

BRAMMER STANDARD COMPANY, INC.

Certificate of Analysis

BS 181B

Certified Reference Material for High Manganese Stainless Steel (Nitronic 60) - UNS Number S21800

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²	
Al	0.0119	0.0009		Ti	0.0051	0.0007
C	0.070	0.002		V	0.044	0.001
Co	0.044	0.002		W	0.016	0.001
Cr	16.17	0.06				
Cu	0.206	0.006				
Fe	62.8	0.2				
Mn	8.07	0.08				
Mo	0.173	0.007				
N	0.158	0.002				
Nb	0.026	0.001				
Ni	8.18	0.05				
O	0.0010	0.0003				
P	0.021	0.002				
S	0.0009	0.0002				
Si	3.94	0.04				

Informational Values^{3,4}

As (0.002)	B (0.0008)	Ca (0.001)	Mg (0.0003)	Pb (0.0005)
Sb (0.0007)	Sn (0.004)	Zr (0.0004)		

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

Trace element information values for Rb and Zn are shown on page 4.

The requirements of ISO Guides 31, 34, and 35 were followed for the preparation of this Certified Reference Material and certificate of analysis. This is a Certified Reference Material as defined by ISO Guide 30.

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* Code for method Certified values listed as weight percent

Analysis	*	Al	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo
1	5	0.009633	1	0.061233	5	0.035667	12	16.00	5	0.166667	13	62.51667	4	7.76	5	0.13667
2	5	0.010433	1	0.067667	3	0.039133	13	16.06433	3	0.194667	16	[62.57]	4	7.879	12	0.15667
3	4	0.011	3	0.069	12	0.040667	3	16.08333	3	0.199	16	[62.61667]	14	8.003333	3	0.164
4	4	0.011033	1	0.069967	10	0.0418	4	16.09667	10	0.200	3	62.62	4	8.022333	10	0.167333
5	5	0.011367	1	0.070	3	0.042	10	16.10667	4	0.2006	10	62.680	4	8.03	4	0.17
6	4	0.011767	1	0.070067	4	0.042733	10	16.11	4	0.201667	16	[62.69667]	4	8.041833	4	0.17333
7	10	0.011833	1	0.070667	3	0.0438	13	16.135	14	0.202667	14	62.73333	13	8.061667	5	0.17493
8	14	0.012167	1	0.071133	14	0.044333	3	16.14	10	0.2033333	4	62.8	10	8.063333	10	0.176
9	3	0.0124	1	0.071667	4	0.044467	4	16.14533	4	0.2033333	16	[62.1933]	3	8.14	10	0.17667
10	12	0.012667	1	0.071733	4	0.0446	4	16.17333	10	0.205	4	62.90333	4	8.146667	4	0.177
11	4	0.012767	3	0.0718	4	0.044867	4	16.196	4	0.208	10	62.95333	10	8.15	4	0.177967
12	4	0.013267	1	0.0749	10	0.045	3	16.21	4	0.2083	16	[63.41333]	4	8.153333	4	0.1798
13	3	0.0148			4	0.045333	17	16.21213	4	0.21	10	63.52	3	8.16	4	0.180333
14	3	0.015			8	0.0481	14	16.23333	3	0.210			3	8.20	4	0.181333
15					5	0.048133	4	16.24333	12	0.213333			4	8.229833	14	0.181333
16					2	0.049	4	16.26667	5	0.213467					7	0.182
17					4	0.0506	10	16.28667	4	0.215333					3	0.187
18									8	0.229333						
Average		0.01189		0.0702		0.04413		16.165		0.2061		62.768		8.06942		0.173080
Std dev		0.00055		0.0020		0.00024		0.054		0.0038		0.060		0.00082		0.000077
H		0.00077		0.0019		0.0015		0.09		0.0035		0.33		0.051		0.0032
U ₁		0.00095		0.0028		0.0015		0.11		0.0051		0.34		0.051		0.0032
t-statistic		2.16		2.20		2.12		2.12		2.11		2.18		2.14		2.12
U ₂		0.0020		0.0061		0.0031		0.23		0.011		0.74		0.11		0.0067
U ₃		0.00055		0.0018		0.00080		0.056		0.0026		0.20		0.028		0.0016
Certified		0.0119		0.070		0.044		16.17		0.206		62.8		8.07		0.173
Uncertainty		0.0009		0.002		0.002		0.06		0.006		0.2		0.08		0.007
Tolerance		0.0027		0.006		0.006		0.23		0.018		0.7		0.24		0.021

Analysis	*	N	*	Nb	*	Ni	*	O	*	P	*	S	*	Si	*	Ti
1	2	0.152067	4	0.022333	10	7.853333	2	0.000367	10	0.014667	1	0.000567	6	3.855	5	0.0037
2	2	0.153057	4	0.023733	4	8.043333	2	0.000667	3	0.0170	1	0.000637	6	3.857667	4	0.004333
3	2	0.153333	5	0.0247	4	8.069667	2	0.00087	5	0.018667	1	0.0008	4	3.863333	12	0.004333
4	2	0.156333	4	0.025	13	8.137333	2	0.00103	4	0.018667	12	0.000813	4	3.867333	5	0.0044
5	2	0.156333	10	0.025133	10	8.14	2	0.00109	5	0.018833	1	0.000833	4	3.913333	4	0.0046
6	2	0.157333	4	0.025567	4	8.183333	2	0.001233	4	0.019133	1	0.0009	4	3.933333	14	0.004867
7	2	0.157667	14	0.026367	4	8.19	2	0.00157	7	0.0209	1	0.000967	17	3.933933	4	0.0049
8	2	0.160267	3	0.0264	10	8.19	2	0.001377	3	0.021	1	0.0010	10	3.946667	3	0.005
9	2	0.164	3	0.027	4	8.203433			12	0.021	1	0.0010	10	3.95	4	0.005167
10	2	0.164667	10	0.027	14	8.206667			4	0.0215	1	0.001363	4	3.958333	10	0.0053
11			4	0.0277	4	8.2084			4	0.021633	1	0.0015	3	3.97	3	0.0053
12			4	0.0297	3	8.23			4	0.021667	3	0.0019	10	3.97	4	0.005737
13					4	8.23			10	0.022			3	3.983333	3	0.005833
14					4	8.263333			4	0.022767			14	4.003333	10	0.006067
15					3	8.336667			14	0.0231			3	4.09		
16					3	8.35			3	0.0235						
Average		0.15751		0.0261		8.17722		0.00099		0.02123		0.000883		3.93971		0.00511
Std dev		0.00032		0.0013		0.00025		0.00011		0.00098		0.000078		0.00026		0.00025
H		0.0030		0.0011		0.052		0.00031		0.0010		0.00030		0.028		0.00055
U ₁		0.0030		0.0017		0.052		0.00033		0.0014		0.00031		0.028		0.00060
t-statistic		2.26		2.20		2.13		2.36		2.13		2.20		2.14		2.16
U ₂		0.0068		0.0038		0.11		0.00079		0.0030		0.00069		0.061		0.0013
U ₃		0.0021		0.0011		0.028		0.00028		0.00080		0.00020		0.016		0.00035
Certified		0.158		0.026		8.18		0.0010		0.021		0.0009		3.94		0.0051
Uncertainty		0.002		0.001		0.05		0.0003		0.002		0.0002		0.04		0.0007
Tolerance		0.007		0.004		0.15		0.0008		0.006		0.0007		0.12		0.0021

BS 181B * Code for method Certified values listed as weight percent

Analysis	*	V	*	W
1	12	0.0410	4	0.010333
2	4	0.042267	12	0.011333
3	5	0.042333	3	0.015133
4	14	0.043167	7	0.015433
5	4	0.043567	4	0.015667
6	7	0.043833	10	0.015867
7	4	0.043933	5	0.015967
8	10	0.044067	5	0.016
9	5	0.0442	4	0.01633
10	4	0.0446	4	0.016767
11	3	0.0455	4	0.0174
12	4	0.0457	4	0.017567
13	10	0.0460	3	0.0178
14	3	0.047233	14	0.018133
Average		0.0438		0.01555
Std dev		0.0016		0.00078
H		0.0015		0.0009
U ₁		0.0022		0.0012
t-statistic		2.16		2.16
U ₂		0.0047		0.0025
U ₃		0.0013		0.00070
Certified		0.044		0.016
Uncertainty		0.001		0.001
Tolerance		0.005		0.003

BS 181B * Code for method Informational values listed as weight percent

Analysis	*	As	*	B	*	Ca	*	Mg	*	Pb	*	Sb	*	Sn	*	Zr
1	12	0.0021	4	0.000233	12	0.00024	12	0.000257	12	0.0000113	5	0.000667	9	0.0019	12	0.000443
2	5	0.002333	12	0.000453	4	0.000267			4	0.0009			3	0.0021		
3			4	0.0005	4	0.000627							4	0.002133		
4			7	0.0005	3	0.00063							12	0.0032		
5			3	0.00071	4	0.00106							4	0.004133		
6			5	0.000967	4	0.005667							5	0.004603		
7			3	0.0011									5	0.004633		
8			4	0.0016									5	0.004833		
9													5	0.004967		
Average		0.002		0.0008		0.0014		0.00026		0.0005		0.0007		0.004		0.0004
Std dev		0.020		0.0016		0.0055		0.00049		0.0012		0.0035		0.020		0.0015
H		0.000		0.0003		0.0003		0.00023		0.0003		0.0003		0.000		0.0002
U ₁		0.020		0.0016		0.0055		0.00054		0.0012		0.0035		0.020		0.0016
t-statistic		12.71		2.36		2.57		12.71		12.71		12.71		2.31		12.71
U ₂		0.25		0.0037		0.014		0.0068		0.015		0.044		0.046		0.020
U ₃		0.18		0.0013		0.0058		0.0068		0.011		0.044		0.015		0.020
(Informational)		(0.002)		(0.0008)		(0.001)		(0.0003)		(0.0005)		(0.0007)		(0.004)		(0.0004)

For each element, in accordance with the requirements of ISO Guides 34 and 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.

BS 181B * Code for analytical method Trace analysis listed as mg/kg (ppm)

Analysis	* Rb	* Zn
1	5 11	5 9
2	5 11	5 9
3	5 11	5 10

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 Wet |
| 6 Gravimetric | 12 GD Mass Spectrometry | |

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

Laboratory

Location

Registrar

Accreditation

Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895
Telephone: (281) 440-9396 Fax: (281) 440-4432 Website: www.brammerstandard.com
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Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, Guide 34
Evans Analytical Group	Liverpool, NY	A2LA	17025
Dirats Laboratories	Westfield, MA	ACLASS	17025
NSL Analytical	Cleveland, OH	ACLASS	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	AB 554
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025
Exova	Glendale Heights, IL	A2LA	17025
Luvak Inc.	Boylston, MA	PRI/Nadcap	17025
Central Iron and Steel Research Institute	Beijing, China	CNAS	17025

A2LA = American Association for Laboratory Accreditation

ACLASS = ANSI-ASQ National Accreditation Board

CNAS = China National Accreditation Service

Nadcap = National Aerospace and Defense Contractors Accreditation Program

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: 12X10180, 12X32550, 13X31254, 13X32101A, 14XMN1, 14XMN3, 212X4001, 212X4003, 212X4004, 212X4005, 215XHB2; LECO 501-320, 501-501, 501-504, 501-644, 501-646, 501-675, 501-676, 501-993, 502-257, 502-416, 502-873; AR 115C, 362, 512, 644, 655, 676, 871, 875, 891, 892, 1647, 1652, 1653, 1656; BAS 152/2, 345, 363, 434, 435, 464/1; BS 180, 180A, 181, 181A, 190, 191, 203MN, 400D, 800; ECRM 85, 86, 87, 285-2, 299-1; 6H, 17B, 18B, 18C, 52A, 199A, 196A; IMZ 1-N4, 1.12/3, 112, 121, 124; JK 37; SRM 7G, 8F, 101C, 101E, 101G, 121D, 160B, 361, 362, 363, 864, 866, 1233, 1297, 1413; Y 41340B.

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 — 501-676, 502-257, 502-873; BS 180, 180A, 181, 190, 191, 203MN; ECRM 299-1; SRM 864, 866, 1233, 1297; Y 41340B.

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 181B is valid indefinitely. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

Source: The bar stock for this CRM was produced by Dunkirk Specialty Steel, LLC.; Dunkirk, NY.

Form: This CRM is machined in the form of a disc, approximately 38 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 181B-082216. 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. **Phone: (281) 440-9396** **Web: www.brammerstandard.com**
14603 Benfer Road
Houston, Texas 77069-2895 USA **Fax: (281) 440-4432** **Email: contact@brammerstandard.com**

Brammer Standard Company, Inc., is accredited by the American Association For Laboratory Accreditation (A2LA) to ISO Guide 34 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 9001:2008 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 9001:2008 Quality Management Systems - Requirements
- ISO Guide 30:1992 Terms and definitions used in connection with reference materials + 2008 amendment
- ISO Guide 31:2000 Reference materials - Contents of certificates and labels
- ISO Guide 33:2000 Uses of certified reference materials
- ISO Guide 34:2009 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

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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 22, 2016.

Beau R. Brammer