

Brammer Standard Company, Inc.

Certificate of Analysis

BS G30

Certified Reference Material for Hastelloy type G-30 - UNS Number N06030

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²
Al	0.263	0.007		Mo	0.09
As	0.0018	0.0004		N	0.002
B	0.0010	0.0004		Nb	0.009
C	0.0044	0.0008		Ni	0.3
Co	2.10	0.07		O	0.0005
Cr	28.89	0.06		P	0.001
Cu	1.22	0.06		S	0.0002
Fe	13.7	0.1		Si	0.02
Mg	0.0063	0.0006		Sn	0.0003
Mn	1.02	0.04		W	0.09
	Reference Value ¹	Estimate of Uncertainty ²	Reference Values^{3,4}	Reference Value ¹	Estimate of Uncertainty ²
Ca	0.0010	0.0005		Ti	0.002
Pb	<0.01			V	0.006
Sb	0.0003	0.0002		Zr	0.001
Ta	0.003	0.002			

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 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 Reference values are not certified and are provided for information only.

Trace element information values for Ce, Ga, Ge, Ir, Os, Pt, Re, U, 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	* As	* B	* C	* Co	* Cr	* Cu	* Fe	* Mg	* Mn
1	5	0.2413333	9 0.0013	11 0.0006	1 0.0029	11 2.03	4 28.73	4 1.16075	4 13.449	12 0.005667	4 0.976
2	4	0.244	15 0.0014133	12 0.0007167	1 0.00349667	4 2.030333	4 28.79	4 1.17466667	3 13.56	14 0.0057	4 0.989667
3	11	0.259	11 0.0015	4 0.0009667	1 0.00366667	4 2.049	4 28.84	10 1.18	4 13.602	4 0.006033	4 0.993667
4	10	0.26	5 0.0016	7 0.0010267	11 0.004	10 2.064	11 28.84	4 1.18933333	4 13.603333	4 0.006067	4 0.99756
5	4	0.26	5 0.0016267	4 0.0010333	1 0.00433333	4 2.072333	13 28.868	4 1.18963333	10 13.61	5 0.006067	4 0.997667
6	3	0.26	4 0.0019333	5 0.0010667	1 0.00455	4 2.07293	4 28.87323	10 1.209	4 13.61	4 0.0061	4 0.99875
7	4	0.2644667	4 0.0020333	4 0.0010667	1 0.005	3 2.09	4 28.877	4 1.212	4 13.6388	3 0.0062	4 1.006667
8	4	0.2663333	3 0.0021	4 0.0013667	1 0.005	4 2.1001	4 28.8972	4 1.21333333	11 13.65	4 0.006273	10 1.01
9	4	0.268	12 0.0021	3 0.0014	1 0.005	4 2.101033	4 28.90437	4 1.217	4 13.689233	5 0.006433	10 1.02
10	14	0.2686667	9 0.0022	14 0.0015	1 0.00503333	14 2.103333	10 28.92	14 1.22	4 13.697767	11 0.0066	11 1.02
11	4	0.2691333	4 0.0024		1 0.00543333	4 2.106667	3 28.93	3 1.23	14 13.7	4 0.007333	4 1.036567
12	4	0.2701667				4 2.13025	14 28.93333	3 1.24	3 13.7	10 0.0074	14 1.04
13	3	0.273				4 2.131667	4 28.95333	11 1.25	4 13.701467		3 1.04
14	4	0.2780667				10 2.15	4 28.99367	4 1.25566667	16 13.799333		3 1.04
15						4 2.152967	3 29.2	4 1.25926667	10 13.8		4 1.06
16						4 2.157333		4 1.2597	16 13.871		4 1.060533
17								4 1.27066667			4 1.067
Average		0.263012	0.001839	0.000996	0.004401	2.096365	28.894	1.219472	13.667621	0.00627	1.020828
Std Dev		0.000085	0.000047	0.000036	0.000095	0.000079	0.055	0.000077	0.000079	0.00023	0.000077
H		0.0052	0.00054	0.00043	0.00076	0.017	0.08	0.012	0.052	0.00089	0.011
U1		0.0052	0.00054	0.00043	0.00077	0.017	0.10	0.012	0.052	0.00091	0.011
t-statistic		2.16	2.23	2.26	2.23	2.13	2.14	2.12	2.13	2.20	2.12
U2		0.011	0.0012	0.0010	0.0017	0.035	0.21	0.026	0.11	0.0020	0.023
U3		0.0030	0.00036	0.00031	0.00052	0.0088	0.055	0.0062	0.028	0.00058	0.0056
Certified		0.263	0.0018	0.0010	0.0044	2.10	28.89	1.22	13.7	0.0063	1.02
Uncertainty		0.007	0.0004	0.0004	0.0008	0.07	0.06	0.06	0.1	0.0006	0.04
Tolerance		0.021	0.0012	0.0009	0.0024	0.21	0.21	0.18	0.3	0.0020	0.12

Analysis	*	Mo	* N	* Nb	* Ni	* O	* P	* S	* Si	* Sn	* W
1	4	4.7003333	2 0.0246667	3 0.406	4 45.0964333	2 0.002167	12 0.008333	1 0.00027	3 0.289	5 0.0004	3 1.78
2	4	4.7943333	2 0.0247333	4 0.4083333	4 45.13	2 0.00217	4 0.0086	1 0.00039	11 0.295	9 0.000933	4 1.786333
3	3	4.81	2 0.0265	4 0.4086	14 45.1666667	2 0.002475	5 0.008767	12 0.0004	5 0.3063333	3 0.0011	4 1.798767
4	4	4.8246667	2 0.0281667	10 0.41	13 45.1836667	2 0.002557	4 0.010033	1 0.00043333	6 0.3088	4 0.0011	4 1.800867
5	4	4.84	2 0.0283667	4 0.411	16 [45.22]	2 0.0026	4 0.0101	1 0.00043333	4 0.310	4 0.001133	14 1.826667
6	4	4.8545	2 0.028475	4 0.41625	16 [45.233]	2 0.002633	4 0.010133	1 0.0006	3 0.31	5 0.001163	4 1.838667
7	4	4.8946333	2 0.0287333	4 0.418	10 45.3	2 0.002667	4 0.010167	11 0.0007	4 0.3100	5 0.001167	4 1.8654
8	4	4.8999667	2 0.0287667	4 0.4185333	4 45.36	2 0.002767	7 0.010333	1 0.0007	14 0.3113333	11 0.0012	10 1.876
9	3	4.9	2 0.029	10 0.419	4 45.3647	2 0.002825	3 0.0105	1 0.00076667	4 0.3157	5 0.001267	4 1.891667
10	10	4.909	2 0.0293	4 0.419	4 45.45	2 0.003067	10 0.0105	1 0.00076667	4 0.3213333	12 0.0014	4 1.893333
11	14	4.9266667	2 0.0300	4 0.4200333	10 45.47		11 0.0112	1 0.0008	4 0.334	4 0.0014	4 1.903333
12	4	4.9288667	2 0.030275	14 0.4223333	16 [45.4711367]		4 0.011567	3 0.0008	4 0.3342333		4 1.910167
13	4	4.9406667	2 0.031	11 0.425	4 45.6		4 0.011733		4 0.3363333		11 1.93
14	4	4.9545333		4 0.4269	16 [45.67]				4 0.343		4 1.942
15	4	4.99		4 0.461							4 1.9975
16	11	5.01									10 2.0
17	10	5.06									
Average		4.896363	0.0284	0.419332	45.336853	0.00271	0.01014	0.000649	0.3157	0.001115	1.877544
Std Dev		0.000077	0.0011	0.000082	0.000085	0.00014	0.00046	0.000029	0.0047	0.000095	0.000079
H		0.027	0.0017	0.0067	0.11	0.0063	0.0036	0.0058	0.0058	0.00044	0.016
U1		0.027	0.0021	0.0067	0.11	0.0064	0.0012	0.00036	0.0075	0.00045	0.016
t-statistic		2.12	2.18	2.14	2.16	2.26	2.18	2.20	2.16	2.23	2.13
U2		0.058	0.0045	0.014	0.24	0.0015	0.0026	0.00080	0.016	0.0010	0.033
U3		0.014	0.0012	0.0037	0.065	0.00046	0.00071	0.00023	0.0043	0.00030	0.0083
Certified		4.90	0.028	0.419	45.3	0.0027	0.010	0.0006	0.32	0.0011	1.88
Uncertainty		0.09	0.002	0.009	0.3	0.0005	0.001	0.0002	0.02	0.0003	0.09
Tolerance		0.27	0.006	0.027	0.9	0.0015	0.003	0.0005	0.06	0.0010	0.27

BS G30 * Code for method Reference values listed as weight percent

Analysis	*	Ca	*	Pb	*	Sb	*	Ta	*	Ti	*	V	*	Zr
1	12	0.000014	5	0.00001	5	0.0001	12	0.00070667	4	0.002	5	0.016333	12	0.0000993
2	11	0.0005	12	0.000019	9	0.0001	5	0.00106667	11	0.0022	4	0.017	5	0.0001133
3	4	0.0008067	4	0.0002	5	0.00023	5	0.00114333	5	0.0031	4	0.017267	4	0.001
4	3	0.0011	3	0.0002	12	0.00024	5	0.00143333	5	0.003433	4	0.020167	11	0.0016
5	4	0.0011	11	0.0002	3	0.0003	5	0.00396667	5	0.00361	4	0.020933	10	0.0018
6	4	0.0011333	9	0.0009667	11	0.0003	11	0.0041	12	0.003667	5	0.022133	4	0.0021
7	4	0.0019333	9	0.0050967	9	0.0005333	4	0.00496667	4	0.0040	12	0.023667	4	0.00216667
8							4	0.005	14	0.004133	14	0.024767	3	0.0023
9							14	0.00513333	4	0.0042	11	0.0248		
10							3	0.0062	4	0.004767	4	0.025967		
11									3	0.005	4	0.026267		
12									4	0.0054	3	0.0264		
13											4	0.0278		
14											4	0.029333		
Average		0.001050		0.0010		0.0003000		0.00337		0.00378		0.02340		0.001958
Std Dev		0.000042		0.0026		0.0000026		0.00010		0.00013		0.00077		0.000045
H		0.00043		0.0004		0.00028		0.00068		0.00072		0.0016		0.00055
U ₁		0.00044		0.0026		0.00028		0.00069		0.00073		0.0018		0.00055
t-statistic		2.45		2.45		2.45		2.26		2.20		2.16		2.36
U ₂		0.0011		0.0063		0.00068		0.0016		0.0016		0.0038		0.0013
U ₃		0.00040		0.0024		0.00026		0.00049		0.00046		0.0010		0.00046
Reference		0.0010		<0.01		0.0003		0.003		0.004		0.023		0.002
Uncertainty		0.0005				0.0002		0.002		0.002		0.006		0.001
Tolerance		0.0009				0.0002		0.002		0.003		0.018		0.001

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

BS G30 * Code for analytical method Trace analysis listed as mg/kg (ppm)

Analysis	*	Ce	*	Ga	*	Ge	*	Ir	*	Os	*	Pt	*	Re	*	U	*	Zn
1	12	0.01	12	47	12	1.8	12	0.05	12	0.06	12	0.12	12	6.7	12	0.003	12	0.26
2	12	0.01	12	48	12	1.8	12	0.05	12	0.06	12	0.13	12	6.9	12	0.004	12	0.26
3	12	0.02	12	48	12	1.8	12	0.05	12	0.06	12	0.16	12	6.9	12	0.005	12	0.26

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	
6 Gravimetric	12 GD Mass Spectrometry	

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, 17034
NSL Analytical	Cleveland, OH	ANAB	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
Vitkovice Testing Center	Ostrava, Czech Republic	Czech Accreditation Institute	17025
Eurofins EAG Materials Science, LLC	Liverpool, NY	A2LA	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
Shiva Analyticals	Hoskote, Bangalore	NABL	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Luvak Inc.	Boylston, MA	PRI	17025
Element Materials Technology	Santa Fe Spring, CA	A2LA	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI	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
 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: 12X15253, 13X12534S, 13XNSA8, 14X12144A; AR 115C, 165, 513, 612B, 657, 659, 662, 668, 673, 675, 869, 870, 882, 885, 892, 911A, 920K, 1650, 1651, 1652; BAS 61, 152/2, 159/3, 345, 351, 387, 408/1, 409, 483; BS C-2000, H2E, H3C, H4, H4A, H4B, H6B, H8, H230, H230A, 45B, 56H, 73C, 179B, 179C, 183C, 187B, 197, 197A, 197B, 431, 625D, 690, 690A, 718C, 750A, 754G, 800A, 825E, 825F, 1045, 2931A, 4820A, 4942A, 6255, 8620E; CKD 168A, 169A, 182A, 185A, 189A; CZ 2025A; DSZU CA013, CA01A; ECRM 377-2; IARM 54B, 56C, 59A, 60B, 62B, 62E, 67B, 69A, 189A, 338A; IMZ 51/1, 55/1, 55/1A; LECO 501-024, 501-320, 501-504, 501-505, 501-646, 501-676, 502-172, 502-195, 502-348, 502-414, 502-416, 502-712, 502-893, 502-870, 502-916, 502-928; SRM 349, 866, 867, 882, 897, 898, 899, 1172, 1263.

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: BS H4, H4A, H4B, H8, H230, 197, 197A, 197B, 690, 690A.

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 G30 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 Haynes International; Kokomo, Indiana.

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.

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 G30-110121. 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 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

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|-------|---|
| 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 17025:2017 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 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 35:2017 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 November 01, 2021.

Beau R. Brammer
President