

**Brammer Standard Company, Inc.**

# Certificate of Analysis

**BS 3961**

**AISI Steel Grade E4320 Reference Material**

	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>		Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
Analysis listed as percent by weight					
<b>C</b>	<b>0.215</b>	0.006	<b>N</b>	<b>0.0079</b>	0.0004
<b>Mn</b>	<b>0.565</b>	0.012			
<b>P</b>	<b>0.016</b>	0.001			
<b>S</b>	<b>0.022</b>	0.0015			
<b>Si</b>	<b>0.236</b>	0.008			
<b>Cu</b>	<b>0.133</b>	0.005		Informational values <sup>3</sup>	
<b>Ni</b>	<b>1.67</b>	0.01	<b>Co</b>	(0.010)	
<b>Cr</b>	<b>0.510</b>	0.008	<b>Sn</b>	(0.008)	
<b>Mo</b>	<b>0.27</b>	0.008	<b>Ti</b>	(<0.003)	
<b>Al</b>	<b>0.022</b>	0.002	<b>V</b>	(0.002)	

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

<sup>2</sup> 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.

<sup>3</sup> Data in parentheses are not certified and are provided for information only.

See reverse side for more information.

Certificate Number 3961-070898p1

**Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895**  
**Telephone (281) 440-9396 Fax (281) 440-4432**

Analysis	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al
1	0.2068	0.553	0.015	0.019	0.228	0.130	1.666	0.501	0.263	0.018
2	0.208	0.554	0.0152	0.0207	0.230	0.130	1.67	0.503	0.264	0.019
3	0.209	0.557	0.0155	0.0209	0.234	0.132	1.671	0.507	0.273	0.0200
4	0.212	0.564	0.016	0.0211	0.238	0.135	1.674	0.507	0.273	0.022
5	0.214	0.566	0.0163	0.0216	0.239	0.135	1.676	0.513	0.273	0.023
6	0.2154	0.579	0.0163	0.0218	0.240	0.136	1.682	0.514	0.274	0.024
7	0.2172	0.584	0.0163	0.0221	0.241	0.136		0.524	0.277	0.024
8	0.220			0.0224	0.242					0.0241
9	0.220			0.0225						0.0247
10	0.220			0.023						
11	0.2226			0.0246						
Average	0.2150	0.5653	0.0158	0.0218	0.2365	0.1334	1.6732	0.5099	0.2710	0.0221
Std Dev	0.0055	0.0122	0.0006	0.0014	0.0052	0.0027	0.0055	0.0078	0.0053	0.0025
Certified	0.215	0.565	0.016	0.022	0.236	0.133	1.67	0.510	0.27	0.022
t	2.2281	2.4469	2.4469	2.2281	2.3646	2.4469	2.5706	2.4469	2.4469	2.306
C(95%)	0.0037	0.0112	0.0005	0.0010	0.0044	0.0025	0.0058	0.0073	0.0049	0.0019

continued from above

Analysis	N	Co	Sn	Ti	V
1	0.0074	0.008	0.0075	<0.001	0.0016
2	0.0077	0.0090	0.0075	0.0012	0.002
3	0.00787	0.012	0.008	0.002	0.002
4	0.00791				
5	0.0080				
6	0.0084				
Average	0.00788	0.0097	0.0077		0.0019
Std Dev	0.00033	0.0021	0.0003		0.0002
Certified	0.0079	(0.010)	(0.008)	(<0.003)	(0.002)
t	2.5706	4.3027	4.3027		4.3027
C(95%)	0.00035	0.0052	0.0007		0.0006

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.

**Supplemental Data:** A nationally known Proficiency Testing Program, with 70 laboratories participating, produced the following data.

	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al
Average	0.2142	0.5653	0.0166	0.0223	0.2365	0.1352	1.6733	0.5100	0.2730	0.0233
Std Dev	0.0060	0.0091	0.0015	0.0018	0.0092	0.0057	0.0384	0.0082	0.0058	0.0021
	N	Co	Sn	Ti	V	As	B	Nb	O	Zr
Average	0.0080	0.0097	0.0081	0.0019	0.0025	0.0052	0.0002	0.0024	0.0026	0.0013
Std Dev	0.0005	0.0006	0.0009	0.0007	0.0011	0.0009	0.0001	0.0014	0.0007	0.0009

**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.

**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 59. 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 used were a combination of ASTM Standard Methods E 350 and E 1019 plus additional ICP and AA spectrometric methods.

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

ANAREM, Prague, Czech Republic  
Auburn Analytical Lab, Inc., Auburn, Michigan  
Brammer Standard Co., Inc., Houston, Texas  
Crucible Specialty Steel, Syracuse, New York  
J. Dirats and Co., Inc., Westfield, Massachusetts  
Laboratory Testing Inc., Dublin, Pennsylvania  
Midstates Analytical Laboratories, Broken Arrow, Oklahoma  
LECO Corporation, St. Joseph, Michigan  
Shiva Analyticals (India) Ltd., Hoskote, Bangalore, India  
VHG Laboratories, Inc., Manchester, New Hampshire

**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 11h, 13g, 50c, 293, 361; ECRM 112-1; BCS 455/1; ICRM C9/2, C16/2.

**Source:** This material was produced by Copperweld Steel Company, Warren, Ohio. The material was made in an electric arc furnace, degassed, 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 disc, approximately 44 mm (1.75") in diameter and 19 mm (0.75") 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 disc (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. Phone: (281) 440-9396  
14603 Benfer Road  
Houston, Texas 77069-2895 USA Fax: (281) 440-4432

Certified by: \_\_\_\_\_ on July 8, 1998.  
G. R. Brammer

**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 59 - 93 Standard Practice for Sampling Steel and Iron for Determination of Chemical Composition

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 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 3961-070898p4**