

Brammer Standard Company, Inc.

Certificate of Analysis

BS 10-2-3

Certified Reference Material for Titanium Alloy 10V-2Fe-3Al - UNS Number R54610

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³	Certified Value ¹	Estimate of Uncertainty ²
Al	3.22	0.08	N	0.0055	0.0008
C	0.032	0.003	Ni	0.022	0.004
Cr	0.023	0.002	O	0.108	0.005
Cu	0.0067	0.0009	S	0.0012	0.0004
Fe	2.01	0.05	Ti	84.8	0.2
H	0.0047	0.0007	V	9.74	0.09
Mo	0.0027	0.0006			

	Reference Value ¹	Estimate of Uncertainty ²	Reference Values ^{3,4}	Reference Value ¹	Estimate of Uncertainty ²
As	0.002	0.001	Sb	0.0003	0.0001
B	<0.005		Si	0.023	0.004
Co	0.002	0.001	Sn	0.002	0.001
Mn	0.004	0.003	W	<0.005	
P	0.0017	0.0007	Zr	<0.005	

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.

Trace element information values for Ce, Ga, Mg, Nb, Th, U, and Zn are shown on page 4.

The requirements of ISO Guides 30 and Standards 33401 and 33405 were followed for the preparation of this Certified Reference Material and certificate of analysis.

Analysis	*	Al	*	C	*	Cr	*	Cu	*	Fe	*	H	*	Mo	*	N	*	Ni	*	O
1	3	3.1	1	0.0285333	3	0.0186	3	0.0051	4	1.940	2	0.0037	5	0.001933	2	0.0043333	5	0.018233	2	0.1013667
2	10	3.16	1	0.0286	4	0.021333	5	0.005833	4	1.96367	2	0.0041	5	0.001967	2	0.0047667	3	0.0183	2	0.103
3	4	3.161667	1	0.0286333	4	0.021933	10	0.0060	4	1.983	2	0.0042667	4	0.0022	2	0.0048667	14	0.018733	2	0.1033333
4	4	3.175667	1	0.0288667	4	0.022	4	0.006333	4	1.99887	2	0.0044	5	0.002253	2	0.0049	10	0.02	2	0.104
5	4	3.199567	1	0.0289	14	0.022233	4	0.006567	4	2.0	2	0.0044333	4	0.0024	2	0.0051833	4	0.020533	2	0.105
6	4	3.199767	1	0.0291333	4	0.022467	4	0.0069	4	2.00133	2	0.0045667	4	0.002767	2	0.0054	4	0.020567	2	0.1053333
7	4	3.203333	3	0.0294	5	0.023133	5	0.006953	4	2.00697	2	0.0046	14	0.0028	2	0.0054	4	0.0211	2	0.1083333
8	14	3.206667	1	0.0302333	4	0.023467	10	0.007	11	2.02	2	0.00465	3	0.0029	2	0.0054333	4	0.0211	2	0.1083333
9	4	3.22	1	0.031	4	0.0239	4	0.007	10	2.02333	2	0.0047	11	0.003	2	0.005525	10	0.021333	2	0.1093333
10	4	3.228767	1	0.031	5	0.024733	4	0.0075	14	2.02333	2	0.0047333	4	0.0030	2	0.0055833	4	0.021433	2	0.11
11	4	3.259333	1	0.0320667	10	0.025	4	0.0079	4	2.02667	2	0.0051	4	0.003033	2	0.0057667	5	0.021533	2	0.1106667
12	10	3.26	11	0.0323	11	0.0256	11	0.0083	10	2.04	2	0.0052	12	0.003267	2	0.006	11	0.024	2	0.1113333
13	4	3.266933	1	0.0338	4	0.028333			3	2.04	2	0.0053967	10	0.003667	2	0.0062667	4	0.024633	2	0.113
14	4	3.296	1	0.0360					4	2.0466	2	0.00625			2	0.0069667	12	0.024667	2	0.1143333
15	11	3.39	1	0.0368667													4	0.029667	2	0.11975
16			1	0.0385																
17			1	0.04																
Average		3.2205		0.0320		0.02331		0.00675		2.0123		0.00472		0.002694		0.00546		0.02190		0.1085
Std Dev		0.0054		0.0037		0.00085		0.00030		0.0058		0.00062		0.000086		0.00067		0.00078		0.0050
H		0.021		0.0018		0.0016		0.00091		0.016		0.00079		0.00063		0.00083		0.001536		0.0033
U ₁		0.022		0.0018		0.0018		0.00096		0.017		0.00079		0.00063		0.00084		0.0017		0.0033
t-statistic		2.14		2.12		2.18		2.20		2.16		2.16		2.18		2.16		2.14		2.14
U ₂		0.047		0.0039		0.0039		0.0021		0.037		0.0017		0.0014		0.0018		0.0037		0.0071
U ₃		0.012		0.00094		0.0011		0.00061		0.010		0.00046		0.00038		0.00048		0.00095		0.0018
Certified		3.22		0.032		0.023		0.0067		2.01		0.0047		0.0027		0.0055		0.022		0.108
Uncertainty		0.08		0.003		0.002		0.0009		0.05		0.0007		0.0006		0.0008		0.004		0.005
Tolerance		0.24		0.012		0.006		0.0027		0.15		0.0021		0.0018		0.0024		0.012		0.015

Analysis	*	S	*	Ti	*	V
1	12	0.000583	16	[84.65]	4	9.618333
2	1	0.000767	4	84.69	10	9.63
3	1	0.000873	4	84.7005	4	9.663
4	1	0.0010	4	84.701533	11	9.71
5	3	0.0012	16	[84.74]	4	9.727333
6	1	0.001633	4	84.766667	4	9.7354
7	1	0.002233	14	84.766667	4	9.746667
8			4	84.967	10	9.773333
9			16	[85]	14	9.796667
10			4	85.043333	4	9.7991
11					4	9.7998
12					4	9.813233
13					4	9.833333
Average		0.00118		84.811		9.742015
Std Dev		0.00057		0.043		0.000088
H		0.00045		0.1729343		0.042
U ₁		0.00047		0.18		0.042
t-statistic		2.45		2.26		2.18
U ₂		0.0011		0.40		0.091
U ₃		0.00043		0.13		0.025
Certified		0.0012		84.8		9.74
Uncertainty		0.0004		0.2		0.09
Tolerance		0.0011		0.6		0.27

Analysis	*	As	*	B	*	Co	*	Mn	*	P	*	Sb	*	Si	*	Sn	*	W	*	Zr
1	5	0.001037	11	0.000092	5	0.000993	14	0.0012	5	0.00091	5	0.0002333	4	0.018633	12	0.0009767	12	0.000317	5	0.0006
2	12	0.003433	12	0.00011	5	0.001267	5	0.001233	3	0.0014	12	0.0003833	14	0.019167	5	0.00103	5	0.00035	5	0.0007333
3			4	0.003	11	0.0013	5	0.0013	12	0.0015667			11	0.0203	10	0.0027	10	0.0012	5	0.0007467
4					5	0.001467	12	0.001467	4	0.0023333			4	0.022033			3	0.0014	10	0.0016667
5					12	0.001733	5	0.001707	4	0.0025667			4	0.022033			5	0.0014	4	0.0019
6					4	0.0025	3	0.0021					4	0.022067			4	0.003567	11	0.0029
7					10	0.003	4	0.0022					4	0.0221					4	0.0033333
8					10	0.003667	4	0.0097					10	0.024						
9							4	0.010067					3	0.0244						
10							11	0.0111					4	0.024733						
11													12	0.0250						
12													4	0.025						
13													4	0.025967						
14													5	0.026967						
15													10	0.029333						
Average		0.002		0.0011		0.00199		0.00421		0.00167		0.00031		0.023449		0.0016		0.0014		0.00079
Std Dev		0.020		0.0048		0.00011		0.00010		0.00028		0.00051		0.000082		0.0093		0.0052		0.00011
H		0.001		0.0004		0.000554		0.000749		0.00052		0.00028		0.0016		0.0005		0.0005		0.00048
U ₁		0.020		0.0048		0.00057		0.00076		0.00059		0.00058		0.0016		0.0093		0.0053		0.00050
t-statistic		12.71		4.30		2.36		2.26		2.78		12.71		2.14		4.30		2.57		2.4469119
U ₂		0.26		0.021		0.0013		0.0017		0.0016		0.0074		0.0034		0.040		0.014		0.0012
U ₃		0.18		0.012		0.00047		0.00054		0.00073		0.0053		0.00088		0.023		0.0055		0.00046
Reference		0.002		<0.005		0.002		0.004		0.0017		0.0003		0.023		0.002		<0.005		<0.005
Uncertainty		0.001				0.001		0.003		0.0007		0.0001		0.004		0.001				
Tolerance		0.001				0.001		0.003		0.0016		0.0002		0.012		0.001				

For each element, in accordance with the requirements of ISO 17034 and ISO 33405, 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.

Validity statement: ISO Standard 33401 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 10-2-3 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 Metalwerks, Inc.; Aliquippa, PA.

Form: This CRM is machined in the form of a disc, approximately 46mm 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 Standard 33403 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 REV10-2-3-013125. 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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Houston, Texas 77069-2895 USA

Phone: (281) 440-9396

Web: www.brammerstandard.com

Fax: (281) 440-4432

Email: contact@brammerstandard.com

Revision: This certified reference material was originally certified as a reference material on January 4, 2023. Additional combustion/fusion testing was performed. C and N have been changed from reference to certified. Revised values for elements H and O are also presented.

Brammer Standard Company, Inc., is accredited by the American Association for Laboratory Accreditation (A2LA) to ISO Standard 17034:2016 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials (our current Certificate Number 656.02 expires 01/31/2027)

Brammer Standard Company's Chemical Laboratory is accredited by A2LA to ISO Standard 17025:2017. (Our current Certificate Number 656.01 expires 01/31/2027)

By current Certificate Number 10539 expiring 01/01/2027, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9001:2015 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 9001:2015 Quality Management Systems - Requirements

ISO Guide 30:2015 Terms and definitions used in connection with reference materials + 2008 amendment

ISO Standard 33401:2024 Reference materials - Contents of certificates, labels, and accompanying documentation

ISO Standard 33403:2024 Reference materials – Requirements and and recommendations for use

ISO Standard 17034:2016 General requirements for the competence of reference material producers

ISO Standard 33405:2024 Reference materials – Approaches for characterization and assessment of homogeneity and stability

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 31, 2025.

Beau R. Brammer
President