

Brammer Standard Company, Inc.

Certificate of Analysis

BS 1020B

Certified Reference Material for Carbon Steel Grade 1020 - UNS Number G10200

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³	Certified Value ¹	Estimate of Uncertainty ²
Al	0.0019	0.0007	Mo	0.018	0.002
As	0.0056	0.0008	N	0.0100	0.0007
B	0.0002	0.0001	Ni	0.058	0.007
C	0.218	0.008	O	0.0049	0.0007
Ca	0.0012	0.0004	P	0.013	0.002
Co	0.0060	0.0009	Pb	0.0006	0.0003
Cr	0.114	0.006	S	0.023	0.002
Cu	0.162	0.008	Sb	0.0017	0.0005
Fe	98.5	0.1	Si	0.23	0.01
H	0.0002	0.0001	Sn	0.017	0.002
Mg	0.0003	0.0002	V	0.034	0.003
Mn	0.593	0.008			
	Reference Value ¹	Estimate of Uncertainty ²	Reference Values ^{3,4}	Reference Value ¹	Estimate of Uncertainty ²
Nb	0.0008	0.0005	Zn	<0.05	
Ti	0.0012	0.0009	Zr	<0.005	
W	<0.05				

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

Trace element information values for Ag, Ce, Cl, Ga, Ge, and Re are shown on page 4.

The requirements of ISO Guides 30, and Standards 33401 and 33405 were followed for the preparation of this Certified Reference Material and certificate of analysis.

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Telephone: (281) 440-9396 Fax (281) 440-4432 Website: www.brammerstandard.com

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Analysis	*	Al	*	As	*	B	*	C	*	Ca	*	Co	*	Cr	*	Cu	*	Fe	*	H
1	11	0.0012	10	0.005	5	0.000087	1	0.205933	4	0.0008667	4	0.005	4	0.103667	4	0.158	16	[98.4667334]	2	0.00010
2	12	0.00123333	3	0.005	12	0.000089	3	0.21	4	0.0011	11	0.0054	4	0.107	4	0.158333	16	[98.48]	2	0.0001
3	5	0.0014	4	0.0051	4	0.0001	1	0.211333	11	0.0011	3	0.0056	3	0.107667	4	0.158333	16	[98.4836334]	2	0.0001033
4	5	0.0014	4	0.00533333	11	0.0001	1	0.212	4	0.00123333	5	0.005767	12	0.11	3	0.158667	16	[98.49]	2	0.000125
5	3	0.00146667	5	0.00539	4	0.0001667	1	0.2121	12	0.00133333	4	0.005867	10	0.11	4	0.158667	16	[98.490667]	2	0.00016
6	5	0.00169333	4	0.0054267	3	0.0002	1	0.215	3	0.0014	4	0.0059	3	0.1100	8	0.16	16	[98.5]	2	0.0002267
7	4	0.00183333	5	0.00543333	3	0.0002	1	0.216	4	0.0014667	4	0.005967	4	0.110267	3	0.16	16	[98.5]	2	0.0002333
8	4	0.0019	5	0.00553333	5	0.0002333	3	0.217	4	0.0016133	4	0.005967	4	0.112	10	0.16	16	[98.5033]	2	0.0002667
9	3	0.0019	4	0.0057	5	0.00057	1	0.217567	5	0.002	8	0.006	4	0.113	10	0.16	10	98.51666667	2	0.0003333
10	3	0.002	4	0.0057667			1	0.218			3	0.006	5	0.113333	3	0.16	4	98.52		
11	4	0.0021	4	0.0058333			1	0.22			3	0.006	3	0.114	7	0.160	3	98.53333333		
12	4	0.00226667	10	0.00583333			1	0.22			12	0.006133	11	0.115	3	0.16				
13	3	0.0025	3	0.0059			1	0.223333			4	0.0062	3	0.115	4	0.1600				
14	4	0.0031	12	0.006			1	0.223333			5	0.006367	4	0.115333	10	0.160333				
15			3	0.006			11	0.224			3	0.0064	4	0.1158	4	0.161				
16			5	0.0064			1	0.224			3	0.0064	10	0.116	3	0.161				
17							1	0.225067			10	0.0064	4	0.117067	4	0.1624				
18							3	0.226			4	0.006533	10	0.117667	11	0.163				
19											4	0.0069	3	0.12	4	0.164967				
20											3	0.007	4	0.12	5	0.166667				
21													3	0.12	4	0.1668				
22													8	0.12	3	0.169				
23													4	0.1212	12	0.1700				
24															4	0.173967				
Average		0.00186		0.00557		0.0001501		0.2178		0.001202		0.00595		0.1141		0.1621		98.502		0.000183
Std Dev		0.00053		0.00018		0.0000012		0.0059		0.000044		0.00020		0.0047		0.0042		0.030		0.000085
H		0.00054		0.00084		0.00022		0.0047		0.00046		0.00087		0.0034		0.0041		0.19		0.00023
U ₁		0.00055		0.00086		0.00022		0.0047		0.00046		0.00089		0.0034		0.0041		0.19		0.00026
t-statistic		2.16		2.13		2.31		2.11		2.31		2.09		2.07		2.07		2.23		2.31
U ₂		0.0012		0.0018		0.00051		0.010		0.0011		0.0019		0.0070		0.0084		0.43		0.00059
U ₃		0.00032		0.00046		0.00017		0.0024		0.00035		0.00042		0.0015		0.0017		0.13		0.00020
Certified		0.0019		0.0056		0.0002		0.218		0.0012		0.0060		0.114		0.162		98.5		0.0002
Uncertainty		0.0007		0.0008		0.0001		0.008		0.0004		0.0009		0.006		0.008		0.1		0.0001
Tolerance		0.0018		0.0024		0.0001		0.024		0.0011		0.0027		0.018		0.024		0.3		0.0001

Analysis	*	Mg	*	Mn	*	Mo	*	N	*	Ni	*	O	*	P	*	Pb	*	S	*	Sb
1	12	0.00018667	8	0.58	4	0.0159	2	0.0094	4	0.0506	2	0.004067	10	0.010233	11	0.0002	1	0.020626667	11	0.0016
2	4	0.0002	4	0.582	12	0.0166667	2	0.009413	10	0.0507333	2	0.004227	3	0.010567	5	0.0003	1	0.021133333	5	0.0016533
3	5	0.0002	3	0.582	3	0.0170	2	0.009767	3	0.0511	2	0.004667	10	0.011	12	0.000407	1	0.021233333	5	0.0016667
4	4	0.00026667	4	0.58533333	3	0.017	2	0.0099	4	0.054	2	0.004867	4	0.011133	5	0.000437	3	0.022	4	0.0016667
5	5	0.00027333	3	0.58633333	5	0.0177667	2	0.009933	5	0.0559667	2	0.005173	4	0.011233	5	0.00046	1	0.0220	5	0.0018
6	3	0.0003	7	0.58833333	4	0.0179	2	0.010167	4	0.0571	2	0.0052	4	0.011447	5	0.000467	1	0.022266667	5	0.0018333
7	4	0.00046	3	0.59	11	0.0179	2	0.0102	4	0.0582	2	0.0053	4	0.0117	3	0.001233	1	0.0224	12	0.0019667
8			3	0.59	4	0.0179667	2	0.010233	11	0.0585	2	0.0055	3	0.012	4	0.001433	3	0.0226		
9			3	0.59	10	0.018	2	0.010293	3	0.059	2	0.005833	4	0.012733			1	0.022666667		
10			4	0.5900	10	0.018	2	0.010333	4	0.0590667			3	0.013			11	0.0229		
11			4	0.59033333	3	0.018	2	0.010333	3	0.0595			11	0.013			1	0.0230		
12			4	0.59033333	3	0.018	2	0.010433	12	0.0596667			13	0.013			10	0.023		
13			10	0.591	4	0.0180667			3	0.0600			4	0.0131			1	0.023		
14			10	0.59133333	4	0.0180667			4	0.060			3	0.013667			4	0.023233333		
15			4	0.59153333	4	0.0182			3	0.060			3	0.0137			12	0.023333333		
16			4	0.59233333	10	0.01903333			4	0.0602			12	0.0140			3	0.024		
17			4	0.59523333	4	0.01913333			4	0.0603667			4	0.014			1	0.024133333		
18			4	0.597	3	0.0195			10	0.061			4	0.014533			1	0.02445		
19			11	0.597	3	0.020			3	0.061			3	0.015						
20			10	0.60	5	0.0205			4	0.0621667			5	0.015733						
21			3	0.601					8	0.063			4	0.016						
22			4	0.61333																
Average		0.000253		0.5931		0.01808		0.01003		0.0582		0.00493		0.01316		0.000596		0.02261		0.00166
Std Dev		0.000031		0.0040		0.00065		0.00035		0.0036		0.00024		0.00051		0.000036		0.00080		0.00013
H		0.00026		0.0081		0.0014		0.0011		0.0024		0.00080		0.0012		0.00035		0.0016		0.00052
U ₁		0.00026		0.0090		0.0016		0.0011		0.0024		0.00084		0.0013		0.00035		0.0018		0.00053
t-statistic		2.45		2.08		2.09		2.20		2.09		2.31		2.09		2.36		2.11		2.45
U ₂		0.00065		0.019		0.0032		0.0024		0.0051		0.0019		0.0028		0.00084		0.0037		0.0013
U ₃		0.00024		0.0040		0.00073		0.00069		0.0011		0.00064		0.00060		0.00030		0.00087		0.00049
Certified		0.0003		0.593		0.018		0.0100		0.058		0.0049		0.013		0.0006		0.023		0.0017
Uncertainty		0.0002		0.008		0.002		0.0007		0.0007		0.0007		0.002		0.0003		0.002		0.0005
Tolerance		0.0002		0.024		0.006		0.0021		0.021		0.0021		0.006		0.0005		0.006		0.0015

BS 1020B * Code for method Certified values listed as weight percent

Analysis	*	Si	*	Sn	*	V
1	4	0.222	10	0.015	4	0.0318667
2	11	0.224	3	0.015	3	0.0328
3	3	0.224	3	0.015	4	0.0333333
4	4	0.22406667	3	0.0156	3	0.0335333
5	3	0.22666667	12	0.0163333	5	0.0336667
6	10	0.227	4	0.0165	3	0.034
7	6	0.23	5	0.0167	10	0.034
8	3	0.23	4	0.0169667	3	0.034
9	4	0.2300	3	0.017	4	0.0342
10	3	0.231	4	0.0170	4	0.0342667
11	7	0.23166667	3	0.017	4	0.0344
12	4	0.23166667	5	0.0180333	11	0.0345
13	4	0.23236667	4	0.0180667	10	0.0347333
14	4	0.23263333	5	0.0181	4	0.0347667
15	10	0.234	4	0.0182	3	0.035
16	3	0.234	5	0.0192333	4	0.035
17	5	0.237			3	0.0350
18	4	0.23733333			4	0.0353667
19	3	0.24			4	0.0356333
20	4	0.24333333			8	0.037
21	4	0.248333				
22	4	0.252				
23	12	0.256667				
Average		0.2312		0.01666		0.0344
Std Dev		0.0033		0.00067		0.0011
H		0.0049		0.0014		0.0019
U₁		0.0059		0.0015		0.0019
t-statistic		2.07		2.13		2.09
U₂		0.012		0.0032		0.0040
U₃		0.0025		0.00081		0.00089
Certified		0.23		0.017		0.034
Uncertainty		0.01		0.002		0.003
Tolerance		0.03		0.006		0.009

BS 1020B * Code for method Reference values listed as weight percent

Analysis	*	Nb	*	Ti	*	W	*	Zn	*	Zr
1	12	0.00027667	12	0.0004833	12	0.0006533	12	0.005267	5	0.00004
2	5	0.00033333	5	0.0005333	5	0.00068			12	0.000075
3	5	0.0004	5	0.0005667	5	0.0007033			4	0.0006667
4	11	0.0004	4	0.0006	5	0.0007333			10	0.0007333
5	3	0.00106667	5	0.0006233	4	0.0018			11	0.0008
6	4	0.00116667	3	0.001	11	0.0042			4	0.0009
7	4	0.0012	3	0.0010	4	0.005				
8	4	0.00133333	4	0.0016	4	0.0050333				
9			4	0.0016	3	0.0057				
10			11	0.0018	4	0.0062667				
11			3	0.0021						
12			4	0.0021333						
13										
14										
15										
16										
17										
18										
19										
20										
21										
Average		0.00077		0.00117		0.00221		0.01		0.000051
Std Dev		0.00046		0.00064		0.00012		0.10		0.000010
H		0.00039		0.00045		0.00058		0.00058		0.00058
U₁		0.00040		0.00046		0.00059		0.10		0.00058
t-statistic		2.36		2.20		2.26		12.71		2.57
U₂		0.0010		0.0010		0.0013		1.28		0.0015
U₃		0.00034		0.00029		0.00042		1.28		0.00061
Reference		0.0008		0.0012		<0.05		<0.05		<0.005
Uncertainty		0.0005		0.0009						
Tolerance		0.0007		0.0011						

For each element, in accordance with the requirements of ISO 17034 and 33405, 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 Standard 33405:2024 section 10.

BS 1020B * Code for analytical method Trace analysis listed as mg/kg (ppm)

Analysis	*	Ag	*	Ce	*	Cl	*	Ga	*	Ge	*	Re								
1	12	1.1	12	0.05	12	0.01	12	6.4	12	13	12	0.01								
2	12	1.1	12	0.09	12	0.02	12	6.6	12	13	12	0.02								
3	12	1.2						12	6.7	12	14	12	0.02							

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
NSL Analytical	Cleveland, OH	ANAB	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
Raghavendra Spectro Metallurgical Laboratory	Karnataka, India	NABL	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Vitkovice Testing Center	Hulvaky, Ostrava	Czech Accreditation Institute	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Eurofins EAG Materials Science, LLC	Liverpool, NY	A2LA	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
Laboratory Testing, Inc.	Hatfield, PA	A2LA	17025
APL, Inc	Milwaukee, WI	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

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: 12X11572, 12X15254Z, 12X15266U, 12X353G, 12X354B, 12X357B, 12X357D, 12XLA2D; AR 546, 614A, 644, 645, 655, 657, 660, 662, 867, 868, 870, 871, 872, 883, 895, 1020, 1650, 1652, 1653; BAS 206/3, 218/2, 236/3, 405, 464/1; BS CSN-1, HON T, XCCS, XCCS-2, 30D, 45B, 46B, 56H, 57A, 57B, 57C, 57D, 57E, 61G, 90F, 300A, 1016, 1018, 1020, 1026, 1026A, 1045, 2023, 2921, 2922, 2931, 3942, 4130, 4142SE, 4330MOD, 4931, 4951, 8620F; CKD 170, 227, 244C, 249C; DSZU CA031; ECRM 082-1, 85-1, 86-1, 87-1; IARM 28F, 28G, 28I, 28J, 30C, 31C, 199C; IMZ 63, 68, 112, 120, 132; IPT 5/2; JSM M402-4; JSS 412-1; LECO 501-503, 502-060, 502-280, 502-449, 502-856, 502-863, 502-93, 502-916, 502-970, 503-537; SPL 303A, 306A; SRM 72G, 160B, 361, 362, 363, 1262, 1263A.

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: AR 1020, BS 57A, 57B, 57C, 57D, 57E, 1020, 1026A, 4951; JSS 412-1.

Validity statement: ISO Standard 33401 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 1020B 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 AMS Resource, Inc.; McHenry, IL.

Form: This CRM is machined in the form of a disc, approximately 38mm in diameter and 19mm 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 Standard 33403 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 1020B-022625. 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 17034:2016 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials (our current Certificate Number 656.02 expires 01/31/2027)

Brammer Standard Company's Chemical Laboratory is accredited by A2LA to ISO Standard 17025:2017. (Our current Certificate Number 656.01 expires 01/31/2027)

By current Certificate Number 10539 expiring 01/01/2027, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9001:2015 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 Standard 33401:2024 Reference materials - Contents of certificates, labels and accompanying documentation

ISO Standard 33403:2024 Reference materials – Requirements and recommendations for use

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

ISO Standard 33405:2024 Reference Materials – Approaches for characterization and assessment of homogeneity and stability

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 February 26, 2025.

Beau R. Brammer

President