

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

B.S. 90F

**Reference Material for AISI Stainless Steel Grade 416**

	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>0.085</b>	0.003	<b>Co</b>	<b>0.021</b>	0.005
<b>Mn</b>	<b>0.53</b>	0.02	<b>N</b>	<b>0.037</b>	0.0015
<b>P</b>	<b>0.023</b>	0.002	<b>Nb</b>	<b>0.011</b>	0.002
<b>S</b>	<b>0.328</b>	0.008	<b>O</b>	<b>0.011</b>	0.0015
<b>Si</b>	<b>0.58</b>	0.02	<b>Sn</b>	<b>0.005</b>	0.002
<b>Cu</b>	<b>0.12</b>	0.01	<b>W</b>	<b>0.032</b>	0.005
<b>Ni</b>	<b>0.30</b>	0.01			
<b>Cr</b>	<b>13.01</b>	0.05	Informational values <sup>3</sup>		
<b>Mo</b>	<b>0.14</b>	0.01	Al	(0.006)	
<b>V</b>	<b>0.076</b>	0.005	Ti	(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 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> Data in parentheses are not certified and are provided for information only.

The requirements of ISO Guide 31 and ISO Guide 35 were generally followed for the preparation of this reference material and certificate of analysis. This is a reference material as defined by ISO Guide 30.

See reverse side for more information.

Certificate Number 90F-REV061094

Analysis	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Co
1	0.0826	0.508	0.022	0.323	0.57	0.109	0.28	12.93	0.134	0.0714	0.013
2	0.083	0.514	0.022	0.327	0.57	0.113	0.29	12.96	0.1397	0.0720	0.015
3	0.084	0.518	0.0223	0.3278	0.57	0.114	0.30	12.96	0.14	0.073	0.02
4	0.0848	0.526	0.023	0.328	0.578	0.114	0.30	12.98	0.14	0.073	0.02
5	0.085	0.528	0.023	0.3284	0.58	0.116	0.301	13.00	0.14	0.075	0.02
6	0.085	0.53	0.023	0.329	0.58	0.117	0.303	13.01	0.141	0.076	0.0202
7	0.0852	0.537	0.023	0.33	0.58	0.118	0.305	13.01	0.141	0.076	0.0218
8	0.086	0.54	0.024	0.332	0.59	0.118	0.307	13.02	0.143	0.0763	0.022
9	0.086	0.542			0.596	0.119	0.308	13.03	0.144	0.078	0.0225
10	0.087					0.12	0.308	13.04	0.145	0.085	0.025
11	0.088					0.12	0.312	13.04	0.149		0.027
12								13.05	0.15		
13								13.05			
Average	0.0851	0.527	0.0228	0.3282	0.579	0.116	0.301	13.006	0.142	0.0756	0.0206
Std Dev	0.0016	0.012	0.0007	0.0026	0.009	0.003	0.009	0.038	0.004	0.0039	0.0040
Certified	0.085	0.53	0.023	0.328	0.58	0.12	0.30	13.01	0.14	0.076	0.021

Analysis	N	Nb	O	Sn	W	Al	Ti
1	0.0356	0.0095	0.00943	0.0028	0.028	0.0018	0.002
2	0.0358	0.010	0.0101	0.0031	0.029	0.006	0.0026
3	0.0361	0.0106	0.0111	0.0042	0.032	0.0088	0.0029
4	0.0369	0.0109	0.0113	0.0048	0.037		
5	0.0370	0.012	0.0117	0.005			
6	0.0374	0.012	0.0130	0.006			
7	0.0384	0.012		0.006			
8	0.04005	0.013					
Average	0.03716	0.0113	0.01111	0.0046	0.0315	0.0055	0.0025
Std Dev	0.00149	0.0012	0.00125	0.0013	0.0040	0.0035	0.0005
Certified	0.037	0.011	0.011	0.005	0.032	(0.006)	(0.002)

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

**Analysis:** Chemical analyses were made on chips prepared by a lathe from the certified portion of the discs. The laboratories participating in the testing normally followed the requirements of ISO Guide 25. The individual values listed above are the average of each analyst's results. Methods of analysis used were a combination of ASTM Standard Methods E 350, E 353, E 572, E 1019, E 1086, plus additional ICP and AA spectrometric methods. The following Certified Reference Materials were used to validate the analytical data listed above: NIST SRM 73c, 101g, 121d, 133b, 160a, 160b, 344, 345, 348a; BCS 345, 346, 466/1, 467/1, 475; ECRM 284-1, 286-1; IMZ 127/3; JK 37.

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

Allegheny Ludlum Steel Corp., Brackenridge, Pennsylvania  
 Allegheny Ludlum Steel Corp., Lockport, New York  
 Analytical Associates, Inc., Detroit, Michigan  
 Brammer Standard Co., Inc., Houston, Texas  
 Coleman Testing Laboratories, Riverside, New Jersey  
 Crucible Specialty Steel, Syracuse, New York  
 Charles C. Kawin Company, Broadview, Illinois  
 Jessop Steel Corporation, Washington, Pennsylvania  
 Metals Analysis, Inc., Huntington Park, California  
 Andrew S. McCreath & Son, Inc., Harrisburg, Pennsylvania  
 Midstates Analytical Laboratories, Tulsa, Oklahoma  
 Republic Engineered Steels, Inc., Canton, Ohio  
 Shiva Technologies, Inc., Cicero, New York  
 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 1219, 1267, C1289; BAS SS 469, 470.

**Source:** This material was produced by Crucible Specialty Metals, Syracuse, New York. The material was made in an electric arc furnace and cast into ingots. The bar stock was hot rolled and annealed.

**Available Form:** This Reference Material is available only in the form of a disc, approximately 38 mm (1.50") in diameter and 12 mm (0.50") 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, it is the best practice to avoid optical emission spectrometric burns in the center of the disc (5 mm radius), as some segregation may be present.

Because this Reference Material contains a high percent of chromium and sulfur, care must be taken in its application. Make certain that corrections are made for possible element interference and dilution effects. Beware of sulfur interference on the 192.6 nm boron line when testing with an optical emission spectrometer (OES). The high sulfur content may also enhance the manganese measurements when testing with OES.

**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 of Analysis Revisions:** The original certificate for this BS 90F Reference Material was issued on October 19, 1989. A new interlaboratory testing program produced additional data that made possible the certification of more elements including nitrogen and oxygen. The addition of new data produced minor changes to some of the originally certified elements. The new certificate of analysis format now lists more details about the reference material, as outlined in ISO Guide 31.

**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 June 10, 1994.  
G. R. Brammer



## References:

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

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

E 353 - 93 Standard Test Methods for Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

E 572 - 88 Standard Test Method for X-Ray Emission Spectrometric Analysis of Stainless 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

E 1086 - 85 Standard Method for Optical Emission Vacuum Spectrometric Analysis of Stainless Steel by the Point-to-Plane Excitation Technique

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

*Other useful documents available at no cost from NIST, U.S. Department of Commerce, Gaithersburg, MD 20899.*

NBS 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

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