

Certificate of Analysis

BS T 81

Certified Reference Material¹

Low Alloy Titanium

	Certified Value²	Estimate of Uncertainty³		Certified Value²	Estimate of Uncertainty³
<i>Analysis listed as mg/kg</i>					
Al	664	30	Ni	90	8
B	82	10	O	669	30
C	161	25	Pd	398	25
Co	395	20	Ru	310	20
Cr	294	20	Si	474	25
Cu	244	15	Sn	155	15
Fe	1144	30	V	186	15
H	35	4	W	372	20
Mn	404	15	Y	17	2
Mo	279	15	Zr	163	5
N	37	4			
Nb	191	25			

¹ 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)

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

³ 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 pages 2 and 3.

See the following pages for more information.

Certificate Number T-81-092404p1

Analysis	*	Al	*	B	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	H
1	ICP	630	OES	68	C	135	PIXE	371	ICP	267	DCP	220	ICP	1090	FU	31
2	ICP	635	GDMS	70	C	135	ICP	380	XRF	279	XRF	231	ICP	1100	FU	31.7
3	ICP	652	ICP	80.5	C	149	ICP	385	ICP	281	ICP	237	XRF	1132	FU	35.5
4	ICPMS	654	ICP	81.5	C	150	ICPMS	390	DCP	285	ICP	240	ICP	1133	FU	36
5	ICP	656	ICP	83	C	154	XRF	391	ICP	286	ICP	240	ICP	1150	FU	36
6	ICP	660	DCP	83.5	C	175	ICP	400	ICP	290	ICP	247	ICP	1150	FU	36
7	DCP	662	ICP	84	C	182	ICP	401	ICPMS	295	ICP	250	ICP	1150	FU	38
8	ICP	670	ICPMS	86	C	185	ICP	412	ICP	300	ICP	255	ICP	1150	FU	38
9	ICP	675	ICP	99	C	186.5	DCP	428	ICP	300	ICP	260	DCP	1170		
10	XRF	704					ICP	380	ICP	305	ICP	260	GDMS	1180		
11	ICP	711					DCP	404	ICP	314			ICP	1182		
12									ICP	332						
Average		664.5		81.7		161.3		394.7		294.5		244.0		1144.3		35.3
Std Dev		25.1		9.0		21.0		16.4		17.4		12.9		29.5		2.6
Certified		664		82		161		395		294		244		1144		35
# Labs		11		9		9		11		12		10		11		8
t		2.2281		2.3060		2.3060		2.2281		2.2010		2.2622		2.2281		2.3646
C(95%)		16.8		7.0		16.1		11.0		11.0		9.2		19.8		2.2

Analysis	*	Mn	*	Mo	*	N	*	Nb	*	Ni	*	O	*	Pd	*	Ru
1	ICP	380	ICP	250	FU	30	ICP	167	ICP	80	FU	630.8	ICP	360	ICPMS	280
2	XRF	387	ICP	260	FU	34.5	ICP	171	ICP	80	FU	654.8	GDMS	373	ICP	295
3	ICP	390	ICP	270	FU	34.5	ICP	180	XRF	86	FU	664.9	ICPMS	375	ICP	300
4	GDMS	400	ICP	271	FU	37	ICPMS	180	ICP	88	FU	677.5	DCP	389	XRF	301
5	ICP	400	DCP	274	FU	37	ICP	190	ICP	90	FU	688	ICP	395	ICP	310
6	ICP	405	ICP	275	FU	37	XRF	192	ICP	92	FU	696	ICP	400	ICP	310
7	ICP	410	XRF	279	FU	37.5	ICP	194	ICPMS	92			ICP	415	DCP	316
8	ICP	410	ICP	280	FU	37.5	ICP	222	DCP	93			XRF	420	ICP	316
9	ICP	412	ICP	290	FU	40	DCP	226	ICP	93			ICP	425	GDMS	337
10	DCP	412	ICPMS	290	FU	40			ICP	95			DCP	425	DCP	340
11	ICP	415	GDMS	295	FU	41.3			ICP	98						
12	ICPMS	426	ICP	297												
13			GDMS	299												
Average		403.9		279.2		36.9		191.3		89.7		668.7		397.7		310.5
Std Dev		13.1		14.7		3.1		20.7		5.8		23.8		23.4		18.3
Certified		404		279		37		191		90		669		398		310
# Labs		12		13		11		9		11		6		10		10
t		2.2010		2.1788		2.2281		2.3060		2.2281		2.5706		2.2622		2.2622
C(95%)		8.3		8.9		2.1		15.9		3.9		25.0		16.7		13.1

* Methods of analysis are listed on page 3.

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Analysis	*	Si	*	Sn	*	V	*	W	*	Y	*	Zr
1	ICP	440	ICP	140	ICP	170	ICP	338	XRF	15	ICP	159
2	DCP	446	ICP	140	ICP	172	XRF	357	ICP	15.7	ICP	160
3	ICP	450	ICP	142.5	ICP	180	ICP	360	ICP	16	ICP	160
4	GDMS	460	DCP	146	GDMS	182	ICP	368	ICP	16	XRF	160
5	ICP	470	ICP	150	ICP	183	ICP	370	ICP	17	ICP	161
6	DCP	487	XRF	154	ICPMS	187	ICP	375	DCP	17	ICP	162
7	ICP	489	ICPMS	157	ICP	190	GDMS	379	ICP	18	ICPMS	164
8	XRF	496	DCP	164	ICP	193	ICP	380	DCP	18	XRF	166
9	ICP	497	ICP	167	DCP	199	GDMS	395	ICP	18	ICP	166
10	ICP	502	GDMS	170	ICP	202	DCP	399	ICP	19	DCP	168
11			ICP	175					ICP	19	GDMS	170
Average		473.7		155.0		185.8		372.1		17.2		163.3
Std Dev		23.4		12.5		10.6		18.0		1.4		3.7
Certified		474		155		186		372		17		163
# Labs		10		11		10		10		11		11
t		2.2622		2.2281		2.2622		2.2622		2.2281		2.2281
C(95%)		16.7		8.4		7.6		12.9		0.9		2.5

* Methods of analysis are listed below.

$C(95\%) = (t \times sd) / \sqrt{n}$ 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
ICP	AES - Inductively Coupled Plasma Spectrometry
DCP	AES - Direct Current Plasma Spectrometry
GDMS	Glow Discharge Mass Spectrometry
ICPMS	Inductively Coupled Plasma Mass Spectrometry
PIXE	Proton Induced X-Ray Emission Spectrometry
XRF	X-Ray Emission Fluorescence Spectrometry
C	Combustion-Infrared Absorption
FU	Inert gas Fusion Method

AES = Atomic Emission Spectrometry

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

Laboratory

AK Steel, Research & Technology, Middletown, Ohio
Allegheny Ludlum Steel Corp., Brackenridge, Pennsylvania
Allvac, Monroe, North Carolina
J. Dirats and Co., Inc., Westfield, Massachusetts
CEZUS, Ugine, France
Elemental Analysis, Inc., Lexington, Kentucky
LECO Corporation, St. Joseph, Michigan
Northern Analytical Laboratory, Inc., Merrimack, New Hampshire
Shiva Technologies, Inc., Syracuse, New York
TIMET, Morgantown, Pennsylvania
TIMET, Henderson Technical Laboratory, Henderson, Nevada
TIMET, Henderson Process Laboratory, Henderson, Nevada
TIMET, Toronto Process Laboratory, Toronto, Ontario, Canada
TIMET, UK-Witton, Birmingham, England
VHG Laboratories, Inc., Manchester, New Hampshire
Wah Chang, Albany, Oregon

Laboratory contact

Robert Crain
Pat Cole
Eric E. Dirats
Laurent Trecani
David Shewmaker
Dennis Lawrenz
William A. Guidoboni
D. Sathyamurthy
Larry Creasy
Gerald Boesenecker
James Kiely
John Low
Matthew Chamberlain-Webber
Julie M. McIntosh
Gary Beck

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. The laboratories participating in the testing normally followed the requirements of ISO Standard 17025. Individual values listed on pages 2 and 3 are the average of each analyst's results. Methods of analysis used were a combination of ASTM Standard Test Methods E 1409, E 1447, E 1937, and E 2371 plus other ICP, DCP, ICPMA, GDMS, and XRF spectrometric methods.

Outliers: Some outlying data was excluded from the data listed on pages 2 and 3 due to technical assessment of the cooperating laboratories and statistical evaluation.

Traceability: The following Reference Materials were used to validate the analytical data listed on pages 2 and 3 **CRMs:** SRM 650, 651, 652, 654, 1640, 2433, 3107, 3101A, 3112A, 3113, 3114, 3126A, 3131, 3132A, 3134, 3136, 3137, 3138, 3139A, 3150, 3161A, 3163, 3165, 3167A, 3169. **RM**s LECO 501-320, 501-348, 501-551, 501-646, 501-657, 501-664, 501-674, 762-741; **BS** T-2A, BS T-4, BS T-4A

Homogeneity: This Reference Material was tested for homogeneity and found acceptable.

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 CRM was produced by TIMET, Henderson, Nevada, It was double vacuum arc melted by the consumable electrode method, cast into ingots, and forged into bars..

Form: This CRM is in the form of a disc, approximately 40 mm in diameter and 12 mm thick.

Use: This CRM 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.

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 T-81-092404-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.

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:

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Houston, Texas 77069-2895 USA

Phone: (281) 440-9396

Fax: (281) 440-4432

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Certified by: _____ on September 24, 2004.

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

By Certificate Number 10539, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9001:2000 by National Quality Assurance, U.S.A.

Brammer Standard Company's Chemical Laboratory is accredited to ISO Standard 17025 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 Website: www.astm.org

E 1409 - 04 Standard Test Method for the Determination of Oxygen in Titanium and Titanium Alloys by the Inert Gas Fusion Technique

E 1447 - 01 Standard Test Method for the Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity Method

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

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

E 1937 - 04 Standard Test Method for the Determination of Nitrogen in Titanium and Titanium Alloys by the Inert gas Fusion Technique

E 2371 – 04 Standard Test Method for Analysis of Titanium and Titanium Alloys by Atomic Emission Plasma Spectrometry

ISO Guides and Standards available from Global Engineering - www.global.ihs.com

ISO Standard 17025 (First edition, 1999), 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