Brammer Standard Company, Inc.

Certificate of Analysis

BS 800A

Certified Reference Material for Incoloy 800 - UNS Number N08800

Certified Values[3]

	Certified Value[1]	Estimate of Uncertainty[2]		Certified Value[1]	Estimate of Uncertainty[2]
Al	**0.362**	0.008	**Si**	**0.361**	0.009
B	**0.0018**	0.0006	**Sn**	**0.0041**	0.0005
C	**0.075**	0.002	**Ti**	**0.526**	0.007
Co	**0.069**	0.004	**V**	**0.058**	0.002
Cr	**21.09**	0.09			
Cu	**0.244**	0.008			
Fe	**42.7**	0.1			
Mg	**0.0022**	0.0003			
Mn	**0.883**	0.009			
Mo	**0.117**	0.005			
N	**0.0126**	0.0007			
Nb	**0.021**	0.002			
Ni	**33.3**	0.1			
O	**0.0014**	0.0003			
P	**0.013**	0.002			

Informational Values[3,4]

As (0.002)	Ca (0.000006)	Pb (0.001)	S (0.0007)	Sb (0.0005)
Ta (0.005)	W (0.030)	Zr (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 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] Values in parentheses are not certified and are provided for information only.

Trace element information values for Bi, Cd, Cl, Ga, Ge, Hf, K, Na, Rb, Re, Se, and Zn are shown on page 4.

The requirements of ISO Guides 31, 34, and 35 were followed for the preparation of this Certified Reference Material and certificate of analysis. This is a Certified Reference Material as defined by ISO Guide 30.

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BS 800A * Code for method Certified values listed as weight percent

Analysis	*	Al	*	B	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	Mg
1	4	0.33	5	0.0010	1	0.069667	12	0.0600	17	20.78223	4	0.212	4	42.26	4	0.001
2	5	0.3334	12	0.0010	1	0.072033	5	0.0600	13	21.04933	5	0.226533	4	42.327	5	0.001767
3	4	0.343	5	0.001667	3	0.0721	3	0.062	10	21.05667	4	0.229667	10	42.53	5	0.0018
4	3	0.361	3	0.002	1	0.072233	4	0.0641	10	21.116	3	0.233	3	42.631	4	0.0020
5	4	0.3626	14	0.0021	1	0.073833	3	0.0648	4	21.12	4	0.233333	14	42.66667	4	0.00201
6	3	0.363	3	0.00224	1	0.07416	14	0.0651	4	21.13333	10	0.236	4	42.68	4	0.002167
7	4	0.366667	7	0.00241	1	0.074533	4	0.067067	4	21.15667	14	0.239667	16	[42.7]	5	0.002233
8	4	0.367233	4	0.002467	3	0.077	5	0.069333	10	21.16	4	0.2415	4	42.73333	4	0.0023
9	14	0.368	5	0.0026	1	0.077067	8	0.0696	3	21.2	8	0.241667	13	42.735	14	0.002367
10	4	0.368667	4	0.002633	1	0.077667	4	0.069767	14	21.2	3	0.242	3	42.75	12	0.0025
11	10	0.37	4	0.002767	1	0.077837	3	0.070033	3	21.208	10	0.242667	10	42.818	3	0.00264
12	4	0.3721667	4	0.002833	1	0.080533	4	0.070467	4	21.27567	4	0.244667	16	[42.84333]	4	0.003233
13	4	0.372	4	0.004			4	0.070533			4	0.245333	16	[42.9263]		
14	10	0.382333					10	0.076			4	0.246967	4	43.05333		
15	3	0.394667					10	0.0764			5	0.250333	10	43.08667		
16							4	0.081			12	0.2600				
17							5	0.083967			3	0.263				
18											10	0.276				
Average		0.3621		0.00175		0.0754		0.0691		21.088		0.2438		42.6803		0.002177
Std dev		0.0043		0.00010		0.0020		0.0020		0.076		0.0035		0.0060		0.000094
H		0.0050		0.00037		0.0019		0.0019		0.12		0.0039		0.23		0.00040
U_1		0.0066		0.00039		0.0028		0.0027		0.14		0.0053		0.23		0.00041
t-statistic		2.14		2.18		2.20		2.12		2.20		2.11		2.14		2.20
U_2		0.014		0.00084		0.0062		0.0058		0.31		0.011		0.49		0.00091
U_3		0.0037		0.00023		0.0018		0.0014		0.090		0.0026		0.13		0.00026
Certified		**0.362**		**0.0018**		**0.075**		**0.069**		**21.09**		**0.244**		**42.7**		**0.0022**
Uncertainty		**0.008**		**0.0006**		**0.002**		**0.004**		**0.09**		**0.008**		**0.1**		**0.0003**
Tolerance		0.024		0.0018		0.006		0.012		0.31		0.024		0.5		0.0009

Analysis	*	Mn	*	Mo	*	N	*	Nb	*	Ni	*	O	*	P	*	Si
1	3	0.822333	5	0.096333	2	0.0113	4	0.012	10	33.11667	2	0.001183	12	0.0080	10	0.343
2	4	0.856667	3	0.0988	2	0.01185	4	0.015167	4	33.12633	2	0.0012	5	0.008733	3	0.347
3	4	0.860333	14	0.103	2	0.012533	14	0.015267	6	33.12933	2	0.00121	4	0.011	14	0.349
4	10	0.866333	3	0.106	2	0.012667	3	0.0153	13	33.19267	2	0.001425	10	0.012833	10	0.355333
5	10	0.873	10	0.1100	2	0.012933	10	0.021	4	33.233	2	0.00145	5	0.013333	3	0.356667
6	4	0.874667	12	0.110	2	0.013	4	0.021367	3	33.319	2	0.001533	3	0.0135	4	0.357
7	4	0.877233	4	0.1167	2	0.013073	4	0.021367	10	33.32	2	0.001933	10	0.014	4	0.358667
8	4	0.877667	5	0.117833	2	0.013267	7	0.0228	4	33.320	2	0.001967	4	0.014367	4	0.358733
9	3	0.878	5	0.1184	2	0.013467	5	0.023333	4	33.34			4	0.014533	3	0.361
10	3	0.882	10	0.119333	2	0.013775	5	0.023333	10	33.397			3	0.014633	4	0.366333
11	4	0.882667	4	0.120667			4	0.023633	3	33.43			14	0.0150	4	0.371667
12	14	0.883667	4	0.121			10	0.024	14	33.43333			5	0.015367	4	0.377
13	8	0.888667	10	0.121			12	0.0270	4	33.46443			4	0.015433	4	0.377967
14	4	0.900267	4	0.124133			5	0.027367	4	33.62667			4	0.016867	5	0.3892
15	10	0.905	7	0.125667					4	33.80			4	0.0175	6	0.390333
16			4	0.126667									7	0.0176		
17			4	0.127												
Average		0.8827		0.1166		0.01257		0.02067		33.346		0.001390		0.01328		0.3607
Std dev		0.0057		0.0031		0.00051		0.00091		0.067		0.000050		0.00067		0.0047
H		0.009		0.0025		0.00079		0.0010		0.18		0.00035		0.0008		0.0050
U_1		0.011		0.0039		0.00095		0.0014		0.19		0.00035		0.0011		0.0069
t-statistic		2.14		2.12		2.26		2.16		2.14		2.36		2.13		2.14
U_2		0.023		0.0084		0.0021		0.0029		0.42		0.00083		0.0022		0.015
U_3		0.0060		0.0020		0.00068		0.00080		0.11		0.00029		0.00060		0.0038
Certified		**0.883**		**0.117**		**0.0126**		**0.021**		**33.3**		**0.0014**		**0.013**		**0.361**
Uncertainty		**0.009**		**0.005**		**0.0007**		**0.002**		**0.1**		**0.0003**		**0.002**		**0.009**
Tolerance		0.027		0.015		0.0021		0.006		0.4		0.0008		0.006		0.027

BS 800A * Code for method Certified values listed as weight percent

Analysis	*	Sn	*	Ti	*	V
1	12	0.0035	5	0.460133	12	0.0510
2	3	0.0038	4	0.493333	3	0.0515
3	4	0.0039	4	0.505	10	0.053
4	5	0.003933	10	0.506333	4	0.0530
5	4	0.0040	3	0.507	10	0.055833
6	9	0.004067	3	0.519	5	0.056533
7	5	0.004367	7	0.522333	14	0.0574
8	5	0.004567	4	0.523667	4	0.057567
9	5	0.004663	4	0.524667	4	0.0579
10	5	0.0047	4	0.526	5	0.058933
11	5	0.004867	4	0.527267	3	0.06
12	3	0.007	14	0.530	4	0.060033
13	4	0.007	10	0.531	4	0.0608
14			3	0.541	10	0.061
15			4	0.541933	4	0.062
16			10	0.542	3	0.066033
17			4	0.5455	5	0.0782
Average		0.00412		0.5258		0.0585
Std dev		0.00018		0.0043		0.0016
H		0.00050		0.0064		0.0017
U_1		0.00053		0.0077		0.0023
t-statistic		2.18		2.12		2.12
U_2		0.0012		0.016		0.0049
U_3		0.00032		0.0040		0.0012
Certified		**0.0041**		**0.526**		**0.058**
Uncertainty		**0.0005**		**0.007**		**0.002**
Tolerance		0.0015		0.021		0.006

BS 800A * Code for method Informational values listed as weight percent

Analysis	*	As	*	Ca	*	Pb	*	S	*	Sb	*	Ta	*	W	*	Zr
1	4	0.000967	12	0.0000064	12	0.000015	12	0.000050	5	0.000457	12	0.000030	12	0.0190	5	0.000467
2	4	0.001			5	0.000017	1	0.00018	12	0.00050	4	0.001067	5	0.023667	5	0.000667
3	9	0.0012			5	0.0001	1	0.000267	5	0.00052	3	0.015	5	0.024667	4	0.001
4	3	0.0014			4	0.001	1	0.000333	5	0.0006			4	0.025133	12	0.0050
5	5	0.0024			3	0.006	1	0.000443					10	0.03		
6	4	0.002467					1	0.0005					4	0.03		
7	15	0.002667					4	0.0016					3	0.034		
8	5	0.002833					1	0.0019								
9	5	0.002833														
10	12	0.0030														
11	5	0.003267														
Average		0.0022		0.00000640		0.0014		0.0007		0.0005		0.005		0.03		0.002
Std dev		0.0083		0.00000020		0.0061		0.0012		0.0011		0.060		0.24		0.010
H		0.0004		0.00016		0.0003		0.0003		0.0003		0.001		0.00		0.0004
U_1		0.0083		0.00016		0.0061		0.0012		0.0011		0.060		0.24		0.010
t-statistic		2.23		12.71		2.78		2.36		3.18		4.30		2.45		3.18
U_2		0.019		0.0021		0.017		0.0029		0.0035		0.26		0.58		0.032
U_3		0.0056		0.0021		0.0076		0.0010		0.0017		0.15		0.22		0.016
(Informational)		**(0.002)**		**(0.000006)**		**(0.001)**		**(0.0007)**		**(0.0005)**		**(0.005)**		**(0.030)**		**(0.002)**

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 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 it's mean (M_L). The standard deviation (S) is calculated as the square root of the reciprocal of the sum of the weights. U_1 is the combined uncertainty from homogeneity and labs. U_2 is U_1 multiplied by the coverage factor (95 % t-statistic). U_3 is U_2 divided by the square root of the number of determinations (n). Thus:

$$C_L = \sqrt{S_L^2 + U_L^2} \qquad W_L = \frac{1}{C_L^2} \qquad A = \frac{\sum_{i=1}^{n} W_L M_L}{\sum_{i=1}^{n} W_L} \qquad S = \frac{1}{\sqrt{\sum_{i=1}^{n} W_L}} \qquad U_1 = \sqrt{H^2 + S^2} \qquad U_2 = t \times U_1 \qquad U_3 = \frac{U_2}{\sqrt{n}}$$

*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 U_3 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 800A * Code for analytical method Trace analysis listed as mg/kg (ppm)

Analysis	*	Bi	*	Cd	*	Cl	*	Ga	*	Ge	*	Hf	*	K	*	Na	*	Rb	*	Re
1	12	0.01	5	3	12	0.029	12	22	5	12	5	0.14	12	0.24	12	0.19	5	2	12	0.30
2			5	3			5	26	5	13	5	0.26					5	2	5	0.74
3			5	3			5	26	5	13	5	0.35					5	2	5	0.75
4							5	26	12	15									5	0.76
5							5	27												
6							5	28												
7							5	29												

Analysis	*	Se	*	Zn
1	3	0.032	12	1.5
2	5	2	5	10
3			5	13
4			5	13

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		

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

Laboratory	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, Guide 34
Laboratory Testing, Inc.	Hatfield, PA	PRI/Nadcap	17025
NSL Analytical	Cleveland, OH	ACLASS	17025
Dirats Laboratories	Westfield,MA	ACLASS	17025
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	AB 554
Luvak Inc.	Boylston, MA	PRI/Nadcap	17025
Exova	Glendale Heights, Il	A2LA	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Evans Analytical Group	Liverpool, NY	A2LA	17025
Northern Analytical Laboratory, Inc.	Londonderry, NH	PRI/Nadcap	17025

A2LA = American Association for Laboratory Accreditation
ACLASS = ANSI-ASQ National Accreditation Board
CNAS = China National Accreditation Service
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: 13X32100, 23X8005, 23XDS2; 501-320, 501-348, 501-501, 501-502, 501-503, 501-644, 501-674, 501-675, 501-676, 501-991, 501-993, 502-257, 502-414, 502-449, 502-873; AR 644, 645, 654, 660, 662, 670, 673, 875, 888, 892, 960, 1648, 1651, 1653, 1656; BAS 387; BS HH5157A, HH5179A, HH5196A, HH5300A, H3C, 86A, 86C, 86E, 86F, 160A, 181A, 387, 800; ECRM 299-1; IARM 2C, 4C, 16C, 26B, 54B, 56C, 57A, 58A, 58B, 62E, 101D, 101E, 152A, 190A, 866; JK 37; SRM 15G, 33D, 101E, 121B, 335, 339, 349, 864, 865, 866, 867, 1246, 1249, 1263A, 1264A, 3137, 3165; Y 41340B.

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 — 501-676, 502-257, 502-873; BS HH5157A, HH5179A, HH5196A, HH5300A, 86A, 86E, 86F, 181A; ECRM 299-1; SRM 864, 866, 1246; Y 41340B.

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 800A is valid indefinitely. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

Source: The bar stock for this CRM was produced by Electralloy; Oil City, PA.

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 800A-080516. 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. **Phone: (281) 440-9396** **Web: www.brammerstandard.com**
14603 Benfer Road
Houston, Texas 77069-2895 USA **Fax: (281) 440-4432** **Email: contact@brammerstandard.com**

Brammer Standard Company, Inc., is accredited by the American Association For Laboratory Accreditation (A2LA) to ISO Guide 34 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 30:1992 Terms and definitions used in connection with reference materials + 2008 amendment

ISO Guide 31:2000 Reference materials - Contents of certificates and labels

ISO Guide 33:2000 Uses of certified reference materials

ISO Guide 34:2009 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 August 05, 2016.

Beau R. Brammer