

Brammer Standard Company, Inc.

Certificate of Analysis

BS 161B

Certified Reference Material for Maraging 300 High Temperature Alloy Steel (AMS 6514) - UNS Number K93120

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²	
Al	0.073	0.002		N	0.0011	0.0003
B	0.0027	0.0005		Ni	18.56	0.09
C	0.0031	0.0004		O	0.0005	0.0003
Co	9.28	0.08		S	0.0007	0.0003
Cr	0.034	0.003		Si	0.0107	0.0009
Cu	0.010	0.001		Ti	0.67	0.03
Fe	66.6	0.2		V	0.0011	0.0005
Mn	0.010	0.001		W	0.010	0.001
Mo	4.87	0.09				

	Reference Value ¹	Estimate of Uncertainty ²	Reference Values^{3,4}	Reference Value ¹	Estimate of Uncertainty ²	
Nb	0.0034	0.0007		Ta	0.017	0.003
P	0.004	0.001		Zr	0.005	0.002
Sn	0.0011	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 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.

Analysis	*	Al	*	B	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo	*	N
1	10	0.06	14	0.0019667	1	0.00213	4	9.2056667	5	0.0312	5	0.0073	16	[66.4]	8	0.007	11	4.7975	2	0.000833
2	5	0.0656333	5	0.0022767	1	0.002333	4	9.2353333	4	0.0312	8	0.008	14	66.4333333	4	0.0086667	4	4.801	2	0.00097
3	4	0.0709333	4	0.0024	1	0.00282	4	9.2533333	14	0.031933	4	0.008233	16	[66.495]	4	0.00897	3	4.8175	2	0.000977
4	4	0.07126	7	0.0024033	1	0.0031	4	9.2586667	3	0.032	8	0.00875	4	66.5052	4	0.0090667	4	4.829767	2	0.0010
5	4	0.07179	3	0.0025	1	0.0032	3	9.26	4	0.033033	4	0.009093	16	[66.5075]	11	0.0098	4	4.845667	2	0.00101
6	14	0.0719333	11	0.0026	1	0.00323	4	9.2624333	4	0.033333	4	0.009647	16	[66.51067]	4	0.00991	4	4.848333	2	0.00107
7	4	0.0719667	4	0.0027967	1	0.003253	4	9.2644667	3	0.033475	4	0.010033	16	[66.515467]	4	0.0099667	10	4.85	2	0.001173
8	5	0.0737333	4	0.0028667	3	0.0033	10	9.27	8	0.035	4	0.010707	13	66.528	4	0.0099667	14	4.853333	2	0.001183
9	3	0.073875	3	0.003075	11	0.0033	4	9.278	4	0.035567	4	0.010767	16	[66.63]	3	0.01045	8	4.86	2	0.0012
10	8	0.074	5	0.0032333	11	0.003367	11	9.28	4	0.0356	4	0.010833	10	66.7	4	0.0111	4	4.877667	2	0.0013
11	3	0.074			1	0.003367	4	9.2964	4	0.035867	10	0.011	16	[66.784234]	5	0.0113	4	4.8782	2	0.0014
12	11	0.074875			1	0.003383	4	9.2994667	4	0.03618	14	0.011	16	[66.87067]	4	0.0113667	10	4.90	2	0.0015
13	4	0.0768667					14	9.3033333			3	0.0114			14	0.0120	3	4.93		
14	4	0.07869					8	9.33			11	0.012375					4	4.964333		
15							3	9.3475									4	4.983933		
16							10	9.37												
Average		0.0732		0.002716		0.00307		9.282175		0.0340		0.009938		66.595		0.009966		4.869149		0.001070
Std Dev		0.0018		0.000083		0.00012		0.000079		0.0011		0.000085		0.053		0.000088		0.000082		0.000051
H		0.0027		0.0006271		0.00066		0.0406022		0.0019		0.0011		0.15		0.0010804		0.027		0.00044
U ₁		0.0033		0.00063		0.00067		0.041		0.0022		0.0011		0.16		0.0011		0.027		0.00044
t-statistic		2.16		2.26		2.20		2.13		2.20		2.16		2.20		2.18		2.14		2.20
U ₂		0.0070		0.0014		0.0015		0.087		0.0048		0.0023		0.34		0.0024		0.059		0.0010
U ₃		0.0019		0.00045		0.00043		0.022		0.0014		0.00062		0.10		0.00066		0.015		0.00028
Certified		0.073		0.0027		0.0031		9.28		0.034		0.010		66.6		0.010		4.87		0.0011
Uncertainty		0.002		0.0005		0.0004		0.08		0.003		0.001		0.2		0.001		0.09		0.0003
Tolerance		0.007		0.0015		0.0015		0.24		0.009		0.003		0.6		0.003		0.27		0.0010

Analysis	*	Ni	*	O	*	S	*	Si	*	Ti	*	V	*	W						
1	10	18.4	2	0.0001333	1	0.000277	4	0.0065	3	0.633	3	0.00065	4	0.0086						
2	6	18.480033	2	0.0003667	1	0.000353	3	0.00865	11	0.64525	11	0.0007	4	0.0089						
3	3	18.505	2	0.0004833	1	0.000433	4	0.0099333	4	0.647667	4	0.000767	3	0.0094						
4	4	18.506667	2	0.0005	1	0.000567	4	0.0101667	4	0.648667	4	0.001133	4	0.0094						
5	6	18.528667	2	0.00051	1	0.000653	4	0.0104333	4	0.649933	14	0.0013	4	0.00968667						
6	4	18.536667	2	0.0005233	1	0.0007	13	0.0104333	14	0.650333	4	0.002123	14	0.0098						
7	11	18.545	2	0.000575	1	0.000777	4	0.0109667	4	0.651733			5	0.00982						
8	4	18.545333	2	0.0008	11	0.0008	14	0.0110667	4	0.662			4	0.01						
9	7	18.55	2	0.001	1	0.00083	11	0.011475	3	0.68			11	0.010125						
10	3	18.56			1	0.000839	4	0.0132167	4	0.6881			5	0.01063333						
11	4	18.561133			4	0.000867			4	0.693667			4	0.01176667						
12	14	18.568667			3	0.0012			4	0.7			4	0.01368						
13	4	18.598967							10	0.72										
14	4	18.641333																		
15	10	18.69																		
16	4	18.719667																		
Average		18.558446		0.000524		0.000736		0.01068		0.666950		0.00111		0.010151						
Std Dev		0.000079		0.000064		0.000043		0.00044		0.000088		0.00013		0.000091						
H		0.063		0.00034		0.000381		0.0011136		0.0086		0.00044		0.0011						
U ₁		0.063		0.00034		0.00038		0.0012		0.0086		0.00046		0.0011						
t-statistic		2.13		2.31		2.20		2.26		2.18		2.57		2.20						
U ₂		0.13		0.00079		0.00084		0.0027		0.019		0.0012		0.0024						
U ₃		0.034		0.00026		0.00024		0.00086		0.0052		0.00048		0.00069						
Certified		18.56		0.0005		0.0007		0.0107		0.67		0.0011		0.010						
Uncertainty		0.09		0.0003		0.0003		0.0009		0.03		0.0005		0.001						
Tolerance		0.27		0.0004		0.0006		0.0027		0.09		0.0011		0.003						

Analysis	*	Nb	*	P	*	Sn	*	Ta	*	Zr
1	5	0.0015	5	0.0013533	5	0.0003	4	0.0090667	4	0.00277
2	4	0.0026667	7	0.0014867	5	0.000343	3	0.019625	5	0.002823
3	5	0.00321	10	0.003	5	0.0011	4	0.0196267	5	0.003233
4	4	0.0034333	4	0.0034	4	0.001233	11	0.01985	14	0.003767
5	3	0.003525	14	0.0039	3	0.001325			4	0.00509
6	4	0.0062333	7	0.0041667	4	0.001367			11	0.005725
7			4	0.0042667	9	0.002			4	0.005763
8			3	0.0046					3	0.00595
9			4	0.00465					4	0.006
10			4	0.0047667					4	0.006754
11			11	0.004875						
Average		0.00343		0.003679		0.00110		0.01704		0.00479
Std Dev		0.00013		0.000095		0.00012		0.00016		0.00010
H		0.00069		0.00071		0.00044		0.0014		0.00079
U ₁		0.00070		0.00072		0.00046		0.0014		0.00080
t-statistic		2.57		2.23		2.45		3.18		2.26
U ₂		0.0018		0.0016		0.0011		0.0044		0.0018
U ₃		0.00074		0.00048		0.00042		0.0022		0.00057
Reference		0.0034		0.004		0.0011		0.017		0.005
Uncertainty		0.0007		0.001		0.0008		0.003		0.002
Tolerance		0.0021		0.003		0.0010		0.009		0.004

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.

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 | | |
| 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
NSL Analytical	Cleveland, OH	ANAB	17025
Vitkovice Testing Center	Hulvaky, Ostrava	ILAC	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
LECO Corporation	St. Joseph, MI	A2LA	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Luvak Inc.	Boylston, MA	PRI	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Element Materials Technology	Huntington Beach, CA	A2LA	17025
Shiva Analyticals Private Limited	Hoskote, Bangalore	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: 12XLA10, 12XLA90, 13X12534X, 13X12855N, 13X14211R, 13X14935, 22X9030, 23X80010, 24X26310; AR 644, 654, 659, 662, 668, 673, 688, 881, 885, 892, 946, 1647, 1650, 1653; BAS 312, 351, 401, 401/1, 431, 459/1, 464/1; BS CSN-4, XCCS-1, 54H, 160A, 161, 161A, 1018, 1020, 1026, 1045, 2931A, 8620E; CKD 164A; CT 250; CSZU CA01A, CA011; ECRM 082-1, 85-1, 86-1, 87-1, 285-2; IARM 18, 30C, 54B, 56C, 62B, 98B, 99D; IMZ 64/1, 65, 112, 130, 139, 198, 199; IPT 12A, 39, 43, 97; JSS 170-7, 171-5; KMS LCSON-001; LECO 501-024, 501-504, 501-505, 501-644, 501-646, 502-704, 502-712, 502-893, 502-916, 502-990, 502-991, 503-501, 503-520; SRM 13F, 126C, 160B, 361, 363, 897, 898, 899, 1156, 1263, 1264, 1765, 1766, 3163; USS BBB; Y 31901.

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: BS CSN-2, 160A, 161, 161A; DSZU CA01A; ECRM 285-2; IARM FeKovar-18, 98B; KMS LCSON-001; SRM 126C, 1156, 1250; Y 31901.

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 161B 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 ATI Specialty Materials; Richburg, SC.

Form: This CRM is machined in the form of a disc, approximately 41mm 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 161B-012122. 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.
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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 17025:2017 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 January 20, 2022.

Beau R. Brammer
President