

**Brammer Standard Company, Inc.**  
**Certificate of Analysis**

B.S. 47A

**Reference Material for F-5 Grade Cr-Mo Steel Alloy**

	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>0.130</b>	0.005	<b>Al</b>	<b>0.015</b>	0.002
<b>Mn</b>	<b>0.44</b>	0.01	<b>Co</b>	<b>0.011</b>	0.002
<b>P</b>	<b>0.017</b>	0.001	<b>N</b>	<b>0.018</b>	0.001
<b>S</b>	<b>0.015</b>	0.002	<b>Nb</b>	<b>0.002</b>	0.001
<b>Si</b>	<b>0.27</b>	0.01	<b>Sn</b>	<b>0.008</b>	0.002
<b>Cu</b>	<b>0.11</b>	0.01	<b>Ti</b>	<b>0.003</b>	0.001
<b>Ni</b>	<b>0.12</b>	0.01	<b>V</b>	<b>0.016</b>	0.002
<b>Cr</b>	<b>4.22</b>	0.02			
<b>Mo</b>	<b>0.47</b>	0.02	<b>O</b>	<b>(0.003)<sup>3</sup></b>	

<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 possible bias in the determined analytical values. No attempt is made to derive exact statistical measurements of imprecision because several methods were used in the determination of most constituents.

<sup>3</sup> The value in parentheses is shown for information only and is not certified.

See the following pages for more information.

Original Certificate Number REV-47A-032092  
 New Certificate Number REV2-47A-120409

**New Certificate Number REV2-47A-120409 Revised to show uncertainty values on December 4, 2009**

Analysis	C	Mn	P	S	Si	Cu	Ni	Cr	Mo
1	0.128	0.43	0.015	0.0133	0.26	0.10	0.11	4.19	0.45
2	0.129	0.432	0.016	0.015	0.263	0.109	0.11	4.20	0.464
3	0.129	0.44	0.016	0.015	0.27	0.11	0.12	4.20	0.47
4	0.130	0.440	0.017	0.0154	0.27	0.11	0.12	4.21	0.47
5	0.131	0.44	0.0174	0.016	0.277	0.11	0.12	4.22	0.471
6	0.136	0.45	0.018	0.0173		0.117	0.122	4.22	0.48
7		0.45	0.018			0.12	0.124	4.23	0.49
8		0.46					0.125	4.25	0.49
9		0.46							
Average	0.1305	0.443	0.0168	0.0153	0.268	0.111	0.119	4.215	0.473
Std Dev	0.0029	0.011	0.0011	0.0013	0.007	0.006	0.006	0.019	0.013
Certified	0.130	0.44	0.017	0.015	0.27	0.11	0.12	4.22	0.47
t	2.57	2.31	2.45	2.57	2.78	2.45	2.36	2.36	2.36
C (95%)	0.003	0.008	0.0011	0.0014	0.008	0.006	0.005	0.016	0.0112

continued from above

Analysis	Al	Co	N	Nb	Sn	Ti	V	O
1	0.013	0.008	0.0178	0.001	0.0062	0.002	0.013	0.0032
2	0.014	0.009	0.0179	0.001	0.0072	0.003	0.014	
3	0.015	0.010	0.0185	0.002	0.008	0.003	0.015	
4	0.016	0.010		0.002	0.0082	0.003	0.0153	
5	0.016	0.010		0.0029	0.0086	0.0038	0.016	
6	0.0162	0.011			0.0088	0.004	0.017	
7		0.012					0.018	
8		0.0123					0.019	
9		0.013						
Average	0.0150	0.0106	0.01807	0.0018	0.0078	0.0031	0.0159	
Std Dev	0.0013	0.0016	0.00038	0.0008	0.001	0.0007	0.002	
Certified	0.015	0.011	0.018	0.002	0.008	0.003	0.016	(0.003)
t	2.57	2.31	4.3	2.78	2.57	2.57	2.36	
C (95%)	0.0014	0.0013	0.00094	0.00099	0.001	0.0007	0.0017	

$C(95\%) = (t \times sd) / \sqrt{n}$  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 35:2006 section 6.

Some of the co-operating laboratories were:

- Allegheny Ludlum Steel Corporation, Brackenridge, PA
- Allegheny Ludlum Steel Corporation, Lockport, NY
- Brammer Standard Co., Inc., Houston, TX
- Crucible Specialty Metals, Syracuse, NY
- J. Dirats and Co., Inc., Westfield, MA
- Jessop Steel Company, Washington, PA
- Midstates Analytical Laboratories, Inc., Tulsa, OK
- VHG Laboratories, Inc., Manchester, NH

**Analysis:** Chemical analyses were made on millings from cross-sections of the bars. The individual values listed above are the average of each analyst's results.

**Analytical Methods:** Methods of analysis used were a combination of ASTM Standard Methods E 350, E 415, E 1019, plus additional ICP, and AA spectrometric methods.

**Traceability:** The following Certified Reference Materials were used to validate the analytical data listed above: NIST SRM 32e, 125b, 361 to 365; BAM 039-2, 044-1; BCS 455/1, 456/1, 458/1; ECRM 085-1, 088-1, 096-1, 184-1, 481-1; GBW 01402; IMZ 1.22, 1.74

**Homogeneity:** This Reference Material was tested for homogeneity using ASTM Standard Method E 826 and found acceptable. It was also examined by optical emission spectrometry and found to be compatible with the following NIST Certified Reference Materials: SRM 1222, 1224, 1225, 1261A to 1265A, 1761 to 1767

**Form:** This Reference Material is machined in the form of a disc, approximately 38 mm diameter and 19 mm thick by Brammer Standard Company. The bar stock used for this material was produced by hot-rolling billets and annealing.

**Certified area:** The entire depth of the disc may be used.

**Caution:** As with any bar material, avoid spark atomic 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.

**Certificate Number:** The unique identification number for this certificate of analysis is REV2-47A-120409. This BS 47A Certificate of Analysis was revised to show the estimate of uncertainty for the certified values.

This Reference Material was first revised after retesting by additional laboratories in 1991 and 1992. Additional elements were certified. Also, as a result of the retesting, the certified analysis was revised slightly for C, S, Cr, Al, and Sn.

Refer to the "Certificates" section of the Brammer Standard Company website for any revision to this or other Brammer Standard Company's Certificates of Analysis.

**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	website: <a href="http://brammerstandard.com">brammerstandard.com</a> email: <a href="mailto:contact@brammerstandard.com">contact@brammerstandard.com</a>
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Certified by: \_\_\_\_\_ on December 4, 2009  
Beau R. Brammer

**Certificate Number REV2-47A-120409**

## Referenced Documents

*ASTM documents available from ASTM, 1916 Race Street, Philadelphia, PA, 19103.*

Versions available at the time of the interlaboratory testing

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

E 415 - 85 (Reapproved 1989) Standard Test Method for Optical Emission Vacuum Spectrometric Analysis of Carbon and Low-Alloy Steel

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

*ISO Guides and Standards available from Global Engineering - [www.global.ihs.com](http://www.global.ihs.com)*

ISO Guide 35 Reference Materials - General and statistical principles for certification

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