12							4	0.00120				
Average		0.00039		0.00029		0.0011		0.00059		0.00047		0.003
Std dev		0.00084		0.00029		0.0027		0.00080		0.00076		0.013
H		0.00025		0.00023		0.00032		0.000271		0.000257		0.00044
U_1		0.00088		0.00037		0.0027		0.00084		0.00080		0.013
t-statistic		12.71		2.78		2.26		2.20		2.78		2.45
U_2		0.011		0.0010		0.0060		0.0019		0.0022		0.033
U_3		0.0079		0.00046		0.0019		0.00054		0.00100		0.012
(Informational)		**(0.0004)**		**(0.0003)**		**(0.001)**		**(0.0006)**		**(0.0005)**		**(0.003)**

For each element, in accordance with the requirements of ISO Guides 34 and 35, an effort must be made to account for the effects on the certified value of the uncertainty estimate from homogeneity testing (H) and the uncertainties of the contributing laboratories. The average (A) is calculated using a weighted mean where the reciprocal of the square of each laboratory's combined uncertainty (C_L), calculated from its standard deviation (S_L) and its uncertainty estimate (U_L), is used as the weight (W_L) for it's mean (M_L). The standard deviation (S) is calculated as the square root of the reciprocal of the sum of the weights. U_1 is the combined uncertainty from homogeneity and labs. U_2 is U_1 multiplied by the coverage factor (95 % t-statistic). U_3 is U_2 divided by the square root of the number of determinations (n). Thus:

$$C_L = \sqrt{S_L^2 + U_L^2} \qquad W_L = \frac{1}{C_L^2} \qquad A = \frac{\sum_{i=1}^{n} W_L M_L}{\sum_{i=1}^{n} W_L} \qquad S = \frac{1}{\sqrt{\sum_{i=1}^{n} W_L}} \qquad U_1 = \sqrt{H^2 + S^2} \qquad U_2 = t \times U_1 \qquad U_3 = \frac{U_2}{\sqrt{n}}$$

*All but the final reported values are taken to two significant figures as determined by each quantity's uncertainty estimate. The final reported Uncertainty is U_3 rounded to one significant figure and represents the half width of the 95 % confidence interval for the **Certified** value. The final reported **Certified** value is A rounded to the same decimal place as the Uncertainty. The Tolerance is the half width of the 95 % confidence interval for measurements rounded to the same decimal place as the Uncertainty. The Uncertainty is a measure of the quality of the **Certified** value. The Tolerance is a measure of the expected performance of an analysis.*

For further information regarding the confidence interval for the certified value see ISO Guide 35:2006 section 6.

BS XCCS-1 * Code for analytical method Trace analysis listed as mg/kg (ppm)

Analysis	*	O
1	2	10.9
2	2	13.8
3	2	16.9

Analytical Method Codes:

1	Combustion (ASTM E1019)	8	Flame Atomic Absorption	14	DCP Atomic Emission
2	Fusion (ASTM E1019)	9	GF Atomic Absorption	15	HG Atomic Fluorescence
3	Spark Atomic Emission	10	X-Ray Fluorescence	16	Difference
4	ICP Atomic Emission	11	GD Atomic Emission	17	Volumetric
5	ICP Mass Spectrometry	12	GD Mass Spectrometry	18	Atomic Absorption Spectrometry
6	Gravimetric	13	Titrimetric	19	Reduced Molybdoantimonyl Phosphoric
7	Photometric				

ICP = Inductively Coupled Plasma GF = Graphite Furnace GD = Glow Discharge
DCP = Direct Current Plasma HG = Hydride Generation

Laboratory	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, Guide 34
LECO Corporation	St. Joseph, MI	A2LA	17025
NSL Analytical	Cleveland, OH	ACLASS	17025
Dirats Laboratories	Westfield,MA	ACLASS	17025
Luvak Inc.	Boylston, MA	PRI/Nadcap	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025
Exova	Glendale Heights, Il	A2LA	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	AB 554
Taiyuan Iron & Steel Group Co., Ltd.	Taiyuan, China	CNAS	17025
Wuhan Ir on & Steel Group Co., Ltd.	Wuhan, China	CNAS	17025
Shanghai Research Institute of Minerals	Shanghai, China	CNAS	17025
Panzhihua Iron & Steel Group Co., Ltd.	Panzhihua, China	CNAS	17025
Jinan Zhongbiao Scientific Co., LTD.	Jinan, China	CNAS	17025
Shijiazhuang Trump Scientific Co., LTD.	Shijiazhuang, China	CNAS	17025

A2LA = American Association for Laboratory Accreditation
ACLASS = ANSI-ASQ National Accreditation Board
CNAS = China National Accreditation Service
Nadcap = National Aerospace and Defense Contractors Accreditation Program
PCA = Polish Center For Accreditation
PRI =Performance Review Institute

Analysis: Chemical analyses were made on solid pieces from representative samples for the certified portion of the lot in accordance with ASTM Standard Practice E1806. The laboratories participating in the testing followed the requirements of ISO Standard 17025.

Traceability: The following Certified Reference Materials were used to validate the analytical data: 12X15252, 12X32550, 12X44220, 13X31254, 13X32101; 501-320, 501-501, 501-503, 501-504, 501-550, 501-644, 501-673, 501-675, 501-676, 501-993, 502-414, 502-873; AR 148, 642, 872, 875, 892, 911A, 1653; BAS 111, 409, 409/1, 434, 435, 464/1; BS CSN-4, 30D, 56G, 56H, 300, 1026, 1030; IARM 28G, 35H, 156B, 210C; IMZ 55/1, 58/1, 130, 139; JK Nr8F, 37; SRM 16F, 33C, 33D, 33E, 55D, 72F, 107B, 160B, 361, 362, 363, 364, 691, 1228, 1261, 1765, 1766, 1767, 2167, 3109A, 3131A, 3163, 3169.

Homogeneity: This Certified Reference Material (CRM) was tested for homogeneity using ASTM Standard Method E826 and found acceptable. It was also examined by spark atomic emission spectrometry and found to be compatible with the following Reference Materials — 501-676; BAS 111; BS CSN-4, 56G; SRM 1765, 1766, 1767, 2167.

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. The certification of BS XCCS-1 is valid indefinitely. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

Source: The cast stock for this CRM was produced by Jey Swen Enterprises; Koahsiung, China.

Form: This CRM is machined in the form of a disc, approximately 40 mm in diameter and 30 mm thick by Brammer Standard

Company, Inc.

Use: This CRM is intended for use in spark atomic emission, glow discharge, and x-ray spectrometric methods of analysis. Refer to ISO Guide 33 for information about the use of Certified Reference Materials.

Certified Area: The certified area of each disc is the portion extending several mm inward from each surface.

Sample Preparation: For best analytical results, use the same method for preparing the analytical surface on all reference materials as used for production specimens. Avoid overheating the sample during surface preparation.

Certificate Number: The unique identification number for this certificate of analysis is XCCS-1-020316. You may obtain information on revisions of certificates from the internet at **www.brammerstandard.com**.

Safety Notice: A Safety Data Sheet (SDS) 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. **Phone: (281) 440-9396** **Web: www.brammerstandard.com**
14603 Benfer Road
Houston, Texas 77069-2895 USA **Fax: (281) 440-4432** **Email: contact@brammerstandard.com**

Brammer Standard Company, Inc., is accredited by the American Association For Laboratory Accreditation (A2LA) to ISO Guide 34 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials (Certificate Number 656.02)

Brammer Standard Company's Chemical Laboratory is accredited by A2LA to ISO Standard 17025. (Certificate Number 656.01)

By Certificate Number 10539, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9001:2008 by National Quality Assurance (NQA), U.S.A.

The scopes of accreditation are listed on the website: www.brammerstandard.com

References:

Versions used were those available at the time of testing and characterization

E826 Standard Practice for Testing Homogeneity of a Metal Lot or Batch in Solid Form by Spark Atomic Emission Spectrometry

E1019 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques

E1806 Standard Practice for Sampling Steel and Iron for Determination of Chemical Composition

ISO Standard 17025:2005 General requirements for the competence of testing and calibration laboratories

ISO Standard 9001:2008 Quality Management Systems - Requirements

ISO Guide 30:1992 Terms and definitions used in connection with reference materials + 2008 amendment

ISO Guide 31:2000 Reference materials - Contents of certificates and labels

ISO Guide 33:2000 Uses of certified reference materials

ISO Guide 34:2009 General requirements for the competence of reference material producers

ISO Guide 35:2006 Reference Materials - General and statistical principles for certification

ASTM documents available from ASTM, 100 Barr Habor Drive, West Conshohocken, PA, 19428.

ISO Guides and Standards available from Global Engineering - ***www.global.ihs.com***

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

Certified by: _____ on February 03, 2016.

Beau R. Brammer