

Brammer Standard Company, Inc.

Certificate of Analysis

BS 1762A

Certified Reference Material for Low Alloy Steel

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³	Certified Value ¹	Estimate of Uncertainty ²
Al	0.064	0.003	Nb	0.102	0.005
As	0.029	0.003	Ni	1.194	0.009
B	0.005	0.001	O	0.0052	0.0008
C	0.368	0.008	P	0.047	0.005
Co	0.070	0.001	S	0.044	0.004
Cr	0.903	0.008	Si	0.453	0.009
Cu	0.158	0.008	Sn	0.080	0.006
Fe	93.7	0.2	Ta	0.035	0.003
H	0.00015	0.00008	Ti	0.114	0.009
Mn	2.08	0.06	V	0.219	0.007
Mo	0.370	0.009	Zr	0.031	0.003
N	0.0140	0.0009			
	Reference Value ¹	Estimate of Uncertainty ²	Reference Values ^{3,4}	Reference Value ¹	Estimate of Uncertainty ²
Pb	<0.05		W	0.022	0.009
Sb	0.020	0.009			

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, Ba, Bi, Ca, Ga, Ge, Hf, Mg, Re, Te, Th, U, and Zn are shown on page 4.

The requirements of ISO Guides 30, and Standards 33401 and 33405 were followed for the preparation of this Certified Reference Material and certificate of analysis.

Analysis	*	Al	*	As	*	B	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	H	*	Mn
1	5	0.057967	5	0.0249333	5	0.0033	1	0.3575	10	0.067	3	0.89	4	0.150333	16	[93.256333]	2	0.000071	4	2.022333
2	4	0.060933	4	0.026	3	0.004	1	0.358	4	0.068	11	0.895	5	0.150333	16	[93.51667]	2	0.000073	4	2.029
3	4	0.061333	10	0.027	12	0.0044	1	0.360167	10	0.0688	4	0.895333	10	0.154	10	93.54666667	2	0.0001	4	2.042667
4	4	0.061967	12	0.0276667	14	0.004767	11	0.363	3	0.069	3	0.895667	4	0.154	16	[93.56]	2	0.000112	4	2.059
5	3	0.063	5	0.0285333	4	0.0057	1	0.363333	12	0.069	10	0.90	4	0.154	16	[93.56333]	2	0.0001425	8	2.07
6	11	0.0633	5	0.0287333	11	0.0058	1	0.364533	5	0.0693333	3	0.90	3	0.155	16	[93.5813667]	2	0.00017333	10	2.07
7	3	0.063667	4	0.0291	5	0.005867	1	0.365	4	0.0696333	4	0.90	11	0.155	4	93.58333333	2	0.00018	10	2.07
8	4	0.064033	5	0.0293	3	0.0059	1	0.366	4	0.0700	10	0.9000	4	0.158267	16	[93.5900]	2	0.00018667	4	2.076667
9	4	0.064067	9	0.0296	4	0.0062	1	0.3661	3	0.07	4	0.901067	4	0.159333	14	93.6	2	0.00019333	3	2.08
10	3	0.0641	3	0.0298	5	0.006273	1	0.367433	3	0.0701	3	0.903333	10	0.16	3	93.65	2	0.00027333	3	2.08
11	3	0.064233	4	0.0298	4	0.0063	1	0.37	4	0.0701	14	0.903333	3	0.16	16	[93.6975]			3	2.08
12	4	0.064333	3	0.0298667	3	0.006933	1	0.370	3	0.0703333	4	0.904	3	0.16	16	[93.76]			3	2.086667
13	14	0.064433	10	0.030			3	0.37	4	0.0703333	3	0.904667	8	0.16	16	[93.760667]			4	2.088067
14	3	0.0649	4	0.03			1	0.3700	14	0.0705	3	0.905	4	0.160	16	[93.82]			3	2.09
15	3	0.065	4	0.0301667			3	0.373	3	0.0709	3	0.906	4	0.1600	4	94.34333333			11	2.09
16	4	0.0668	3	0.0304			1	0.374667	8	0.071	4	0.908	3	0.161					4	2.0900
17	12	0.068	3	0.032			3	0.375	4	0.0711667	10	0.909	14	0.162					14	2.096667
18	4	0.0784					3	0.38	3	0.0712667	8	0.91	3	0.164					3	2.1
19							1	0.391667	4	0.0722667	13	0.91	3	0.164667					3	2.1
20									4	0.0728667	13	0.910667	3	0.165					7	2.107
21																			10	2.113333
Average		0.0636		0.02910		0.00547		0.3683		0.0702		0.9026		0.1583		93.664		0.000151		2.078
Std Dev		0.0014		0.00085		0.00019		0.0032		0.0016		0.0057		0.0044		0.028		0.000063		0.024
H		0.0025		0.0018		0.00084		0.0062		0.0027		0.010		0.0040		0.19		0.00022		0.016
U ₁		0.0029		0.0019		0.00086		0.0070		0.0031		0.010		0.0040		0.19		0.00024		0.016
t-statistic		2.11		2.12		2.20		2.10		2.09		2.09		2.09		2.14		2.26		2.09
U ₂		0.0062		0.0041		0.0019		0.015		0.0065		0.021		0.0084		0.40		0.00055		0.034
U ₃		0.0015		0.0010		0.00054		0.0034		0.0014		0.0048		0.0019		0.10		0.00017		0.0075
Certified		0.064		0.029		0.005		0.368		0.070		0.903		0.158		93.7		0.00015		2.08
Uncertainty		0.003		0.003		0.001		0.008		0.001		0.008		0.008		0.2		0.00008		0.06
Tolerance		0.009		0.009		0.003		0.024		0.006		0.024		0.024		0.6		0.00014		0.18

Analysis	*	Mo	*	N	*	Nb	*	Ni	*	O	*	P	*	S	*	Si	*	Sn	*	Ta
1	3	0.36	2	0.0130	10	0.095	14	1.173333	2	0.0046333	10	0.042033	1	0.03938	3	0.437	3	0.07	12	0.032
2	4	0.361667	2	0.0131333	4	0.095933	3	1.183333	2	0.0047	10	0.043	3	0.040	4	0.439	5	0.07533333	4	0.0324
3	4	0.362	2	0.0134333	5	0.096667	4	1.186667	2	0.0048333	4	0.0447	3	0.0405	3	0.44233333	12	0.076	14	0.0337
4	4	0.362333	2	0.0138667	4	0.099133	4	1.187333	2	0.00495	13	0.045	1	0.041467	3	0.444	10	0.079	4	0.034033
5	10	0.365	2	0.0139	3	0.10	4	1.189333	2	0.0050333	4	0.0455	1	0.04147	14	0.445666667	3	0.079	3	0.034367
6	3	0.365	2	0.0139667	4	0.1	3	1.19	2	0.0052	11	0.0455	12	0.042	4	0.4493	4	0.07983333	3	0.0345
7	4	0.365	2	0.014	10	0.100233	7	1.19	2	0.0052	10	0.046	1	0.042033	3	0.45	3	0.0800	5	0.0347
8	4	0.367267	2	0.0141	4	0.100667	3	1.19	2	0.0052667	4	0.0461	11	0.0421	4	0.4500	9	0.08	4	0.035167
9	3	0.367667	2	0.0141	4	0.100667	10	1.19	2	0.0060	3	0.0463	1	0.042167	3	0.45	4	0.0800	4	0.035667
10	3	0.368	2	0.0141667	3	0.101	10	1.19	2	0.0061	12	0.046333	1	0.043067	3	0.45133333	3	0.0802	4	0.0361
11	3	0.368	2	0.014175	4	0.102	4	1.1900	3	0.0464	1	0.0464	1	0.043333	10	0.45133333	10	0.08033333	4	0.036267
12	11	0.369	2	0.0142333	4	0.102333	3	1.193333	14	0.046467	1	0.046467	1	0.043333	7	0.45233333	4	0.08053333	4	0.0364
13	4	0.369967			14	0.102667	3	1.196667	3	0.046667	3	0.046667	1	0.0438	4	0.459	4	0.08053333	4	0.0396
14	3	0.37			3	0.103	4	1.197	3	0.047	1	0.047	1	0.044	4	0.459666667	3	0.08066667	10	0.0400
15	10	0.37			3	0.103	4	1.201	4	0.0470	1	0.044067	10	0.46	3	0.0808				
16	4	0.3700			3	0.104667	4	1.201433	3	0.047733	3	0.047733	3	0.0464	3	0.46	4	0.08143333		
17	4	0.371333			10	0.11	10	1.203333	4	0.047733	3	0.046533	6	0.46	4	0.083				
18	14	0.372333			4	0.111333	4	1.205667	3	0.048	10	0.047	10	0.46	5	0.0861				
19	10	0.380333					4	1.207	4	0.0488	1	0.0473	4	0.4606						
20	4	0.381333					11	1.21	4	0.0494	1	0.048	4	0.46133333						
21	7	0.39							4	0.050333			11	0.463						
22									3	0.0517										
Average		0.3699		0.01401		0.1017		1.193772		0.00519		0.0470		0.0438		0.4527		0.0799		0.0346
Std Dev		0.0035		0.00049		0.0024		0.000071		0.00010		0.0011		0.0011		0.0079		0.0019		0.0012
H		0.0063		0.0013		0.0032		0.012		0.00082		0.0022		0.0021		0.0070		0.0028		0.0019
U ₁		0.0072		0.0013		0.0040		0.012		0.00082		0.0025		0.0024		0.0070		0.0034		0.0022
t-statistic		2.09		2.20		2.11		2.09		2.26		2.08		2.09		2.09		2.11		2.16
U ₂		0.015		0.0030		0.0084		0.025		0.0019		0.0051		0.0050		0.015		0.0072		0.0048
U ₃		0.0033		0.00086		0.0020		0.0056		0.00059		0.0011		0.0011		0.0032		0.0017		0.0013
Certified		0.370		0.0140		0.102		1.194		0.0052		0.047		0.044		0.453		0.080		0.035
Uncertainty		0.009		0.0009		0.005		0.009		0.0008		0.005		0.004		0.009		0.006		0.003
Tolerance		0.027		0.0030		0.015		0.027		0.0027		0.015		0.012		0.027		0.018		0.009

BS 1762A

* Code for method

Certified values listed as weight percent

Analysis	*	Ti	*	V	*	Zr
1	10	0.104333	4	0.209	4	0.027333
2	5	0.106	3	0.21	5	0.027367
3	11	0.107	4	0.212	4	0.029067
4	10	0.11	10	0.215	12	0.029333
5	4	0.110	3	0.215	4	0.0297
6	4	0.110	11	0.215	3	0.029867
7	3	0.11	3	0.216	11	0.0299
8	3	0.112333	10	0.2196667	10	0.030
9	4	0.113867	4	0.2199667	4	0.030833
10	3	0.115	8	0.22	3	0.031
11	4	0.115	4	0.220	3	0.031
12	4	0.115	3	0.22	10	0.031667
13	3	0.115333	3	0.22	3	0.031933
14	4	0.116	4	0.221	5	0.0324
15	3	0.117	14	0.221	10	0.0326
16	4	0.1172	3	0.222	4	0.033033
17	10	0.12	4	0.2223333	3	0.034
18	3	0.1200	4	0.2234333	14	0.0343
19	14	0.12	4	0.2243333	4	0.0351
20	4	0.120	3	0.225	3	0.0353
21	3	0.122				
Average		0.1141		0.218537		0.0313
Std Dev		0.0050		0.000071		0.0023
H		0.0034		0.0047		0.0015
U ₁		0.0034		0.0047		0.0015
t-statistic		2.09		2.09		2.09
U ₂		0.0071		0.010		0.0032
U ₃		0.0015		0.0022		0.00072
Certified		0.114		0.219		0.031
Uncertainty		0.009		0.007		0.003
Tolerance		0.027		0.021		0.009

BS 1762A

* Code for method

Reference values listed as weight percent

Analysis	*	Pb	*	Sb	*	W
1	12	0.0084	3	0.0124333	12	0.011
2	3	0.011333	3	0.0127	4	0.012
3			9	0.0137	3	0.0128
4			5	0.0167667	5	0.0164
5			12	0.022	4	0.017967
6			5	0.0237	4	0.018633
7			5	0.0237667	4	0.019367
8			4	0.0240	5	0.0209
9			5	0.0292	3	0.021767
10					4	0.0225
11					3	0.028767
12					3	0.0289
13					4	0.031267
14					4	0.0320
15					14	0.0321
Average		0.00987		0.0196		0.0218
Std Dev		0.00069		0.0011		0.0073
H		0.0011		0.0015		0.0015
U ₁		0.0013		0.0018		0.0015
t-statistic		12.71		2.31		2.14
U ₂		0.016		0.0042		0.0033
U ₃		0.011		0.0014		0.00085
Reference		<0.05		0.020		0.022
Uncertainty				0.009		0.009
Tolerance				0.019		0.021

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

For each element, in accordance with the requirements of ISO 17034 and Standard 33405, 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. U₁ is the combined uncertainty from homogeneity and labs. U₂ is U₁ multiplied by the coverage factor (95 % t-statistic). U₃ is U₂ 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 U₃ 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 Standard 33405:2024 section 10.

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* Code for analytical method

Trace analysis listed as mg/kg (ppm)

Analysis	*	Ag	*	Ba	*	Bi	*	Ca	*	Ga	*	Ge	*	Hf	*	Mg	*	Re	*	Te
1	12	1.1	12	0.07	12	120	12	22	12	7.7	12	6.3	12	2.1	12	0.64	12	0.12	12	0.08
2	12	1.3	12	0.10	12	120	12	28	12	7.8	12	6.5	12	2.5	12	0.70	12	0.14	12	0.08
3	12	1.3	12	0.15	12	130	12	28	12	8.4	12	6.8	12	2.7	12	0.77	12	0.14	12	0.08
Analysis	*	Th	*	U	*	Zn														
1	12	0.02	12	0.06	12	130														
2	12	0.03	12	0.07	12	130														
3	12	0.04	12	0.09	12	130														

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
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Eurofins EAG Materials Science, LLC	Liverpool, NY	A2LA	17025
Vitkovice Testing Center	Hulvaky, Ostrava	Czech Accreditation Institute	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Luvak Inc.	Boylston, MA	PRI	17025
APL, Inc	Milwaukee, WI	A2LA	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
Laboratory Testing, Inc.	Hatfield, PA	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 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: AR 319, 555, 637, 645, 647, 657, 659, 668, 670, 673, 675, 867, 870, 871, 873, 878, 881, 892, 895, 896, 1650, 1651, 1652; BAS 4/88, 214, 224, 251/1, 255/1, 329, 403/1, 409, 410, 410/2, 455/1, 464/1; BS LF2B, XCCS, 40B, 43A, 55H, 300A, 1018A, 1026A, 1762, 1763, 2023, 2931, 3310, 4130, 4142SE, 8620F; CKD CZ 2005A; 166, 171, 181A, 181B; ECRM 085-1, 086-1, 087-1, 184-1; IARM 31C, 152B; IMZ 74B, 112; IPT 7-1, 15-6, 43; KMS LCSON-001E; LECO 501-503, 502-060, 502-719, 502-856, 502-863, 502-903, 502-916; NCS NS 20035B, 21006; SPL 301A, 306A, 307A, 2004A, 2005A; SRM 9C, 50A, 72F, 160B, 178, 361, 362, 363, 364, 1162, 167, 1271, 1762, 1762A, 1763, 1767.

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 403/1, 455/1; BS 40B, 1763; CKD 181A; SRM 1162, 1167, 1762, 1762A, 1763.

Validity statement: ISO Standard 33401 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 1762A 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 cast stock for this CRM was produced by SPL-LABMAT s.r.o; Bohumin, CZ.

Form: This CRM is machined in the form of a disc, approximately 36mm in diameter and 25mm 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 Standard 33403 for information about the use of Certified Reference Materials.

Certified Area: The certified area of each disc is the portion extending upward 10 mm from the larger diameter surface.

Note: Shrinkage cavities may appear in the top portion of some discs. These cavities are normal and will not affect the certified portion of the disc.

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 1762A-073025. 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 17034:2016 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials (our current Certificate Number 656.02 expires 01/31/2027)

Brammer Standard Company's Chemical Laboratory is accredited by A2LA to ISO Standard 17025:2017. (Our current Certificate Number 656.01 expires 01/31/2027)

By current Certificate Number 10539 expiring 01/01/2027, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9001:2015 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 Standard 33401:2024 Reference materials - Contents of certificates, labels, and accompanying documentation

ISO Standard 33403:2024 Reference materials – Requirements and recommendations or use

ISO Standard 17034:2016 General requirements for the competence of reference material producers

ISO Standard 33405:2024 Reference Materials – Approaches for characterization and assessment of homogeneity and stability

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 July 28, 2025.

Beau R. Brammer
President