Brammer Standard Company, Inc.

Certificate of Analysis

BS 9310

Certified Reference Material for AISI Steel Grade 9310 - UNS Number G93106

Certified Values[3]

	Certified Value[1]	Estimate of Uncertainty[2]		Certified Value[1]	Estimate of Uncertainty[2]
Al	**0.028**	0.002	**N**	**0.0107**	0.0007
As	**0.0048**	0.0004	**Ni**	**3.04**	0.09
C	**0.091**	0.005	**O**	**0.0009**	0.0003
Ca	**0.0002**	0.0001	**P**	**0.010**	0.002
Co	**0.013**	0.002	**S**	**0.0053**	0.0007
Cr	**1.16**	0.06	**Sb**	**0.0019**	0.0004
Cu	**0.146**	0.007	**Si**	**0.224**	0.009
Fe	**94.5**	0.1	**Sn**	**0.0078**	0.0005
H	**0.0002**	0.0001	**Ti**	**0.0011**	0.0004
Mn	**0.638**	0.009	**V**	**0.0035**	0.0009
Mo	**0.093**	0.005	**Zr**	**0.0010**	0.0004

Reference Values[3,4]

	Reference Value[1]	Estimate of Uncertainty[2]		Reference Value[1]	Estimate of Uncertainty[2]
B	**<0.005**		**Pb**	**<0.005**	
Mg	**<0.005**		**W**	**<0.05**	
Nb	**<0.05**		**Zn**	**<0.005**	

[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 Ag, Cl, Ga, Ge, Ir, Li, Na, Os, and Re 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.

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BS 9310 * Code for method Certified values listed as weight percent

Analysis	*	Al	*	As	*	C	*	Ca	*	Co	*	Cr	*	Cu	*	Fe	*	H	*	Mn
1	5	0.0269333	5	0.0043667	1	0.0836667	12	0.000040	3	0.010	3	1.10	4	0.1393333	10	94.44	2	0.000085	4	0.6226667
2	4	0.0270667	15	0.0045733	3	0.0857	10	0.0001	4	0.01003333	4	1.122	4	0.1399667	16	[94.4738]	2	0.0001	3	0.632
3	4	0.0271667	10	0.0046	1	0.0863	3	0.0001	12	0.0110	10	1.14	3	0.14	4	94.4993333	2	0.0001	4	0.6323333
4	3	0.0273667	3	0.0046	1	0.0896667	4	0.0001	4	0.0125	11	1.14	4	0.1400667	14	94.5	2	0.00018667	17	0.634
5	14	0.028	4	0.0046333	11	0.0897	11	0.0001	4	0.0127	3	1.143333	4	0.1406667	16	[94.5]	2	0.0002	4	0.6352
6	3	0.028	4	0.0047667	1	0.0897333	4	0.0001	4	0.0133	4	1.148	4	0.1438667	4	94.5133333	2	0.00020333	11	0.637
7	3	0.028	10	0.0048	1	0.090	4	0.0007333	5	0.01333333	3	1.151	3	0.144	13	94.5183333	2	0.00063333	4	0.6376667
8	4	0.0280333	4	0.0048	1	0.0911333	4	0.0008	5	0.01353333	4	1.1545	3	0.145	16	[94.5307667]			3	0.638
9	4	0.0280333	5	0.0048	1	0.0912333			4	0.01363333	3	1.156667	14	0.1453333	16	[94.531]			4	0.6396
10	4	0.0280667	5	0.0048333	1	0.0912667			14	0.0140	14	1.156667	4	0.1456	16	[94.5314]			4	0.64
11	4	0.0283	4	0.0050	1	0.092			10	0.014	4	1.159	4	0.1456667	3	94.5366667			3	0.64
12	3	0.0283333	3	0.005	1	0.0923333			4	0.014	3	1.16	11	0.146	16	[94.54]			10	0.64
13	4	0.0284333	3	0.005	1	0.0925			3	0.01423333	4	1.16	4	0.147	16	[94.54334]			3	0.6400
14	5	0.0284667	4	0.0051	1	0.0928667			4	0.01426667	4	1.163	3	0.1476667	16	[94.55]			3	0.64
15	3	0.0285	9	0.0051	1	0.093			3	0.0144	4	1.163	5	0.148					4	0.6402
16	11	0.0286			1	0.0938			11	0.0146	3	1.1700	4	0.1487667					4	0.6403333
17	4	0.0292667			1	0.0944667			3	0.01466667	13	1.17	3	0.15					4	0.641
18	3	0.030			12	0.0953333			4	0.0154	4	1.17	10	0.15					4	0.6413
19	4	0.0301			3	0.0992			3	0.016	4	1.17	3	0.15					14	0.644
20					1	0.0993333					10	1.176667	10	0.15					3	0.644
21					3	0.10					10	1.19	10	0.152667					4	0.646767
22											4	1.196	17	0.153					10	0.648
23											4	1.200167	4	0.153333					10	0.65
24											4	1.208667	7	0.156667						
25													4	0.1595						
Average		0.02826		0.00481		0.0912		0.0001001		0.01339		1.1647		0.1460		94.521		0.000165		0.6380
Std Dev		0.00085		0.00016		0.0020		0.0000026		0.00046		0.0042		0.0023		0.028		0.000014		0.0037
H		0.0017		0.00079		0.0030		0.00019		0.0012		0.012		0.0038		0.19		0.00023		0.0084
U_1		0.0019		0.00081		0.0036		0.00019		0.0013		0.013		0.0045		0.19		0.00023		0.0092
t-statistic		2.10		2.14		2.09		2.36		2.10		2.07		2.06		2.16		2.45		2.07
U_2		0.0040		0.0017		0.0076		0.00046		0.0028		0.026		0.0092		0.41		0.00056		0.019
U_3		0.00093		0.00045		0.0017		0.00016		0.00063		0.0053		0.0018		0.11		0.00021		0.0040
Certified		**0.028**		**0.0048**		**0.091**		**0.0002**		**0.013**		**1.16**		**0.146**		**94.5**		**0.0002**		**0.638**
Uncertainty		0.002		0.0004		0.005		0.0001		0.002		0.06		0.007		0.1		0.0001		0.009
Tolerance		0.006		0.0012		0.015		0.0001		0.006		0.18		0.021		0.4		0.0001		0.027

Analysis	*	Mo	*	N	*	Ni	*	O	*	P	*	S	*	Sb	*	Si	*	Sn	*	Ti
1	3	0.0871333	2	0.0095	4	2.953	2	0.00070	12	0.00643333	1	0.0045	12	0.0016	4	0.21316667	12	0.0058	12	0.00044
2	4	0.088	2	0.0100	4	3.009	2	0.0008333	5	0.00733333	1	0.004533	5	0.0016767	10	0.21333333	4	0.0068	5	0.0008233
3	4	0.0897667	2	0.0101667	3	3.01	2	0.0008567	10	0.008	1	0.004733	9	0.0017	11	0.219	5	0.00729667	11	0.0009
4	10	0.0898333	2	0.0103333	4	3.0146667	2	0.0009	4	0.0083	1	0.004767	4	0.0017667	6	0.22	5	0.0075	4	0.0010
5	4	0.0903	2	0.0106667	17	3.0233333	2	0.0009	3	0.0085	1	0.0048	5	0.0018333	3	0.22	3	0.00756667	4	0.00101
6	3	0.0908	2	0.0107	4	3.024	2	0.0010333	4	0.00877	3	0.005	5	0.0019	3	0.22	3	0.0076	4	0.0010667
7	10	0.091	2	0.01072	4	3.0287667	2	0.0010667	6	0.009	1	0.005	4	0.0020	3	0.22	5	0.00773333	4	0.0011
8	3	0.091	2	0.0107333	4	3.0329333	2	0.0011	3	0.009	1	0.005033	11	0.0021	4	0.22003333	5	0.00776667	3	0.0011
9	4	0.0912	2	0.0108667	4	3.0396667	2	0.0011	4	0.0090	1	0.0051	5	0.0021333	7	0.22013333	4	0.00777	3	0.0012
10	4	0.0913333	2	0.0109	7	3.04	2	0.0013667	14	0.009	1	0.005333	3	0.0025	3	0.221	3	0.0078	5	0.00128
11	4	0.0935667	2	0.011	11	3.04	2	0.0014	3	0.009	1	0.0054			3	0.222	9	0.0079	14	0.0015
12	11	0.0936	2	0.0111	4	3.04			11	0.0092	11	0.0054			4	0.22243333	4	0.0080	3	0.0016
13	4	0.0936333	2	0.0111	4	3.0400			4	0.00936667	1	0.0054			3	0.223	4	0.008	4	0.0019
14	7	0.0939667	2	0.0111667	4	3.0424667			3	0.0095	1	0.00550			4	0.22333333	3	0.008		
15	3	0.094			3	3.0433333			4	0.0096	4	0.005667			4	0.2236	3	0.008		
16	3	0.0943333			14	3.0466667			4	0.0096	3	0.0058			5	0.22433333	4	0.00803333		
17	4	0.0945			3	3.0466667			3	0.0103	3	0.0058			14	0.225	4	0.00806667		
18	10	0.095			3	3.05			4	0.0111	1	0.005933			4	0.22566667	10	0.0081		
19	14	0.0950			3	3.05			4	0.01126667	10	0.006			4	0.2262	4	0.00826667		
20	4	0.095			3	3.06			10	0.0126					10	0.23	3	0.009		
21	4	0.095133			10	3.06			3	0.014					4	0.232	3	0.009		
22	3	0.096			10	3.06									7	0.22	10	0.009		
23	5	0.096067			4	3.065667									4	0.235				
24	7	0.101			4	3.0777									4	0.236				
25					10	3.10														
Average		0.0934		0.01072		3.0402		0.000938		0.00961		0.00529		0.001916		0.2235		0.00784		0.00115
Std Dev		0.0018		0.00037		0.0058		0.000075		0.00034		0.00017		0.000080		0.0029		0.00025		0.00037
H		0.0031		0.0011		0.021		0.00042		0.0011		0.00082		0.00055		0.0048		0.0010		0.0004264
U_1		0.0036		0.0012		0.021		0.00042		0.0011		0.00084		0.00055		0.0056		0.0010		0.00043
t-statistic		2.07		2.16		2.06		2.23		2.09		2.10		2.26		2.07		2.09		2.18
U_2		0.0074		0.0025		0.044		0.00094		0.0023		0.0018		0.0012		0.012		0.0021		0.00093
U_3		0.0015		0.00068		0.0088		0.00028		0.00051		0.00041		0.00039		0.0024		0.00046		0.00026
Certified		**0.093**		**0.0107**		**3.04**		**0.0009**		**0.010**		**0.0053**		**0.0019**		**0.224**		**0.0078**		**0.0011**
Uncertainty		0.005		0.0007		0.09		0.0003		0.002		0.0007		0.0004		0.009		0.0005		0.0004
Tolerance		0.015		0.0025		0.27		0.0009		0.006		0.0021		0.0012		0.027		0.0015		0.0010

BS 9310 * Code for method Certified values listed as weight percent

Analysis	*	V	*	Zr
1	5	0.00284	12	0.000041
2	5	0.0030	4	0.0007
3	4	0.003	4	0.0010
4	4	0.0031567	4	0.0010
5	11	0.0032	3	0.0013
6	5	0.0033	11	0.0014
7	3	0.0035	4	0.0018
8	4	0.0035		
9	4	0.0035667		
10	4	0.0037333		
11	4	0.0037333		
12	4	0.0040333		
13	14	0.0040333		
14	3	0.0044333		
Average		0.00348		0.000996
Std Dev		0.00013		0.000034
H		0.00069		0.00067
U_1		0.00070		0.00067
t-statistic		2.16		2.45
U_2		0.0015		0.0016
U_3		0.00041		0.00062
Certified		**0.0035**		**0.0010**
Uncertainty		0.0009		0.0004
Tolerance		0.0027		0.0009

BS 9310 * Code for method Reference values listed as weight percent

Analysis	*	B	*	Mg	*	Nb	*	Pb	*	W	*	Zn
1	12	0.000032	12	0.0001267	12	0.000095	12	0.000054	11	0.0011	12	0.00064
2	3	0.000075	4	0.0005667	5	0.0001633	5	0.000060	12	0.00143333	5	0.000817
3	4	0.0001			4	0.0008333	5	0.00008	5	0.00186667	17	0.000923
4	4	0.0001			11	0.0019	3	0.0003	5	0.00203		
5	11	0.0001			4	0.0022	4	0.0003	5	0.00203333		
6	3	0.0001			3	0.0022	11	0.0004	4	0.00223333		
7	4	0.0001			3	0.0031667	14	0.0005	4	0.00224333		
8	4	0.0002			5	0.0032			3	0.0031		
9					4	0.0052333			4	0.0040		
10									4	0.00416667		
11									3	0.00416667		
Average		0.0001000		0.00053		0.00211		0.000137		0.00324		0.00085
Std Dev		0.0000013		0.00029		0.00040		0.000017		0.00012		0.00024
H		0.00019		0.00034		0.00057		0.00021		0.00067		0.00067
U_1		0.00019		0.00044		0.00069		0.00021		0.00068		0.00071
t-statistic		2.36		12.71		2.31		2.45		2.23		4.302653
U_2		0.00046		0.0056		0.0016		0.00053		0.0015		0.0031
U_3		0.00016		0.0040		0.00053		0.00020		0.00046		0.0018
Reference		**<0.005**		**<0.005**		**<0.05**		**<0.005**		**<0.05**		**<0.005**
Uncertainty												
Tolerance												

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. 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 9310 * Code for analytical method Trace analysis listed as mg/kg (ppm)

Analysis	*	Ag	*	Cl	*	Ga	*	Ge	*	Ir	*	Li	*	Na	*	Os	*	Re
1	12	0.57	12	0.02	12	8.4	12	8.3	12	0.01	12	0.01	12	0.01	12	0.01	12	0.1
2	12	0.58			12	8.6	12	8.7	12	0.01			12	0.02	12	0.01	12	0.12
3	1	0.64			12	9.1	12	9.3	12	0.01					12	0.01	12	0.12

Analytical Method Codes:

1 Combustion (ASTM E1019)
2 Fusion (ASTM E1019)
3 Spark Atomic Emission
4 ICP Atomic Emission
5 ICP Mass Spectrometry
6 Gravimetric
7 Photometric
8 Flame Atomic Absorption
9 GF Atomic Absorption
10 X-Ray Fluorescence
11 GD Atomic Emission
12 GD Mass Spectrometry
13 Titrimetric
14 DCP Atomic Emission
15 HG Atomic Fluorescence
16 Difference
17 AAS

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

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: 12X353E, 12X357B; AR 612B, 614A, 641, 644, 657, 660, 667, 668, 673, 675, 870, 882, 890, 947, 960, 1650, 1651, 4340; BAM 184-1; BAS 56, 254/1, 409, 409/1, 458/1, 460, 464/1; BS D6A, HON U, LF2B, 56H, 58C, 58D, 58E, 61G, 74C, 293A, 2931, 3310, 3941, 4130, 4140C, 4330MOD, 4330V, 4340A, 4820A, 4820B, 5620F, 8620E, 9325B; CKD 181A, 186A, 249C; DSZU CA037; ECRM 85-1, 86-1, 87-1, 096-1; IARM 20A, 30C, 156A, 156C, 9310; IMZ 111, 175; IPT 5/2, 36; JSS GS-1D, 168-7; LECO 501-502, 501-506, 502-503, 502-868, 502-913, 502-928, 502-963, 520-990, 503-514; NCS NS 21006; SRM 16E, 111B, 160B, 178, 361, 362, 363; Y TSN 013; YSBC 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: AR 4340; BS 58C, 58D, 58E, 4330MOD, 4330V; IRSID 1728; USS FF; VS K6.

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 9310 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 Timken Steel; Canton, OH.

Form: This CRM is machined in the form of a disc, approximately 41mm 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 9310-042524. 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:

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14603 Benfer Road
Houston, Texas 77069-2895 USA

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

Web: www.brammerstandard.com
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 (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

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 April 25, 2024.

Beau R. Brammer

President