

Brammer Standard Company, Inc.

Certificate of Analysis

BS 431A

Certified Reference Material for Stainless Steel Grade 431 - UNS Number S43100

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³	Certified Value ¹	Estimate of Uncertainty ²
As	0.0033	0.0007	Ni	2.21	0.07
B	0.0002	0.0001	O	0.0067	0.0005
C	0.159	0.008	P	0.019	0.002
Co	0.041	0.003	S	0.0036	0.0008
Cr	15.78	0.08	Sb	0.0012	0.0004
Cu	0.111	0.004	Si	0.31	0.01
Fe	80.5	0.2	Sn	0.0047	0.0009
Mn	0.53	0.02	Ti	0.0010	0.0003
Mo	0.172	0.008	V	0.079	0.003
N	0.058	0.002	W	0.021	0.004
Nb	0.0062	0.0009	Zr	0.0012	0.0004
	Reference Value ¹	Estimate of Uncertainty ²	Reference Values ^{3,4}	Reference Value ¹	Estimate of Uncertainty ²
Al	0.0012	0.0007	Mg	0.0002	0.0001
Ca	0.0003	0.0002	Pb	0.0003	0.0002

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 Ga, Ge, Ir, Os, Re, and Zn are shown on page 4.

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

Analysis	*	As	*	B	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo	*	N
1	3	0.0027	3	0.000085	1	0.145	3	0.037267	3	15.575	3	0.103	4	80.34	10	0.50	4	0.150667	2	0.0557
2	4	0.002733	3	0.00012	1	0.1539325	5	0.038733	10	15.60	3	0.104667	16	[80.4]	4	0.506667	4	0.1595	2	0.0564333
3	5	0.0030	12	0.00012	3	0.155	4	0.039567	3	15.68	5	0.107333	14	80.4	4	0.507667	4	0.166667	2	0.0573333
4	3	0.00305	3	0.0001715	1	0.15666667	10	0.039633	10	15.7	3	0.108	4	80.423867	4	0.513333	4	0.167333	2	0.05734
5	4	0.003067	4	0.0002	1	0.15666667	4	0.039733	17	15.722867	10	0.108333	16	[80.454233]	8	0.516	3	0.169	2	0.0574433
6	4	0.003267	7	0.0002	3	0.157	4	0.040067	4	15.74	4	0.10875	16	[80.46167]	4	0.51975	4	0.170033	2	0.0575333
7	12	0.0033	4	0.0002	1	0.157	3	0.0404	10	15.76	4	0.1092	16	[80.475]	3	0.525	4	0.17041	2	0.0576
8	5	0.003333	4	0.0002	11	0.1575	3	0.0405	4	15.762333	4	0.11	16	[80.48]	4	0.5258	11	0.171	2	0.0578667
9	15	0.003343	11	0.0003	3	0.158	10	0.041	3	15.79	3	0.11	16	[80.5125]	10	0.528	4	0.171233	2	0.058
10	3	0.0034	3	0.00035667	3	0.1585	11	0.0413	4	15.8	3	0.11	16	[80.515]	4	0.528367	4	0.171267	2	0.0581
11	3	0.003475			2	0.1587	3	0.0414	14	15.8	4	0.110133	4	80.516667	3	0.53	4	0.171333	2	0.0582333
12	9	0.0035			1	0.159	4	0.041933	4	15.8012	4	0.110827	16	[80.56033]	8	0.530	3	0.171667	2	0.0583333
13	5	0.00355			1	0.15966667	4	0.041967	4	15.804733	10	0.111	3	80.573333	3	0.53	4	0.172	2	0.0588
14	3	0.00365			1	0.15966667	4	0.042	3	15.81	11	0.111	16	[80.616033]	4	0.5303	3	0.1735	2	0.0590667
15	10	0.0038			1	0.15966667	14	0.042067	4	15.810567	3	0.111	10	80.646667	11	0.531	14	0.173667	2	0.0595
16	4	0.004			1	0.16	8	0.043	3	15.8225	3	0.111	16	[80.655]	4	0.531567	3	0.174	2	0.0596667
17	9	0.004033			1	0.16033333	4	0.043133	13	15.827	4	0.111067	14	0.532	3	0.175	2	0.060175		
18					3	0.1615	3	0.0436	13	15.83	14	0.113333			4	0.533	10	0.175		
19					1	0.16166667	3	0.04475	3	15.83	4	0.114333	10	0.536333	3	0.176				
20					1	0.165	4	0.045333	11	15.84	8	0.115	3	0.537	3	0.176625				
21					1	0.166667			3	15.9	4	0.117	3	0.537	10	0.177333				
22					1	0.1691			4	15.93	4	0.117	3	0.538	5	0.178667				
23					1	0.1701					4	0.119333	4	0.538333	10	0.19				
24											10	0.12	4	0.541667						
25													3	0.546667						
Average		0.00330		0.00020		0.1597		0.041369		15.8006		0.1115		80.501894		0.5281		0.1707		0.0580
Std Dev		0.00012		0.00010		0.0022		0.000071		0.0025		0.0019		0.000079		0.0032		0.0024		0.0014
H		0.00068		0.00024		0.0040		0.0021		0.057		0.0034		0.17		0.0076		0.0042		0.0024
U ₁		0.00069		0.00026		0.0046		0.0021		0.057		0.0039		0.17		0.0082		0.0048		0.0028
t-statistic		2.12		2.26		2.07		2.09		2.08		2.07		2.13		2.06		2.07		2.12
U ₂		0.0015		0.00059		0.0095		0.0043		0.12		0.0080		0.36		0.017		0.010		0.0059
U ₃		0.00035		0.00019		0.0020		0.0010		0.025		0.0016		0.089		0.0034		0.0021		0.0014
Certified		0.0033		0.0002		0.159		0.041		15.78		0.111		80.5		0.53		0.172		0.058
Uncertainty		0.0007		0.0001		0.008		0.003		0.08		0.004		0.2		0.02		0.008		0.002
Tolerance		0.0021		0.0001		0.024		0.009		0.24		0.012		0.6		0.06		0.024		0.006

Analysis	*	Nb	*	Ni	*	O	*	P	*	S	*	Sb	*	Si	*	Sn	*	Ti	*	V
1	3	0.0053	4	2.12625	2	0.00620333	12	0.016333	1	0.0024	9	0.000733	3	0.28825	5	0.0033	12	0.00031	4	0.0690333
2	4	0.005433	4	2.14933333	2	0.0064	4	0.017333	3	0.0024	5	0.0008	4	0.29125	12	0.003467	5	0.000563	10	0.0725
3	5	0.00548	4	2.1517	2	0.0064	5	0.017433	1	0.0027333	5	0.000843	4	0.2969	5	0.003967	5	0.000747	5	0.0758
4	4	0.0056	4	2.16866667	2	0.00648333	3	0.018025	2	0.002825	12	0.00086	10	0.301	3	0.004	4	0.000833	4	0.0776
5	5	0.005733	4	2.183	2	0.0066	4	0.018333	1	0.0029	5	0.000887	3	0.3016667	5	0.004233	3	0.000875	3	0.0778
6	10	0.0058	4	2.2	2	0.00662	3	0.019	1	0.0029467	9	0.0009	3	0.307	10	0.004267	4	0.001	4	0.079
7	5	0.005833	7	2.20	2	0.00663333	4	0.0191	12	0.0029667	11	0.0016	6	0.3088	3	0.0044	3	0.001	11	0.0797
8	14	0.005933	11	2.2	2	0.0067	10	0.019167	10	0.003	4	0.0017	3	0.309	4	0.004433	4	0.001067	14	0.0797667
9	4	0.005933	3	2.2025	2	0.00673333	3	0.0192	1	0.0032667	4	0.002633	4	0.309	9	0.0045	14	0.001167	4	0.0798
10	4	0.005967	3	2.205	2	0.00684	3	0.019433	1	0.0033667	4	0.3098	5	0.004547	3	0.00125	4	0.0798667		
11	3	0.0062	10	2.20666667	2	0.00686667	4	0.019567	11	0.00345	4	0.31	10	0.0046	11	0.0013	10	0.080		
12	4	0.007	4	2.20796667	2	0.00693333	13	0.019833	1	0.00366	10	0.31	4	0.004733	4	0.001333	3	0.08005		
13	4	0.007233	3	2.208	2	0.00723333	4	0.019867	1	0.0036667	3	0.31	3	0.004825	3	0.0014	4	0.0800667		
14	3	0.0074	4	2.21	2	0.00733333	4	0.020	1	0.0036667	14	0.3116667	9	0.004933	4	0.0016	4	0.0803667		
15	3	0.007575	10	2.22			10	0.020	1	0.0037333	4	0.3134933	3	0.004933			3	0.0804		
16			3	2.22333333			13	0.020	1	0.004	11	0.3175	4	0.0050			3	0.0805		
17			4	2.22666667			11	0.0201	3	0.004	3	0.319	3	0.0052			10	0.081		
18			4	2.22966667			4	0.020133	3	0.004	4	0.3193333	3	0.00525			3	0.081		
19			10	2.23			3	0.0206	1	0.0043	6	0.32	3	0.00525			4	0.081		
20			4	2.2313			3	0.02075	1	0.0044	4	0.3203333	11	0.00545			4	0.0818		
21			14	2.0233333			3	0.0219	3	0.00455	4	0.321667	4	0.005667			3	0.082525		
22			8	2.24					1	0.004653	5	0.322					3	0.084		
23			4	2.244					1	0.0047	3	0.324					3	0.082525		
24			3	2.26					1	0.004767							3	0.084		
25			3	2.295																
Average		0.006161		2.2039		0.00667		0.01964		0.003598		0.001184		0.310507		0.00469		0.001032		0.0794
Std Dev		0.000082		0.0040		0.00021		0.00055		0.000065		0.000049		0.000066		0.00015		0.000085		0.0016
H		0.00088		0.017		0.00091		0.0015		0.00070		0.00045		0.0057		0.00078		0.000431		0.0028
U ₁		0.00088		0.017		0.00093		0.0016		0.00071		0.00046		0.0057		0.00080		0.00044		0.0032
t-statistic		2.14		2.06		2.16		2.09		2.07		2.31		2.07		2.09		2.16		2.08
U ₂		0.0019		0.036		0.0020		0.0033		0.0015		0.0012		0.012		0.0017		0.00095		0.0067
U ₃		0.00049		0.0072		0.00054		0.00071		0.00030		0.00035		0.0025		0.00036		0.00025		0.0014
Certified		0.0062		2.21		0.0067		0.019		0.0036		0.0012		0.31		0.0047		0.0010		0.079
Uncertainty		0.0009		0.07		0.0005		0.002		0.0008		0.0004		0.01		0.0009		0.0003		0.003
Tolerance		0.0027		0.21		0.0020		0.006		0.0024		0.0011		0.03		0.0027		0.0009		0.009

BS 431A

* Code for method

Certified values listed as weight percent

Analysis	*	W	*	Zr
1	12	0.015333	12	0.00022
2	3	0.01815	3	0.0008
3	3	0.01825	3	0.00085
4	4	0.018933	4	0.00096667
5	3	0.0192	4	0.00106667
6	4	0.019833	11	0.0011
7	5	0.020067	4	0.00113333
8	3	0.0206	3	0.00115
9	4	0.020667	3	0.00195
10	14	0.0209	4	0.003
11	4	0.021		
12	3	0.021		
13	10	0.0210		
14	5	0.0210		
15	4	0.0212		
16	4	0.021333		
17	4	0.021867		
18	3	0.0241		
19	11	0.02685		
Average		0.020594		0.00122
Std Dev		0.000073		0.00010
H		0.0015		0.00046
U₁		0.0015		0.00047
t-statistic		2.10		2.26
U₂		0.0031		0.0011
U₃		0.00072		0.00034
Certified		0.021		0.0012
Uncertainty		0.004		0.0004
Tolerance		0.012		0.0011

BS 431A

* Code for method

Reference values listed as weight percent

Analysis	*	Al	*	Ca	*	Mg	*	Pb
1	3	0.00035	3	0.0000685	12	0.0000597	9	0.00003
2	5	0.000663	12	0.00016333	3	0.00015	3	0.0001
3	12	0.000883	4	0.0003	3	0.0002	4	0.0003
4	3	0.0009	3	0.0003	4	0.0002	9	0.0004
5	5	0.000943	4	0.0003	4	0.00023333	11	0.0004
6	11	0.001	4	0.0004	4	0.00026667	3	0.0005
7	4	0.001033	3	0.00057	3	0.00028		
8	4	0.001033	3	0.000575	3	0.0003		
9	14	0.0011			4	0.0003		
10	4	0.001267						
11	3	0.0018						
12	3	0.0019						
13	4	0.002333						
Average		0.001212		0.000378		0.0001503		0.00029
Std Dev		0.000037		0.000043		0.0000017		0.00013
H		0.00046		0.00030		0.00022		0.00027
U₁		0.00046		0.00030		0.00022		0.00030
t-statistic		2.18		2.36		2.31		2.57
U₂		0.0010		0.00072		0.00051		0.00078
U₃		0.00028		0.00025		0.00017		0.00032
Reference		0.0012		0.0003		0.0002		0.0003
Uncertainty		0.0007		0.0002		0.0001		0.0002
Tolerance		0.0011		0.0002		0.0001		0.0002

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
Vitkovice Testing Center	Hulvaky, Ostrava	ILAC	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Instituto Metalurgii Zelaza	Gliwice, Poland	PCA	17025
Shiva Analyticals Private Limited	Hoskote, Bangalore	NABL	17025
Luvak Inc.	Boylston, MA	PRI	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Element Materials Technology	Huntington beach, 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: 12XLA10, 12XLA90, 13XNSA8, 23X80010, 23X80030; AR 165, 614A, 644, 646, 659, 662, 668, 675, 870, 872, 882, 885, 890, 892, 920K, 960, 1650, 1652, 1653; BAS 4-88, 4-94, 8-1, 72, 152/2, 159/3, 258-1, 342, 345, 346A, 451/1, 454, 464/1, 472; BS H8, H230A, 13B, 17-4PHC, 56H, 73C, 80F, 88D, 91D, 91E, 91F, 179B, 179C, 183C, 187B, 431, 625D, 800A, 825E, 825F, 2931A, 3310, 4330MOD, 8620E, 9812; CKD 166B, 167, 167B, 168A, 169A; CZ 2025A; ECRM 45-1, 082-1, 179-2, 184-1, 193-1, 327-2; IARM 1A, 2C, 2F, 5B, 12A, 12C, 16A, 59A, 62E, 67B, 189A, 190A; IPT 12A, 17A, 26, 39, 97; JSS 168-7, 172-7, 173-5, 174-5, 175-7, 650-8; LECO 501-024, 501-503, 501-504, 501-505, 501-506, 501-644, 501-646, 501-676, 501-677, 502-195, 502-257, 502-414, 502-416, 502-712, 502-873, 502-916, 502-935; NS NS11022, NS11037, NS11078, NS21006; SRM C2400, 160B, 291, 293, 343A, 345, 361, 363, 878, 897, 898, 899, 1219, 1263, 2171, 2172; Y41129.

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 472; BS 91D, 91E, 91F, 431; JSS 650-8; SRM 1219.

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 431A 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 Universal Stainless, Bridgeville, PA.

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 431A-113021. 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

- 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 30, 2021.

Beau R. Brammer

President