

Brammer Standard Company, Inc.

Certificate of Analysis

BS 625E

Certified Reference Material for Inconel 625 - UNS Number N06625

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²	
Al	0.214	0.004		N	0.0074	0.0008
B	0.0022	0.0003		Nb	3.56	0.06
C	0.049	0.003		Ni	60.7	0.4
Co	0.031	0.001		O	0.0015	0.0005
Cr	22.44	0.06		P	0.004	0.001
Cu	0.024	0.004		S	0.0005	0.0002
Fe	3.81	0.07		Si	0.065	0.009
Mg	0.0021	0.0003		Ti	0.27	0.01
Mn	0.050	0.009		V	0.020	0.001
Mo	8.77	0.07		W	0.016	0.001

Informational Values^{3,4}

As (0.003)	Ca (0.0006)	Pb (0.00005)	Sb (0.0001)	Sn (0.0006)
Ta (0.0036)	Zr (0.003)			

For each element, the certified value listed is the present best estimate of the true value based on the mean of the results of an interlaboratory testing program. See page 3 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 3 for more information on its calculation.

³ Values are given in weight percent. Values in brackets are reported by difference.

⁴ Values in parentheses are not certified and are provided for information only.

Trace element information values for Cd, Ga, Ge, Ir, La, Os, Re, Te, Tl, and Zn are shown on page 3.

The requirements of ISO Guides 30, 31, and 35 were followed for the preparation of this Certified Reference Material and certificate of analysis.

Analysis	* Al	* B	* C	* Co	* Cr	* Cu	* Fe	* Mg	* Mn	* Mo
1	18 0.166667	4 0.001566667	3 0.045625	4 0.025	10 22.073	4 0.013567	4 3.686666667	4 0.001	4 0.036367	10 8.617
2	10 0.2	3 0.001595	1 0.0459	8 0.026767	10 22.2	12 0.018667	4 3.696666667	4 0.0015	4 0.038667	10 8.66
3	4 0.205333	5 0.0016	1 0.0462	10 0.027	3 22.305	5 0.020467	4 3.703333333	12 0.0017	4 0.039	4 8.686667
4	3 0.208	14 0.001866667	1 0.046373333	10 0.028333	17 22.327433	14 0.020833	4 3.74	4 0.001867	5 0.041433	10 8.699
5	3 0.208333	5 0.0019	1 0.046666667	4 0.0284	14 22.366667	8 0.022133	4 3.745333333	3 0.0019	10 0.042	18 8.7
6	10 0.209333	4 0.001966667	1 0.048866667	4 0.029	10 22.383333	3 0.02245	4 3.75	4 0.00194	4 0.042	3 8.7027
7	4 0.21	4 0.002166667	1 0.049	4 0.029267	4 22.396667	5 0.0236	4 3.763333333	5 0.002033	10 0.043	4 8.703333
8	10 0.21	3 0.0022	3 0.049	10 0.03	10 22.41	10 0.023633	10 3.789	4 0.002033	4 0.044267	4 8.72
9	3 0.21	12 0.002333333	1 0.049	10 0.030567	4 22.416667	10 0.024	4 3.79	3 0.003343	10 0.044333	4 8.721333
10	3 0.2101	4 0.002566667	1 0.0494	4 0.030667	4 22.42	4 0.025	18 3.796666667	5 0.003767	4 0.0444	4 8.73
11	14 0.210333	3 0.0026	1 0.050166667	12 0.031	4 22.433333	4 0.025833	4 3.798666667		3 0.0513	4 8.75
12	4 0.2117	4 0.004	1 0.051	4 0.031267	13 22.438	3 0.026	10 3.8		3 0.055	4 8.77
13	4 0.212333		3 0.0515	4 0.031667	13 22.466667	4 0.027	4 3.803333333		3 0.055	10 8.78
14	4 0.213333		1 0.051666667	5 0.031667	4 22.473333	3 0.0284	14 3.826666667		14 0.059867	10 8.78
15	4 0.215433		1 0.062	3 0.031967	4 22.482667	4 0.0285	10 3.83		10 0.061	3 8.8
16	4 0.216			3 0.032075	3 22.4831	10 0.030333	3 3.83		4 0.062333	14 8.816667
17	4 0.216333			3 0.0326	3 22.5	3 0.035133	4 3.834933333		10 0.063	3 8.825
18	5 0.2185			5 0.032633	3 22.533333		10 3.836666667		4 0.0646	4 8.833333
19	4 0.222667			14 0.032967	4 22.56667		10 3.849		18 0.070333	4 8.84
20	4 0.225			18 0.038333	4 22.56667		3 3.85			4 8.844333
21	4 0.235667				10 22.58		3 3.88			3 8.896667
22	10 0.266				4 22.6		3 3.8811			4 8.921333
23					4 22.80667		4 3.893			4 8.971633
24							4 4.010			
Average	0.213685	0.002197	0.049491	0.030559	22.444748	0.024444	3.807682	0.00211	0.050416	8.772891
Std Dev	0.000067	0.000091	0.000082	0.000071	0.000066	0.000077	0.000065	0.00010	0.000073	0.000066
H	0.0038	0.00045	0.0017	0.0013	0.12	0.0012	0.027	0.00044	0.0017	0.053
U1	0.0038	0.00046	0.0017	0.0013	0.12	0.0012	0.027	0.00045	0.0017	0.053
t-statistic	2.08	2.20	2.14	2.09	2.07	2.12	2.07	2.26	2.10	2.07
U2	0.0079	0.0010	0.0036	0.0028	0.24	0.0025	0.057	0.0010	0.0036	0.11
U3	0.0017	0.00029	0.00093	0.00062	0.051	0.00061	0.012	0.00032	0.00082	0.023
Certified	0.214	0.0022	0.049	0.031	22.44	0.024	3.81	0.0021	0.050	8.77
Uncertainty	0.004	0.0003	0.001	0.001	0.06	0.004	0.07	0.0003	0.009	0.07
Tolerance	0.012	0.0010	0.009	0.003	0.18	0.016	0.21	0.0010	0.027	0.21

Analysis	* N	* Nb	* Ni	* O	* P	* S	* Si	* Ti	* V	* W
1	2 0.005067	10 3.44	6 60.26866667	2 0.001	10 0.0026667	1 0.0002	3 0.0383	4 0.257	3 0.018	12 0.0103
2	2 0.005333	4 3.476666667	10 60.28166667	2 0.001025	7 0.0028533	1 0.000233	3 0.052525	4 0.258333	3 0.018475	10 0.011
3	2 0.0061	4 3.48	13 60.31433333	2 0.001053	4 0.0029	12 0.000347	4 0.057333333	10 0.26	4 0.019067	4 0.015067
4	2 0.00665	4 3.494666667	4 60.35666667	2 0.00108	4 0.0031	1 0.000467	10 0.057833333	4 0.26	4 0.019733	5 0.0152
5	2 0.00693	3 3.5041	3 60.37333333	2 0.001138	4 0.0031067	10 0.0005	10 0.059	4 0.260267	18 0.02	4 0.015667
6	2 0.00777	10 3.508	4 60.41993333	2 0.001267	12 0.0033	1 0.0005	18 0.059666667	4 0.260333	12 0.02	18 0.017
7	2 0.008	4 3.516666667	10 60.52	2 0.0016	14 0.0039	1 0.000533	3 0.060466667	3 0.2605	10 0.02	4 0.017267
8	2 0.00811	4 3.53	16 [60.5466666666667]	2 0.00166	3 0.004	1 0.000633	4 0.062966667	4 0.263	4 0.020333	4 0.0175
9	2 0.008133	3 3.5325	14 60.63333333	2 0.001667	7 0.0043333	1 0.000833	3 0.063	5 0.263367	5 0.0208	5 0.017533
10	2 0.0086	4 3.537	16 [60.64933333333333]	2 0.0023	3 0.0046	3 0.000925	4 0.063	3 0.2659	5 0.020967	3 0.0178
11	2 0.009	3 3.57	6 60.7	2 0.002633	4 0.0048		12 0.068333333	18 0.27	10 0.021	14 0.018033
12	2 0.009183	10 3.574666667	10 60.75333333	4 0.005	4 0.005		4 0.068766667	10 0.27	3 0.0212	4 0.0204
13	4 3.577333333	16 [60.775]		10 0.005			5 0.070033333	3 0.27	4 0.021333	4 0.0211
14	4 3.583333333	4 61		10 0.005			6 0.070333333	4 0.2766	4 0.021467	
15	14 3.583333333	4 61.03333333		3 0.0072			4 0.072	4 0.279667		
16	10 3.596666667	4 61.03333333					7 0.076	4 0.281		
17	4 3.5991	4 61.1					10 0.078333333	3 0.282		
18	4 3.605	10 61.13					4 0.083833333	4 0.283		
19	10 3.61	18 61.14						7 0.283333		
20	3 3.61667	16 [61.177]						10 0.286333		
	4 3.616667							4 0.29		
	4 3.621867									
	4 3.643333									
	18 3.736667									
Average	0.007406	3.564760	60.710297	0.001493	0.004117	0.00052	0.064540	0.270506	0.020170	0.016451
Std Dev	0.000091	0.000065	0.000071	0.000095	0.000082	0.00010	0.000075	0.000069	0.000085	0.000088
H	0.00070	0.026	0.29	0.00039	0.00056	0.00029	0.0019	0.0044	0.0011	0.00099
U1	0.00071	0.026	0.29	0.00041	0.00056	0.00031	0.0019	0.0044	0.0011	0.00099
t-statistic	2.20	2.07	2.09	2.23	2.14	2.26	2.11	2.09	2.16	2.18
U2	0.0016	0.054	0.60	0.00090	0.0012	0.00070	0.0041	0.0092	0.0023	0.0022
U3	0.00045	0.011	0.13	0.00027	0.00031	0.00022	0.0010	0.0020	0.00063	0.00060
Certified	0.0074	3.56	60.7	0.0015	0.004	0.0005	0.065	0.27	0.020	0.016
Uncertainty	0.0008	0.06	0.4	0.0005	0.001	0.0002	0.009	0.01	0.001	0.001
Tolerance	0.0024	0.18	1.2	0.0015	0.003	0.0005	0.027	0.03	0.003	0.003

Analysis	* As	* Ca	* Pb	* Sb	* Sn	* Ta	* Zr
1	5 0.00015	12 0.00009667	12 0.000036	12 0.000137	12 0.0002233	12 0.0019	12 0.00008
2	15 0.00039	4 0.00021	5 0.00003733		4 0.001	4 0.002067	5 0.00008033
3	12 0.00055	3 0.0006625	9 0.00004667			10 0.003	5 0.000156667
4	3 0.00075	14 0.000833333	5 0.00005			5 0.003667	4 0.000366667
5	5 0.0011	4 0.001266667	3 0.0001			5 0.004	3 0.0005
6	10 0.001667					5 0.004167	3 0.0011
7	4 0.015333					4 0.0062	10 0.0022
8						4 0.02	14 0.022033333
9						18 0.031	
10						14 0.071433	
Average	0.003	0.0006	0.0000540	0.00014	0.0006	0.00357	0.003
Std Dev	0.016	0.0013	0.0000052	0.00012	0.0021	0.00012	0.019
H	0.000	0.0003	0.00019	0.00022	0.0003	0.00053	0.000
U1	0.016	0.0014	0.00019	0.00025	0.0021	0.00054	0.019
t-statistic	2.45	2.78	2.78	12.71	12.71	2.26	2.36
U2	0.039	0.0038	0.00054	0.0032	0.027	0.0012	0.044
U3	0.0150	0.0017	0.00024	0.0032	0.019	0.00039	0.015
Informational	(0.003)	(0.0006)	(0.00005)	(0.0001)	(0.0006)	(0.0036)	(0.003)

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. The standard deviation (S) is calculated. 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:

$$U_1 = \sqrt{H^2 + S^2} \quad U_2 = t \times U_1 \quad U_3 = \frac{U_2}{\sqrt{n}}$$

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.

Analysis	* Cd	* Ga	* Ge	* Ir	* La	* Os	* Re	* Te	* Tl	* Zn
1	12 0.16	12 18	12 0.32	12 0.06	12 0.02	12 0.05	12 0.33	12 0.01	12 0.01	12 5.2
2	12 0.29	12 18	12 0.35	12 0.06	12 0.03	12 0.06	12 0.4	12 0.02	12 0.02	12 5.3
3	12 0.43	12 23	12 0.35	12 0.07	12 0.07	12 0.06	12 0.51			12 5.4

Analytical Method Codes:

- | | | |
|---------------------------|---------------------------|---------------------------|
| 1 Combustion (ASTM E1019) | 7 Photometric | 13 Titrimetric |
| 2 Fusion (ASTM E1019) | 8 Flame Atomic Absorption | 14 DCP Atomic Emission |
| 3 Spark Atomic Emission | 9 GF Atomic Absorption | 15 HG Atomic Fluorescence |
| 4 ICP Atomic Emission | 10 X-Ray Fluorescence | 16 Difference |
| 5 ICP Mass Spectrometry | 11 GD Atomic Emission | 17 Wet |
| 6 Gravimetric | 12 GD Mass Spectrometry | 18 PIXE |

ICP = Inductively Coupled Plasma GF = Graphite Furnace GD = Glow Discharge
 DCP = Direct Current Plasma HG = Hydride Generation

Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, Guide 34
NSL Analytical	Cleveland, OH	ANAB	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
Exova	Glendale Heights, IL	A2LA	17025
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	AB 554
Luvak Inc.	Boylston, MA	PRI/Nadcap	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
TUV Rheinland India Pvt Ltd.	Bandalore, India	NABL	17025
Andrew S. McCreath & Son, Inc.	Harrisburg, PA	A2LA	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025

A2LA = American Association for Laboratory Accreditation

ANAB = ANSI-ASQ National Accreditation Board

CNAS = China National Accreditation Service

NABL = National Accreditation Board for Testing and Calibration Laboratories

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: 12X10180, 12X12749, 12X12749W, 12X352D, 12X353E, 12XLA5, 24X7001, 28X7182; AR 644, 654, 657, 668, 670, 673, 875, 891, 892, 1648, 1652, 1653; BAS 4-94, 342, 346A, 351, 387, 434, 459; BS H3C, H-6, H-6A, TM-1, 32C, 56H, 61G, 200-1, 200A, 625, 625A, 625B, 625C, 625D, 690A, 718D, 725, 750C, 800, 860C, 1030; CKD 181A; DSZU CA01A; ECRM 85-1, 86-1, 87-1, 186-1; IARM 51C, 54A, 54B, 54C, 54F, 56C, 56D, 62C, 65B, 68C, 95B, 100B, 154B, 158B, 203A; IMN 90/1; IMZ 74, 112; LECO 501-501, 501-502, 501-503, 501-504, 501-644, 501-644, 501-674, 501-676, 501-676, 501-693, 502-102, 502-873; SRM C2400, 9D, 72F, 349, 855, 864, 865, 866, 867, 1112, 1155, 1155A, 1172, 1113, 1245, 1245A, 1246, 1247, 1250, 1261, 1262, 1265A, 1269, 2159, 3109A.

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 — BAS 4-94, 351; BS H-6, H-6A, 625, 625A, 625B, 625C, 690A, 725; DSZU CA01A; LECO 501-676, 502-873; SRM 864, 865, 1245.

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 625E 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 stock for this CRM was produced by Carpenter Technology Corporation; Reading, Pa.

Form: This CRM is machined in the form of a disc, approximately 35mm 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.

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 625E-060917. 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.
14603 Benfer Road
Houston, Texas 77069-2895 USA

Phone: (281) 440-9396 Web: www.brammerstandard.com

Fax: (281) 440-4432 Email: contact@brammerstandard.com

Brammer Standard Company, Inc., is accredited by the American Association For Laboratory Accreditation (A2LA) to ISO Standard 17034 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 30:2015 Terms and definitions used in connection with reference materials + 2008 amendment

ISO Guide 31:2015 Reference materials - Contents of certificates and labels

ISO Guide 33:2015 Uses of certified reference materials

ISO Standard 17034:2016 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, 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 June 09, 2017.

Beau R. Brammer

President