

Brammer Standard Company, Inc.

Certificate of Analysis

B.S. 187C

Reference Material for Steel Grade Alloy 20 (20Cb-3)

| | Certified Value ¹ | Estimate of Uncertainty ² | | Certified Value ¹ | Estimate of Uncertainty ² |
|--------------------------------------|------------------------------|--------------------------------------|-----------|-----------------------------------|--------------------------------------|
| Analysis listed as percent by weight | | | | | |
| C | 0.020 | 0.002 | Nb | 0.36 | 0.01 |
| Mn | 0.77 | 0.02 | O | 0.0024 | 0.0004 |
| P | 0.024 | 0.002 | Sn | 0.004 | 0.001 |
| S | <0.002 | | V | 0.059 | 0.004 |
| Si | 0.77 | 0.02 | | | |
| Cu | 3.17 | 0.03 | | Informational values ³ | |
| Ni | 32.93 | 0.15 | B | (0.0019) | |
| Cr | 20.16 | 0.15 | Ca | (0.0004) | |
| Mo | 2.07 | 0.04 | Ce | (0.004) | |
| Al | 0.10 | 0.01 | La | (0.0008) | |
| Co | 0.096 | 0.005 | Ta | (<0.002) | |
| N | 0.022 | 0.001 | Ti | (0.001) | |

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 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.

³ 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 187C-020195

| Analysis | C | Mn | P | S | Si | Cu | Ni | Cr | Mo | Al | Co | N |
|-----------|--------|--------|--------|---------|--------|--------|--------|--------|-------|--------|--------|---------|
| 1 | 0.018 | 0.754 | 0.0215 | <0.0003 | 0.7527 | 3.14 | 32.68 | 19.94 | 2.02 | 0.090 | 0.090 | 0.0217 |
| 2 | 0.0182 | 0.756 | 0.0215 | <0.0005 | 0.755 | 3.15 | 32.70 | 19.97 | 2.027 | 0.092 | 0.0909 | 0.02187 |
| 3 | 0.0192 | 0.7579 | 0.024 | <0.001 | 0.757 | 3.15 | 32.76 | 20.010 | 2.03 | 0.095 | 0.0958 | 0.0219 |
| 4 | 0.0195 | 0.76 | 0.0241 | 0.0004 | 0.761 | 3.16 | 32.841 | 20.10 | 2.03 | 0.0959 | 0.096 | 0.0220 |
| 5 | 0.0197 | 0.766 | 0.025 | 0.00044 | 0.786 | 3.17 | 32.872 | 20.103 | 2.06 | 0.099 | 0.097 | 0.0220 |
| 6 | 0.020 | 0.79 | 0.0256 | 0.0005 | 0.790 | 3.174 | 32.873 | 20.13 | 2.06 | 0.100 | 0.099 | 0.0221 |
| 7 | 0.020 | 0.790 | 0.026 | 0.0015 | | 3.1751 | 32.92 | 20.19 | 2.084 | 0.1022 | 0.104 | |
| 8 | 0.021 | 0.792 | 0.027 | | | 3.20 | 32.94 | 20.20 | 2.10 | 0.110 | | |
| 9 | 0.022 | | | | | 3.20 | 32.94 | 20.223 | 2.10 | 0.1138 | | |
| 10 | 0.022 | | | | | 3.20 | 32.94 | 20.24 | 2.11 | | | |
| 11 | | | | | | | 32.99 | 20.30 | 2.115 | | | |
| 12 | | | | | | | 33.00 | 20.33 | | | | |
| 13 | | | | | | | 33.054 | 20.33 | | | | |
| 14 | | | | | | | 33.08 | | | | | |
| Average | 0.0200 | 0.771 | 0.0243 | | 0.767 | 3.172 | 32.899 | 20.159 | 2.067 | 0.0998 | 0.0961 | 0.02193 |
| Std Dev | 0.0014 | 0.017 | 0.0020 | | 0.017 | 0.022 | 0.122 | 0.131 | 0.036 | 0.0079 | 0.0048 | 0.00014 |
| Certified | 0.020 | 0.77 | 0.024 | <0.002 | 0.77 | 3.17 | 32.93 | 20.16 | 2.07 | 0.10 | 0.096 | 0.022 |

| Analysis | Nb | O | Sn | V | B | Ca | Ce | La | Ta | Ti |
|-----------|--------|---------|--------|--------|----------|----------|---------|----------|----------|---------|
| 1 | 0.341 | 0.0021 | 0.0038 | 0.0515 | 0.0015 | 0.0002 | 0.0014 | 0.00066 | <0.0005 | 0.00084 |
| 2 | 0.348 | 0.0021 | 0.0038 | 0.057 | 0.0015 | 0.00029 | 0.0027 | 0.0007 | <0.002 | 0.0012 |
| 3 | 0.355 | 0.00230 | 0.0042 | 0.057 | 0.00153 | 0.00034 | 0.003 | 0.00074 | 0.001 | 0.0013 |
| 4 | 0.360 | 0.0025 | 0.005 | 0.058 | 0.0016 | 0.00044 | 0.0040 | 0.001 | 0.0015 | |
| 5 | 0.365 | 0.0026 | 0.0050 | 0.060 | 0.00184 | 0.0009 | 0.005 | | | |
| 6 | 0.365 | 0.00277 | | 0.0601 | 0.00189 | | 0.005 | | | |
| 7 | 0.3657 | | | 0.0602 | 0.0022 | | | | | |
| 8 | 0.372 | | | 0.062 | 0.0023 | | | | | |
| 9 | | | | 0.062 | 0.0023 | | | | | |
| 10 | | | | 0.064 | 0.0024 | | | | | |
| Average | 0.3590 | 0.00240 | 0.0044 | 0.0592 | 0.0019 | 0.0004 | 0.0035 | 0.0008 | | 0.0011 |
| Std Dev | 0.0103 | 0.00027 | 0.0006 | 0.0035 | 0.0004 | 0.0003 | 0.0014 | 0.0002 | | 0.0002 |
| Certified | 0.36 | 0.0024 | 0.004 | 0.059 | (0.0019) | (0.0004) | (0.004) | (0.0008) | (<0.002) | (0.001) |

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.

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
 ANAREM, Prague, Czech Republic
 Brammer Standard Co., Inc., Houston, Texas
 Coleman Testing Laboratories, Riverside, New Jersey
 Crucible Specialty Steel, Syracuse, New York
 J. Dirats and Co., Inc., Westfield, Massachusetts
 J & L Specialty Steel, Midland, Pennsylvania
 LECO Corporation, St. Joseph, Michigan
 Ledoux & Company, Teaneck, New Jersey
 Andrew S. McCreath & Son, Inc., Harrisburg, Pennsylvania
 Jeffrey A. Nunes Laboratories, Inc., Washington, Pennsylvania
 Shiva Technologies, Inc., Cicero, New York
 Slater Steels Corporation, Fort Wayne, Indiana
 Spectrochemical Laboratories, Inc., Pittsburgh, Pennsylvania
 VHG Laboratories, Inc., Manchester, New Hampshire

Additional analytical data: This material was used as an unknown test specimen in the Brammer Standard Company's Stainless Steel Proficiency Testing Program (PTP). The participating laboratories used a combination of combustion instruments, XRF spectrometers, and optical emission spectrometers. The data shown below are the results from the PTP as listed in the PTP Report Number SS-2-1994.

| | C | Mn | P | S | Si | Cu | Ni |
|--------------------|--------|-------|--------|--------|-------|-------|--------|
| Number of Labs | 15 | 18 | 14 | 11 | 18 | 18 | 17 |
| Grand Average | 0.0202 | 0.773 | 0.0227 | 0.0007 | 0.783 | 3.226 | 32.887 |
| Standard Deviation | 0.0021 | 0.017 | 0.0023 | 0.0005 | 0.037 | 0.106 | 0.341 |

| | Cr | Mo | Co | N | Nb | O | V | B |
|--------------------|--------|-------|-------|--------|-------|--------|-------|--------|
| Number of Labs | 17 | 18 | 14 | 13 | 17 | 9 | 16 | 10 |
| Grand Average | 20.203 | 2.089 | 0.099 | 0.0222 | 0.359 | 0.0024 | 0.058 | 0.0022 |
| Standard Deviation | 0.240 | 0.044 | 0.006 | 0.0009 | 0.015 | 0.0003 | 0.005 | 0.0006 |

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 1246, 1247. The following Certified Reference Materials were used to validate the analytical data listed on page 2: NIST SRM 73c, 101g, 121d, 123c, 125b, 126c, 160b, 339, 342, 344, 345, 346a, 348a, 362, 892; ECRM 088-1, 284-1, 286-1, 292-1; BCS 466/1, 467/1, 475; JK 37; BAM 230-1.

Source: This material was produced by Slater Steels Corporation, Fort Wayne, Indiana. 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 44 mm (1.75") 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, 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 copper, nickel, chromium, and molybdenum, care must be taken in its application. Make certain that corrections are made for possible element interference and dilution effects.

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 February 1, 1995.
G. R. Brammer

Certificate Number 187C-020195

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 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

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