

Brammer Standard Company, Inc.

Certificate of Analysis

BS 8630

Certified Reference Material for Low Alloy Steel Grade 8630 - UNS Number G86300

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²
Al	0.023	0.001		Ni	0.008
As	0.0038	0.0007		O	0.0003
C	0.315	0.008		P	0.0006
Co	0.0029	0.0004		S	0.0007
Cr	0.477	0.009		Sb	0.0003
Cu	0.046	0.002		Si	0.007
Fe	97.3	0.2		Sn	0.0006
Mn	0.752	0.005		Ti	0.0002
Mo	0.194	0.004		V	0.0003
N	0.0038	0.0005			

Informational Values^{3,4}

B (0.0002)	Ca (0.0007)	Mg (0.0007)	Nb (0.0006)	Pb (0.0007)
W (0.001)	Zr (0.001)			

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 Ga, Ge, K, Na, 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.

Analysis	*	Al	*	As	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo	*	N
1	4	0.019933	5	0.0028667	1	0.29686667	4	0.00236667	17	0.422	10	0.035	16	[97.2367]	4	0.731	3	0.187	2	0.00371
2	3	0.020	4	0.003	1	0.30	10	0.0024	4	0.458	12	0.035666667	3	97.3233333	3	0.745	4	0.189	2	0.00371
3	14	0.020633	3	0.003	1	0.306	5	0.0024	4	0.46933333	10	0.043433333	16	[97.329367]	14	0.74633	4	0.1900	2	0.00372
4	5	0.021967	4	0.0034	1	0.30733333	3	0.00243333	14	0.46966667	17	0.045	10	97.3366667	8	0.74733	10	0.190033	2	0.0039
5	4	0.022233	3	0.0036	1	0.309	8	0.00260667	13	0.47006667	4	0.045	16	[97.3367]	3	0.748	4	0.191	2	0.00393
6	3	0.0224	10	0.0036667	1	0.31133333	14	0.00266667	10	0.471	3	0.045066667	16	[97.3433]	4	0.74893	10	0.191	2	0.00395
7	3	0.0224	10	0.0037	3	0.314	3	0.0027	13	0.47166667	4	0.046	11	97.35	4	0.749	11	0.191	2	0.00407
8	11	0.0225	12	0.0037667	1	0.318	4	0.00272333	3	0.474	4	0.046366667	4	97.3533333	4	0.74987	10	0.191667	2	0.0042
9	10	0.022867	4	0.004	1	0.31866667	4	0.00273333	4	0.47433333	3	0.047	16	[97.39]	3	0.75	10	0.192	2	0.0043
10	4	0.023567	15	0.0040333	1	0.31933333	12	0.0028	4	0.47466667	3	0.047	14	97.4	4	0.75033	3	0.192	2	0.00431
11	4	0.023667	5	0.0041767	3	0.32	5	0.00289333	3	0.475	4	0.047033333	13	97.5466667	10	0.752	4	0.192	2	0.0046
12	4	0.0237	4	0.0042667	1	0.32	3	0.003	4	0.4758	8	0.0471	17	97.560	4	0.754	14	0.192333		
13	5	0.024467	11	0.0045	1	0.320	3	0.003	10	0.47643333	3	0.0473			11	0.754	4	0.192633		
14	4	0.024767	4	0.0045867	1	0.321	4	0.0031	11	0.477	4	0.047433333			4	0.75467	4	0.193		
15	4	0.025	5	0.0046667	11	0.322	10	0.0033	10	0.478	11	0.0478			4	0.75533	17	0.193		
16	3	0.025			1	0.32366667	5	0.00333333	3	0.48	10	0.0479			10	0.7559	3	0.193		
17					3	0.328	4	0.004	4	0.48563333	4	0.0479			10	0.762	6	0.195333		
18									4	0.489	10	0.048			10	0.770	4	0.195667		
19									4	0.492	4	0.048033333			3	0.772	4	0.196		
20									4	0.494	4	0.048233333			4	0.78967	7	0.196667		
21									3	0.504333	14	0.048833			4	0.814	3	0.200		
22									10	0.505667	12	0.048833					12	0.203333		
23											5	0.0510					4	0.206767		
Average		0.02284		0.003815		0.315012		0.00295		0.476709		0.0465		97.327		0.7522		0.193671		0.00382
Std Dev		0.00073		0.000082		0.000077		0.00013		0.000067		0.0012		0.030		0.0039		0.000066		0.00018
H		0.0014		0.00065		0.00053		0.00059		0.00067		0.0020		0.24		0.0088		0.0041		0.00065
U ₁		0.0016		0.00065		0.00053		0.00060		0.0067		0.0023		0.24		0.0096		0.0041		0.00067
t-statistic		2.13		2.14		2.12		2.12		2.08		2.07		2.20		2.09		2.07		2.23
U ₂		0.0034		0.0014		0.011		0.0013		0.014		0.0047		0.52		0.020		0.0085		0.0015
U ₃		0.00084		0.00036		0.0027		0.00031		0.0030		0.0010		0.15		0.0044		0.0018		0.00045
Certified		0.023		0.0038		0.315		0.0029		0.477		0.046		97.3		0.752		0.194		0.0038
Uncertainty		0.001		0.0007		0.008		0.0004		0.009		0.002		0.2		0.005		0.004		0.0005
Tolerance		0.003		0.0021		0.024		0.0013		0.027		0.006		0.5		0.020		0.012		0.0015

Analysis	*	Ni	*	O	*	P	*	S	*	Sb	*	Si	*	Sn	*	Ti	*	V
1	10	0.532	2	0.0002333	12	0.0023	1	0.0032	4	0.00083333	10	0.226	12	0.00166667	12	0.00033	4	0.0002
2	10	0.536	2	0.0004167	12	0.00244333	2	0.00323333	5	0.00088	3	0.248	10	0.00198333	4	0.00063	3	0.0003
3	4	0.536	2	0.0005	5	0.00245667	1	0.00363333	12	0.00091	6	0.253666667	4	0.00233333	10	0.00067	12	0.000323
4	3	0.536	2	0.0005867	7	0.00261667	1	0.00366	5	0.00096667	4	0.253666667	4	0.00236667	5	0.00069	4	0.00055
5	4	0.539967	2	0.0007867	4	0.00262333	1	0.00373333	5	0.001	4	0.254	5	0.00236667	5	0.0007	4	0.000567
6	3	0.541	2	0.0008	5	0.00273333	12	0.00393333	12	0.00103	10	0.254	5	0.00243333	14	0.0008	5	0.0006
7	14	0.541667	2	0.0009483	4	0.003	1	0.004	4	0.00123333	4	0.255666667	5	0.00253333	5	0.0008	5	0.00062
8	4	0.542333	2	0.0009667	11	0.0032	1	0.004	9	0.0013	10	0.2569	4	0.00283333	4	0.00087	5	0.000773
9	4	0.544	2	0.001	14	0.0033	1	0.00426667	11	0.0014	3	0.257	3	0.0029	4	0.0009	4	0.001
10	4	0.544	2	0.0011133	4	0.0033	1	0.0043	4	0.00166667	3	0.258	3	0.003	3	0.001	3	0.001
11	4	0.544333	2	0.0013	4	0.00333333	11	0.0046			10	0.258	10	0.0030	3	0.001	14	0.0012
12	4	0.545			4	0.00346667	10	0.0046			6	0.259	9	0.0038	4	0.00107		
13	8	0.546667			3	0.0037	1	0.00486333			3	0.26	4	0.006	3	0.0011		
14	4	0.548133			3	0.0038	3	0.005			11	0.26			11	0.0012		
15	11	0.549			10	0.0038	1	0.005			14	0.261						
16	3	0.55			4	0.00386667	1	0.0053			4	0.265033333						
17	10	0.5514			3	0.00396667	3	0.0058			5	0.267						
18	10	0.552									4	0.268						
19	4	0.553467									4	0.273366667						
20	3	0.556									17	0.275						
21											4	0.292						
Average		0.544448		0.000787		0.003171		0.004301		0.001219		0.2609		0.00287		0.00079		0.000648
Std Dev		0.000071		0.000095		0.000077		0.000077		0.000056		0.0033		0.00013		4.1E-05		0.000095
H		0.0073		0.00036		0.00060		0.00068		0.00042		0.0048		0.00058		0.00036		0.00034
U ₁		0.0073		0.00037		0.00061		0.00068		0.00043		0.0058		0.00059		0.00037		0.00035
t-statistic		2.09		2.12		2.12		2.12		2.12		2.09		2.18		2.16		2.23
U ₂		0.015		0.00083		0.0013		0.0015		0.0010		0.012		0.0013		0.00079		0.00078
U ₃		0.0034		0.00025		0.00031		0.00035		0.00030		0.0026		0.00036		0.00021		0.00024
Certified		0.544		0.0008		0.0032		0.0043		0.0012		0.261		0.0029		0.0008		0.0006
Uncertainty		0.008		0.0003		0.0006		0.0007		0.0003		0.007		0.0006		0.0002		0.0003
Tolerance		0.024		0.0008		0.0018		0.0021		0.0010		0.021		0.0018		0.0008		0.0006

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* Code for method

Informational values listed as weight percent

Analysis	*	B	*	Ca	*	Mg	*	Nb	*	Pb	*	W	*	Zr
1	12	0.000137	12	0.000017	12	0.0000013	5	0.00005	12	0.0000293	12	0.0000487	5	0.000047
2	3	0.00019	4	0.0002067	4	0.0013	5	0.0000527	5	0.00004	5	0.000067	5	0.00015667
3	7	0.000193	4	0.0002133			5	0.00014	5	0.0000583	12	0.0000703	3	0.0008
4	4	0.00023	3	0.00023			4	0.00023333	12	0.0000597	5	0.0000943	10	0.00084
5			5	0.0026667			10	0.00061	5	0.0000633	5	0.000113333	11	0.001
6							4	0.00066667	3	0.0003	3	0.0005	3	0.001
7							3	0.0007	9	0.0004	4	0.0008	4	0.001
8							4	0.002	10	0.00054	3	0.005	4	0.00126667
9									11	0.0008	4	0.005	4	0.00403333
10									4	0.00084				
11									4	0.00403333				
Average		0.00019		0.0007		0.0007		0.00056		0.0007		0.0013		0.0011
Std Dev		0.00012		0.0015		0.0023		0.00086		0.0010		0.0039		0.0030
H		0.00023		0.0003		0.0003		0.00032		0.0003		0.0004		0.0004
U ₁		0.00026		0.0016		0.0024		0.00092		0.0011		0.0039		0.0031
t-statistic		3.18		2.78		12.71		2.36		2.23		2.31		2.31
U ₂		0.00083		0.0044		0.030		0.0022		0.0023		0.0090		0.0070
U ₃		0.00042		0.0020		0.021		0.00077		0.00071		0.0030		0.0023
Informational		(0.0002)		(0.0007)		(0.0007)		(0.0006)		(0.0007)		(0.001)		(0.001)

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.

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* Code for analytical method

Trace analysis listed as mg/kg (ppm)

Analysis	*	Ga	*	Ge	*	K	*	Na	*	Se	*	U	*	Zn
1	12	5.6	12	6.3	17	10	12	0.01	12	3.4	12	0.006	12	2.6
2	12	6.4	12	6.5					12	3.6	12	0.008	12	2.7
3	12	6.8	12	6.6					12	3.7	12	0.009	12	2.8

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	

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
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: 12X12748U, 12X352D, 12XLA3B; AR 115C, 165B, 644, 654, 668, 875, 882, 892, 956, 960, 1648, 1653, 1655; BAS 111, 260/4, 404, 404/1, 434, 451, 464/1; BS D-6, HON U, XCCS, 06A, 54F, 56H, 61C, 61G, 73A, 1061, 1144A, 1951, 2992, 4130, 8620B, 8620C, 8620E; CKD 166A, 188A; ECRM 85-1, 86-1, 87-1; IARM 31B, 32B, 32C, 32D, 34C, 182B, 252C, 270A, 373A; IMZ 55/1A, 65, 112, 116; JSS 502-5; LECO 501-320, 501-501, 501-504, 501-505, 501-644, 501-646, 501-675, 501-676, 501-677, 501-991, 501-993, 502-197, 502-364, 502-411, 502-702, 502-712, 502-874, 502-893, 502-895, 502-903, 504-646; MQ CA01A; SRM 55D, 72F, 132A, 160B, 160B, 293, 361, 362, 363, 364, 1222, 1225, 1262, 1262A, 1263, 1264, 1265A, 1413, 3131A, 3137, 3161A.

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 111; BS HON U, XCCS, 62G, 73A, 1951, 2992, 8620C; JSS 502-5; LECO 501-676; MQ CA01A; SRM 293, 1222.

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 8630 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 Instytut Metalurgii Zelaza, Gliwice, Poland.

Form: This CRM is machined in the form of a disc, approximately 44 mm 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 8630-122018. 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 20, 2018.

Beau R. Brammer

President