

Certificate of Analysis

BS 234

Low Alloy Steel Reference Material

	Certified Value ¹	Estimate of Uncertainty ²		Certified Value ^{1,3}	Estimate of Uncertainty ²
Analysis listed as percent by weight					
C	0.312	0.003	Ca	(<0.0005)	
Mn	0.75	0.01	Co	0.004	0.001
P	0.010	0.001	N	0.0013	0.0006
S	0.0018	0.0005	O	0.0016	0.0004
Si	0.26	0.01	Nb	(0.001)	
Cu	0.049	0.002	Sb	(<0.002)	
Ni	1.68	0.015	Sn	(<0.002)	
Cr	0.64	0.01	Ti	0.0014	0.0004
Mo	0.10	0.004	V	0.009	0.001
Al	0.007	0.001	W	(<0.002)	
As	0.001	0.0004	Zr	(<0.003)	
B	0.0037	0.0004			

¹ The certified value listed is the present best estimate of the true value based on the results of an interlaboratory testing program.

² The uncertainties listed are based on value judgments of the material inhomogeneity and the 95% confidence interval. The half-width confidence interval C(95%) is shown on page 2.

³ Data in parentheses are not certified and are provided for information only.

See the following pages for more information.

Certificate Number 234-021999p1

Analysis	*	C	*	Mn	*	P	*	S	*	Si	*	Cu	*	Ni	*	Cr	*	Mo
1	7	0.308	4	0.736	1	0.0080	7	0.0009	2	0.246	2	0.0447	1	1.66	1	0.626	4	0.09458
2	7	0.308	4	0.7362	1	0.009	7	0.0009	1	0.253	1	0.0468	1	1.67	19	0.629	1	0.0972
3	7	0.3089	1	0.74	1	0.009	7	0.0010	10	0.255	2	0.0475	2	1.67	1	0.63	1	0.098
4	7	0.309	30	0.744	2	0.0094	7	0.0010	10	0.257	1	0.0480	4	1.672	1	0.633	1	0.098
5	7	0.309	2	0.747	14	0.0096	7	0.0016	2	0.259	1	0.049	1	1.68	2	0.638	2	0.099
6	7	0.310	33	0.748	1	0.0099	7	0.0016	2	0.26	1	0.049	1	1.68	4	0.6392	2	0.101
7	7	0.311	2	0.748	1	0.0101	7	0.0017	10	0.263	1	0.0499	1	1.682	1	0.64	1	0.1010
8	7	0.312	1	0.75	2	0.0103	7	0.0019	1	0.265	28	0.0501	2	1.695	2	0.641	2	0.1017
9	2	0.312	1	0.750	34	0.0105	7	0.0021	1	0.268	2	0.051	2	1.699	42	0.646	38	0.102
10	7	0.313	2	0.751	2	0.0107	7	0.0022	24	0.268	1	0.052	18	1.70	1	0.648	1	0.1031
11	7	0.314	1	0.753	26	0.0118	7	0.0023			4	0.053			1	0.654	1	0.104
12	7	0.3144	1	0.755			7	0.0025							2	0.658	1	0.105
13	7	0.316					7	0.0026										
14	2	0.316					2	0.0028										
15	7	0.317																
Average		0.3119		0.747		0.0098		0.00179		0.259		0.0492		1.681		0.640		0.100
Std Dev		0.0031		0.006		0.0010		0.00066		0.007		0.0024		0.014		0.010		0.003
Certified		0.312		0.75		0.010		0.0018		0.26		0.049		1.68		0.64		0.10
t		2.1448		2.201		2.2281		2.1604		2.2622		2.2281		2.2622		2.201		2.201
C (95%)		0.0017		0.0040		0.0007		0.00038		0.0050		0.0016		0.010		0.006		0.002

Analysis	*	Al	*	As	*	B	*	Ca	*	Co	*	N	*	O
1	4	0.00596	2	0.0004	1	0.0027	8	<0.0003	1	0.002	11	0.0009	11	0.0012
2	1	0.006	2	0.0005	2	0.0033	2	0.0001	1	0.003	11	0.0011	11	0.0012
3	1	0.006	5	0.0006	6	0.0034	2	0.00038	1	0.003	11	0.0011	11	0.0012
4	2	0.0062	1	0.0008	1	0.0035			4	0.0034	11	0.0012	11	0.0014
5	1	0.0063	1	0.001	21	0.0036			12	0.0040	11	0.0013	11	0.0015
6	16	0.0068	1	0.001	2	0.0036			1	0.0040	11	0.0013	11	0.0016
7	1	0.007	2	0.0011	1	0.0037			1	0.0042	11	0.00139	11	0.0019
8	1	0.0074			1	0.0038			2	0.0044	11	0.0014	11	0.0020
9	2	0.0078			21	0.0038			2	0.0044	11	0.00146	11	0.0021
10	1	0.0085			2	0.0040			1	0.0044	40	0.0020	11	0.0024
11	29	0.0091			1	0.0041			2	0.0046				
12	2	0.0091			1	0.0044			1	0.0047				
Average		0.0072		0.0008		0.00366				0.0038		0.00132		0.00165
Std Dev		0.0012		0.0003		0.00043				0.0008		0.00029		0.00043
Certified		0.007		0.001		0.0037		(<0.0005)		0.004		0.0013		0.0016
t		2.201		2.4469		2.201				2.201		2.2622		2.2622
C (95%)		0.0008		0.0003		0.00027				0.0005		0.00021		0.00031

Analysis	*	Nb	*	Sb	*	Sn	*	Ti	*	V	*	W	*	Zr
1	1	0.0004	8	<0.00001	8	<0.0005	1	0.0010	1	0.0085	1	<0.001	1	<0.0001
2	1	0.0004	46	<0.00005	1	<0.001	1	0.0010	1	0.0089	1	<0.001	1	<0.0002
3	1	0.0005	46	<0.00005	1	<0.001	1	0.0011	1	0.009	1	<0.002	1	<0.0002
4	2	0.0007	22	<0.0001	8	<0.002	2	0.0014	1	0.009	2	0.0002	1	<0.001
5	1	0.001	5	<0.0001	1	0.0008	2	0.0014	2	0.0091	1	0.0007	1	<0.001
6	1	0.0020	5	0.0005	2	0.0008	1	0.0017	27	0.0092	2	0.0010	1	<0.001
7	2	0.0021	1	0.0008	2	0.0009	2	0.0018	2	0.0092			44	0.0002
8	1	0.0025	2	0.0009	1	0.0013	1	0.0021	1	0.0092			2	0.0005
9	2	0.003	1	0.001	2	0.0013			1	0.0093			1	0.001
10									2	0.0099			2	0.0010
11									1	0.010			2	0.002
12									4	0.0114				
Average		0.0014						0.00144		0.0094				
Std Dev		0.0010						0.00040		0.0008				
Certified		(0.001)		(<0.002)		(<0.002)		0.0014		0.009		(<0.002)		(<0.003)
t		2.306						2.3646		2.201				
C (95%)		0.0008						0.00034		0.0005				

* Methods of analysis

Data in parentheses are not certified but provided for information only.

Data listed as mass fraction expressed as percent.

$C(95\%) = (t \times sd) / \sqrt{n}$ The half-width confidence interval, where t is the appropriate Student's t value, sd is the interlaboratory standard deviation, and n is the number of acceptable mean values. For further information regarding the confidence interval for the certified value see ISO Guide 35:1989 section 4.

Methods of analysis:**Certificate Number 234-021999p3**

*Method	Description
1	AES - Inductively Coupled Plasma
2	AES - Optical Emission
4	Atomic Absorption Spectrometry
5	Atomic Absorption Spectrometry with hydride generation
6	B Carmine Method
7	C, S Combustion-Infrared Absorption (ASTM E 1019)
8	Graphite Furnace Atomic Absorption Spectrometry
10	Si Gravimetry with perchloric acid (ASTM 350)
11	N, O Inert gas Fusion Method (ASTM E 1019)
12	Co MAS - 5-Cl-PADAB spectrophotometric
14	P MAS - Bismuth-phosphorus-molybdenum blue photometric
16	Al MAS - Chromazurol S photometric after separation with cupferron
18	Ni MAS - Dimethylglyoxime photometric
19	Cr MAS - Diphenyl carbazide
21	B MAS - Distillation separation-curcumin photometric
22	Sb MAS - Methylbenzene extraction crystal violet photometric
24	Si MAS - Molybdenum blue photometric method
26	P MAS - Molybdivanadophosphoric acid photometric
27	V MAS - N-benzoyl phenylhydroxylamine-trichloromethane extraction photometric
28	Cu MAS - Neocuprone-trichloromethane extraction photometric
29	Al MAS - Nitrated Eriochromcyanine-R
30	Mn MAS - Periodate
33	Mn MAS - Potassium periodate oxidation photometric
34	P MAS - P-V-Mo, blue
38	Mo MAS - Thiocyanate after extraction with butyl acetate
40	N Neutralization titrimetric with distillation separation
42	Cr Persulfate oxidation, ferrous sulfate titrimetric 4971, ST 605, 639,
44	Zr MAS - Arsenazo III
46	Sb Flame Atomic Absorption Spectrometry after extraction of antimony (III) iodide with TOPO/MIBK

AES = Atomic Emission Spectrometry

MAS = Molecular Absorption Spectrometry (photometric, spectrophotometric methods)

Certification Process: The requirements of ISO Guide 31, ISO Guide 34, ISO Guide 35, and ASTM Standard Guides E 1724 and E 1831 were followed for the preparation of this reference material and certificate of analysis. This is a reference material as defined by ISO Guide 30.

Certificate Number: The unique identification number for this certificate of analysis is 234-021999-px where x indicates the page number. Refer to future Brammer Standard Company catalogs for information on any revisions to this or other Brammer Standard reference materials. You may also obtain information on revisions of certificates from the internet at brammerstandard.com.

Analysis: Chemical analyses were made on chips prepared by a lathe from the certified portion of the bars in accordance with

ASTM Standard Practice E 1806. The laboratories participating in the testing normally followed the requirements of ISO Guide 25. The individual values listed on page 2 are the average of each analyst's results. Methods of analysis are listed on page 3.

Co-operating Laboratories: Some of the co-operating laboratories were:

Laboratory

ANAREM, Prague, Czech Republic
Armco Inc., Research & Development, Middletown, Ohio
Brammer Standard Co., Inc., Houston, Texas
China National Analysis Center for Iron and Steel, Beijing, China
J. Dirats and Co., Inc., Westfield, Massachusetts
LECO Corporation, St. Joseph, Michigan
Shiva Technologies, Inc., Syracuse, New York
Shiva Analyticals (India) Ltd., Hoskote, Bangalore, India
The Timken Company, Canton, Ohio
VHG Laboratories, Inc., Manchester, New Hampshire

Laboratory contact

Karel Bičovský
Howard P. Vail
Richard Beaumont
Prof. Wang Haizhou
Eric E. Dirats
Dennis Lawrenz
Don Shuman
Dr. T. V. Ramakrishna
Douglas Gapen
Julie M. McIntosh

Homogeneity: This Reference Material was tested for homogeneity using ASTM Standard Practice E 826 and found acceptable.

Traceability: This Reference Material was also examined by optical emission spectrometry and found to be compatible with the following Certified Reference Materials: NIST SRM C1173, 1261a through 1265a, 1761 through 1767; ECRM 186-1, 191-1; SS 457/1, 458/1; JSS 169-4, 170-6, 171-4.

The following Certified Reference Materials were used to validate the analytical data listed on page 2: NIST SRM 13g, 16f, 73c, 291, 885, 100b; CKD 180A through 187A; BCS 455; ECRM 184-1.

Source: This material was produced by the Bethlehem Steel Corporation Homer Research Laboratories. The material was made in a vacuum induction melting furnace and cast into ingots. The bar stock was hot rolled and heat treated.

Available Form: This Reference Material is available in the form of a block, approximately 32 mm x 32 mm and 19 mm thick.

Use: This Reference Material is intended for use in optical emission and x-ray spectrometric methods of analysis. The entire depth of the disc may be used.

Caution: As with any bar material, avoid optical emission spectrometric burns in the center of the block (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 you use for production specimens. Avoid overheating the disc during surface preparation.

Safety Notice: A Material Safety Data Sheet (MSDS) 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

Certified by: _____ on February 19, 1999.
G. R. Brammer

Certificate Number 234-021999p4

By Certificate Number R-021, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9002 by the American Association for Laboratory Accreditation (A2LA).

**Brammer Standard Company's Chemical Laboratory is accredited to ISO Guide 25 by A2LA.
(Certificate Number 656.01)**

References:

*ASTM documents available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959,
Telephone: 610-832-9500 Fax: 610-832-9555 e-mail: service@astm.org Website: www.astm.org*

E 350 - 90 Standard Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

E 826 - 85 (Reapproved 1990) Standard Practice for Testing Homogeneity of Materials for the Development of Reference Materials

E 1019 - 93 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel and in Iron, Nickel, and Cobalt Alloys

E 1724 - 95 Standard Guide for Testing and Certification of Metal and Metal-Related Reference Materials

E 1806 - 96 Standard Practice for Sampling Steel and Iron for Determination of Chemical Composition

E 1831 - 96 Standard Guide for Preparing Certificates for Reference Materials Relating to Chemical Composition of Metals, Ores, and Related Materials.

ISO Guides available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

ISO Guide 25 (Third edition, 1990), General requirements for the competence of calibration and testing laboratories.

ISO Guide 30 (Second edition, 1991), Terms and definitions used in connection with reference materials.

ISO Guide 31 (First edition, 1981), Contents of certificates of reference materials.

ISO Guide 33 (First edition, 1989), Uses of certified reference materials.

ISO Guide 34 (First edition, 1996), Quality system guidelines for the production of reference materials.

ISO Guide 35 (Second edition, 1989), Certification of reference materials - General and statistical principles.

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

Certificate Number 234-021999p5