

Certificate of Analysis

BS 1144

Certified Reference Material¹ for Grade 1144 Alloy Steel
(UNS Number G11440)

	Certified Value ²	Estimate of Uncertainty ³	Certified Value ²	Estimate of Uncertainty ³
Analysis listed as percent by weight				
C	0.483	0.005	O	0.0016 0.0003
Mn	1.55	0.025	Sn	0.0113 0.0006
P	0.022	0.001	Ti	0.002 0.001
S	0.243	0.008	V	0.0039 0.0005
Si	0.262	0.010		
Cu	0.462	0.006		
Ni	0.097	0.004		
Cr	0.193	0.010	Information Values⁴	
Mo	0.017	0.003	Al	(0.002)
As	0.009	0.001	Nb	(0.004)
Co	0.011	0.002	Pb	(0.001)
N	0.0093	0.0007	W	(0.003)

¹ Brammer Standard Company, Inc., is accredited to ISO Guide 34 as a Reference Material Producer to produce Certified Reference Materials by A2LA (Certificate Number 656.02)

² The certified value listed is the present best estimate of the true value based on the results of an interlaboratory testing program.

³ 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.

⁴ Information values are not certified and are provided for information only.

See the following pages for more information.

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Analysis	* C	* Mn	* P	* S	* Si	* Cu	* Ni	* Cr	* Mo	* As
1	1 0.4789	9 1.525	3 0.0201	1 0.231	3 0.2497	4 0.458	6 0.0931	3 0.182	3 0.0149	4 0.0077
2	1 0.479	9 1.528	4 0.021	1 0.2348	4 0.256	3 0.460	6 0.0942	3 0.189	3 0.0158	8 0.0077
3	1 0.4791	3 1.548	3 0.021	1 0.239	3 0.258	3 0.460	3 0.0961	3 0.1898	3 0.0159	3 0.0083
4	1 0.480	3 1.556	3 0.0218	1 0.240	5 0.259	3 0.4606	3 0.0970	3 0.192	3 0.016	3 0.0093
5	1 0.481	3 1.56	10 0.0219	1 0.245	5 0.264	3 0.4620	3 0.0973	4 0.196	3 0.0175	3 0.0094
6	1 0.481	3 1.5766	10 0.0219	1 0.247	3 0.2672	6 0.464	3 0.098	3 0.2080	4 0.020	3 0.0097
7	1 0.482	3 1.586	3 0.0220	1 0.249	5 0.268	6 0.466	4 0.0989			6 0.0099
8	1 0.483		3 0.0224	1 0.251	5 0.273		3 0.1010			6 0.0099
9	1 0.486			1 0.252						
10	1 0.488									
11	1 0.491									
Average	0.4826	1.5542	0.02151	0.2432	0.2619	0.46151	0.0970	0.1928	0.0167	0.0090
Std Dev	0.0040	0.0228	0.0007	0.0074	0.0076	0.0027	0.0025	0.0087	0.0019	0.0009
Certified	0.483	1.55	0.022	0.243	0.262	0.462	0.097	0.193	0.017	0.009
# Labs	11	7	8	9	8	7	8	6	6	8
t	2.2281	2.4469	2.3646	2.306	2.3646	2.4469	2.3646	2.5706	2.5706	2.3646
C(95%)	0.0027	0.0211	0.0006	0.0057	0.0063	0.0025	0.0021	0.0092	0.0020	0.0008

* method of analysis code

Analysis	* Co	* N	* O	* Sn	* Ti	* V	* Al	* Nb	* Pb	* W
1	6 0.0084	2 0.0085	2 0.0012	3 0.0107	7 0.0012	3 0.0036	7 0.0005	4 0.0026	8 0.0001	3 0.0022
2	6 0.0085	2 0.0085	2 0.0013	3 0.0109	3 0.0014	3 0.0038	3 0.0016	3 0.0030	7 0.00026	7 0.0023
3	3 0.010	2 0.0086	2 0.0015	7 0.0114	3 0.0021	3 0.0039	4 0.0018	7 0.0041	7 0.0004	3 0.0030
4	3 0.0103	2 0.0094	2 0.0017	3 0.0114	4 0.0027	3 0.0041	3 0.0020	7 0.0047	7 0.0004	3 0.0031
5	3 0.0106	2 0.00977	2 0.00182	3 0.0115	3 0.0030	4 0.0042			3 0.0016	3 0.0044
6	3 0.0110	2 0.00979	2 0.00186	7 0.0117	3 0.0033					
7	3 0.0119	2 0.00981	2 0.00187							
8	4 0.0137	2 0.00990	2 0.00187							
Average	0.0106	0.00928	0.00164	0.01127	0.00228	0.00392	0.00148	0.00360	0.0006	0.00300
Std Dev	0.0017	0.00064	0.00027	0.00038	0.00086	0.00024	0.00067	0.00097	0.0006	0.00088
Certified	0.011	0.0093	0.0016	0.0113	0.002	0.0039	(0.002)	(0.004)	(0.001)	(0.003)
# Labs	8	8	8	6	6	5	4	4	5	5
t	2.3646	2.3646	2.3646	2.5706	2.5706	2.7764	3.18240	3.1824	2.7764	2.7764
C(95%)	0.0015	0.00053	0.00023	0.00040	0.00090	0.00030	0.00107	0.00154	0.00074	0.00109

$C(95\%) = (t \times sd) / \sqrt{n}$ 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

Code Method

1	Combustion - Inferred Absorption Method	6	Flame Atomic Absorption Spectrometry
2	Fusion - Thermal Conductivity Method	7	AES-ICP-MS Inductively Coupled Plasma with Mass Spectrometry
3	AES-ICP Inductively Coupled Plasma Spectrometry	8	Graphite Furnace - Atomic Absorption Spectrometry
4	AES- Spark Optical Emission Spectrometry	9	Colorimetric method
5	Gravimetric method	10	Spectrophotometric method

AES = Atomic Emission Spectrometry

Co-operating Laboratories: The co-operating laboratories were:

Laboratory

Brammer Standard Co., Inc., Houston, Texas
 China National Analysis Center for Iron and Steel, Beijing, China
 J. Dirats and Co., Inc., Westfield, Massachusetts
 Laboratory Testing Inc., Hatfield, Pennsylvania
 LECO Corporation, St. Joseph, Michigan
 VHG Laboratories, Inc., Manchester, New Hampshire

Contact person

Richard P. Beaumont
 Prof. Wang Haizhou
 Eric E. Dirats
 Rick Heist
 Dennis Lawrenz
 Julie M. McIntosh

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 Certified Reference Material as defined by ISO Guide 30.

Analysis: Chemical analyses were made on chips prepared by a lathe from the certified portion of the discs in accordance with ASTM Standard Practice E 1806. The laboratories participating in the testing normally followed the requirements of ISO Guide 25 and/or ISO Standard 17025. Individual values listed on page 2 are the average of each analyst's results. Methods of analysis are listed on page 2.

Outliers: Some outlying data was excluded from the data listed on page 2 due to technical assessment of the cooperating laboratories and statistical evaluation.

Traceability: The following Certified Reference Materials were used to validate the analytical data listed on page 2: NIST SRM 12h, 30f, 129c, 293, 337a, 3101a, 3103a, 3112a, 3113, 3114, 3128, 3132, 3134, 3136, 3137, 3139a, 3150, 3161a, 3162a, 3163, 3165; JK 6A; ECRM 037-1; BS CSN2-1, CSN 4.

Homogeneity: This Certified Reference Material was tested for homogeneity using ASTM Standard Method E 826 and found acceptable. It was also examined by optical emission spectrometry using ASTM Standard Test Method E 415 and found to be compatible with the following Reference Materials: NIST SRM 1136, C1221, BAS SS 433/1, 434/1; BS 42A, 66B, 3942, CSN-2D.

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. Whereas this material is in a solid form and stable, no expiration date is specified.

Source: This material was produced by Nucor Cold Finish, Nucor Corporation, Brigham City, Utah.

Form: This Certified Reference Material is in the form of a disc, approximately 38 mm (1.50 inches) diameter and 19 mm (0.75 inches) thick.

Use: This Certified Reference Material is intended for use in optical emission and x-ray spectrometric methods of analysis. Refer to ISO Guide 33 for information about the use of Reference Materials.

Certified area: 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 disc (5 mm radius), as some segregation may be present.

The presence of high sulfur concentrations may produce erroneously higher readings for manganese and other elements when analyzed by optical emission spectrometry. An extended spark preburn may be necessary.

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.

Certificate Number: The unique identification number for this certificate of analysis is 1144-031408-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.

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. Phone: (281) 440-9396 web brammerstandard.com
14603 Benfer Road
Houston, Texas 77069-2895 USA Fax: (281) 440-4432 e-mail contact@brammerstandard.com

Certified by: _____ on March 14, 2008.

Beau R. Brammer

Certificate Number 1144-031408p3

Brammer Standard Company, Inc., is accredited to ISO Guide 34 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials by A2LA (Certificate Number 656.02) The scope of accreditation is listed on the website: www.brammerstandard.com

By Certificate Number 10539, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9001:2000 by National Quality Assurance, U.S.A.

Brammer Standard Company's Chemical Laboratory is accredited to ISO Standard 17025 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 415-99a(2005) Standard Test Method for Optical Emission Vacuum Spectrometric Analysis of Carbon and Low-Alloy Steel

E 826 - 85 (Withdrawn 2005) Standard Practice for Testing Homogeneity of Materials for the Development of Reference Materials

E 1019 - 2003 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel and in Iron, Nickel, and Cobalt Alloys

E 1085-95(2004) Standard Test Method for X-Ray Emission Spectrometric Analysis of Low-Alloy Steels

E 1724 - 95 (Reapproved 2001) Standard Guide for Testing and Certification of Metal and Metal-Related Reference Materials

E 1806-96(2006) Standard Practice for Sampling Steel and Iron for Determination of Chemical Composition

E 1831 - 96 (Withdrawn 2005) Standard Guide for Preparing Certificates for Reference Materials Relating to Chemical Composition of Metals, Ores, and Related Materials.

ISO Guides and Standards available from Global Engineering - www.global.ihs.com

ISO Standard 17025 (Second edition, 2005), General requirements for the competence of calibration and testing laboratories.

ISO Guide 30 (Second edition, 1992), Terms and definitions used in connection with reference materials.

ISO Guide 31 (Second edition, 2000), Reference materials -Contents of certificates and labels.

ISO Guide 33 (Second edition, 2000), Uses of certified reference materials.

ISO Guide 34 (Second edition, 2000), General requirements for the competence of reference material producers.

ISO Guide 35 (Third edition, 2006), 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 1144-031408p4