Brammer Standard Company, Inc.

Certificate of Analysis

BS 1020A

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

Certified Values[3]

	Certified Value[1]	Estimate of Uncertainty[2]		Certified Value[1]	Estimate of Uncertainty[2]
Al	**0.0018**	0.0005	**Mo**	**0.018**	0.002
As	**0.0054**	0.0008	**N**	**0.0101**	0.0008
B	**0.0002**	0.0001	**Ni**	**0.058**	0.003
C	**0.220**	0.009	**O**	**0.006**	0.001
Ca	**0.0013**	0.0004	**P**	**0.013**	0.001
Co	**0.0061**	0.0008	**Pb**	**0.0005**	0.0003
Cr	**0.114**	0.006	**S**	**0.022**	0.002
Cu	**0.160**	0.008	**Sb**	**0.0016**	0.0005
Fe	**98.5**	0.1	**Si**	**0.228**	0.008
H	**0.0002**	0.0001	**Sn**	**0.017**	0.002
Mg	**0.0003**	0.0002	**V**	**0.035**	0.004
Mn	**0.577**	0.009			

Reference Values[3,4]

	Reference Value[1]	Estimate of Uncertainty[2]		Reference Value[1]	Estimate of Uncertainty[2]
Nb	**0.0008**	0.0006	**Zn**	**<0.05**	
Ti	**0.0012**	0.0008	**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, Na, 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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BS 1020A * Code for method Certified values listed as weight percent

Analysis	*	Al	*	As	*	B	*	C	*	Ca	*	Co	*	Cr	*	Cu	*	Fe	*	H
1	11	0.0009	3	0.005	5	0.00009	1	0.2100	4	0.0006667	10	0.0050	4	0.107667	10	0.15	16	[98.4853667]	2	0.00009
2	12	0.001333	10	0.005	12	0.000091	1	0.211	4	0.0008667	11	0.0053	3	0.108	3	0.153	16	[98.49]	2	0.0001
3	5	0.001367	3	0.005	11	0.0001	1	0.211033	11	0.0011	5	0.005733	10	0.11	4	0.155667	16	[98.5]	2	0.00012
4	5	0.0014	4	0.0051	4	0.0002	1	0.211667	5	0.0013333	3	0.0058	3	0.11	4	0.156667	16	[98.5009334]	2	0.0001367
5	3	0.001467	5	0.0052333	3	0.0002	1	0.215	4	0.0014	4	0.005823	12	0.1100	7	0.158333	16	[98.505667]	2	0.0001467
6	4	0.0018	5	0.0052667	3	0.0002	1	0.217333	12	0.0014	12	0.005867	4	0.110167	4	0.158667	16	[98.508]	2	0.00017
7	3	0.0019	10	0.0053333	5	0.000333	1	0.218367	3	0.0015	4	0.005933	3	0.112	3	0.158667	16	[98.51]	2	0.0002333
8	3	0.0020	4	0.0053333	5	0.00056	1	0.22	4	0.0015633	5	0.005967	4	0.112333	4	0.159333	4	98.5333333	2	0.0002433
9	4	0.002	5	0.00539			1	0.22	4	0.0016333	3	0.006	5	0.112333	3	0.16	16	[98.54334]		
10	3	0.002	4	0.0054867			3	0.22			8	0.006	4	0.113	3	0.16	3	98.5433333		
11	5	0.00204	4	0.0056			1	0.22			3	0.006	10	0.114	10	0.16	10	98.5633333		
12	4	0.0021	4	0.0056667			1	0.223			4	0.006033	4	0.115	4	0.16				
13	4	0.0023	3	0.0058			1	0.223			4	0.006033	3	0.115	4	0.16				
14	4	0.002667	12	0.0061333			1	0.224			3	0.0062	4	0.1151	3	0.16				
15			5	0.0061667			1	0.225033			3	0.006333	4	0.1158	3	0.161				
16							11	0.227			4	0.006433	11	0.116	4	0.161133				
17							3	0.228			4	0.006633	4	0.117433	10	0.161333				
18							3	0.23			4	0.0070	10	0.118667	11	0.163				
19													3	0.12	5	0.164				
20													3	0.12	4	0.164967				
21													4	0.120033	4	0.1651				
22															12	0.166667				
23															4	0.1667				
24															8	0.17				
Average		0.00178		0.00539		0.00022		0.2197		0.00127		0.00605		0.1139		0.1597		98.520		0.000155
Std Dev		0.00012		0.00018		0.00016		0.0061		0.00033		0.00022		0.0039		0.0026		0.030		0.000057
H		0.00053		0.00083		0.00025		0.0048		0.00047		0.00087		0.0034		0.0040		0.19		0.00023
U_1		0.00054		0.00085		0.00027		0.0048		0.00048		0.00090		0.0034		0.0048		0.19		0.00025
t-statistic		2.16		2.14		2.36		2.11		2.31		2.11		2.09		2.07		2.23		2.36
U_2		0.0012		0.0018		0.00065		0.010		0.0011		0.0019		0.0071		0.010		0.43		0.00059
U_3		0.00031		0.00047		0.00023		0.0024		0.00037		0.00045		0.0015		0.0020		0.13		0.00021
Certified		**0.0018**		**0.0054**		**0.0002**		**0.220**		**0.0013**		**0.0061**		**0.114**		**0.160**		**98.5**		**0.0002**
Uncertainty		0.0005		0.0008		0.0001		0.009		0.0004		0.0008		0.006		0.008		0.1		0.0001
Tolerance		0.0015		0.0024		0.0001		0.027		0.0012		0.0024		0.018		0.024		0.4		0.0001

Analysis	*	Mg	*	Mn	*	Mo	*	N	*	Ni	*	O	*	P	*	Pb	*	S	*	Sb
1	5	0.0002	4	0.5653333	12	0.0160	2	0.009413	4	0.0508667	2	0.002267	10	0.0103	11	0.0003	1	0.02023333	4	0.0015667
2	12	0.000217	3	0.569	4	0.016533	2	0.0096	3	0.0520	2	0.004967	3	0.0104	5	0.00033	1	0.02066667	5	0.0016
3	4	0.000267	3	0.57	3	0.016967	2	0.0096	10	0.0522333	2	0.005333	10	0.011	12	0.000333	10	0.021	5	0.0016567
4	5	0.000293	10	0.57	5	0.017933	2	0.0099	4	0.0533333	2	0.00599	4	0.011313	5	0.000427	1	0.02103333	5	0.0016667
5	4	0.0003	4	0.5703333	3	0.018	2	0.009967	5	0.0553333	2	0.0065	4	0.0114	5	0.00043	1	0.0211	11	0.0017
6	3	0.0003	3	0.5706667	10	0.018	2	0.010	3	0.0566667	2	0.0065	4	0.0119	5	0.000433	1	0.02178	5	0.0017333
7	4	0.000427	4	0.5713333	3	0.018	2	0.010087	10	0.058	2	0.0071	3	0.012	3	0.001067	4	0.022	12	0.0021
8			10	0.573	10	0.018	2	0.010133	4	0.0580667	2	0.007377	4	0.0128			3	0.0223		
9			4	0.5733333	4	0.0180	2	0.0102	4	0.0583	2	0.007433	13	0.013			1	0.02243333		
10			7	0.574	4	0.018033	2	0.010267	12	0.0586667			3	0.013			1	0.02266667		
11			10	0.5756667	4	0.0181	2	0.010367	11	0.0588			4	0.013033			11	0.023		
12			4	0.5798667	11	0.0181			3	0.059			11	0.0132			1	0.023		
13			3	0.58	4	0.0182			3	0.059			3	0.013333			1	0.0232		
14			3	0.5800	4	0.0185			4	0.0592667			4	0.0136			1	0.0237		
15			4	0.58	10	0.018933			3	0.0595			3	0.0136			3	0.024		
16			4	0.5801	3	0.019			4	0.0599667			4	0.014			4	0.02406667		
17			4	0.581	3	0.019			4	0.0600			3	0.014			1	0.024275		
18			11	0.583	4	0.019033			4	0.0604667			5	0.014133			12	0.02433333		
19			4	0.585	3	0.020			3	0.061			12	0.014333			3	0.025		
20			3	0.585	5	0.020033			8	0.061			4	0.0148						
21			8	0.59	4	0.021			4	0.061667										
Average		0.000255		0.5765		0.0184		0.01009		0.0578		0.00593		0.01310		0.000529		0.02240		0.00165
Std Dev		0.000030		0.0065		0.0011		0.00036		0.0032		0.00027		0.00048		0.000034		0.00076		0.00013
H		0.00026		0.0080		0.0014		0.0011		0.0024		0.00086		0.0012		0.00034		0.0016		0.00052
U_1		0.00026		0.0080		0.0014		0.0011		0.0024		0.00091		0.0013		0.00034		0.0017		0.00053
t-statistic		2.45		2.09		2.09		2.23		2.09		2.31		2.09		2.45		2.10		2.45
U_2		0.00065		0.017		0.0030		0.0025		0.0051		0.0021		0.0027		0.00083		0.0036		0.0013
U_3		0.00024		0.0036		0.00065		0.00077		0.0011		0.00070		0.00061		0.00031		0.00083		0.00049
Certified		**0.0003**		**0.577**		**0.018**		**0.0101**		**0.058**		**0.006**		**0.013**		**0.0005**		**0.022**		**0.0016**
Uncertainty		0.0002		0.009		0.002		0.0008		0.003		0.001		0.001		0.0003		0.002		0.0005
Tolerance		0.0002		0.027		0.006		0.0024		0.009		0.003		0.003		0.0004		0.006		0.0015

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

Analysis	*	Si	*	Sn	*	V
1	10	0.220	3	0.015	12	0.028333
2	4	0.220	12	0.0153333	3	0.0327
3	3	0.222	3	0.0156	4	0.0332
4	5	0.223	3	0.016	5	0.033233
5	11	0.223	10	0.016	3	0.0334
6	4	0.223	4	0.0160233	10	0.034
7	3	0.224	5	0.0165	3	0.034
8	3	0.225	3	0.0166667	3	0.034
9	4	0.226367	4	0.0168	4	0.034233
10	3	0.226667	3	0.017	4	0.0343
11	4	0.228	4	0.0170333	11	0.0345
12	4	0.229967	4	0.0171	4	0.035
13	3	0.23	5	0.0179333	3	0.035
14	3	0.23	5	0.0179333	4	0.035
15	6	0.23	4	0.0182	4	0.0352
16	7	0.230667	5	0.0183667	3	0.035333
17	4	0.231267			4	0.035333
18	4	0.234333			4	0.0354
19	4	0.236			5	0.0366
20	10	0.236333			8	0.0385
21	4	0.239				
22	4	0.249333				
Average		0.2278		0.01663		0.0349
Std Dev		0.0033		0.00064		0.0010
H		0.0048		0.0014		0.0019
U_1		0.0058		0.0015		0.0022
t-statistic		2.08		2.13		2.09
U_2		0.012		0.0032		0.0045
U_3		0.0026		0.00080		0.0010
Certified		**0.228**		**0.017**		**0.035**
Uncertainty		0.008		0.002		0.004
Tolerance		0.024		0.006		0.012

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

Analysis	*	Nb	*	Ti	*	W	*	Zn	*	Zr
1	12	0.00026	12	0.00042	12	0.000577	12	0.005133	5	0.000031
2	5	0.000333	5	0.0004533	5	0.00063			12	0.000079
3	5	0.000377	5	0.0004667	5	0.000727			4	0.0005667
4	11	0.0004	5	0.0005567	5	0.000733			4	0.0007
5	4	0.001033	4	0.0005667	4	0.0018			11	0.0007
6	3	0.001067	3	0.0010	4	0.004067			10	0.0008
7	4	0.001167	3	0.001	11	0.0043				
8	4	0.0014	4	0.0016	3	0.005				
9			11	0.0019	4	0.005033				
10			4	0.0019667	4	0.0051				
11			3	0.002						
12			4	0.0022333						
Average		0.00075		0.00118		0.00221		0.005		0.0000374
Std Dev		0.00046		0.00071		0.00010		0.097		0.0000081
H		0.00038		0.00045		0.00058		0.001		0.00058
U_1		0.00040		0.00046		0.00059		0.097		0.00058
t-statistic		2.36		2.20		2.26		12.71		2.57
U_2		0.00094		0.0010		0.0013		1.24		0.0015
U_3		0.00033		0.00029		0.00042		1.24		0.00061
Reference		**0.0008**		**0.0012**		**<0.05**		**<0.05**		**<0.005**
Uncertainty		0.0006		0.0008						
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. 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 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 1020A * Code for analytical method Trace analysis listed as mg/kg (ppm)

Analysis	*	Ag	*	Ce	*	Cl	*	Ga	*	Ge	*	Na	*	Re
1	12	1.2	12	0.04	12	0.04	12	6.4	12	12	12	0.01	12	0.01
2	12	1.2	12	0.04	12	0.06	12	6.8	12	12	12	0.01	12	0.01
3	12	1.2	12	0.08			12	6.9	12	13	12	0.02	12	0.01

Analytical Method Codes:

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

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
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
Raghavendra Spectro Metallurgical Laboratory	Karnataka, India	NABL	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Vitkovice Testing Center	Hulvaky, Ostrava	Czech Accreditation Institute	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Laboratory Testing, Inc.	Hatfield, PA	A2LA	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
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, 12X354B, 12X357B, 12XLA2D, 13X353G; AR 546, 612B, 614A, 644, 645, 655, 657, 662, 867, 868, 870, 871, 875, 883, 895, 1020, 1650, 1652, 1653; BAS 206/3, 218/2, 236/3, 405, 464/1; BS CSN-1, HON T, XCCS, XCCS-2, 12B, 30, 45B, 46B, 56H, 57A, 57B, 57C, 57D, 57E, 61G, 300A, 1016, 1018, 1020, 1026, 1026A, 1030A, 1040, 1045, 2023, 2921, 2922, 2931, 3942, 4130, 4142SE, 4330MOD, 8620F; CKD 170, 227, 244C, 249C; DSZU CA031; ECRM 082-1, 85-1, 86-1, 87-1; IARM Fe1020-18, 28F, 28G, 28I, 31C, 199C; IMZ 63, 68, 112, 120, 132; IPT 5/2; JSM M402-4; JSS 412-1; LECO 501-503, 501-677, 502-060, 502-280, 502-449, 502-503, 502-856, 502-863, 502-903, 502-916, 502-970, 503-537, 503-543; SPL CM22A, 302A, 303A, 306A, 2005; 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 1020A 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 1020A-021925. 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 17034:2016 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 19, 2025.

Beau R. Brammer

President