

Brammer Standard Company, Inc.

Certificate of Analysis

BS XCCS-2

Certified Reference Material for Carbon Steel

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³	Certified Value ¹	Estimate of Uncertainty ²
Al	0.073	0.002	Mo	0.013	0.002
B	0.021	0.001	N	0.0139	0.0009
C	0.021	0.001	Ni	0.099	0.002
Ca	0.0032	0.0007	O	0.0066	0.0008
Co	0.016	0.001	P	0.0055	0.0008
Cr	0.039	0.001	S	0.0059	0.0006
Cu	0.047	0.002	Si	0.40	0.02
Fe	98.6	0.1	Ti	0.011	0.001
Mg	0.0003	0.0001	V	0.018	0.001
Mn	0.58	0.01	W	0.020	0.002
	Reference Value ¹	Estimate of Uncertainty ²	Reference Values ^{3,4}	Reference Value ¹	Estimate of Uncertainty ²
As	0.004	0.002	Sn	0.0015	0.0008
Nb	0.003	0.002	Ta	0.023	0.004
Pb	0.0004	0.0003	Zn	0.008	0.001
Sb	0.0016	0.0006	Zr	0.0015	0.0006

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 3 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 3 for more information on its calculation.

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

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

Trace element information values Zn are shown on page 4.

The requirements of ISO Guides 30, 31, and 35 were followed for the preparation of this Certified Reference Material and certificate of analysis.

Analysis	*	Al	*	B	*	C	*	Ca	*	Co	*	Cr	*	Cu	*	Fe	*	Mg	*	Mn
1	4	0.06586	4	0.015966667	1	0.0186	14	0.0019667	4	0.014633	4	0.0377	4	0.043701	16	[98.48633]	4	0.0002	4	0.552
2	4	0.06906	11	0.0179	3	0.0188	11	0.0025	4	0.0150	4	0.037975	4	0.045	16	[98.5495]	3	0.0002	4	0.580667
3	4	0.0714	4	0.020	1	0.019933	4	0.00295	10	0.015	4	0.0381	3	0.046	16	[98.56333]	11	0.0003	4	0.56765
4	5	0.07237	4	0.02001980	11	0.019967	4	0.0030867	11	0.015	4	0.0383	3	0.046	4	98.5693	11	0.0003	8	0.57
5	11	0.07277	4	0.0201	1	0.02	4	0.0031667	8	0.015	4	0.038363	4	0.046067	16	[98.5992334]	4	0.0003167	4	0.571067
6	4	0.0728	4	0.020166667	1	0.020333	11	0.0032333	4	0.015	3	0.0386	4	0.046667	14	98.6	4	0.00032	3	0.573
7	14	0.07287	14	0.020166667	1	0.020533	3	0.0034	4	0.0152	11	0.0386	4	0.046767	16	[98.6]			8	0.574667
8	4	0.0729	4	0.020233333	1	0.020567	4	0.0036033	3	0.0152	4	0.038833	4	0.04677	16	[98.6]			10	0.575
9	3	0.073	4	0.020366667	1	0.0206	3	0.0037	4	0.0153	14	0.038833	4	0.046867	16	[98.62333]			11	0.575
10	10	0.073	3	0.0216	1	0.02063	4	0.0047726	14	0.015333	11	0.0389	11	0.0469	16	[98.64]			4	0.578328
11	8	0.073	11	0.0216	1	0.021033			11	0.015733	10	0.039	10	0.047	16	[98.69]			4	0.580167
12	4	0.073	5	0.0220	11	0.0214			3	0.0158	8	0.039	8	0.047	13	98.6946667			4	0.5802
13	3	0.0735	3	0.0221	1	0.021467			4	0.015985	5	0.039433	14	0.047167					11	0.580333
14	4	0.0738	4	0.023176667	1	0.021667			4	0.016567	4	0.040	5	0.047667					7	0.580667
15	4	0.07457			3	0.022			5	0.0178	3	0.040	4	0.047853					4	0.581267
16	3	0.0749			1	0.0220			4	0.017833	3	0.040	3	0.048					14	0.581333
17	11	0.0763							4	0.040633	11	0.0488							3	0.582
18	4	0.07767							4	0.042507	4	0.048967							4	0.589333
19																			3	0.59
Average		0.0732		0.02054		0.02062		0.00324		0.015649		0.0393		0.0471		98.601		0.0003115		0.5758
Std Dev		0.0016		0.00064		0.00067		0.00010		0.000079		0.0010		0.0012		0.031		0.0000072		0.0036
H		0.0027		0.0015		0.0015		0.00067		0.0013		0.0020		0.0022		0.19		0.00028		0.0080
U ₁		0.0032		0.0016		0.0016		0.00068		0.0013		0.0023		0.0025		0.19		0.00028		0.0087
t-statistic		2.11		2.16		2.13		2.26		2.13		2.11		2.11		2.20		2.57		2.10
U ₂		0.0067		0.0035		0.0035		0.0015		0.0028		0.0048		0.0053		0.43		0.00072		0.018
U ₃		0.0016		0.00094		0.00087		0.00049		0.00070		0.0011		0.0013		0.12		0.00029		0.0042
Certified		0.073		0.021		0.021		0.0032		0.016		0.039		0.047		98.6		0.0003		0.58
Uncertainty		0.002		0.001		0.001		0.0007		0.001		0.001		0.002		0.1		0.0001		0.01
Tolerance		0.007		0.004		0.003		0.0021		0.003		0.005		0.006		0.4		0.0002		0.03

Analysis	*	Mo	*	N	*	Ni	*	O	*	P	*	S	*	Si	*	Ti	*	V	*	W
1	4	0.01027	2	0.013633333	4	0.084113	2	0.005333	11	0.004533	1	0.005	11	0.388667	3	0.010	4	0.016	4	0.017568
2	4	0.0108	2	0.0137	4	0.095967	4	0.00581	3	0.0049	1	0.0053	4	0.390333	10	0.01	4	0.016796	3	0.0178
3	4	0.01163	2	0.013725	10	0.097	2	0.006075	3	0.005	1	0.005433	11	0.392	3	0.010	5	0.0169	4	0.018
4	4	0.01177	2	0.013766667	3	0.097	2	0.0061633	4	0.005133	1	0.005633	6	0.399667	4	0.01056667	3	0.017	3	0.018
5	3	0.012	2	0.013766667	4	0.098333	2	0.0062	4	0.005233	1	0.005767	6	0.40	4	0.0109	3	0.0171	4	0.01822
6	4	0.01257	2	0.0138	11	0.099	2	0.0063	3	0.0053	1	0.00596	3	0.40	14	0.01103333	4	0.0172	4	0.019833
7	5	0.01287	2	0.013866667	11	0.0992	2	0.0063	11	0.0054	11	0.006	4	0.400	4	0.01106667	3	0.0175	4	0.020267
8	3	0.013	2	0.0139	4	0.0994	2	0.0068	4	0.005467	3	0.006	6	0.400267	4	0.01107436	4	0.0175	4	0.020367
9	14	0.01353	2	0.0140	4	0.099427	2	0.0071667	7	0.00556	11	0.006	14	0.401333	4	0.01109	4	0.0177667	5	0.020667
10	4	0.01433	2	0.0141	4	0.099633	2	0.00811	7	0.00559	1	0.006033	4	0.4021	4	0.0112	14	0.0178	4	0.02085
11	11	0.0146	2	0.014366667	4	0.099649	2	0.0081533	4	0.005603	1	0.006167	4	0.402367	11	0.01126667	4	0.0178	14	0.020867
12	10	0.0150	2	0.0144	3	0.0998			5	0.005767	1	0.0062	3	0.407	3	0.0115	4	0.0178633	4	0.021
13	4	0.015			8	0.100			4	0.005887	1	0.006267	4	0.409	5	0.0116	4	0.0179667	4	0.02122
14	11	0.01503			5	0.100867			10	0.0059	1	0.0063	4	0.41319	4	0.01173333	10	0.0180	3	0.023
15	3	0.0154			3	0.101			4	0.0060	1	0.00631	4	0.413333	11	0.012	11	0.0187		
16					14	0.101			4	0.006567	3	0.0064	3	0.417	4	0.012	4	0.0188067		
17					4	0.101667			4	0.007501			10	0.418			11	0.0191		
18					4	0.1046														
Average		0.01317		0.01389		0.098759		0.006583		0.00547		0.00595		0.4025		0.011064		0.01764		0.01984
Std Dev		0.00046		0.00049		0.000075		0.000095		0.00019		0.00019		0.0036		0.000079		0.00056		0.00072
H		0.0012		0.0013		0.0032		0.00090		0.00084		0.00087		0.0065		0.0011		0.0014		0.0015
U ₁		0.0013		0.0013		0.0032		0.00091		0.00086		0.00089		0.0075		0.0011		0.0015		0.0016
t-statistic		2.14		2.20		2.11		2.23		2.12		2.13		2.12		2.13		2.12		2.16
U ₂		0.0028		0.0030		0.0067		0.0020		0.0018		0.0019		0.016		0.0024		0.0032		0.0035
U ₃		0.00072		0.00085		0.0016		0.00061		0.00044		0.00047		0.0038		0.00060		0.00077		0.00094
Certified		0.013		0.0139		0.099		0.0066		0.0055		0.0059		0.40		0.011		0.018		0.020
Uncertainty		0.002		0.0009		0.002		0.0008		0.0008		0.0006		0.02		0.001		0.001		0.002
Tolerance		0.006		0.0030		0.007		0.0024		0.0024		0.0018		0.06		0.003		0.003		0.006

Analysis	*	As	*	Nb	*	Pb	*	Sb	*	Sn	*	Ta	*	Zn	*	Zr
1	3	0.0021	5	0.00123	5	0.0001	9	0.0004867	9	0.0001	11	0.0155	4	0.001767	4	0.00079667
2	4	0.0025	11	0.0017	5	0.000103	9	0.0007	3	0.0004	3	0.0198	4	0.00839	3	0.0009
3	15	0.00292	11	0.001933333	3	0.0002	5	0.00095	5	0.000753	4	0.020	4	0.00845	4	0.00102
4	10	0.0030	10	0.002	10	0.0005	5	0.0010533	5	0.001	4	0.023333	4	0.00854	3	0.0011
5	9	0.0030	4	0.002706667	4	0.00051	3	0.0015	10	0.0016	4	0.024093	4	0.008823	11	0.0012
6	5	0.00311	4	0.002933333	11	0.0006	11	0.0015	4	0.001833	5	0.025267	5	0.0091	10	0.0017
7	4	0.00414	4	0.003033333	9	0.0006	4	0.0020667	4	0.002033	5	0.026233			11	0.0019
8	4	0.0044	3	0.0046	11	0.000933	4	0.00208	11	0.0021	4	0.026737			4	0.00311
9	4	0.00467	4	0.004916667			4	0.0021	11	0.002233	4	0.026867				
10	5	0.00503					11	0.0034	4	0.002567	4	0.027				
11	4	0.00698														
Average		0.00380		0.00278		0.00044		0.00158		0.001464		0.02300		0.008		0.00147
Std Dev		0.00015		0.00011		0.00011		0.00010		0.000043		0.00092		0.065		0.00011
H		0.00072		0.00063		0.00032		0.00051		0.00049		0.0016		0.0009		0.00049
U ₁		0.00073		0.00064		0.00034		0.00052		0.00049		0.0018		0.065		0.00051
t-statistic		2.23		2.31		2.36		2.26		2.26		2.26		2.57		2.36
U ₂		0.0016		0.0015		0.00079		0.0012		0.0011		0.0041		0.17		0.0012
U ₃		0.00049		0.00049		0.00028		0.00037		0.00035		0.0013		0.068		0.00042
Reference		0.004		0.003		0.0004		0.0016		0.0015		0.023		0.008		0.0015
Uncertainty		0.002		0.002		0.0003		0.0006		0.0008		0.004		0.001		0.0006
Tolerance		0.003		0.002		0.0003		0.0015		0.0014		0.012		0.003		0.0014

For each element, in accordance with the requirements of ISO 17034 and Guide 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 its mean (M_L). The standard deviation (S) is calculated as the square root of the reciprocal of the sum of the weights. U₁ is the combined uncertainty from homogeneity and labs. U₂ is U₁ multiplied by the coverage factor (95 % t-statistic). U₃ is U₂ divided by the square root of the number of determinations (n). Thus:

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

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 U₃ 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 Uncertainty is a measure of the quality of the **Certified** value.

The Tolerance is a measure of the expected performance of an analysis. This involves further expanding the sample uncertainty to include instrument and operator uncertainty, for those without access to such calculations.

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

Analytical Method Codes:

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

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

Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, 17034
Jey Swen Enterprise Co.	Koahsiung, Taiwan	CNAS	17025
NSL Analytical	Cleveland, OH	ANAB	17025
Vitkovice Testing Center	Hulvaky, Ostrava	ILAC	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
LECO Corporation	St. Joseph, MI	A2LA	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
Luvak Inc.	Boylston, MA	PRI	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI	17025
Shiva Analyticals Private Limited	Hoskote, Bangalore	NABL	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Element Materials Technology	Huntington Beach, CA	A2LA	17025

A2LA = American Association for Laboratory Accreditation

ANAB = ANSI-ASQ National Accreditation Board

CNAS = China National Accreditation Service

NABL = National Accreditation Board for Testing and Calibration Laboratories

PCA = Polish Center For Accreditation

PRI =Performance Review Institute

Analysis: Chemical analyses were made on solid pieces and chips prepared by an end mill 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: 12XLA10, 12XLA90, 13X12534X, 13X12855N, 13X14211R, 22X9030, 24X26310; AR 511, 512, 644, 654, 657, 659, 662, 668, 673, 869, 881, 885, 892, 1647, 1650, 1651, 1653; BAS 312, 346A, 401, 401/1, 431/1, 452/1, 459/1, 464/1; BS CCS-1, CE 012, XCCS, XCCS-1, 54H, 57E, 160A, 203, 231, 1009, 1016, 1018, 1020, 1026, 1045, 2931A, 8620E, 8740; CKD 164A, 165I, 235; DSZU CA013; ECRM 082-1, 85-1, 86-1, 87-1; IARM 30C, 38A, 98B, 189A, 190A, 270A, 1456A; IMZ 64/1, 65, 112, 130, 139, 198, 199; IPT 12A, 39, 43, 97; JSM M402-4; JSS 170-7, 171-5, 175-6; LECO 501-024, 501-504, 501-505, 501-506, 501-644, 501-646, 501-712, 502-893, 502-916, 502-928, 502-991, 503-501; NCS NS 21006; SPL CM-25A, 182A; SRM 13F, 153, 160B, 293, 361, 363, 364, 1167, 1263, 1264, 1765, 1766, 2166, 3113, 3131A; USS AAT, MM.

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: BAS 452/1; BS XCCS, XCCS-1, 57E, 203, 1009, 1016, 2931A; CKD 165I; JSS 169-6; SRM 1167.

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-2 is valid indefinitely. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

Storage: This CRM must be stored in a cool, dry, non-corrosive environment.

Source: The cast stock for this CRM was produced by Jey Swen Enterprise Co.; Kaohsiung, Taiwan.

Form: This CRM is machined in the form of a disc, approximately 37mm in diameter and 30mm 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.

Note: Shrinkage cavities may appear in the horizontal center of some discs. These cavities are normal and will not affect the certified portions of the disc.]

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.

Caution: CRM contains significant insoluble soft metal inclusions. Surface smearing may occur. Spark atomic emission spectrometers may require extended preburns to compensate.

Certificate Number: The unique identification number for this certificate of analysis is XCCS-2-011022. 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.
14603 Benfer Road
Houston, Texas 77069-2895 USA

Phone: (281) 440-9396
Fax: (281) 440-4432

Web: www.brammerstandard.com
Email: contact@brammerstandard.com

Brammer Standard Company, Inc., is accredited by the American Association For Laboratory Accreditation (A2LA) to ISO Standard 17034 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 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 17025:2017 General requirements for the competence of testing and calibration laboratories

ISO Standard 9001:2015 Quality Management Systems - Requirements

ISO Guide 30:2015 Terms and definitions used in connection with reference materials + 2008 amendment

ISO Guide 31:2015 Reference materials - Contents of certificates and labels

ISO Guide 33:2015 Uses of certified reference materials

ISO Standard 17034:2016 General requirements for the competence of reference material producers

ISO Guide 35:2017 Reference Materials - General and statistical principles for certification

ASTM documents available from ASTM, 100 Barr Harbor Dr., 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 January 10, 2022.

Beau R. Brammer

President