Brammer Standard Company, Inc.

Certificate of Analysis

BS 8620G

Certified Reference Material for ASTM A331 Grade 8620 - UNS Number G86200

Certified Values[3]

	Certified Value[1]	Estimate of Uncertainty[2]		Certified Value[1]	Estimate of Uncertainty[2]
Al	**0.027**	0.001	**N**	**0.0080**	0.0007
As	**0.0049**	0.0005	**Nb**	**0.0020**	0.0005
B	**0.0002**	0.0001	**Ni**	**0.58**	0.02
C	**0.215**	0.006	**O**	**0.0032**	0.0008
Ca	**0.0015**	0.0005	**P**	**0.0094**	0.0009
Co	**0.0077**	0.0008	**S**	**0.020**	0.002
Cr	**0.568**	0.008	**Sb**	**0.0020**	0.0006
Cu	**0.191**	0.009	**Si**	**0.264**	0.007
Fe	**97.1**	0.1	**Sn**	**0.0095**	0.0008
Mn	**0.799**	0.009	**Ti**	**0.0011**	0.0004
Mo	**0.205**	0.009	**V**	**0.0018**	0.0006

Reference Values[3,4]

	Reference Value[1]	Estimate of Uncertainty[2]		Reference Value[1]	Estimate of Uncertainty[2]
H	**<0.005**		**W**	**0.0022**	0.0009
Mg	**0.0004**	0.0002	**Zn**	**<0.005**	
Pb	**<0.005**		**Zr**	**0.0007**	0.0006
Ta	**<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.

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BS 8620G * Code for method Certified values listed as weight percent

Analysis	*	Al	*	As	*	B	*	C	*	Ca	*	Co	*	Cr	*	Cu	*	Fe	*	Mn
1	4	0.026	4	0.0043333	4	0.0002	1	0.2090333	14	0.0010	8	0.007	8	0.54	4	0.180	16	[96.97367]	4	0.7887
2	4	0.0261667	4	0.0045667	4	0.0002	1	0.21	4	0.0010333	4	0.0071	4	0.5453333	3	0.1823333	16	[97.03]	8	0.791
3	4	0.0263	9	0.0046	3	0.0002	3	0.21	3	0.0012	5	0.0071667	4	0.5501333	10	0.1833333	3	97.04	10	0.791
4	3	0.0264333	5	0.0046667	3	0.0002	3	0.21	11	0.0012	5	0.0072667	10	0.56	8	0.186	4	97.04	4	0.7943333
5	4	0.0264667	10	0.0047	5	0.0002267	1	0.212	4	0.00149	11	0.0074	3	0.566	14	0.1863333	10	97.0566667	4	0.7953333
6	11	0.0267	4	0.0047667	7	0.00024	1	0.2146667	3	0.0015	4	0.0075333	4	0.5667667	4	0.1890333	4	97.067	3	0.796
7	3	0.0267	4	0.0049433	11	0.0003	1	0.2146667	4	0.0015667	4	0.0076667	3	0.567	3	0.19	16	[97.07]	4	0.799
8	4	0.0269333	4	0.0049667	4	0.0003333	1	0.2146667	3	0.0016	4	0.0077	14	0.567	3	0.19	16	[97.074467]	4	0.7999333
9	14	0.0269667	3	0.005			1	0.215	4	0.0017667	3	0.0078	4	0.5673333	10	0.19	16	[97.08]	4	0.7999667
10	4	0.0269667	5	0.0052333			11	0.216	4	0.0018667	14	0.0078333	4	0.5682	3	0.19	16	[97.1]	3	0.8
11	8	0.027	5	0.0053267			1	0.2183	4	0.0020333	3	0.008	4	0.569	4	0.1900333	16	[97.100933]	3	0.8
12	4	0.027	4	0.00541			1	0.22			10	0.008	4	0.5695	4	0.1906667	13	97.1163333	10	0.8
13	3	0.0277					1	0.2250667			17	0.0080233	4	0.5697	4	0.1908667	14	97.1333333	14	0.802
14	5	0.0278					1	0.227			4	0.0080667	3	0.57	4	0.1909667	16	[97.15]	4	0.8038333
15	4	0.0279									4	0.00809	13	0.57	11	0.192			4	0.8046667
16	4	0.0279									3	0.0085	4	0.5700333	4	0.1927333			4	0.8062667
17	3	0.028											11	0.572	4	0.1934333			11	0.808
18													10	0.573	4	0.1976667			10	0.8133333
19													3	0.5826667	10	0.198				
20													10	0.5933333	17	0.1993333				
21													4	0.596667	4	0.203667				
Average		0.02711		0.00495		0.0002007		0.215457		0.001478		0.007697		0.568270		0.190781		97.072		0.7994
Std Dev		0.00082		0.00018		0.0000047		0.000085		0.000095		0.000079		0.000069		0.000069		0.030		0.0041
H		0.0017		0.00080		0.00024		0.0047		0.00049		0.00097		0.0079		0.0044		0.19		0.010
U_1		0.0019		0.00082		0.00024		0.0047		0.00050		0.00097		0.0079		0.0044		0.19		0.010
t-statistic		2.12		2.20		2.36		2.16		2.23		2.13		2.09		2.09		2.16		2.11
U_2		0.0040		0.0018		0.00057		0.010		0.0011		0.0021		0.016		0.0092		0.41		0.022
U_3		0.0010		0.00052		0.00020		0.0027		0.00034		0.00052		0.0036		0.0020		0.11		0.0052
Certified		**0.027**		**0.0049**		**0.0002**		**0.215**		**0.0015**		**0.0077**		**0.568**		**0.191**		**97.1**		**0.799**
Uncertainty		0.001		0.0005		0.0001		0.006		0.0005		0.0008		0.008		0.009		0.1		0.009
Tolerance		0.004		0.0018		0.0001		0.018		0.0014		0.0024		0.024		0.027		0.4		0.027

Analysis	*	Mo	*	N	*	Nb	*	Ni	*	O	*	P	*	S	*	Sb	*	Si	*	Sn
1	4	0.1873333	2	0.00765	5	0.00019	4	0.5588333	2	0.0023333	4	0.007	1	0.0176667	5	0.0014333	10	0.25366667	4	0.0088333
2	5	0.1936667	2	0.0077667	5	0.0001933	3	0.5616667	2	0.0025667	5	0.0070	1	0.0183	9	0.0015	3	0.25766667	5	0.0089667
3	7	0.1943333	2	0.008	3	0.0015	4	0.5626667	2	0.002625	4	0.0086467	1	0.0184667	5	0.00198	14	0.25933333	3	0.0089667
4	4	0.1983	2	0.008	4	0.0018667	10	0.5686667	2	0.0028267	3	0.0088	1	0.01857	10	0.002	4	0.25946667	4	0.0091
5	8	0.200	2	0.0080667	11	0.0019	4	0.5688	2	0.0030267	4	0.009	1	0.0189333	5	0.0020667	4	0.25966667	5	0.0091667
6	3	0.2	2	0.0080667	4	0.0019	10	0.57	2	0.0030667	4	0.0090333	1	0.0193333	4	0.0021	4	0.25996667	3	0.0093
7	10	0.2	2	0.0080933	4	0.002	4	0.570	2	0.0033067	6	0.0090333	1	0.0196667	4	0.00217	6	0.26003333	4	0.0093
8	4	0.203	2	0.0081667	14	0.0020	14	0.576	2	0.0035667	7	0.0090633	1	0.0198	5	0.0022667	4	0.26366667	4	0.00935
9	10	0.203	2	0.0082			11	0.577	2	0.0035667	14	0.0094	1	0.0199667	3	0.0023	4	0.26466667	14	0.0094
10	10	0.204	2	0.0082067			4	0.5787333	2	0.004	4	0.0094333	3	0.020	4	0.0028667	11	0.265	5	0.0096
11	4	0.2043	2	0.0085			3	0.579	2	0.0040	4	0.0094667	10	0.020			4	0.26526667	10	0.010
12	3	0.2043333					4	0.5797667	2	0.0041	11	0.0097	1	0.020			4	0.26666667	3	0.010
13	7	0.205					3	0.58			3	0.0097	3	0.0201			3	0.269	5	0.0102333
14	11	0.206					3	0.580			3	0.010	11	0.0203			3	0.269	4	0.0103
15	3	0.207					7	0.58			10	0.01	1	0.0208			10	0.27	10	0.0105
16	4	0.2099667					4	0.5800333			4	0.0103	1	0.0208333			5	0.270		
17	4	0.2100333					4	0.5853333			10	0.0103667	1	0.0213667			6	0.27		
18	14	0.2103333					4	0.5856667			3	0.0108					3	0.27		
19	3	0.214					10	0.587			4	0.0127								
20	4	0.2146667					8	0.590												
21	4	0.216333																		
22	4	0.216533																		
Average		0.2047		0.00804		0.001988		0.575958		0.003249		0.009444		0.019653		0.001988		0.2641		0.009534
Std Dev		0.0026		0.00030		0.000059		0.000071		0.000091		0.000073		0.000077		0.000088		0.0037		0.000082
H		0.0046		0.0010		0.00055		0.0080		0.00067		0.0011		0.0015		0.00055		0.0052		0.0011
U_1		0.0053		0.0010		0.00056		0.0080		0.00068		0.0011		0.0015		0.00056		0.0064		0.0011
t-statistic		2.08		2.23		2.36		2.09		2.20		2.10		2.12		2.26		2.11		2.14
U_2		0.011		0.0023		0.0013		0.017		0.0015		0.0022		0.0031		0.0013		0.013		0.0023
U_3		0.0023		0.00069		0.00047		0.0037		0.00043		0.00051		0.00075		0.00040		0.0032		0.00059
Certified		**0.205**		**0.0080**		**0.0020**		**0.58**		**0.0032**		**0.0094**		**0.020**		**0.0020**		**0.264**		**0.0095**
Uncertainty		0.009		0.0007		0.0005		0.02		0.0008		0.0009		0.002		0.0006		0.007		0.0008
Tolerance		0.027		0.0023		0.0015		0.06		0.0024		0.0027		0.006		0.0018		0.021		0.0024

BS 8620G * Code for method Certified values listed as weight percent

Analysis	*	Ti	*	V
1	3	0.0008	5	0.0013667
2	5	0.0008033	4	0.0013833
3	4	0.0009	5	0.0013867
4	4	0.0009	5	0.0015
5	4	0.0009667	4	0.0015
6	11	0.001	3	0.0017
7	4	0.0010067	11	0.0017
8	5	0.0010633	4	0.0021
9	4	0.0012	14	0.0021
10	3	0.0015	4	0.0022
11	14	0.0015	4	0.0023667
12			10	0.0025
Average		0.001058		0.001817
Std Dev		0.000095		0.000091
H		0.00044		0.00054
U_1		0.00045		0.00054
t-statistic		2.23		2.20
U_2		0.0010		0.0012
U_3		0.00030		0.00034
Certified		**0.0011**		**0.0018**
Uncertainty		0.0004		0.0006
Tolerance		0.0010		0.0017

BS 8620G * Code for method Reference values listed as weight percent

Analysis	*	Hf	*	Mg	*	Pb	*	Ta	*	W	*	Zn	*	Zr
1	2	0.000083	4	0.0002	5	0.000052	5	0.000057	4	0.0008667	5	0.002210	5	0.0001133
2	2	0.0000886	4	0.00040	5	0.000053			5	0.00157			5	0.00013
3	2	0.0000961	3	0.0004	11	0.0001			4	0.0018333			16	0.0006
4	2	0.0001067	4	0.0004067	9	0.0002			5	0.0018333			4	0.0007667
5	2	0.0001097			4	0.0003			5	0.0020			3	0.0009
6	2	0.0001333			3	0.0005			3	0.0027			4	0.0009333
7	2	0.0001367							11	0.0031			3	0.001
8	2	0.0004333							4	0.0036			10	0.001
Average		0.0001082		0.000400		0.00020		0.000057		0.00219		0.00221		0.00068
Std Dev		0.0000063		0.000025		0.00013		0.000013		0.00011		0.00040		0.00011
H		0.00020		0.00031		0.00024		0.000164		0.00058		0.000578		0.00037
U_1		0.00020		0.00031		0.00027		0.00016		0.00059		0.00070		0.00039
t-statistic		2.36		3.18		2.57		12.71		2.36		12.71		2.36
U_2		0.00047		0.0010		0.00071		0.0021		0.0014		0.0089		0.00091
U_3		0.00017		0.00049		0.00029		0.0021		0.00049		0.0089		0.00032
Reference		**<0.005**		**0.0004**		**<0.005**		**<0.0005**		**0.0022**		**<0.005**		**0.0007**
Uncertainty				0.0002						0.0009				0.0006
Tolerance				0.0003						0.0021				0.0006

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
17 AAS

ICP = Inductively Coupled Plasma GF = Graphite Furnace GD = Glow Discharge
DCP = Direct Current Plasma HG = Hydride Generation AAS = Atomic Absorption Spectrometry

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:

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

*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 Guide 35:2006 section 6.

Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, 17034
Element Materials Technology	Glendale Heights, IL	A2LA	17025
NSL Analytical	Cleveland, OH	ANAB	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, 644, 645, 659, 662, 668, 881, 882, 884, 895, 960, 8620; BAS 328, 329, 407, 410/2, 451, 464/1; BS CC11A, 33F, 55G, 61D, 61G, 72B, 286A, 1026, 1026A, 1045, 1762, 2012, 2991, 8620A, 8620B, 8620C, 8620E; CKD 166, 181A, 244, 247; CZ 02033 1A, 02003 6C, 02033 13B; DSZU CA031; ECRM 085-1, 086-1, 087-1, 190-1, 479-1, 480-1; IARM FeDP1080, 20A, 31G, 32D, 143C; IPT 12A, 75A, 97l; JSM M402-4; JSS GS; LECO 501-503, 501-677, 502-870, 502-903, 502-913, 502-916, 502-928, 502-935, 761-747; NCS NS 11079; SPL LA-3F; SRM 13F, 32E, 160B, 293, 361, 363, 364.

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 8620; BS 61D, 2012, 2991, 8620A, 8620B, 8620C.

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 8620G 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 Nucor Cold Finish Wisconsin; Oak Creek, WI.

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 8620G-080923. 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:

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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 9, 2023.

Beau R. Brammer

President