Brammer Standard Company, Inc.

Certificate of Analysis

BS 189A

Certified Reference Material for Specialty Steel Grade AL6XN - UNS Number N08367

Certified Values[3]

	Certified Value[1]	Estimate of Uncertainty[2]		Certified Value[1]	Estimate of Uncertainty[2]
Al	**0.0129**	0.0007	**N**	**0.198**	0.004
As	**0.0039**	0.0007	**Ni**	**23.8**	0.1
C	**0.0147**	0.0009	**O**	**0.0024**	0.0004
Co	**0.100**	0.004	**P**	**0.019**	0.001
Cr	**20.4**	0.2	**Si**	**0.30**	0.01
Cu	**0.184**	0.004	**Sn**	**0.0035**	0.0005
Fe	**[48.1]**	0.2	**Ti**	**0.0065**	0.0007
Mn	**0.639**	0.009	**V**	**0.054**	0.001
Mo	**6.04**	0.03	**W**	**0.037**	0.003

Reference Values[3,4]

	Reference Value	Estimate of Uncertainty		Reference Value	Estimate of Uncertainty
Nb	**0.13**	0.02			

Informational Values[3,5]

B (0.0002) Ca (0.0004) S (0.001) Zr (0.001)

[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.

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

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.

BS 189A * Code for method Certified values listed as weight percent

Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895
Telephone: (281) 440-9396 Fax: (281) 440-4432 Website: www.brammerstandard.com

Analysis	*	Al	*	As	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	Mn
1	10	0.0115	5	0.003433	1	0.013867	3	0.0933	3	19.95	5	0.1761	16	47.64333	10	0.55133
2	3	0.0122	15	0.003477	1	0.014233	4	0.093567	14	19.95333	10	0.1779	16	47.75	4	0.617
3	4	0.0124	5	0.003633	1	0.014467	14	0.095333	4	19.97667	4	0.178333	10	47.84333	8	0.620333
4	14	0.012433	5	0.0041	1	0.014533	10	0.096	4	19.98547	10	0.18	16	48.11333	4	0.621
5	4	0.0126	9	0.004867	3	0.0151	8	0.096433	13	19.995	4	0.18	13	48.187	4	0.627
6	3	0.013			1	0.015247	4	0.096633	4	20.12333	4	0.180333	4	48.25333	3	0.63
7	4	0.0133			1	0.0156	4	0.098067	10	20.20	14	0.185333	16	48.26327	10	0.63
8	5	0.013733			3	0.016	3	0.10	13	20.26133	4	0.188367	14	48.50333	4	0.636333
9	4	0.014067			1	0.0164	5	0.100567	3	20.34	3	0.19	16	48.74	4	0.638333
10	3	0.014333					4	0.1027	10	20.37437	8	0.19267			4	0.6396
11							4	0.108733	4	20.405	4	0.195333			10	0.64667
12							4	0.11	10	20.47667					4	0.64667
13							10	0.115467	4	20.54333					14	0.649
14									4	20.56933						
Average		0.01285		0.00391		0.01469		0.0999		20.4043		0.1838		48.14		0.6388
Std dev		0.00070		0.00028		0.00083		0.0025		0.0038		0.0045		0.10		0.0057
H		0.0008		0.00049		0.0008		0.0022		0.12		0.0031		0.29		0.00715
U_1		0.0010		0.00056		0.0012		0.0033		0.12		0.0055		0.30		0.0091
t-statistic		2.26		2.78		2.31		2.18		2.16		2.23		2.31		2.18
U_2		0.0024		0.0016		0.0027		0.0073		0.27		0.012		0.70		0.020
U_3		0.00075		0.00070		0.00090		0.0020		0.070		0.0037		0.23		0.0055
Certified		**0.0129**		**0.0039**		**0.0147**		**0.100**		**20.4**		**0.184**		**[48.1]**		**0.639**
Uncertainty		**0.0007**		**0.0007**		**0.0009**		**0.004**		**0.2**		**0.004**		**0.2**		**0.009**
Tolerance		0.0024		0.0016		0.0027		0.007		0.3		0.012		0.7		0.02

Analysis	*	Mo	*	N	*	Ni	*	O	*	P	*	Si	*	Sn
1	4	5.958	2	0.186333	14	23.71	2	0.001775	4	0.016	4	0.22963	3	0.0028
2	4	6.013333	2	0.194667	13	23.73533	2	0.00197	7	0.016133	10	0.283333	5	0.0029
3	4	6.039817	2	0.195667	4	23.77333	2	0.002207	4	0.016467	4	0.287667	5	0.0029
4	4	6.045333	2	0.199	3	23.81	2	0.002233	5	0.0173	3	0.29	5	0.003643
5	4	6.049	2	0.200	4	23.84333	2	0.002333	3	0.019	10	0.29	4	0.003667
6	4	6.057367	2	0.2007	4	23.87333	2	0.002533	4	0.019733	4	0.290267	5	0.003867
7	3	6.06	2	0.2015	10	23.88333	2	0.0026	4	0.0199	10	0.297333	4	0.004
8	10	6.06	2	0.2023	3	23.9	2	0.00289	10	0.02	5	0.2998		
9	3	6.09	2	0.203633	4	23.93			4	0.020767	6	0.308		
10	10	6.092633	2	0.204033	13	23.95			10	0.024033	4	0.321333		
11	14	6.093333			10	23.95077			14	0.024267	14	0.324		
12	4	6.106667			10	23.98					4	0.324667		
13					4	24.0922					3	0.325		
14					4	24.12167					4	0.346667		
Average		6.0408		0.1978		23.7738		0.002412		0.0190		0.3016		0.00352
Std dev		0.0060		0.0044		0.0035		0.000081		0.0011		0.0048		0.00024
H		0.041		0.0033		0.14		0.00041		0.0009		0.0043		0.00047
U_1		0.042		0.0055		0.14		0.00042		0.0014		0.0064		0.00053
t-statistic		2.20		2.26		2.16		2.36		2.23		2.16		2.45
U_2		0.092		0.012		0.31		0.0010		0.0032		0.014		0.0013
U_3		0.027		0.0039		0.080		0.00035		0.0010		0.0037		0.00049
Certified		**6.04**		**0.198**		**23.8**		**0.0024**		**0.019**		**0.30**		**0.0035**
Uncertainty		**0.03**		**0.004**		**0.1**		**0.0004**		**0.001**		**0.01**		**0.0005**
Tolerance		0.09		0.012		0.3		0.0010		0.003		0.01		0.0013

BS 189A * Code for method Certified values listed as weight percent

Analysis	*	Ti	*	V	*	W
1	4	0.005433	10	0.047867	4	0.031633
2	4	0.005833	14	0.049467	3	0.0317
3	3	0.006	4	0.049867	14	0.0328
4	14	0.006133	5	0.0501	4	0.0346
5	4	0.007	4	0.0525	4	0.035867
6	5	0.0077	4	0.052667	5	0.037767
7			10	0.053	4	0.038883
8			4	0.053983	4	0.041333
9			3	0.054	4	0.043433
10			4	0.054867	7	0.043833
11			7	0.0550		
12			4	0.0597		
13			3	0.0613		
Average		0.00651		0.0537		0.0374
Std dev		0.00033		0.0017		0.0013
H		0.00059		0.0015		0.0013
U_1		0.00068		0.0023		0.0018
t-statistic		2.57		2.18		2.26
U_2		0.0017		0.0050		0.0041
U_3		0.00071		0.0014		0.0013
Certified		**0.0065**		**0.054**		**0.037**
Uncertainty		**0.0007**		**0.001**		**0.003**
Tolerance		0.0017		0.005		0.004

BS 189A * Code for method Reference values listed as weight percent

Analysis	*	Nb
1	3	0.107
2	4	0.108633
3	14	0.113333
4	10	0.133333
5	4	0.141667
6	4	0.146
7	5	0.148733
8	3	0.15
9	10	0.15
10	4	0.150583
11	4	0.154333
12		
13		
14		
Average		0.1344
Std dev		0.0043
H		0.0026
U_1		0.0050
t-statistic		2.23
U_2		0.011
U_3		0.0030
Reference		**0.13**
Uncertainty		**0.02**
Tolerance		0.01

BS 189A * Code for method Informational values listed as weight percent

Analysis	*	B	*	Ca	*	S	*	Zr	*	*	*	*
1	3	0.00005	4	0.00034	1	0.0001	5	0.000233				
2	4	0.000197	3	0.00039	1	0.000233	3	0.001				
3	7	0.000303	4	0.00041	1	0.000287	4	0.001033				
4			4	0.000533	1	0.000293	4	0.0017				
5					1	0.0004						
6					2	0.000467						
7					1	0.001567						
8					3	0.0052						
Average		0.00018		0.00042		0.0011		0.0010				
Std dev		0.00012		0.00067		0.0030		0.0037				
H		0.00023		0.00026		0.00033		0.0003				
U_1		0.00026		0.00072		0.0030		0.0037				
t-statistic		4.30		3.18		2.36		3.18				
U_2		0.0011		0.0023		0.0072		0.012				
U_3		0.00064		0.0011		0.0025		0.0059				
(Informational)		**(0.0002)**		**(0.0004)**		**(0.001)**		**(0.001)**				

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 it's 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 Tolerance is the half width of the 95 % confidence interval for measurements 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.

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)
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

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.	Houston, TX	A2LA	17025, Guide 34
NSL Analytical	Cleveland, OH	ACLASS	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Luvak Inc.	Boylston, MA	PRI/Nadcap	17025
LECO Corporation	St. Joseph, MI	A2LA	17025
Exova	Glendale Heights, Il	A2LA	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	AB 554

A2LA = American Association for Laboratory Accreditation
ACLASS = ANSI-ASQ National Accreditation Board
BSI = British Standards Institution
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: 12X356, 12X357, 12X3255, 12X43400, 12X72M24, 13X12855, 13X31254, 13X32101, 13XNCS3, 13XNSA11; 501-320, 501-501, 501-502, 501-504, 501-644, 501-646, 501-952, 501-953, 501-993, 502-197, 502-348, 502-414, AR 612B, 644, 646, 662, 673, 676, 712C, 875, 1632, 1647; BAS 55, 65, 464, 464/1, 474; BS H3C, 83E, 187D, 188A; CKD 166A, 181; ECRM 85, 86, 87; IARM 157C; IMZ 112, 504; JK 37; JSS 654-8, 655-13; SRM 33E, 101C, 101D, 101E, 123A, 285, 345, 348, 361, 362, 363, 367, 1162, 1186, 1225, 1230, 1261, 1413.

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, 502-416; BAS 464, 474; BS 81N, 83E, 188A; ECRM 196-2, 299-1; JK 37; JSS 654-8; NCS NS 11022; SRM 1230, 2171.

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 189A 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 ATI Allvac, Richburg, SC.

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.

Certificate Number: The unique identification number for this certificate of analysis is 189A-041015. You may obtain information on revisions of certificates from the internet at www.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: www.brammerstandard.com
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, 1916 Race Street, Philadelphia, PA, 19103.

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

Certified by: _____ on April 10, 2014.

Beau R. Brammer