

Brammer Standard Company, Inc.

Certificate of Analysis

BS 54H

Certified Reference Material for Carbon Steel AISI Grade 1070 - UNS Number G10700

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²	
Al	0.032	0.001		N	0.0039	0.0004
As	0.0036	0.0006		Ni	0.373	0.009
C	0.737	0.007		P	0.0030	0.0006
Co	0.0030	0.0003		S	0.0044	0.0007
Cr	0.369	0.008		Si	0.521	0.009
Cu	0.046	0.002		Sn	0.0030	0.0007
Fe	97.0	0.2		Ti	0.0009	0.0003
Mn	0.829	0.009		V	0.0008	0.0003
Mo	0.0106	0.0009				

Informational Values^{3,4}

B (0.0001)	Ca (0.0001)	Mg (0.0004)	Nb (0.0003)	O (0.001)
Pb (0.001)	Sb (0.001)	W (0.003)	Zr (0.0008)	

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

Trace element information values for Bi, Ga, Ge, Na, Re, Se, U, 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.

BS 54H

* Code for method

Certified values listed as weight percent

Analysis	*	Al	*	As	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo	*	N
1	4	0.0293333	4	0.0025333	11	0.725	4	0.0024	4	0.3563	12	0.03733333	3	96.93	3	0.818	3	0.0083	2	0.00284
2	3	0.030	5	0.0028333	3	0.73	5	0.00246667	4	0.358	17	0.03933333	16	[96.96]	14	0.8186667	12	0.0085	2	0.00337
3	4	0.0307	3	0.0029	1	0.73	14	0.00283333	10	0.361	3	0.044	10	96.99	4	0.820	4	0.0094	2	0.00368
4	5	0.0307	4	0.0030	1	0.73033333	12	0.00283333	3	0.362	4	0.0453	13	97.035333	4	0.8200	10	0.0095667	2	0.0037
5	14	0.031	4	0.0031333	1	0.73333333	8	0.00288	13	0.3653333	3	0.0462	16	[97.0367]	4	0.8296667	5	0.0097333	2	0.00409
6	10	0.0311	5	0.0038667	3	0.734	5	0.00289667	4	0.367	8	0.04663333	4	97.056667	3	0.83	3	0.010	2	0.00412
7	3	0.0312	15	0.0040067	1	0.73466667	3	0.0029	11	0.368	4	0.04686667	16	[97.0567]	8	0.8303333	3	0.010	2	0.00413
8	4	0.0314667	12	0.0040333	1	0.738	5	0.0029	10	0.3684	14	0.04696667	16	[97.078267]	4	0.8309333	4	0.0102333	2	0.00417
9	4	0.0316667	4	0.0041333	1	0.73866667	4	0.00296667	10	0.369	4	0.04696667	16	[97.08]	11	0.831	7	0.0102667	2	0.00423
10	4	0.0319667	10	0.0041667	1	0.74	4	0.00297333	14	0.3696667	3	0.047	14	97.1	10	0.831	4	0.0103333	2	0.00428
11	3	0.032	5	0.0043233	1	0.74033333	3	0.003	18	0.3697333	5	0.047	16	[97.1]	4	0.8323333	14	0.0104667	2	0.0044
12	3	0.0321	4	0.0045333	3	0.742	10	0.003	3	0.37	4	0.0470			4	0.8325333	5	0.0106	2	0.005
13	4	0.0329667			1	0.74633333	4	0.00303333	3	0.371	4	0.0472			4	0.833	4	0.0107333		
14	5	0.0343			4	0.7487	4	0.0031	4	0.3713333	11	0.0475			10	0.833	10	0.0107333		
15	4	0.0399667			1	0.74966667	12	0.0032667	4	0.3719	4	0.04773333			10	0.8363333	4	0.0107333		
16							10	0.0034	5	0.3746667	4	0.04776667			10	0.8363333	4	0.0109333		
17							11	0.0035	17	0.376	3	0.04796667			4	0.838	10	0.011		
18									4	0.3766667	10	0.0487			17	0.8453333	3	0.0112333		
19									4	0.3840333	4	0.04876667			3	0.8473333	5	0.0112667		
20									10	0.3866667	10	0.049					12	0.0112667		
21									4	0.389	10	0.0494					11	0.0117		
22																	10	0.012		
23																	4	0.0124		
Average		0.0321		0.003622		0.737402		0.00301		0.3689		0.0463		97.011		0.8292		0.01055		0.00392
Std Dev		0.0010		0.000091		0.000082		0.00011		0.0031		0.0012		0.029		0.0044		0.00039		0.00015
H		0.0017		0.00064		0.0087		0.00059		0.0059		0.0020		0.23		0.009		0.0010		0.00066
U ₁		0.0019		0.00064		0.0087		0.00060		0.0066		0.0023		0.23		0.010		0.0011		0.00068
t-statistic		2.14		2.20		2.14		2.12		2.09		2.09		2.23		2.10		2.07		2.20
U ₂		0.0041		0.0014		0.019		0.0013		0.014		0.0048		0.52		0.022		0.0022		0.0015
U ₃		0.0011		0.00041		0.0048		0.00031		0.0030		0.0010		0.16		0.0050		0.00046		0.00043
Certified		0.032		0.0036		0.737		0.0030		0.369		0.046		97.0		0.829		0.0106		0.0039
Uncertainty		0.001		0.0006		0.007		0.0003		0.008		0.002		0.2		0.009		0.0009		0.0004
Tolerance		0.004		0.0018		0.021		0.0013		0.024		0.006		0.5		0.027		0.0027		0.0015

Analysis	*	Ni	*	P	*	S	*	Si	*	Sn	*	Ti	*	V
1	3	0.342	3	0.0021333	1	0.00313333	4	0.49566667	5	0.0009633	12	0.00026	12	0.0003033
2	10	0.351	12	0.0022333	1	0.00329667	4	0.49766667	12	0.0014667	5	0.0005	4	0.0005
3	4	0.3601	4	0.0022667	1	0.0037	11	0.504	10	0.0022	4	0.00057	4	0.00055
4	14	0.362	7	0.0023567	1	0.00396667	6	0.512	3	0.0024	5	0.00064	5	0.0005667
5	4	0.3629333	5	0.0023867	1	0.004	3	0.513	5	0.0025	4	0.00073333	4	0.0005667
6	5	0.3636667	12	0.0024967	1	0.004	14	0.51633333	12	0.00256	5	0.00076667	12	0.0006167
7	4	0.371	3	0.0026	1	0.004	4	0.517	5	0.0025867	3	0.0008	5	0.0006267
8	11	0.373	5	0.0028	1	0.00406667	17	0.51733333	4	0.0027667	14	0.0008	5	0.00066
9	8	0.375	4	0.0029	12	0.00456667	3	0.518	3	0.004	17	0.001	4	0.0008
10	10	0.3753333	4	0.0030	1	0.0047	4	0.51946667	4	0.0041	3	0.0012	3	0.0009
11	10	0.376	4	0.0030	3	0.0048	6	0.52	4	0.0042667	4	0.00136667	4	0.0010667
12	4	0.376	4	0.0031667	12	0.00495667	3	0.52	3	0.0046	4	0.00143333	11	0.0011
13	10	0.3763333	11	0.0033	3	0.005	4	0.52066667	9	0.005	4	0.0015	10	0.0011
14	4	0.377	4	0.0034	10	0.0051	10	0.52133333					4	0.0011333
15	3	0.377	4	0.0034333	1	0.0051	10	0.522					14	0.0012
16	4	0.3793	3	0.0035	1	0.00519667	4	0.5242						
17	3	0.38	14	0.0035333	1	0.0053	3	0.536						
18	4	0.3824333	3	0.004			4	0.54533333						
19	4	0.384	10	0.0040			10	0.549						
20	4	0.41												
Average		0.3733		0.00303		0.004405		0.5213		0.003032		0.000890		0.000795
Std Dev		0.0034		0.00011		0.000077		0.0040		0.000088		0.000088		0.000032
H		0.0059		0.00059		0.00069		0.0071		0.00059		0.00037811		0.00036
U ₁		0.0068		0.00060		0.00069		0.0082		0.00060		0.00039		0.00037
t-statistic		2.09		2.10		2.12		2.10		2.18		2.18		2.14
U ₂		0.014		0.0013		0.0015		0.017		0.0013		0.00085		0.00078
U ₃		0.0032		0.00029		0.00036		0.0039		0.00036		0.00023		0.00020
Certified		0.373		0.0030		0.0044		0.521		0.0030		0.0009		0.0008
Uncertainty		0.009		0.0006		0.0007		0.009		0.0007		0.0003		0.0003
Tolerance		0.027		0.0018		0.0021		0.027		0.0021		0.0009		0.0008

Analysis	*	B	*	Ca	*	Mg	*	Nb	*	O	*	Pb	*	Sb	*	W	*	Zr
1	7	0.0001067	12	0.000018	12	0.0000015	5	0.0000433	2	0.00014	12	0.000031	5	0.00091	12	0.000047	12	0.000039
2	3	0.00013	11	0.0001	5	0.000045	5	0.0000507	2	0.000525	5	0.00006	12	0.0009133	3	0.004	5	0.000041
3	4	0.0001333	3	0.00012	3	0.00007	5	0.00010	2	0.0006333	12	0.000061	12	0.0010267	4	0.0056	5	0.00007
4	12	0.0001567	4	0.00026			4	0.00103333	2	0.0006567	5	0.0000687	4	0.0011667			3	0.0002
5							4	0.0011	2	0.0007	5	0.00010333					5	0.0002233
6							3	0.0012	2	0.0007267	9	0.0005					3	0.0005
7							4	0.004	2	0.0007333	4	0.00133333					4	0.0007
8									2	0.0008	3	0.0018					10	0.00074
9									2	0.0009237	4	0.00206667					4	0.0010
10									2	0.00109	11	0.0024					11	0.0012
11									2	0.0011233	4	0.00323333					4	0.0040333
12									2	0.0014								
13									2	0.0029333								
Average		0.000132		0.000125		0.0000398		0.000263		0.0010		0.0011		0.0010		0.003		0.0008
Std Dev		0.000054		0.000047		0.0000029		0.000025		0.0019		0.0025		0.0037		0.029		0.0015
H		0.00021		0.00020		0.00015		0.00025		0.0004		0.0004		0.0004		0.001		0.0004
U ₁		0.00021		0.00021		0.00015		0.00026		0.0019		0.0025		0.0037		0.029		0.0015
t-statistic		3.18		3.18		4.30		2.45		2.18		2.23		3.18		4.30		2.23
U ₂		0.00068		0.00067		0.00066		0.00062		0.0042		0.0055		0.012		0.12		0.0033
U ₃		0.00034		0.00033		0.00038		0.00024		0.0012		0.0017		0.0059		0.072		0.0010
Informational		(0.0001)		(0.0001)		(0.00004)		(0.0003)		(0.001)		(0.001)		(0.001)		(0.003)		(0.0008)

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.

Analysis	*	Bi	*	Ga	*	Ge	*	Na	*	Re	*	Se	*	U	*	Zn
1	12	0.007	12	5.9	12	6.7	12	0.01	12	0.02	12	3.2	12	0.005	12	3.7
2	12	0.009	12	6.3	12	6.8			12	0.02	12	3.4	12	0.005	12	3.7
3	12	0.01	12	6.4	12	7.1			12	0.02	12	3.4	12	0.006	12	3.8

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 PIXE
6 Gravimetric	12 GD Mass Spectrometry	18 AAS

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
Laboratory Testing, Inc.	Hatfield, PA	PRI	17025
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
NSL Analytical	Cleveland, OH	ANAB	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
Evans Analytical Group	Liverpool, NY	A2LA	17025
Elemental Analysis, Inc.	Lexington, KY	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
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Exova	Santa Fe Spring, 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: 12XLA3, 12X12748, 12X352; AR 644, 654, 668, 670, 875, 882, 892, 956, 960, 1648, 1653, 1655; BAS 260/4, 404, 404/1, 434, 451, 455, 464/1, 486; BS D-6, HON U, LC-6, 02, 06A, 35D, 54F, 54G, 56H, 61C, 61G, 203, 1061, 1144A, 8620C; CKD 166A, 181A; DSZU CA01A; ECRM 85-1, 86-1, 87-1; IARM 30E, 31B, 32B, 32D; IMZ 55, 65, 112, 116; LECO 501-320, 501-501, 501-504, 501-505, 501-644, 501-646, 501-675, 501-676, 501-677, 501-679, 501-991, 501-993, 52-197, 502-411, 502-412, 502-513, 502-702, 502-712, 502-874, 502-893, 502-895, 502-903, 502-916, 504-646; SRM 32E, 55D, 123A, 156, 160B, 361, 362, 363, 364, 1222, 1225, 1262, 1262A, 1263, 1264, 1265A, 1413, 1763, 1766, 2172.

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 455, 486; BS HON U, LC-6, 35D, 54F, 54G, 203; DSZU CA01A; LECO 501-676, 501-991; SRM 1222, 1763, 1766, 2172.

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 54H 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 stock for this CRM was produced by Instytut Metalurgii Zelaza, Gliwice, Poland.

Form: This CRM is machined in the form of a disc, approximately 44 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 54H-121418. 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 December 14, 2018.

Beau R. Brammer
President