

Brammer Standard Company, Inc.

Preliminary Certificate of Analysis

Final Version expected by August 13, 2022

BS 8740

Certified Reference Material for Low Alloy Steel Grade 8740 - UNS Number G87400

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³	Certified Value ¹	Estimate of Uncertainty ²
Al	0.038	0.002	N	0.0074	0.0008
As	0.0051	0.0007	Ni	0.54	0.01
C	0.39	0.01	S	0.023	0.002
Co	0.0088	0.0008	Sb	0.0020	0.0002
Cr	0.49	0.01	Si	0.26	0.02
Cu	0.16	0.01	Sn	0.0081	0.0008
Fe	97.0	0.1	Ti	0.0011	0.0004
Mn	0.86	0.01	V	0.0019	0.0004
Mo	0.26	0.01	W	0.0026	0.0004

Informational Values^{3,4}

B (0.0003)	Ca (0.0004)	Mg (0.0002)	Nb (0.0001)	O (0.0011)
P (0.012)	Pb (0.0005)	Ta (0.003)	Zr (0.002)	

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.

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 3 for more information on its calculation.

³ Values are given in weight percent. Values in brackets are reported by difference.

⁴ Values in parentheses are not certified and are provided for information only.

Trace element information values for Bi, Cl, Ga, Ge, K, Na, Re, Sr, 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.

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Analysis	*	Al	*	As	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo	*	N
1	12	0.0230	12	0.004467	3	0.376	12	0.0071	4	0.473333	4	0.15	16	[96.86333]	4	0.84	10	0.257	2	0.0069
2	4	0.031	12	0.0048	1	0.377333	12	0.0072	4	0.476	4	0.15	16	[96.86333]	4	0.84	4	0.26	2	0.0073
3	4	0.031	5	0.004833	3	0.37875	5	0.0076	4	0.48	10	0.156333	4	96.90667	10	0.844	4	0.26	2	0.0073
4	3	0.036233	5	0.004867	1	0.3789	3	0.0082	4	0.48	3	0.157	16	[96.91]	4	0.850667	10	0.260	2	0.007367
5	4	0.036667	5	0.004933	1	0.388333	5	0.008367	10	0.484667	4	0.157333	3	96.91333	10	0.851	4	0.261467	2	0.007433
6	11	0.0367	3	0.0051	1	0.389333	5	0.0086	10	0.487	10	0.157333	4	96.91667	3	0.851667	3	0.262333	2	0.007513
7	3	0.0373	11	0.0051	11	0.391	5	0.008667	3	0.491	4	0.158	3	96.91667	3	0.852	3	0.262667	2	0.007567
8	5	0.037633	5	0.0051	1	0.391333	4	0.008933	4	0.493333	3	0.159333	16	[96.918]	4	0.852333	11	0.266	2	0.007597
9	4	0.037667	4	0.005533	11	0.392375	3	0.0094	3	0.494	11	0.16	16	[96.95]	3	0.854	4	0.266667	2	0.00768
10	3	0.037667			1	0.393667	3	0.009433	11	0.495	5	0.16	10	96.99667	11	0.859	4	0.268		
11	4	0.038			1	0.395667	11	0.0095	4	0.495333	5	0.16	10	97.01	4	0.861567	3	0.271		
12	5	0.039733			1	0.396333			3	0.495667	4	0.160397	4	97.4	4	0.873333	5	0.289333		
13					1	0.40			4	0.496233	3	0.160667	4	97.4	4	0.875333	5	0.291667		
14					1	0.407667														
15					1	0.41														
16					1	0.421														
Average		0.0378		0.00509		0.3876		0.00880		0.4937		0.1592		96.997		0.8576		0.2664		0.00736
Std Dev		0.0017		0.00029		0.0042		0.00047		0.0067		0.0049		0.027		0.0068		0.0064		0.00037
H		0.0020		0.00081		0.0064		0.00102		0.0073		0.0040		0.19		0.0099		0.0053		0.00095
U ₁		0.0026		0.00086		0.0077		0.0011		0.0099		0.0083		0.19		0.012		0.0083		0.0010
t-statistic		2.20		2.31		2.13		2.23		2.18		2.18		2.18		2.18		2.18		2.31
U ₂		0.0057		0.0020		0.0160		0.0025		0.022		0.014		0.42		0.026		0.018		0.0023
U ₃		0.0016		0.00066		0.0041		0.00076		0.0060		0.0038		0.12		0.0073		0.0050		0.00078
Certified		0.038		0.0051		0.39		0.0088		0.49		0.16		97.0		0.86		0.26		0.0074
Uncertainty		0.002		0.0007		0.01		0.0008		0.01		0.01		0.1		0.01		0.01		0.0008
Tolerance		0.006		0.0021		0.03		0.0025		0.03		0.03		0.4		0.03		0.03		0.0023

Analysis	*	Ni	*	S	*	Sb	*	Si	*	Sn	*	Ti	*	V	*	W
1	3	0.522	1	0.0190	5	0.001733	10	0.233	12	0.006933	12	0.000667	12	0.0014	3	0.0019
2	3	0.537	1	0.0200	12	0.0018	10	0.235667	5	0.0074	12	0.00074	12	0.0015	12	0.002233
3	3	0.538667	1	0.021533	12	0.0019	3	0.246667	5	0.0076	3	0.0011	5	0.001733	12	0.0023
4	4	0.544	1	0.021733	5	0.0019	3	0.247667	3	0.0077	11	0.0011	3	0.0019	4	0.0025
5	4	0.545333	3	0.0219	5	0.002	4	0.248	5	0.0078	5	0.0011	5	0.002	5	0.002567
6	10	0.546	1	0.0219	5	0.002	4	0.249333	5	0.0079	5	0.0011	5	0.002067	5	0.002567
7	10	0.547667	1	0.022333			11	0.252	4	0.007967	5	0.001133	4	0.0022	4	0.002567
8	4	0.55	1	0.022333			4	0.257817	4	0.008033	5	0.001133	5	0.002467		
9	11	0.551	11	0.0224			3	0.259	11	0.0089			11	0.0027		
10	4	0.553	1	0.023267			4	0.26								
11	4	0.559167	1	0.023533			4	0.26								
12	4	0.56	1	0.023667			5	0.269333								
13	4	0.567667	1	0.024033			5	0.274667								
14			1	0.0246												
Average		0.5443		0.02302		0.00200		0.2569		0.00815		0.00111		0.001861		0.002561
Std Dev		0.0068		0.00077		0.00021		0.0059		0.00047		0.00011		0.000083		0.000097
H		0.0077		0.0016		0.00056		0.0052		0.00099		0.00044		0.00054		0.000613
U ₁		0.010		0.0018		0.00059		0.0078		0.0011		0.00046		0.00055		0.00062
t-statistic		2.18		2.16		2.57		2.18		2.31		2.36		2.31		2.45
U ₂		0.022		0.0038		0.0015		0.017		0.0025		0.0011		0.0013		0.0015
U ₃		0.0062		0.0010		0.00062		0.0047		0.00084		0.00038		0.00042		0.00057
Certified		0.54		0.023		0.0020		0.26		0.0081		0.0011		0.0019		0.0026
Uncertainty		0.01		0.002		0.0002		0.02		0.0008		0.0004		0.0004		0.0004
Tolerance		0.03		0.006		0.0006		0.06		0.0025		0.0010		0.0013		0.0012

Analysis	*	B	*	Ca	*	Mg	*	Nb	*	O	*	P	*	Pb	*	Ta	*	Zr
1	12	0.00026	12	0.000067	12	0.000095	12	0.000080	2	0.000433	12	0.008333	12	0.0000117	3	0.0033	12	0.0000427
2	3	0.0003	12	0.000077	12	0.0000967	12	0.000087	2	0.000533	12	0.008867	12	0.0000127			12	0.0000467
3	5	0.0003	3	0.0002	5	0.0001333	5	0.00009	2	0.00054	5	0.010633	11	0.0007			3	0.0014
4	5	0.0003	11	0.0002	3	0.0002	5	0.0001	2	0.0006	5	0.010667					11	0.0018
5	12	0.00091	4	0.0007	5	0.0002667	5	0.0001	2	0.000667	4	0.0114						
6			4	0.0011			5	0.000107	2	0.0010	4	0.011433						
7							3	0.0007	2	0.0010	11	0.0115						
8							11	0.0009	2	0.00209	10	0.0121						
9									2	0.002353	10	0.012367						
10											4	0.012433						
11											3	0.0137						
											3	0.013733						
											3	0.0178						
Average		0.003000		0.000438		0.000174		0.000113		0.00107		0.01300		0.00049		0.00330		0.00169
Std Dev		0.000032		0.000055		0.000014		0.000011		0.00013		0.00065		0.00017		0.00080		0.00035
H		0.00028		0.00032		0.00023		0.00020		0.00044		0.0012		0.00033		0.00068		0.00052
U ₁		0.00028		0.00032		0.00023		0.00020		0.00046		0.0014		0.00037		0.0010		0.00062
t-statistic		2.78		2.57		2.78		2.36		2.31		2.18		4.30		12.71		3.18
U ₂		0.00078		0.00082		0.00064		0.00048		0.0011		0.0030		0.0016		0.013		0.0020
U ₃		0.00035		0.00034		0.00029		0.00017		0.00035		0.00083		0.00092		0.013		0.00099
Informational		(0.0003)		(0.0004)		(0.0002)		(0.0001)		(0.0011)		(0.012)		(0.0005)		(0.003)		(0.002)

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. 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 Guide 35:2006 section 6.

Analysis	*	Bi	*	Cl	*	Ga	*	Ge	*	K	*	Na	*	Re	*	Sr	*	Zn
1	12	0.02	12	0.01	12	7.7	12	13	12	0.18	12	0.01	12	0.16	12	0.01	12	1.7
2	12	0.02	12	0.01	12	7.9	12	13	12	0.18	12	0.02	12	0.17	12	0.01	12	1.7
3	12	0.02	12	0.01	12	7.9	12	13	12	0.18	12	0.02	12	0.18	12	0.01	12	1.7
4	12	0.02			12	8	12	13.0	12	0.19	12	0.02	12	0.19	12	0.01	12	1.7
5	12	0.02			12	8.2	12	13.0	12	0.2	12	0.02	12	0.19	12	0.01	12	1.7
6	12	0.03			12	8.3	12	13.0	12	0.23	12	0.02	12	0.2			12	1.7

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
Eurofins EAG Materials Science, LLC	Liverpool, NY	A2LA	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Dirats Laboratories	Westfield, MA	ANAB	17025

A2LA = American Association for Laboratory Accreditation
ANAB = ANSI-ASQ National Accreditation Board

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: AR 644, 657, 886, 1652, 1657; BAS 464/1; BS CSN 2-1, XEEH, 61B, 67A, 67B, 1026, 1045, 1951, 8620A, 8620E, 8822; CKD 181A; DSZU CA013; LECO 501-644, 502-327, 502-698, 502-712, 502-855, 502-868, 502-916; NCS NS20035B; SRM 139B, 160B, 293, 361, 363, 1222.

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 CSN 2-1, XEEH, 61B, 67A, 67B, 8620A, 8620E, 8822; CKD 181A; DSZU CA013; NCS NS20035B; SRM 139B, 293, 1222; R FE 2/1.

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 8740 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 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 Prelim8740-081320. 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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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 35:2006 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 August 13, 2020.

Beau R. Brammer

President