

Brammer Standard Company, Inc.

Certificate of Analysis

BS 180B

Certified Reference Material for High Manganese Stainless Steel (Nitronic 50) - UNS Number S20910

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³	Certified Value ¹	Estimate of Uncertainty ²
B	0.0011	0.0002	Nb	0.131	0.008
C	0.022	0.001	Ni	11.9	0.1
Ca	0.0009	0.0004	O	0.0043	0.0006
Co	0.111	0.005	P	0.017	0.001
Cr	21.5	0.1	S	0.0008	0.0002
Cu	0.201	0.005	Si	0.46	0.02
Fe	58.5	0.3	Sn	0.0040	0.0004
Mn	4.65	0.04	V	0.149	0.005
Mo	2.20	0.02	W	0.050	0.004
N	0.315	0.005			

Informational Values^{3,4}

Al (0.007)	As (0.004)	Mg (0.0007)	Pb (0.002)	Sb (0.0007)
Ta (0.003)	Ti (0.005)	Zr (0.0009)		

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 Ag, Au, Ba, Cd, Ce, Ga, Ge, In, Ir, La, Na, Nd, Os, Pd, Pm, Pt, Re, Ru, Sr, Y, 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	*	B	*	C	*	Ca	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo	*	N
1	14	0.0008	1	0.0198333	12	0.00082	10	0.1	4	21.133333	10	0.190497	4	57.763333	10	4.575865	4	2.14	2	0.28
2	4	0.0009667	1	0.0199333	4	0.000873	4	0.100433	12	21.2	10	0.192	13	58.106333	4	4.5866667	4	2.16	2	0.301333
3	12	0.00099	1	0.0203333	3	0.00103	3	0.105	4	21.2	3	0.194	18	58.116667	10	4.5933333	12	2.16	2	0.30625
4	4	0.001	1	0.0203333	14	0.0010333	3	0.106	4	21.22	4	0.1949333	16	[58.28]	3	4.598	4	2.1666667	2	0.31
5	5	0.001	3	0.021	4	0.0013	4	0.107	14	21.366667	3	0.196	3	58.29	4	4.6006667	4	2.1766667	2	0.311
6	4	0.0011	1	0.0211	12	0.0013667	4	0.1091	13	21.37	4	0.1963333	10	58.315	4	4.6033333	4	2.18	2	0.3142667
7	12	0.00115	1	0.0213333			3	0.11	10	21.38	4	0.1966667	14	58.366667	3	4.61	4	2.19	2	0.3166667
8	3	0.00122	1	0.0213667			4	0.11	4	21.396667	4	0.1966667	16	[58.37]	12	4.61	4	2.1929333	2	0.3173333
9	7	0.00135	1	0.022			12	0.11	13	21.411667	10	0.197	10	58.453333	4	4.6133333	4	2.1959333	2	0.321
10	4	0.0014333	3	0.0223			4	0.11	10	21.446667	8	0.1976667	16	[58.49667]	10	4.62	3	2.2	2	0.3220667
11	3	0.0015	1	0.0224333			4	0.11	4	21.453333	4	0.1986667	4	58.5	3	4.62	14	2.2033333	2	0.3236
12	3	0.002	1	0.0227333			8	0.111	10	21.455467	3	0.20	16	[58.5033]	14	4.62	10	2.21	2	0.3272
13			1	0.023			4	0.112	3	21.46	12	0.2	3	58.565	18	4.6333333	3	2.21		
14			1	0.0234667			4	0.114	3	21.466667	4	0.20	16	[58.84]	4	4.642	4	2.2153333		
15			3	0.026			10	0.1146667	3	21.514	4	0.2003333	12	59	4	4.65	4	2.2193333		
16			4	0.026			10	0.11637	3	21.53	14	0.2006667	4	59.066667	4	4.658	10	2.22055		
17			1	0.028			4	0.1186667	18	21.556667	3	0.203			3	4.66	3	2.223		
18							3	0.119	10	21.599	4	0.2033333			10	4.66	18	2.2233333		
19							4	0.1226667	4	21.6	5	0.2053333			4	4.674	7	2.228667		
20							5	0.124	4	21.695333	4	0.2079			4	4.703	3	2.23		
21									4	21.79667					4	4.7366667	10	2.23		
22									4	21.84737					4	4.7533333	4	2.23		
23															4	4.867633				
Average		0.001137		0.02202		0.000888		0.1115		21.3977		0.2007		58.483		4.646		2.1974		0.3155
Std Dev		0.000031		0.00080		0.000095		0.0026		0.0037		0.0031		0.059		0.097		0.0057		0.0056
H		0.000363		0.001128		0.000338		0.002605		0.112483		0.003664		0.277606		0.31916		0.018086		0.00483
U ₁		0.00036		0.0014		0.00035		0.0037		0.11		0.0048		0.28		0.10		0.019		0.0074
t-statistic		2.20		2.12		2.57		2.09		2.08		2.08		2.13		2.07		2.08		2.20
U ₂		0.00080		0.0029		0.00090		0.0078		0.23		0.010		0.60		0.21		0.039		0.016
U ₃		0.00023		0.00071		0.00037		0.0017		0.050		0.0021		0.15		0.044		0.0084		0.0047
Certified		0.0011		0.022		0.0009		0.111		21.5		0.201		58.5		4.65		2.20		0.315
Uncertainty		0.0002		0.001		0.0004		0.005		0.1		0.005		0.3		0.04		0.02		0.005
Tolerance		0.0008		0.003		0.0009		0.015		0.3		0.015		0.9		0.12		0.06		0.016

Analysis	*	Nb	*	Ni	*	O	*	P	*	S	*	Si	*	Sn	*	V	*	W		
1	12	0.11	10	11.70	2	0.003	4	0.0129667	1	0.0004733	10	0.4243333	9	0.0025667	18	0.13	12	0.0390		
2	4	0.11	3	11.81	2	0.0037	12	0.0130	1	0.00058	3	0.4293333	10	0.0027	10	0.138	14	0.0397667		
3	4	0.1133333	10	11.810983	2	0.0037333	10	0.0141	1	0.0008333	3	0.43	5	0.0032	4	0.1446667	4	0.0408667		
4	3	0.12	4	11.833333	2	0.0038533	5	0.0156667	12	0.00086	5	0.4353333	12	0.0036	3	0.1463333	3	0.042		
5	10	0.123	10	11.836667	2	0.0038967	3	0.016	1	0.0009	4	0.4396667	4	0.0036333	10	0.148	3	0.0449		
6	4	0.127	4	11.836667	2	0.004125	3	0.016	1	0.0009	10	0.4396667	4	0.0038667	10	0.1498833	10	0.047		
7	10	0.1283333	6	11.845	2	0.0043267	10	0.0163233	1	0.0009	10	0.44	10	0.004	10	0.15	10	0.047		
8	4	0.1326333	4	11.861	2	0.0047	3	0.0167	1	0.0009667	6	0.4433333	3	0.004	4	0.15	5	0.047		
9	10	0.1329933	10	11.866	2	0.0047	3	0.0167	3	0.001	6	0.445	5	0.0042333	3	0.15	4	0.0470333		
10	5	0.133	14	11.9	2	0.0051333	4	0.0169667	1	0.001	4	0.4489	5	0.0043367	12	0.15	4	0.0474333		
11	4	0.135	12	11.9	2	0.0055667	4	0.0170	1	0.0010333	3	0.45	3	0.0045	4	0.15	10	0.0478733		
12	3	0.135	4	11.9	2	0.0060	7	0.0174667	1	0.0011	4	0.45	12	0.0052667	4	0.15	4	0.0486		
13	4	0.1353333	4	11.903333	2	0.008	14	0.0177333	1	0.0012	4	0.451	4	0.1507	4	0.1507	4	0.0500667		
14	7	0.136	3	11.913			4	0.0177333	1	0.0013	4	0.452	3	0.151	12	0.151	12	0.0520		
15	4	0.1363333	13	11.916667			10	0.018	1	0.0013667	14	0.452	14	0.1516667	10	0.1516667	10	0.0540667		
16	18	0.1366667	4	11.92			4	0.018	12	0.0015333	10	0.454	3	0.153	4	0.154	4	0.0547667		
17	3	0.138	3	11.953333			4	0.018	3	0.0018	4	0.455	4	0.1540	4	0.154	4	0.063		
18	14	0.1383333	18	11.96			4	0.0182667			4	0.4626667	4	0.154	18	0.1546667	18	0.0646667		
19	4	0.1395	4	11.993333			12	0.0196667			18	0.4633333	4	0.1546667	4	0.1546667	4	0.0653333		
20	4	0.14	4	11.994							3	0.47	4	0.1566667	3	0.158	3	0.0685667		
21	10	0.143	4	12.01333							4	0.489433								
22	4	0.1461	4	12.1							4	0.49								
23											10	0.51								
24											4	0.513333								
Average		0.1372		11.90		0.00489		0.01703		0.000771		0.4517		0.00403		0.1487		0.0503		
Std Dev		0.0025		0.25		0.00017		0.00063		0.000051		0.0038		0.00015		0.0025		0.0013		
H		0.002931		0.068224		0.000595		0.001002		0.000325		0.006064		0.000553		0.003071		0.001695		
U ₁		0.0038		0.26		0.00062		0.0012		0.00033		0.0071		0.00057		0.0040		0.0021		
t-statistic		2.08		2.08		2.18		2.1		2.12		2.07		2.20		2.08		2.09		
U ₂		0.0080		0.55		0.0014		0.0025		0.00070		0.015		0.0013		0.0083		0.0045		
U ₃		0.0017		0.12		0.00037		0.00057		0.00017		0.0030		0.00036		0.0018		0.0010		
Certified		0.131		11.9		0.0043		0.017		0.0008		0.46		0.0040		0.149		0.050		
Uncertainty		0.008		0.1		0.0006		0.001		0.0002		0.02		0.0004		0.005		0.004		
Tolerance		0.024		0.5		0.0018		0.003		0.0007		0.06		0.0013		0.015		0.012		

BS 180B

* Code for method

Informational values listed as weight percent

Analysis	*	Al	*	As	*	Mg	*	Pb	*	Sb	*	Ta	*	Ti		Zr
1	5	0.0024	14	0.002033	12	0.00016	5	0.00002	12	0.00046		0.000095	10	0.002	5	0.00004
2	10	0.003	12	0.0024	3	0.00018	4	0.000023	12	0.00087		0.000097	3	0.003	12	0.00032
3	12	0.0031	5	0.003033	4	0.00021	12	0.000029				0.0001	5	0.003133	10	0.00038
4	12	0.004233	15	0.003167	12	0.000243	12	0.000463				0.000107	4	0.0033	12	0.00041
5	5	0.0049	5	0.0032	5	0.000333	3	0.0007				0.000283	12	0.0035	4	0.000467
6	3	0.005	4	0.004	4	0.002967	4	0.001				0.0076	5	0.004733	4	0.0011
7	3	0.0051	5	0.0047			3	0.009				0.016	3	0.0048	3	0.0039
8	4	0.005467	4	0.005367									4	0.004833		
9	4	0.006007	12	0.005933									4	0.005		
10	4	0.008467											4	0.005533		
11	3	0.009											12	0.005567		
12	4	0.009733											5	0.0058		
13	4	0.012											10	0.006243		
14	4	0.014											14	0.007767		
15	4	0.015033											10	0.009		
16													4	0.009233		
Average		0.007		0.004		0.0007		0.0016		0.0007		0.003		0.005		0.0009
Std Dev		0.039		0.021		0.0015		0.0063		0.0024		0.021		0.050		0.0025
H		0.000685		0.000552		0.000316		0.000403		0.000316		0.000497		0.0006		0.000339
U ₁		0.039		0.021		0.0015		0.0063		0.0024		0.021		0.050		0.0025
t-statistic		2.1400		2.31000		2.57		2.45		12.71		2.45		2.13		2.45
U ₂		0.083		0.048		0.0039		0.015		0.031		0.052		0.11		0.0062
U ₃		0.021		0.016		0.0016		0.0059		0.022		0.020		0.026		0.0023
Informational		(0.007)		(0.004)		(0.0007)		(0.002)		(0.0007)		(0.003)		(0.005)		(0.0009)

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. 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.

BS 180B

* Code for analytical method

Trace analysis listed as mg/kg (ppm)

Analysis	*	Ag	*	Au	*	Ba	*	Cd	*	Ce	*	Ga	*	Ge	*	In	*	Ir	*	La	
1	12	0.24	12	0.11	12	0.35	12	0.1	12	0.03	12	27	12	6.9	12	0.41	12	0.12	12	0.009	
2	12	0.25	12	0.11	12	0.45	12	0.12				12	31	12	9.5	12	0.59	12	0.13	12	0.01
3	12	0.28	12	0.12	12	0.59						12	33	12	9.5	12	1.1	12	0.14	12	0.01
4	12	0.29			12	0.68						12	35	12	9.7	12	1.3	12	0.21	12	0.01
Analysis	*	Na	*	Nd	*	Os	*	Pd	*	Pt	*	Re	*	Ru	*	Sr	*	Y	*	Zn	
1	12	0.01	12	0.01	12	0.10	12	0.12	12	0.14	12	1.9	12	0.07	12	0.09	12	0.02	12	0.45	
2					12	0.14	12	0.15	12	0.16	12	2								12	0.59
3					12	0.16	12	0.15	12	0.21	12	2.4								12	0.95
4					12	0.19			12	0.27	12	2.4								12	1

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	18 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
NSL Analytical	Cleveland, OH	ANAB	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
Evans Analytical Group	Liverpool, NY	A2LA	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025
Carpenter Technology Corporation	Reading, PA	A2LA	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	AB 554
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
TUV Rheinland India Pvt Ltd	Bangalore, India	NABL	17025
Exova	Glendale Heights, IL	A2LA	17025
Luvak Inc.	Boylston, MA	PRI/Nadcap	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Elemental Analysis, Inc.	Lexington, KY	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 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, 12X15253, 12X357, 12X41450, 12XLA2, 12XLA3, 13X12859, 13X14211, 13X18004, 13X31254, 13X31254, 13X41001, 13X43100, 13XNSC3, 14XMN2, 14XMN4, 219X0882, 219X8825; AR 646, 654, 657, 659, 670, 676, 875, 891, 1648, 1652, 1653; BAS 320, 408, 434, 451, 464/1, 474; BS H3C, 82A, 82E, 177, 180, 180A, 181B, 253, 718D, 1026; CKD 169A, 180A; ECRM 86, 87, 287-1; IARM 2C, 4C, 16C, 17A, 17B, 17D, 21C, 59A, 62E, 190A, 296A; IMZ 1-N4, 112; JK 8F, 21, 37; LECO 501-018, 501-320, 501-501, 501-502, 501-504, 501-644, 501-674, 501-676, 501-887, 501-993, 502-411, 502-704, 502-855, 502-870, 502-895; NCS NS11037; SRM 55D, 101C, 160B, 339, 348A, 361, 362, 363, 367, 866, 868, 2159, 3101A, 3109A, 3131A, 3155, 3169.

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 474; BS 82A, 82E, 177, 180, 180A, 253; ECRM 287-1; IARM 17D; LECO 501-676, 502-887; NCS NS11037; SRM 348A, 868.

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 180B 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 Electralloy Carlson Plate; Oil City, PA.

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 180B-072117. 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 9001:2008 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 30:2015 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 July 21, 2017.

Beau R. Brammer

President