

Brammer Standard Company, Inc.

Certificate of Analysis

BS 55H

Certified Reference Material for Mold Steel Grade P20 Modified

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³	Certified Value ¹	Estimate of Uncertainty ²
Al	0.025	0.001	Mo	0.144	0.009
As	0.0041	0.0008	N	0.0052	0.0006
B	0.0007	0.0003	Ni	0.93	0.03
C	0.394	0.006	O	0.0007	0.0003
Ca	0.0013	0.0003	P	0.012	0.001
Co	0.0149	0.0009	S	0.0040	0.0008
Cr	1.82	0.02	Si	0.323	0.006
Cu	0.156	0.006	Sn	0.011	0.001
Fe	94.7	0.1	Ti	0.0020	0.0005
H	0.00007	0.00003	V	0.0047	0.0009
Mn	1.43	0.02			

	Reference Value ¹	Estimate of Uncertainty ²	Reference Values ^{3,4}	Reference Value ¹	Estimate of Uncertainty ²
Mg	<0.005		Ta	<0.05	
Nb	0.004	0.001	W	0.0013	0.0008
Pb	0.0002	0.0001	Zn	<0.005	
Sb	0.0014	0.0008	Zr	0.0011	0.0005

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.

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

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

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* Code for method

Certified values listed as weight percent

Analysis	*	Al	*	As	*	B	*	C	*	Ca	*	Co	*	Cr	*	Cu	*	Fe	*	H
1	4	0.0239	4	0.0029667	3	0.0002	1	0.3883633	4	0.0009767	14	0.0136333	8	1.80	10	0.15	16	[94.6217667]	2	0.000063
2	5	0.024	3	0.0031	4	0.0002667	1	0.3884667	11	0.0011	4	0.0139333	4	1.80	3	0.15	3	94.63333333	2	0.00007
3	4	0.0240	11	0.0035	3	0.0006	1	0.39	3	0.0011	5	0.0140	4	1.8053667	4	0.151633	16	[94.65]	2	0.000070
4	5	0.0242333	4	0.0036667	3	0.0007	11	0.39	14	0.0012	4	0.0144333	4	1.8054333	3	0.152	16	[94.66]	2	0.00007
5	3	0.0243	10	0.0044	4	0.0008	1	0.391	4	0.0012	11	0.0146	3	1.81	4	0.153	16	[94.685667]	2	0.00007
6	4	0.0245	15	0.00446	7	0.0008867	1	0.3911667	4	0.0012667	4	0.01498	10	1.81	4	0.154133	4	94.69383	2	0.000074
7	4	0.0246667	4	0.0044667	4	0.00098	3	0.395	4	0.0013667	8	0.015	13	1.81	3	0.155667	14	94.7	2	0.00010333
8	3	0.0250333	5	0.0044733	11	0.001	1	0.396	4	0.00138	10	0.015	3	1.8166667	4	0.155867	4	94.70666667	2	0.00010333
9	4	0.0255333	9	0.0046			1	0.399	3	0.0014	3	0.015	4	1.8173667	11	0.156	10	94.71666667		
10	3	0.0257	5	0.0046333			1	0.399	4	0.0014	4	0.0150667	4	1.8192367	3	0.156	13	94.72766667		
11	4	0.0259333	5	0.0047333			1	0.3996667	3	0.0016	4	0.0150667	11	1.82	10	0.157	16	[94.73]		
12	11	0.026	4	0.0049			3	0.40			5	0.0151667	3	1.82	4	0.157	16	[94.7301334]		
13	8	0.026	3	0.0050			1	0.40			17	0.0151667	10	1.82	14	0.157667	16	[94.757]		
14	3	0.026					1	0.4005333			4	0.0152	4	1.8202	4	0.157967	16	[94.87333]		
15	4	0.02610									4	0.0154	4	1.8206667	8	0.160				
16	14	0.0261333									3	0.0158	4	1.8266667	10	0.16				
17	4	0.0262333									3	0.016	4	1.829	4	0.160033				
18													14	1.8333333	4	0.160063				
19													3	1.84	4	0.161667				
20															17	0.163667				
Average		0.025192		0.00409		0.00068		0.3940		0.001272		0.01494		1.817049		0.156468		94.662		0.0000736
Std Dev		0.000077		0.00018		0.00011		0.0041		0.000095		0.00051		0.000073		0.000071		0.021		0.0000035
H		0.0016		0.00074		0.00037		0.0065		0.00047		0.0013		0.015		0.0040		0.19		0.00018
U ₁		0.0016		0.00076		0.00039		0.0077		0.00048		0.0014		0.015		0.0040		0.19		0.00018
t-statistic		2.12		2.18		2.36		2.16		2.23		2.12		2.10		2.09		2.16		2.36
U ₂		0.0035		0.0017		0.00091		0.017		0.0011		0.0029		0.032		0.0083		0.41		0.00042
U ₃		0.00084		0.00046		0.00032		0.0044		0.00032		0.00071		0.0073		0.0019		0.11		0.00015
Certified		0.025		0.0041		0.0007		0.394		0.0013		0.0149		1.82		0.156		94.7		0.00007
Uncertainty		0.001		0.0008		0.0003		0.006		0.0003		0.0009		0.02		0.006		0.1		0.00003
Tolerance		0.003		0.0024		0.0006		0.018		0.0009		0.0027		0.06		0.018		0.4		0.00006

Analysis	*	Mn	*	Mo	*	N	*	Ni	*	O	*	P	*	S	*	Si	*	Sn	*	Ti
1	8	1.40	4	0.135	2	0.004925	7	0.90	2	0.0002	4	0.0103333	1	0.0024333	5	0.310	9	0.0097	5	0.00159
2	3	1.41	3	0.137	2	0.0049667	4	0.9044333	2	0.0004867	5	0.0106667	1	0.0031667	10	0.317667	11	0.0099	4	0.00169333
3	4	1.4129333	7	0.139	2	0.005	3	0.91	2	0.0005933	7	0.0110333	11	0.0033	4	0.318367	5	0.0101	5	0.0017
4	4	1.4197333	3	0.14	2	0.00506	4	0.9172333	2	0.00075	14	0.0112667	1	0.0035367	14	0.319333	5	0.010333333	4	0.00196667
5	4	1.4199	4	0.1400667	2	0.0052	4	0.922	2	0.0008333	4	0.0116333	1	0.0036333	6	0.32	4	0.010333333	11	0.002
6	4	1.4207	4	0.1401867	2	0.0053	4	0.9233333	2	0.0008333	4	0.0117333	1	0.0036667	10	0.32	4	0.010933333	4	0.002
7	10	1.421	3	0.142	2	0.00544	10	0.9246667	2	0.000954	3	0.0119	1	0.0039333	3	0.32	4	0.010966667	3	0.0020
8	14	1.4233333	14	0.142	2	0.0054433	10	0.93	2	0.0009867	6	0.0119667	10	0.004	4	0.32	4	0.0111	5	0.0020
9	10	1.4233333	4	0.1421333	2	0.0054667	4	0.9383333	2	0.001015	4	0.0119667	1	0.004	4	0.3205	4	0.011366667	4	0.00203333
10	4	1.4266667	4	0.143	2	0.0056	4	0.9383333	13	0.012	1	0.004	6	0.32080	3	0.0114	4	0.00206667		
11	4	1.4283333	11	0.143			3	0.94	4	0.0122333	3	0.004	3	0.004	3	0.321	4	0.01150	3	0.0025
12	11	1.43	10	0.145			4	0.9405333	11	0.0123	1	0.0040733	4	0.321333	3	0.0116	4	0.0025		
13	3	1.43	3	0.146			3	0.9413333	3	0.0123	3	0.0041	4	0.322433	5	0.011766667	14	0.0032		
14	10	1.43	4	0.1462			14	0.944	4	0.0124	1	0.0042	4	0.327333	10	0.012				
15	3	1.43	10	0.147			3	0.945	10	0.013	1	0.0042333	3	0.333	3	0.012				
16	4	1.4309333	8	0.149			10	0.947	3	0.013	1	0.0044	11	0.334	3	0.012566667				
17	4	1.4346667	10	0.1493333			4	0.9501333	4	0.0131667	1	0.006	4	0.336333	5	0.012566667				
18	3	1.44	7	0.15			4	0.9503667	10	0.0135333										
19	4	1.454	5	0.150			11	0.96	3	0.0137333										
20			4	0.151			8	0.967												
Average		1.4252		0.1436		0.00525		0.934685		0.00074		0.012114		0.00400		0.3233		0.011184		0.002011
Std Dev		0.0047		0.0024		0.00020		0.000071		0.00011		0.000073		0.00013		0.0039		0.000077		0.000071
H		0.013		0.0038		0.00082		0.010		0.00038		0.0012		0.00073		0.0058		0.0011		0.00056
U ₁		0.014		0.0045		0.00085		0.010		0.00040		0.0012		0.00074		0.0070		0.0011		0.00056
t-statistic		2.10		2.09		2.26		2.09		2.31		2.10		2.12		2.12		2.12		2.18
U ₂		0.029		0.0094		0.0019		0.022		0.00091		0.0025		0.0016		0.015		0.0024		0.0012
U ₃		0.0068		0.0021		0.00061		0.0049		0.00030		0.00057		0.00038		0.0036		0.00059		0.00034
Certified		1.43		0.144		0.0052		0.93		0.0007		0.012		0.0040		0.323		0.011		0.0020
Uncertainty		0.02		0.009		0.0006		0.03		0.0003		0.001		0.0008		0.006		0.001		0.0005
Tolerance		0.06		0.027		0.0019		0.09		0.0006		0.003		0.0024		0.018		0.003		0.0015

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. 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:

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

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 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 Guide 35:2006 section 6.

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
Shiva Analyticals Private Limited	Hoskote, Bangalore	NABL	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
Vitkovice Testing Center	Hulvaky, Ostrava	Czech Accreditation Institute	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
Luvak Inc.	Boylston, MA	PRI	17025
Raghavendra Spectro Metallurgical Laboratory	Karnataka, India	NABL	17025
Laboratory Testing, Inc.	Hatfield, PA	A2LA	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	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: AR 115C, 148, 303, 546, 555, 614A, 641, 644, 659, 661, 662, 668, 868, 881, 882, 884, 892, 960, 1653; BAS 328, 329, 403, 406/1, 407, 410/1, 410/2, 451, 464/1; BS 33F, 55G, 72B, 286A, 1026, 1026A, 1045, 1762, 1763, 8620C, 8620E; CKD 186A, 244, 247; DSZU Ca031; ECRM 086-1, 087-1, 190-1, 479-1, 480-1; IARM FeDP1080, 20A, 31G, 143C, 305B, 321A; IPT 12A, 75A, 97; JSM M402-4; LECO 501-677, 502-616, 502-870, 502-903, 502-916, 502-928, 502-935, 762-747; NCS NS 11079; SPL LA-3F; CZ 02003 1A; 02003 6C; 02003 13B; SRM 13F, 32E, 160B, 293, 361, 363, 364, 1139A, 1263A, 2171; TS N013.

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 403; BS 55G, 1763; CMSI 2064; SRM 1139A, 1263A, 1764.

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 55H 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 Swiss Steel International

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 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 55H-080723. 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 August 7, 2023.

Beau R. Brammer
President