

# Brammer Standard Company, Inc.

## Certificate of Analysis

### BS 800B

Certified Reference Material for Incoloy 800 - UNS Number N08800

	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	Certified Values <sup>3</sup>	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>Al</b>	<b>0.362</b>	0.009	<b>Mo</b>	<b>0.121</b>	0.004
<b>As</b>	<b>0.0025</b>	0.0005	<b>N</b>	<b>0.0129</b>	0.0009
<b>B</b>	<b>0.0022</b>	0.0005	<b>Ni</b>	<b>33.5</b>	0.3
<b>C</b>	<b>0.076</b>	0.003	<b>Sb</b>	<b>0.0006</b>	0.0003
<b>Co</b>	<b>0.068</b>	0.003	<b>Si</b>	<b>0.37</b>	0.02
<b>Cr</b>	<b>21.14</b>	0.04	<b>Sn</b>	<b>0.0042</b>	0.0008
<b>Cu</b>	<b>0.247</b>	0.007	<b>Ti</b>	<b>0.56</b>	0.02
<b>Fe</b>	<b>42.6</b>	0.2	<b>V</b>	<b>0.056</b>	0.003
<b>Mg</b>	<b>0.0027</b>	0.0006	<b>W</b>	<b>0.027</b>	0.003
<b>Mn</b>	<b>0.88</b>	0.01	<b>Zr</b>	<b>0.0009</b>	0.0004
	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	Reference Values <sup>3,4</sup>	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>Ca</b>	<b>0.010</b>	0.009	<b>P</b>	<b>0.014</b>	0.002
<b>H</b>	<b>0.0007</b>	0.0005	<b>Pb</b>	<b>&lt;0.001</b>	
<b>Nb</b>	<b>0.023</b>	0.009	<b>S</b>	<b>0.0005</b>	0.0004
<b>O</b>	<b>0.0012</b>	0.0005			

<sup>1</sup> 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.

<sup>2</sup> 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.

<sup>3</sup> Values are given in weight percent. Values in brackets are reported by difference.

<sup>4</sup> Reference values are not certified and are provided for information only.

Trace element information values for Be, Cl, Ga, Ge, Hf, 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.

**BS 800B**

\* Code for method

Certified values listed as weight percent

Analysis	*	Al	*	As	*	B	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	Mg	*	Mn	
1	4	0.3475	3	0.001333	5	0.0015	3	0.071767	12	0.059667	4	21.06863333	3	0.24	16	[42.3667]	11	0.0017333	3	0.861667	
2	4	0.349667	4	0.0020	14	0.0017	1	0.0757	3	0.063967	4	21.08066667	4	0.240333	16	[42.3733]	14	0.0020667	4	0.862333	
3	4	0.352	9	0.0020	4	0.001933	1	0.0733	4	0.065267	3	21.1	4	0.241567	16	[42.5]	4	0.0021333	4	0.87	
4	4	0.356667	3	0.002233	4	0.001967	1	0.074867	5	0.0658	14	21.1	4	0.24175	14	42.5	12	0.0022	10	0.87	
5	3	0.359667	4	0.002233	3	0.0020	11	0.075367	4	0.066333	4	21.10663333	3	0.242333	10	42.5	10	0.0024	4	0.875	
6	10	0.36	9	0.002267	4	0.002033	1	0.0757	4	0.066967	13	21.116	4	0.242667	4	42.5339	4	0.0026333	3	0.877333	
7	3	0.36	5	0.002667	3	0.002033	1	0.076	4	0.067567	4	21.13333333	4	0.244933	4	42.561233	4	0.0030433	4	0.878667	
8	5	0.360333	12	0.002767	4	0.0022	1	0.076267	3	0.068	4	21.13676667	4	0.245333	4	42.623333	5	0.0031333	8	0.88	
9	4	0.363133	15	0.002793	3	0.00225	1	0.076667	4	0.068033	4	21.14213333	10	0.247	10	42.64	3	0.00319	3	0.88	
10	3	0.364333	5	0.002823	4	0.0023	3	0.077	14	0.068167	4	21.145	8	0.25	16	[42.66]	4	0.0032	4	0.880267	
11	4	0.365267	4	0.002933	11	0.0024	1	0.077667	3	0.068267	11	21.15	11	0.25	16	[42.6667]	5	0.0035333	4	0.880333	
12	14	0.367333	11	0.003733	7	0.00256	1	0.078033	8	0.069	13	21.17	4	0.250233	4	42.6725			14	0.881333	
13	11	0.367667			12	0.0026	1	0.0781	4	0.069	4	21.17333333	4	0.2512	4	42.759867			4	0.885333	
14	4	0.370			4	0.002633	3	0.078633	4	0.069267	10	21.18	14	0.253667	3	42.8			4	0.8867	
15	8	0.37			5	0.0027	1	0.078667	10	0.070	3	21.18666667	4	0.254333	16	[42.87]			4	0.88875	
16	4	0.3703					1	0.07915	11	0.070533	10	21.2	3	0.256333	4	42.916667			10	0.893	
17	4	0.3715					1	0.079467	4	0.0716									4	0.895667	
18									4	0.078767										11	0.899667
Average		0.362080		0.002482		0.002193		0.0759		0.068122		21.136823		0.246980		42.621510			0.002661		0.8769
Std Dev		0.000077		0.000091		0.000061		0.0019		0.000075		0.000079		0.000079		0.000079			0.000095		0.0046
H		0.0062		0.00060		0.00058		0.0028		0.0026		0.069		0.0051		0.11			0.00062		0.010
U <sub>1</sub>		0.0062		0.00061		0.00058		0.0034		0.0026		0.069		0.0051		0.11			0.00063		0.011
t-statistic		2.12		2.20		2.14		2.12		2.11		2.13		2.13		2.13			2.23		2.11
U <sub>2</sub>		0.013		0.0013		0.0012		0.0072		0.0056		0.15		0.011		0.23			0.0014		0.023
U <sub>3</sub>		0.0032		0.00039		0.00032		0.0017		0.0013		0.037		0.0027		0.058			0.00042		0.0055
Certified		<b>0.362</b>		<b>0.0025</b>		<b>0.0022</b>		<b>0.076</b>		<b>0.068</b>		<b>21.14</b>		<b>0.247</b>		<b>42.6</b>			<b>0.0027</b>		<b>0.88</b>
Uncertainty		0.009		0.0005		0.0005		0.003		0.003		0.04		0.007		0.2			0.0006		0.01
Tolerance		0.027		0.0015		0.0015		0.009		0.009		0.15		0.021		0.6			0.0018		0.03

Analysis	*	Mo	*	N	*	Ni	*	Sb	*	Si	*	Sn	*	Ti	*	V	*	W	*	Zr	
1	10	0.117	2	0.01165	10	33.1	5	0.0003	3	0.340333	12	0.00276667	4	0.5295	10	0.05	12	0.0186667	3	0.0002	
2	5	0.117667	2	0.0118	7	33.2	9	0.0005	4	0.345667	5	0.00356667	4	0.534	4	0.0526	4	0.02	12	0.000487	
3	4	0.118	2	0.0120	4	33.27143	5	0.000523	4	0.352	3	0.0036	4	0.537333	3	0.0530033	3	0.0241	4	0.0006	
4	4	0.119	2	0.0120	13	33.31333	12	0.000527	3	0.354333	3	0.0039	11	0.537333	4	0.0538667	5	0.0254	5	0.000737	
5	14	0.119	2	0.012667	3	33.39667	5	0.000607	4	0.358667	4	0.0040	4	0.537667	4	0.0539667	4	0.0255333	4	0.0009	
6	4	0.119333	2	0.013	4	33.41667	4	0.000833	6	0.358967	11	0.00413333	4	0.5469	14	0.054	4	0.0257333	5	0.00094	
7	4	0.1195	2	0.013073	4	33.45333	11	0.000867	3	0.36	4	0.00413333	4	0.554367	11	0.0541333	4	0.0264	4	0.001	
8	3	0.12	2	0.013233	3	33.46	9	0.0009	6	0.36	9	0.00443333	4	0.559967	4	0.0548667	4	0.0266	4	0.0010	
9	10	0.12	2	0.013333	4	33.46013			4	0.360133	5	0.00446667	4	0.56	5	0.0549	14	0.0269333	10	0.0011	
10	4	0.120133	2	0.013667	4	33.4618			14	0.361333	9	0.00448667	4	0.561067	3	0.0576	4	0.027	3	0.001633	
11	4	0.121333	2	0.013833	10	33.51			4	0.363333	5	0.00466667	14	0.563333	4	0.0576667	4	0.028	11	0.001667	
12	11	0.121333	2	0.0143	4	33.51			11	0.366	4	0.00483333	3	0.569	4	0.0576667	11	0.0294333			
13	4	0.1219			4	33.54			10	0.367	5	0.00497333	3	0.571	4	0.0585	10	0.030			
14	4	0.122333			4	33.59877			5	0.376667			4	0.582667	3	0.059	3	0.03			
15	4	0.123333			14	33.6			4	0.379667			10	0.59	10	0.059	4	0.0317333			
16	3	0.13			11	33.62667			4	0.380633			10	0.596	4	0.0599667	4	0.0326333			
17					4	33.761			4	0.419333											
Average		0.1206		0.012880		33.4532		0.00063		0.3652		0.00423		0.558133		0.0558		0.026760		0.000931	
Std Dev		0.0026		0.000091		0.0021		0.00011		0.0036		0.00013		0.000079		0.0015		0.000079		0.000024	
H		0.0035		0.0012		0.092		0.00036		0.0062		0.00075		0.0078		0.0024		0.0017		0.00041	
U <sub>1</sub>		0.0044		0.0012		0.093		0.00038		0.0072		0.00076		0.0078		0.0028		0.0017		0.00042	
t-statistic		2.13		2.20		2.12		2.36		2.12		2.18		2.13		2.13		2.13		2.23	
U <sub>2</sub>		0.0093		0.0027		0.20		0.00089		0.015		0.0017		0.017		0.0060		0.0036		0.00093	
U <sub>3</sub>		0.0023		0.00077		0.048		0.00031		0.0037		0.00046		0.0042		0.0015		0.00090		0.00028	
Certified		<b>0.121</b>		<b>0.0129</b>		<b>33.5</b>		<b>0.0006</b>		<b>0.37</b>		<b>0.0042</b>		<b>0.56</b>		<b>0.056</b>		<b>0.027</b>		<b>0.0009</b>	
Uncertainty		0.004		0.0009		0.3		0.0003		0.02		0.0008		0.02		0.003		0.003		0.0004	
Tolerance		0.012		0.0027		0.9		0.0005		0.06		0.0024		0.06		0.009		0.009		0.0008	

Analysis	*	Ca	*	H	*	Nb	*	O	*	P	*	Pb	*	S
1	4	0.000467	2	0.000195	12	0.011333	2	0.00068	4	0.011667	12	0.0000767	1	0.000127
2	4	0.001167	2	0.000211	3	0.014667	2	0.000733	4	0.011767	5	0.0000163	12	0.00013
3	4	0.006767	2	0.0003	4	0.0207	2	0.0008	3	0.012833	9	0.00003	11	0.000145
4	3	0.0135	2	0.00034	4	0.020833	2	0.000933	4	0.012967	9	0.0001	1	0.000203
5	4	0.015033	2	0.000423	14	0.021167	2	0.000975	3	0.013033	4	0.000766667	1	0.000333
6	4	0.015467	2	0.0005	4	0.021333	2	0.001107	12	0.013667	11	0.0008	1	0.000333
7	11	0.0166	2	0.000633	4	0.021667	2	0.00121	7	0.013767	9	0.0009	1	0.0004
8			2	0.003	11	0.021867	2	0.00135	4	0.0138			1	0.000407
9					10	0.022	2	0.0022	4	0.013933			1	0.000543
10					5	0.022833	2	0.0022	10	0.014			1	0.0007
11					4	0.023033			4	0.014167			1	0.001
12					4	0.023333			11	0.014867			3	0.0012
13					4	0.027067			5	0.015067				
14					3	0.0271			4	0.015167				
15					4	0.027767			4	0.0154				
16					4	0.033667								
Average		0.00986		0.00070		0.022523		0.00122		0.013740		0.00037		0.000466
Std Dev		0.00012		0.00011		0.000079		0.00012		0.000082		0.00012		0.000024
H		0.0011		0.00037		0.0016		0.00046		0.0012		0.00030		0.00032
U <sub>1</sub>		0.0011		0.00039		0.0016		0.00047		0.0012		0.00032		0.00032
t-statistic		2.45		2.36		2.13		2.26		2.14		2.45		2.20
U <sub>2</sub>		0.0026		0.00092		0.0033		0.0011		0.0027		0.00079		0.00071
U <sub>3</sub>		0.0010		0.00033		0.00083		0.00034		0.00069		0.00030		0.00021
Reference		<b>0.010</b>		<b>0.0007</b>		<b>0.023</b>		<b>0.0012</b>		<b>0.014</b>		<b>&lt;0.001</b>		<b>0.0005</b>
Uncertainty		0.009		0.0005		0.009		0.0005		0.002				0.0004
Tolerance		0.009		0.0006		0.022		0.0011		0.006				0.0004

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<sub>L</sub>), calculated from its standard deviation (S<sub>L</sub>) and its uncertainty estimate (U<sub>L</sub>), is used as the weight (W<sub>L</sub>) for its mean (M<sub>L</sub>). The standard deviation (S) is calculated as the square root of the reciprocal of the sum of the weights. U<sub>1</sub> is the combined uncertainty from homogeneity and labs. U<sub>2</sub> is U<sub>1</sub> multiplied by the coverage factor (95 % t-statistic). U<sub>3</sub> is U<sub>2</sub> 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 U<sub>3</sub> 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	*	Be	*	Cl	*	Ga	*	Ge	*	Hf	*	Ir	*	Os	*	Pt	*	Re	*	U
1	12	0.006	12	0.01	12	19	12	4.8	12	0.07	12	0.09	12	0.11	12	0.14	12	0.22	12	0.003
2	12	0.009	12	0.01	12	19	12	4.9	12	0.07	12	0.1	12	0.11	12	0.14	12	0.22	12	0.003
3			12	0.02	12	20	12	5.0	12	0.07	12	0.1	12	0.11	12	0.15	12	0.23	12	0.003
Analysis	*	Zn																		
1	12	1.4																		
2	12	1.4																		
3	12	1.4																		

### 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	
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	Hulvaky, Ostrava	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 Private Limited	Hoskote, Bangalore	NABL	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Luvak Inc.	Boylston, MA	PRI	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Element Materials Technology	Huntington beach, CA	A2LA	17025
Luvak Inc.	Boylston, MA	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, 13XNSA8, 14X12144A, 22X754D, 23X80010, 23X80030; AR 115C, 165, 513, 514, 614A, 654, 659, 662, 668, 673, 675, 870, 882, 885, 892, 911A, 920K, 960, 1650, 1651, 1652, 1653; BAS 61, 152/2, 159/3, 345, 351, 387, 408/1, 409; BS H2E, H3B, H8, H230A, 45B, 56H, 73C, 75G, 86A, 86D, 86E, 86F, 179C, 181A, 183C, 187B, 187D, 431, 625D, 718C, 750A, 800, 800A, 825E, 825F, 1045, 2931A, 4820A, 4942A, 6255, 8620E; CKD 167, 168A, 169A, 182A, 185A, 189A; CZ 2025A; DSZU CA013; ECRM 193-1, 299-1; IARM 24B, 54B, 56C, 58A, 58B, 59A, 60B, 62B, 62E, 67B, 189A, 190A; IMZ 51/1, 55/1, 55/1A; IPT 26, 31; JSS GS-1D, 172-7; LECO 501-024, 501-320, 501-504, 501-505, 501-646, 501-676, 502-060, 502-172, 502-195, 502-257, 502-348, 502-414, 502-416, 502-855, 502-863, 502-873, 502-928; NCS NS11043, NS11078; SRM 349, 864, 866, 867, 897, 898, 899, 1246, 1263, 3109A, 3169; Y41340B.

**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 86A, 86D, 86E, 86F, 800; SRM 1246.

**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 800B 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 Next Generation Metals, Inc; Boca Raton, FL.

**Form:** This CRM is machined in the form of a disc, approximately 38mm 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 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 800B-112221. You may obtain information on revisions of certificates from the internet at [www.brammerstandard.com](http://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:

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## **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 17025:2017 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](http://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 22, 2021.

Beau R. Brammer

President