

# Certificate of Analysis

## BS T-5A

Certified Reference Material<sup>1</sup> for 6Al-4V Grade Titanium Alloy  
(UNS Number R56400, ASTM B348(5))

	Certified Value <sup>2</sup>	Estimate of Uncertainty <sup>3</sup>		Certified Value <sup>2</sup>	Estimate of Uncertainty <sup>3</sup>
Analysis listed as percent by weight					
<b>Al</b>	<b>6.33</b>	0.04	<b>C</b>	<b>0.011</b>	0.001
<b>Cr</b>	<b>0.013</b>	0.001	<b>S</b>	<b>&lt;0.001</b>	
<b>Cu</b>	<b>0.0025</b>	0.0006	<b>N</b>	<b>0.008</b>	0.0006
<b>Fe</b>	<b>0.170</b>	0.006	<b>O</b>	<b>0.190</b>	0.005
<b>Mn</b>	<b>&lt;0.002</b>				
<b>Mo</b>	<b>0.004</b>	0.001			
<b>Ni</b>	<b>0.012</b>	0.002	<b>Information Values<sup>4</sup></b>		
<b>Si</b>	<b>0.02</b>	0.005	<b>H</b>	<b>0.0025</b>	
<b>Sn</b>	<b>0.009<sup>5</sup></b>	0.0015			
<b>V</b>	<b>4.10</b>	0.025			
<b>W</b>	<b>&lt;0.01</b>				
<b>Zr</b>	<b>0.003</b>	0.001			

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

<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.

<sup>5</sup> The original Sn value of 0.008% certified on December 14, 2001 was revised to 0.009% after an additional laboratory reported their results.

See the following pages for more information.

Certificate Number RevT5A-012202p1

Analysis	* Al	* Cr	* Cu	* Fe	* Mn	* Mo	* Ni	* Si	* Sn
1	AIC 6.28	AIC 0.0112	AGM 0.0020	AES 0.164	AIC <0.0006	AIC 0.003	AGM 0.0105	AIC 0.0133	AIC 0.007
2	XRF 6.31	AIC 0.0116	AIC 0.0022	AGM 0.165	AIC <0.0006	AIC 0.0031	AES 0.0105	AIC 0.017	AIC 0.0078
3	XRF 6.32	AIC 0.0117	AIC 0.0023	AIC 0.168	AIC <0.002	AIC 0.0032	AIC 0.011	AIC 0.018	AIC 0.0080
4	AIC 6.321	AIC 0.0119	AIC 0.0023	AIC 0.168	AIC 0.0003	AIC 0.0037	AIC 0.0118	AIC 0.022	AIC 0.008
5	AIC 6.34	AIC 0.013	AIC 0.0025	AIC 0.172	AIC 0.0004	AIC 0.0038	AIX 0.012	AGM 0.024	XRF 0.009
6	AIC 6.352	XRF 0.013	AIC 0.003	AIC 0.1720	AIC 0.00052	XRF 0.004	AIC 0.0123	AGM 0.0260	XRF 0.009
7	AIC 6.36	AIC 0.0135	AIC 0.0034	AIC 0.173	AGM 0.00060	AIC 0.0045	AIC 0.0130		AGM 0.0099
8	AES 6.36	AES 0.0136		AIX 0.179		AIC 0.005	AIC 0.013		AIC 0.0100
9		AIC 0.0138				XRF 0.006	AIC 0.0133		
10		AIX 0.014					AIC 0.0133		
Average	6.330	0.0127	0.00253	0.1701		0.0040	0.0121	0.0201	0.0086
Std Dev	0.028	0.0010	0.00050	0.0049		0.0010	0.0011	0.0048	0.0011
Certified	6.33	0.013	0.0025	0.170	<0.002	0.004	0.012	0.02	0.009
t	2.3646	2.2622	2.4469	2.3646		2.306	2.2622	2.5706	2.3646
C (95%)	0.023	0.0007	0.00046	0.0041		0.0008	0.0008	0.0050	0.0009

Analysis	* V	* W	* Zr	* C	* S	* N	* O	* H
1	AIC 4.079	AIC <0.001	XRF 0.002	C 0.010	C <0.0002	FU 0.0072	FU 0.187	FU 0.0024
2	AIC 4.08	AIC <0.001	AIC 0.0021	C 0.010	C 0.0007	FU 0.0078	FU 0.188	FU 0.0024
3	XRF 4.09	AGM 0.00056	AIC 0.0024	C 0.0103	C 0.0008	FU 0.0078	FU 0.190	FU 0.00257
4	AIC 4.094	AIC 0.0025	AIC 0.0024	C 0.0106	C 0.00095	FU 0.008	FU 0.1905	
5	AIC 4.13	AIC 0.008	AIC 0.0025	AES 0.0108			FU 0.194	
6	XRF 4.13	AGM 0.00814	AGM 0.0030	C 0.0116				
7	AIC 4.13		AIC 0.003	C 0.0118				
8			AES 0.0042					
9			AIC 0.0042					
Average	4.100		0.0029	0.0107		0.0077	0.1899	0.00246
Std Dev	0.022		0.0008	0.0007		0.0003	0.0027	0.00010
Certified	4.10	<0.01	0.003	0.011	<0.001	0.008	0.190	(0.0025)
t	2.4469		2.306	2.4469		3.1824	2.7764	4.3027
C (95%)	0.020		0.0006	0.0007		0.0006	0.0034	0.00024

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

$C(95\%) = (t \times sd) / \sqrt{n}$  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 Method

AES	AES - Spark Source Optical Emission Spectrometry	AES = Atomic Emission Spectrometry
AIX	Average of Inductively Coupled Plasma Spectrometry and X-Ray Fluorescence Spectrometry	
AIC	AES - ICP -Inductively Coupled Plasma Spectrometry	
AGM	AES - Glow Discharge Mass Spectrometry	
C	Combustion-Infrared Absorption (ASTM E 1019) traceable to CRMs	
FU	Inert gas Fusion Method (ASTM E 1019) traceable to CRMs	
XRF	X-Ray Fluorescence Spectrometry	

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

#### Laboratory

AK Steel Research, Middletown, Ohio  
 Allegheny Ludlum, Technical Center, Brackenridge, Pennsylvania  
 Allvac, Monroe, North Carolina  
 Brammer Standard Co., Inc., Houston, Texas  
 J. Dirats and Co., Inc., Westfield, Massachusetts  
 LECO Corporation, St. Joseph, Michigan  
 Northern Analytical Laboratory Inc., Merrimack, New Hampshire  
 Shiva Analyticals (India) Ltd., Hoskote, Bangalore, India  
 Titanium Matels Corporation, Morgantown, Pennsylvania  
 VHG Laboratories, Inc., Manchester, New Hampshire

#### Laboratory contact

Howard P. Vail  
 Shawn D. Cooper  
 Patrick M. Cole  
 Richard P. Beaumont  
 Eric E. Dirats  
 Dennis A. Lawrenz  
 Richard J. Guidoboni  
 Dr. T. V. Ramakrishna  
 Larry E. Creasy  
 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. No standardized sampling procedures are available for titanium, but the principles of ASTM Practice 1806 were used to obtain representative test samples. 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 are listed on page 2.

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

**Traceability:** The following Certified Reference Materials were used to validate the analytical data listed on page 2: SRM 125b, 131e, 173a, 173b, 348a, 651; CE 031.

**Homogeneity:** This Certified 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: BS T2, T4, T5, T19, T20, and T26.

**Validity statement:** ISO Guide 31 states that the certificate of analysis 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 supplied by TechSpec, Inc., Derry, Pennsylvania.

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

**Use:** This Certified 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 RevT5A-012202-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.	Phone: (281) 440-9396	web	<a href="http://brammerstandard.com">brammerstandard.com</a>
14603 Benfer Road			
Houston, Texas 77069-2895 USA	Fax: (281) 440-4432	e-mail	<a href="mailto:bramstan@netropolis.net">bramstan@netropolis.net</a>

Certified by: \_\_\_\_\_ on January 22, 2002.  
G. R. Brammer

**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)*

B 348 - 98 Standard Specification for Titanium and Titanium Alloy Bars and Billets

DS-56G (SAE HS-1086 Jan99) Metals & Alloys in the Unified Numbering System, 8<sup>th</sup> Edition

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