

# Brammer Standard Company, Inc.

## Certificate of Analysis

### BS 422A

Certified Reference Material for Stainless Steel Grade 422 - UNS Number S42200

	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	<b>Certified Values<sup>3</sup></b>	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>Al</b>	<b>0.0063</b>	0.0009	<b>N</b>	<b>0.066</b>	0.002
<b>As</b>	<b>0.0031</b>	0.0005	<b>Ni</b>	<b>0.66</b>	0.03
<b>B</b>	<b>0.0004</b>	0.0002	<b>O</b>	<b>0.0023</b>	0.0005
<b>C</b>	<b>0.206</b>	0.006	<b>P</b>	<b>0.015</b>	0.002
<b>Ca</b>	<b>0.0012</b>	0.0004	<b>S</b>	<b>0.0013</b>	0.0003
<b>Co</b>	<b>0.014</b>	0.003	<b>Sb</b>	<b>0.0008</b>	0.0004
<b>Cr</b>	<b>11.72</b>	0.09	<b>Si</b>	<b>0.349</b>	0.009
<b>Cu</b>	<b>0.040</b>	0.004	<b>Sn</b>	<b>0.0039</b>	0.0008
<b>Fe</b>	<b>84.0</b>	0.2	<b>Ti</b>	<b>0.0017</b>	0.0006
<b>H</b>	<b>0.00010</b>	0.00005	<b>V</b>	<b>0.228</b>	0.009
<b>Mn</b>	<b>0.68</b>	0.03	<b>W</b>	<b>1.04</b>	0.05
<b>Mo</b>	<b>0.96</b>	0.05	<b>Zr</b>	<b>0.0011</b>	0.0004
	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	<b>Reference Values<sup>3,4</sup></b>	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>Nb</b>	<b>0.009</b>	0.002			

<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 4 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 4 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.

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		Ca		Co		Cr		Cu		Fe		H
1	14	0.0054	4	0.0025333	5	0.00019	3	0.198	4	0.0008333	7	0.0113	4	11.539667	8	0.034	3	83.84666667	2	0.000070
2	4	0.0056333	5	0.0026	4	0.0002	1	0.20	4	0.0010	5	0.0114	4	11.593333	10	0.035	10	83.9	2	0.000087
3	5	0.0056333	5	0.00262	5	0.0002	1	0.203	4	0.0011333	4	0.0116667	4	11.659333	3	0.0369	10	83.92666667	2	0.000098
4	4	0.0056667	5	0.0030667	3	0.0003	1	0.2037333	3	0.0012	3	0.0121	4	11.67	3	0.038	16	[83.9364334]	2	0.0001
5	5	0.0059	4	0.0034333	11	0.0003	1	0.2043333	4	0.0012033	5	0.0123667	3	11.67	3	0.038	16	[83.9944]	2	0.0001
6	4	0.0059333	9	0.0035333	4	0.00056667	1	0.206	14	0.0014	4	0.0124667	11	11.68	4	0.0383	14	84	2	0.0006
7	3	0.006	4	0.0035667	4	0.0010	11	0.207	11	0.0015	8	0.013	13	11.681667	5	0.0388	16	[84.01667]		
8	4	0.0060	3	0.0036			1	0.2074			4	0.013	4	11.6998	10	0.039	16	[84.02]		
9	3	0.0063	4	0.0040			1	0.208			4	0.0132333	14	11.7	4	0.03973	16	[84.06]		
10	5	0.00644					3	0.209			4	0.014	10	11.70	4	0.0398	16	[84.08333]		
11	11	0.0067					1	0.2095333			3	0.014	10	11.703333	4	0.040	4	84.11		
12	3	0.007					3	0.21			14	0.0142	3	11.71	7	0.04013	16	[84.12]		
13	4	0.0073					1	0.21			4	0.0144	4	11.7151	3	0.041	16	[84.1933]		
14	4	0.0078667					1	0.2105667			4	0.0144333	3	11.723333	11	0.0414				
15							1	0.2116667			4	0.0150	13	11.75	14	0.04153				
16											3	0.0151	10	11.75	4	0.042				
17											11	0.0167	13	11.750667	4	0.0420				
18											10	0.017	3	11.77	10	0.0422				
19													13	11.786667	4	0.04307				
20													3	11.81	4	0.04347				
21													4	11.896667	4	0.04427				
22													4	11.917	3	0.0448				
Average		0.00627		0.00310		0.00039		0.2057		0.001239		0.0136		11.7151		0.0399		84.014		0.0000928
Std Dev		0.00072		0.00014		0.00030		0.0035		0.00078		0.0017		0.0040		0.0011		0.021		0.0000088
H		0.00089		0.00066		0.00028		0.0046		0.00046		0.0012		0.047		0.0020		0.17		0.00019
U <sub>1</sub>		0.00089		0.00068		0.00028		0.0058		0.00047		0.0012		0.047		0.0023		0.17		0.00019
t-statistic		2.16		2.31		2.45		2.14		2.45		2.11		2.08		2.08		2.18		2.57
U <sub>2</sub>		0.0019		0.0016		0.00068		0.012		0.0011		0.0026		0.10		0.0048		0.38		0.00049
U <sub>3</sub>		0.00051		0.00052		0.00026		0.0032		0.00043		0.00062		21.00		0.0010		0.10		0.00020
Certified		0.0063		0.0031		0.0004		0.206		0.0012		0.014		11.72		0.040		84.0		0.00010
Uncertainty		0.0009		0.0005		0.0002		0.006		0.0004		0.003		0.09		0.004		0.2		0.00005
Tolerance		0.0027		0.0016		0.0003		0.018		0.0011		0.009		0.27		0.012		0.6		0.00009

Analysis		Mn		Mo		N		Ni		O		P		S		Sb		Si		Sn
1	3	0.668	4	0.9116667	3	0.063	10	0.63	2	0.0015	10	0.0111	1	0.0010067	5	0.00041	3	0.334	4	0.0035
2	10	0.67	7	0.92	2	0.06376667	3	0.639	2	0.0019333	5	0.0132	1	0.0010167	5	0.00042	10	0.336333333	3	0.0035
3	4	0.676	4	0.9460667	2	0.0651	3	0.64	2	0.002	4	0.0138	1	0.0010333	5	0.00047	3	0.34	5	0.00353333
4	4	0.6766667	4	0.9499667	2	0.06513333	4	0.6499667	2	0.0022333	3	0.014	1	0.0012	9	0.0007	4	0.340333333	5	0.00363333
5	3	0.678	10	0.95	2	0.06546667	7	0.65	2	0.0022667	4	0.0142	1	0.0012	4	0.0010	3	0.344	4	0.0037
6	4	0.6791	8	0.95	2	0.06573333	4	0.6543333	2	0.0023	4	0.0144	1	0.0012667	3	0.001	11	0.346	5	0.0037
7	10	0.68	3	0.951	2	0.065775	4	0.655	2	0.00262	14	0.0147333	1	0.0013333	4	0.00147	5	0.349333333	4	0.00396667
8	3	0.68	4	0.9533	2	0.066	4	0.6552	2	0.0033	3	0.0148	1	0.0013833			6	0.35	4	0.0040
9	4	0.68	4	0.9546667	2	0.066	4	0.657			4	0.0150	1	0.0014			14	0.35	4	0.0040
10	3	0.6800	14	0.9553333	2	0.06662333	14	0.6573333			10	0.015	11	0.0014			4	0.350033333	9	0.0041
11	14	0.682	4	0.956	2	0.0667	11	0.658	4	0.0150333	1	0.0014667					4	0.350666667	4	0.0045
12	11	0.682	4	0.9563333	2	0.0676	7	0.6593333			4	0.0152333	4	0.0015			4	0.3515	3	0.0047
13	4	0.6826	11	0.958			3	0.66			11	0.0155	3	0.0016			4	0.351666667		
14	4	0.689	3	0.96			10	0.66			4	0.01583	3	0.002			4	0.352666667		
15	8	0.69	10	0.96			4	0.660			3	0.0159333					4	0.353		
16	4	0.691	4	0.9633333			8	0.66			3	0.016					4	0.353		
17	4	0.6943333	10	0.969			4	0.6603667			4	0.0165					3	0.353333333		
18	10	0.6996667	4	0.9696667			4	0.6633333			3	0.0194					4	0.356066667		
19	4	0.7013333	3	0.97			3	0.664									3	0.36		
20	3	0.7063333	3	0.971			10	0.6653333									10	0.36		
21			4	0.979			3	0.67												
22			4	0.9953333			4	0.6843333												
23							4	0.6973333												
Average		0.684		0.957		0.0660		0.659		0.00237		0.0150		0.001349		0.00078		0.3491		0.00392
Std Dev		0.010		0.018		0.0019		0.014		0.00053		0.0017		0.000065		0.00040		0.0071		0.00012
H		0.008749		0.011		0.0026		0.0086		0.00058		0.0013		0.000477		0.00039		0.0061		0.00073
U <sub>1</sub>		0.0087		0.011		0.0032		0.0086		0.00059		0.0013		0.00048		0.00041		0.0061		0.00074
t-statistic		2.09		2.08		2.20		2.07		2.36		2.11		2.16		2.45		2.09		2.20
U <sub>2</sub>		0.018		0.022		0.0071		0.018		0.0014		0.0027		0.0010		0.0010		0.013		0.0016
U <sub>3</sub>		0.0041		0.0047		0.0021		0.0037		0.00050		0.00064		0.00028		0.00038		0.0028		0.00047
Certified		0.68		0.96		0.066		0.66		0.0023		0.015		0.0013		0.0008		0.349		0.0039
Uncertainty		0.03		0.05		0.002		0.03		0.0005		0.002		0.0003		0.0004		0.009		0.0008
Tolerance		0.09		0.15		0.006		0.09		0.0015		0.006		0.0009		0.0007		0.027		0.0024



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.

**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
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Shiva Analyticals Private Limited	Hoskote, Bangalore	NABL	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
Luvak Inc.	Boylston, MA	PRI	17025
Laboratory Testing, Inc.	Hatfield, PA	A2LA	17025
Raghavendra Spectro Metallurgical Laboratory	Karnataka, India	NABL	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
APL, Inc	Milwaukee, WI	A2LA	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: 13X31726A, 13X41600A; AR 555, 644, 645, 659, 662, 668, 673, 675, 867, 868, 869, 870, 884; BAS 261/1, 464/1; BS SS4951, SS4952, 84D, 93F, 97, 98, 151, 179B, 316F, 331, 347C, 410, 410C, 416, 422, 2023, 4932, 4952; 9905A; CKD CZ 2005A; ECRM 195-1, 295-1; IARM 2F, 4F, 16C, 21C, 154B, 205A, 205B, 205D; IMZ 112, 161, 167; IPT 14-6, 23-6, 26; LECO 501-416, 501-503, 501-673, 502-060, 502-298, 502-416, 502-863, 502-881, 502-913, 502-916, 502-986; NCS NS 11043; SRM 13F, 72F, 72G, 73C, 131E, 133B, 139B, 160B, 339, 343A, 361, 363, 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: BS SS 4951, SS4952, 97, 98, 0121P, 0122P, 0331P, 422; IARM 205B; IMZ 161.

**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 422A 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 BHG Edelstahl Freital GmbH; Freital, Germany.

**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 422A-093024. 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:

**Brammer Standard Co., Inc.**  
14603 Benfer Road  
Houston, Texas 77069-2895 USA

**Phone: (281) 440-9396**  
**Fax: (281) 440-4432**

**Web: [www.brammerstandard.com](http://www.brammerstandard.com)**  
**Email: [contact@brammerstandard.com](mailto: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 (our current Certificate Number 656.02 expires 01/31/2025)**

**Brammer Standard Company's Chemical Laboratory is accredited by A2LA to ISO Standard 17025. (Our current Certificate Number 656.01 expires 01/31/2025)**

**By current Certificate Number 10539 expiring 01/01/2027, 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](http://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](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 September 30, 2024.

Beau R. Brammer  
President