

Brammer Standard Company, Inc.

# Certificate of Analysis

BS 161A

Certified Reference Material<sup>1</sup> for Maraging 300 High Temperature Alloy Steel (AMS 6514)  
(UNS Number K93120, ASTM A538 C)

	Certified Value <sup>2</sup>	Estimate of Uncertainty <sup>3</sup>	Certified Value <sup>2</sup>	Estimate of Ucertainty <sup>3</sup>
Analysis listed as percent by weight				
<b>C</b>	<b>0.004</b>	0.001	<b>V</b>	<b>0.031</b> 0.005
<b>Mn</b>	<b>0.031</b>	0.003		
<b>P</b>	<b>0.004</b>	0.0015		
<b>S</b>	<b>0.0007</b>	0.0004	<b>Information Values<sup>4</sup></b>	
<b>Si</b>	<b>0.032</b>	0.005	As	0.002
<b>Cu</b>	<b>0.22</b>	0.01	Ca	0.0008
<b>Ni</b>	<b>18.40</b>	0.10	N	0.002
<b>Cr</b>	<b>0.12</b>	0.005	Nb	0.004
<b>Mo</b>	<b>4.82</b>	0.05	O	0.0004
<b>Al</b>	<b>0.14</b>	0.006	Sn	0.0015
<b>B</b>	<b>0.0023</b>	0.0004	Ta	0.03
<b>Co</b>	<b>9.22</b>	0.006	W	0.008
<b>Ti</b>	<b>0.65</b>	0.01	Zr	0.002

<sup>1</sup> Brammer Standard Company, Inc., is accredited to ISO Guide 34 as a Reference Material Producer to produce Certified Reference Materials by A2LA (Certificate Number 656.02)

<sup>2</sup> The certified value listed is the present best estimate of the true value based on the results of an interlaboratory testing program.

<sup>3</sup> The uncertainties listed are based on value judgments of the material inhomogeneity and the 95% confidence interval. The half-width confidence interval C(95%) is shown on page 2.

<sup>4</sup> Information values are not certified and are provided for information only.

See the following pages for more information.

Certificate Number 161A-031501p1

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Analysis	*	C	* Mn	* P	* S	* Si	* Cu	* Ni	* Cr	* Mo
1	C	0.003	XRF 0.028	MPN 0.0018	C 0.0002	AIC 0.022	IN 0.1990	XRF 18.237	AIC 0.104	AES 4.73
2	C	0.00399	AES 0.0292	AIC 0.002	C 0.0003	XRF 0.027	XRF 0.212	AES 18.25	MCS 0.114	AIC 4.75
3	C	0.0044	IN 0.0292	AIC 0.002	C 0.00033	AIC 0.0292	MCB 0.212	AIC 18.26	XRF 0.116	GMo 4.79
4	C	0.005	AIC 0.030	XRF 0.0027	AES 0.0008	AES 0.033	XRF 0.218	AIC 18.34	AIC 0.116	XRF 4.792
5	C	0.005	AIC 0.030	AES 0.0043	C 0.001	AES 0.0335	AIC 0.22	AIC 18.35	XRF 0.1165	XRF 4.805
6			AIC 0.0313	XRF 0.0045	C 0.0010	AIC 0.0347	AIC 0.220	GN2 18.39	AIC 0.117	XRF 4.808
7			XRF 0.032	AES 0.0048	CP 0.0012	AIC 0.035	AIC 0.220	EN 18.42	AES 0.117	MMT 4.81
8			AIC 0.0326	AIC 0.0051		Gsi 0.0356	MCT 0.222	TN2 18.47	XRF 0.118	XRF 4.824
9			XRF 0.033	AIC 0.0051		AIC 0.036	AES 0.222	XRF 18.492	XRF 0.12	AA 4.84
10			MnP 0.0335	AIC 0.0053		AES 0.0367	AIC 0.222	XRF 18.495	AIC 0.12	AIC 4.85
11			XRF 0.034				XRF 0.227	AIC 18.51	XRF 0.121	MMI 4.87
12							XRF 0.228	XRF 18.52	AIC 0.122	AIC 4.900
13							XRF 0.231		AIC 0.124	AIC 4.94
Average		0.0043	0.0312	0.0038	0.0007	0.0323	0.219	18.395	0.117	4.824
Std Dev		0.0008	0.0020	0.0015	0.0004	0.0047	0.008	0.106	0.005	0.057
Certified		0.004	0.031	0.004	0.0007	0.032	0.22	18.40	0.12	4.82
t		2.7764	2.2281	2.2622	2.4469	2.2622	2.1788	2.201	2.1788	2.1788
C(95%)		0.0010	0.0013	0.0010	0.0004	0.0034	0.005	0.067	0.003	0.035

Analysis	*	Al	* B	* Co	* Ti	* V
1	AA	0.13	AIC 0.0017	AIC 9.12	AIC 0.63	AIC 0.026
2	TAl	0.134	AIC 0.0020	AIC 9.161	MTD 0.641	AES 0.0268
3	AES	0.135	MbD 0.0020	TCT 9.18	XRF 0.644	IN 0.0274
4	AIC	0.136	AIC 0.0021	AIC 9.18	AES 0.65	AIC 0.028
5	AIC	0.1371	AIC 0.0022	XRF 9.19	AIC 0.654	MVE 0.0284
6	MAI	0.139	AIC 0.0023	TCo 9.19	AIC 0.657	AIC 0.0288
7	XRF	0.139	AIC 0.0026	AES 9.22	AIC 0.658	AIC 0.0294
8	XRF	0.139	AES 0.00265	AA 9.24	XRF 0.66	XRF 0.031
9	AES	0.144	AES 0.0027	GCo 9.28	MTD 0.664	XRF 0.032
10	AIC	0.146	AES 0.00307	XRF 9.292	XRF 0.667	XRF 0.0365
11	XRF	0.146		EN 9.31	AIC 0.667	XRF 0.037
12	AIC	0.148		EN 9.31		XRF 0.041
Average		0.1394	0.00233	9.223	0.654	0.0310
Std Dev		0.0055	0.00041	0.063	0.012	0.0047
Certified		0.14	0.0023	9.22	0.65	0.031
t		2.201	2.2622	2.201	2.2281	2.201
C(95%)		0.0035	0.00030	0.040	0.008	0.0030

## Uncertified Values

Analysis	*	As	* Ca	* N	* Nb	* O	* Sn	* Ta	* W	* Zr
1	AAG	0.0016	AIC 0.0004	FU 0.0010	AES 0.0007	FU 0.00018	AIC 0.0012	XRF 0.011	AES 0.001	XRF 0.001
2	AIM	0.0019	AIC 0.0006	FU 0.0013	XRF 0.0027	FU 0.0002	AES 0.0013	AES 0.035	XRF 0.001	XRF 0.002
3	AES	0.0025	AIC 0.0007	FU 0.00135	AIC 0.003	FU 0.0008	AIM 0.0016	XRF 0.040	AIC 0.001	XRF 0.002
4			AES 0.00072	FU 0.0016	XRF 0.004		AIC 0.002		AIC 0.0017	AES 0.0038
5			AIC 0.0010	FU 0.002	XRF 0.008				IN 0.0020	
6			AIC 0.001	FU 0.0022	XRF 0.008				AES 0.0132	
7			AIC 0.0012						XRF 0.0135	
8									XRF 0.0155	
9									XRF 0.018	
Average		0.0020	0.0008	0.0016	0.0044	0.0004	0.0015	0.0287	0.0075	0.0022
Std Dev		0.0005	0.0003	0.0005	0.0030	0.0004	0.0004	0.0155	0.0075	0.0012
Information		(0.002)	(0.0008)	(0.002)	(0.004)	(0.0004)	(0.0015)	(0.03)	(0.008)	(0.002)

\* Methods of analysis listed on page 3

Data in parentheses are not certified but are provided for information only.

Data listed as mass fraction expressed as percent.

$C(95\%) = (t \times sd) / n$  The half-width confidence interval, where  $t$  is the appropriate Student's  $t$  value,  $sd$  is the interlaboratory standard deviation, and  $n$  is the number of acceptable mean values. For further information regarding the confidence interval for the certified value see ISO Guide 35:1989 section 4.

## Methods of Analysis

Code	Element	Method
AA		Flame Atomic Absorption Spectrometry
AAG		Electro-thermal atomization (graphite furnace) Atomic Absorption Spectrometry
AES		AES - Spark Source Optical Emission Spectrometry
AIC		AES - ICP -Inductively Coupled Plasma Spectrometry
AIM		AES - ICP Mass Spectrometry addition method
C	C, S	Combustion-Infrared Absorption (ASTM E 1019) traceable to CRMs
CP	C, S	Combustion-Infrared Absorption traceable to pure substances
EN		Electroplating
FU	N, O	Inert gas Fusion Method (ASTM E 1019) traceable to CRMs
GCo	Co	Gravimetry, 1-nitroso 2-naphthole
GMo	Mo	Gravimetry, Benzolnoxime
GN2	Ni	Gravimetry with diacetyldioxime (dimethylglyoxime) and double precipitation
GSi	Si	Gravimetry with perchloric acid (ASTM 350)
IN		INAA - Neutron Activation
MAI	Al	MAS - Nitrated Eriochromcyanine-R
MBD	B	MAS - Distillation separation-curcumin photometric
MCB	Cu	MAS - Bicyclohexane oxalyldihydrazone photometric
MCS	Cr	MAS - Diphenyl carbazide photometric after separation with Na <sub>2</sub> CO <sub>3</sub>
MCT	Cu	MAS - Tetraethylthiuram disulphide
MMI		MAS - Photometry after ion-exchange
MMT	Mo	MAS - Thiocyanate photometric
MnP	Mn	MAS - Potassium periodate oxidation photometric
MPN	P	MAS - n-butyl alcohol-trichloromethane extraction photometric
MTD	Ti	MAS - Diantipyrylmethane photometric
MVE	V	MAS - n-benzoyl phenylhydroxylamine extraction photometric
TAI	Al	EDTA titration method after separation with cupferron
TCo	Co	Titrimetry with ferricyanide
TCT	Co	Potentiometric titration
TN2	Ni	Titrimetry with EDTA, zinc sulfate
XRF		X-Ray Fluorescence spectrometry

AES = Atomic Emission Spectrometry

MAS = Molecular Absorption Spectrometry (photometric, spectrophotometric methods)

**Co-operating Laboratories:** The co-operating laboratories were:

Laboratory	Laboratory contact
Allvac, Lockport, New York	Thomas Herdlein
Allvac, Monroe, North Carolina	Patrick M. Cole
ANAREM, Prague, Czech Republic	Karel Bi ovsk
Brammer Standard Co., Inc., Houston, Texas	Richard P. Beaumont
China National Analysis Center for Iron and Steel, Beijing, China	Prof. Wang Haizhou
Crucible Specialty Steel, Syracuse, New York	William Mastroe
J. Dirats and Co., Inc., Westfield, Massachusetts	Eric E. Dirats
IncoTest, Huntington, West Virginia	Melissa G. Staley
LECO Corporation, St. Joseph, Michigan	Dennis Lawrenz
VHG Laboratories, Inc., Manchester, New Hampshire	Julie M. McIntosh

**Certification Process:** The requirements of ISO Guide 31, ISO Guide 34, ISO Guide 35, and ASTM Standard Guides E 1724 and E 1831 were followed for the preparation of this reference material and certificate of analysis. This is a Certified Reference Material as defined by ISO Guide 30.

**Analysis:** Chemical analyses were made on chips prepared by a lathe from the certified portion of the discs in accordance with ASTM Standard Practice E 1806. The laboratories participating in the testing normally followed the requirements of ISO Guide 25 and/or ISO Standard 17025. Individual values listed on page 2 are the average of each analyst's results. Methods of analysis used are listed on page 3.

**Outliers:** Some outlying data was excluded from the data listed on page 2 due to technical assessment of the cooperating laboratories and statistical evaluation.

**Traceability:** The following Certified Reference Materials were used to validate the analytical data listed on page 2: NIST SRM 32b, 166b, 343a, 3103a, 3107, 3109a, 3161a; ECRM 285-2

**Homogeneity:** This Reference Material was tested for homogeneity using ASTM Standard Method E 826 and found acceptable. It was also examined by optical emission spectrometry and found to be compatible with the following Reference Materials: SRM 1156; BS 160, 161, 9-4-30; Cameron Iron Works 51959, 52755, 53723, 52724, P-9086.

**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. Whereas this material is in a solid form and stable, no expiration date is specified.

**Source:** This material was produced by Carpenter Technology Corporation, Reading, Pennsylvania. It was melted by a vacuum induction furnace and then remelted in a vacuum electric arc furnace, bottom poured into ingots, hot rolled to billets then to bars, and finished with a normalized heat treatment. The final surface was centerless ground.

**Form:** This Reference Material is in the form of a disc, approximately 38 mm in diameter and 12 mm thick.

**Use:** This Reference Material is intended for use in optical emission and x-ray spectrometric methods of analysis. Refer to ISO Guide 33 for information about the use of Reference Materials.

**Certified area:** The entire depth of the disc may be used.

**Caution:** As with any bar material, avoid optical emission spectrometric burns in the center of the disc (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 you use for production specimens. Avoid overheating the disc during surface preparation.

**Certificate Number:** The unique identification number for this certificate of analysis is 161A-031501-px, where x indicates the page number. Refer to future Brammer Standard Company catalogs for information on any revisions to this or other Brammer Standard reference materials. You may also obtain information on revisions of certificates from the internet at [brammerstandard.com](http://brammerstandard.com).

**Safety Notice:** A Material Safety Data Sheet (MSDS) 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 Fax: (281) 440-4432	web <a href="http://brammerstandard.com">brammerstandard.com</a> e-mail <a href="mailto:bramstan@netropolis.net">bramstan@netropolis.net</a>
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Certified by: \_\_\_\_\_ on March 15, 2001.  
G. R. Brammer

**Certificate Number 161A-031501p4**

**Brammer Standard Company, Inc., is accredited to ISO Guide 34 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials by A2LA (Certificate Number 656.02) The scope of accreditation is listed on the website: [www.brammerstandard.com](http://www.brammerstandard.com)**

**By Certificate Number 10539, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9002:1994 by National Quality Assurance, U.S.A.**

**Brammer Standard Company's Chemical Laboratory is accredited to ISO Guide 25 by A2LA. (Certificate Number 656.01)**

## **References:**

*ASTM documents available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, Telephone: 610-832-9500 Fax: 610-832-9555 e-mail: [service@astm.org](mailto:service@astm.org) Website: [www.astm.org](http://www.astm.org)*

E 826 - 85 (Reapproved 1996) Standard Practice for Testing Homogeneity of Materials for the Development of Reference Materials

E 1019 - 2000 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel and in Iron, Nickel, and Cobalt Alloys

E 1724 - 95 Standard Guide for Testing and Certification of Metal and Metal-Related Reference Materials

E 1806 - 96 Standard Practice for Sampling Steel and Iron for Determination of Chemical Composition

E 1831 - 96 Standard Guide for Preparing Certificates for Reference Materials Relating to Chemical Composition of Metals, Ores, and Related Materials.

*ISO Guides available from Global Engineering - [www.global.ihs.com](http://www.global.ihs.com)*

ISO Standard 17025 (First edition, 1999), General requirements for the competence of calibration and testing laboratories.

ISO Guide 25 (Third edition, 1990), General requirements for the competence of calibration and testing laboratories.

ISO Guide 30 (Second edition, 1991), Terms and definitions used in connection with reference materials.

ISO Guide 31 (Second edition, 2000), Reference materials -Contents of certificates and labels.

ISO Guide 33 (Second edition, 2000), Uses of certified reference materials.

ISO Guide 34 (Second edition, 2000), General requirements for the competence of reference material producers.

ISO Guide 35 (Second edition, 1989), Certification of reference materials - General and statistical principles.

*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

**Certificate Number 161A-031501p5**