

Brammer Standard Company, Inc.

Certificate of Analysis

BS 1035

Certified Reference Material for Carbon Steel Grade 1035 - UNS Number G10350

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²	
Al	0.0008	0.0003		N	0.0105	0.0008
As	0.0051	0.0005		Ni	0.123	0.009
C	0.362	0.006		O	0.0036	0.0005
Ca	0.0017	0.0004		P	0.0100	0.0009
Co	0.0073	0.0006		S	0.028	0.002
Cr	0.151	0.005		Si	0.246	0.006
Cu	0.241	0.003		Sn	0.0207	0.0009
Fe	97.9	0.2		Ti	0.0007	0.0003
Mn	0.758	0.008		V	0.026	0.001
Mo	0.049	0.003		W	0.0020	0.0004

Informational Values^{3,4}

B (0.0002)	Mg (0.0003)	Nb (0.001)	Pb (0.001)	Sb (0.002)
Zr (0.0009)				

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

Trace element information values for Ag, Cl, F, Ga, Ge, In, Na, Re, and Zn are shown on page 3.

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	*	As	*	C	*	Ca	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo
1	12	0.0004267	5	0.0037667	1	0.35	12	0.00046667	5	0.00641	4	0.1433333	4	0.2337	16	[97.86]	4	0.7477333	4	0.0446333
2	5	0.0004967	4	0.00413	1	0.35667	4	0.0016	5	0.00647	4	0.146	4	0.236	16	[97.9233]	4	0.7494333	3	0.0458333
3	3	0.0006	15	0.00472	1	0.3567	3	0.00163	10	0.007	3	0.1463333	10	0.237	3	97.933333	3	0.75	3	0.0461
4	3	0.0006	4	0.0048333	1	0.35673	4	0.0018	8	0.00709	17	0.1497	8	0.23867	10	97.94	10	0.751	4	0.0469333
5	4	0.0007667	10	0.0050333	1	0.35947	4	0.00193333	3	0.0075	4	0.1499	4	0.23987	4	97.948667	3	0.754	4	0.0473
6	5	0.0010	5	0.0050667	3	0.36	4	0.00209667	10	0.0075	3	0.15	4	0.24	4	97.95	10	0.7563333	4	0.0474667
7	4	0.0011867	10	0.0051	1	0.36	4	0.0032	4	0.00757	4	0.15	3	0.241	16	[97.97]	4	0.7586667	10	0.0475
8	10	0.0022333	3	0.0052	1	0.36			3	0.0076	3	0.1508	3	0.241	13	98.016667	10	0.76	3	0.0476
9	4	0.0023333	4	0.0052333	1	0.360			4	0.00767	10	0.152	10	0.24133			4	0.76	4	0.0476
10			12	0.0056667	3	0.361			4	0.00777	3	0.152	10	0.242			4	0.761	10	0.0481
11			3	0.0063	1	0.36167			5	0.00793	10	0.1533333	3	0.242			4	0.763	4	0.0484
12			5	0.0070333	1	0.3645			3	0.008	4	0.1537	4	0.24237			4	0.7636667	10	0.049
13					3	0.3670					4	0.1537	4	0.24267			3	0.764	10	0.0492
14					1	0.37567					4	0.1553333	3	0.2430			4	0.7672	7	0.0504667
15											10	0.158	4	0.2431			3	0.7680	3	0.0511
16											10	0.1583333	4	0.24433					5	0.0539667
17																			4	0.0581
Average		0.000819		0.00515		0.3615		0.001686		0.00735		0.1512		0.2408		97.943		0.758269		0.0489
Std Dev		0.000033		0.00017		0.0047		0.000094		0.00029		0.0028		0.0034		0.039		0.000082		0.0014
H		0.00037		0.00073		0.0057		0.00047		0.00084		0.0036		0.0046		0.24		0.0088		0.0020
U ₁		0.00037		0.00074		0.0074		0.00048		0.00089		0.0045		0.0057		0.25		0.0088		0.0024
t-statistic		2.31		2.20		2.16		2.45		2.20		2.13		2.13		2.36		2.14		2.12
U ₂		0.00085		0.0016		0.016		0.0012		0.0020		0.010		0.012		0.59		0.019		0.0052
U ₃		0.00028		0.00047		0.0043		0.00044		0.00057		0.0024		0.0030		0.21		0.0049		0.0013
Certified		0.0008		0.0051		0.362		0.0017		0.0073		0.151		0.241		97.9		0.758		0.049
Uncertainty		0.0003		0.0005		0.006		0.0004		0.0006		0.005		0.003		0.2		0.008		0.003
Tolerance		0.0008		0.0016		0.018		0.0012		0.0020		0.015		0.012		0.6		0.024		0.009

Analysis	*	N	*	Ni	*	O	*	P	*	S	*	Si	*	Sn	*	Ti	*	V	*	W
1	2	0.010	10	0.099	2	0.0015	5	0.00826667	1	0.021	4	0.2392667	10	0.01817	12	0.0001333	4	0.0238333	12	0.0010667
2	2	0.01015	3	0.112	2	0.00335	4	0.00909667	1	0.02223	3	0.24	4	0.019	5	0.0005	1	0.025	3	0.0016
3	2	0.0102333	10	0.1143333	2	0.00368	7	0.00912	1	0.026	3	0.24	3	0.0202	4	0.0007	4	0.0251	4	0.0018
4	2	0.0104667	4	0.1146667	2	0.00368	4	0.00913333	1	0.0262	4	0.241	10	0.02027	5	0.0007	4	0.0253	10	0.002
5	2	0.0106267	10	0.1181333	2	0.00369	10	0.0093	10	0.027	6	0.2413333	4	0.02047	5	0.0007167	3	0.0255	10	0.0020
6	2	0.0106333	4	0.1193333	2	0.00387	7	0.00933333	3	0.028	4	0.2416667	10	0.0208	3	0.0008	3	0.0258667	5	0.0021733
7	2	0.0107367	4	0.12	2	0.00403	5	0.00943333	10	0.028	10	0.2426667	3	0.021	4	0.0008667	4	0.0260333	5	0.0022333
8	2	0.0109333	8	0.1203333	2	0.0046	3	0.0096	3	0.0285	3	0.2439	4	0.0211	3	0.0009	10	0.0261333	4	0.0022667
9	2	0.011	4	0.1223	2	0.0046	12	0.00973333	1	0.02857	10	0.247	3	0.0212	4	0.0009	5	0.0263	5	0.0023
10			4	0.1238333	2	0.00685	3	0.0099	1	0.02867	4	0.2476667	4	0.02123	10	0.0009667	4	0.0263		
11			3	0.125			4	0.00993333	1	0.0287	4	0.2513	5	0.0213			3	0.0266		
12			3	0.1289			3	0.0100	3	0.0288	10	0.2516667	4	0.02233			4	0.027		
13			4	0.1301			10	0.01023333	1	0.029	4	0.2576333	4	0.0232			10	0.027		
14			4	0.1303			4	0.01033333	1	0.02947	5	0.2656667	5	0.02407			10	0.0275667		
15			4	0.1326667			4	0.0119	1	0.03043							4	0.0279667		
16			10	0.133					12	0.03267										
17			3	0.137					1	0.034										
18			5	0.1413333																
Average		0.01052		0.1226		0.00358		0.01002		0.02795		0.2465		0.02074		0.000746		0.02631		0.001964
Std Dev		0.00050		0.0024		0.00020		0.00036		0.00099		0.0042		0.00088		0.000045		0.00091		0.000056
H		0.0010		0.0032		0.00063		0.0010		0.0015		0.0046		0.0013		0.000354		0.0015		0.00050
U ₁		0.0011		0.0040		0.00066		0.0010		0.0018		0.0062		0.0016		0.00036		0.0017		0.00050
t-statistic		2.31		2.11		2.26		2.14		2.12		2.16		2.16		2.26		2.14		2.31
U ₂		0.0025		0.0085		0.0015		0.0022		0.0038		0.013		0.0034		0.00081		0.0037		0.0012
U ₃		0.00085		0.0020		0.00047		0.00057		0.00093		0.0036		0.00092		0.00026		0.0010		0.00039
Certified		0.0105		0.123		0.0036		0.0100		0.028		0.246		0.0207		0.0007		0.026		0.0020
Uncertainty		0.0008		0.009		0.0005		0.0009		0.002		0.006		0.0009		0.0003		0.001		0.0004
Tolerance		0.0025		0.027		0.0015		0.0027		0.006		0.018		0.0034		0.0007		0.004		0.0012

BS 1035

* Code for method Informational values listed as weight percent

Analysis	*	B	*	Mg	*	Nb	*	Pb	*	Sb	*	Zr								
1	4	0.0001	12	0.000099	12	0.00012	12	0.0000817	4	0.0018	5	0.00002								
2	12	0.0001967	3	0.00022	4	0.0002	5	0.00015333	12	0.00187	12	0.000032								
3	4	0.0002	4	0.00026	3	0.0003	5	0.00018			5	0.0001033								
4	5	0.00022	5	0.0002667	5	0.00032	5	0.0002			4	0.0005								
5	3	0.00022	4	0.00047	4	0.00033	5	0.00023333			3	0.0006								
6	7	0.0002233			5	0.00036	3	0.0004			4	0.0040667								
7	3	0.0004			5	0.0005	10	0.0005												
8					10	0.001	10	0.003												
9					4	0.0025	4	0.0043												
10					4	0.003														
11					3	0.0032														
Average		0.00022		0.00026		0.0011		0.0010		0.002		0.0009								
Std Dev		0.00014		0.00023		0.0025		0.0025		0.015		0.0024								
H		0.00024		0.00025		0.0004		0.0004		0.001		0.0004								
U ₁		0.00028		0.00034		0.0026		0.0025		0.015		0.0024								
t-statistic		2.45		2.78		2.23		2.31		12.71		2.57								
U ₂		0.00068		0.0010		0.0057		0.0058		0.19		0.0063								
U ₃		0.00026		0.00043		0.0017		0.0019		0.13		0.0026								
Informational		(0.0002)		(0.0003)		(0.001)		(0.001)		(0.002)		(0.0009)								

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.

BS 1035

* Code for analytical method Trace analysis listed as mg/kg (ppm)

Analysis	*	Ag	*	Cl	*	F	*	Ga	*	Ge	*	In	*	Na	*	Re	*	Zn						
1	12	2	12	0.04	12	0.05	12	7.6	12	12	12	0.37	12	0.02	12	0.02	12	36						
2	12	2.2	12	0.04			12	7.9	12	12	12	0.39	12	0.03	12	0.02	12	36						
3	12	2.3	12	0.07			12	8.1	12	13	12	0.4	12	0.03	12	0.05	12	36						

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 | 17 AAS |
| 6 Gravimetric | 12 GD Mass Spectrometry | |

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

Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, 17034
LECO Corporation	St. Joseph, MI	A2LA	17025
NSL Analytical	Cleveland, OH	ANAB	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI	17025
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Exova	Santa Fe Spring, CA	A2LA	17025
Evans Analytical Group	Liverpool, NY	A2LA	17025

A2LA = American Association for Laboratory Accreditation

ANAB = ANSI-ASQ National Accreditation Board

CNAS = China National Accreditation Service

PCA = Polish Center For Accreditation

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: 12X349D, 12XLA2; AR 612B, 645, 654, 657, 875, 882, 1648, 1650, 1652, 1653; BAS 206/3, 342, 406, 408, 434, 451, 459, 460, 464/1; BS D-6, 55G, 56H, 61G, 63B, 68E, 73A, 300, 1020, 1026, 1030, 2931A, 2942, 3942, 4931, 8630B, 8620E; CKD 167A, 168A; ECRM 85-1, 86-1, 87-1; IARM 14D, 19F, 28D, 28E, 28H, 28I, 32D, 182B, 209C, 209D, 210C, 360A; IMZ 74A, 112, 114, 124, 132; LECO 501-320, 501-501, 501-503, 501-504, 501-505, 501-644, 501-646, 501-675, 501-676, 501-677, 501-991, 501-993, 502-197, 502-348, 502-856, 502-870, 502-874, 502-894, 502-895, 502-916, 502-918; SRM 72F, 132A, 153A, 160B, 361, 362, 363, 364, 365, 1162, 1261A, 1262A, 1264A, 1265A, 3101A, 3134, 3137.

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 410/2, 458/1; BS HON-U, 56G, 56H, 63B, 1020, 1030, 2942, 3942, 4931; CKD CZ 2005A; DSZU CA013; LECO 501-676; NCS NS 21006.

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 1035 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 bar stock for this CRM was produced by Next Generation Metals; Boca Raton, FL.

Form: This CRM is machined in the form of a disc, approximately 40mm in diameter and 19 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 entire depth of the CRM may be used.

Caution: As with any bar material, avoid spark atomic emission spectrometric burns in the center of the CRM (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 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 1035-072618. 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 Web: www.brammerstandard.com

Fax: (281) 440-4432

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 17025:2005 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 35:2006 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 July 26, 2018.

Beau R. Brammer

President