

Brammer Standard Company, Inc.
Certificate of Analysis

B.S. 3932

Reference Material for AISI Steel Grade 4130

| | Certified Value ¹ | Estimate of Uncertainty ² | | Certified Value ¹ | Estimate of Uncertainty ² |
|--------------------------------------|------------------------------|--------------------------------------|-----------|------------------------------|--------------------------------------|
| Analysis listed as percent by weight | | | | | |
| C | 0.321 | 0.005 | Al | 0.020 | 0.002 |
| Mn | 0.54 | 0.015 | As | 0.004 | 0.001 |
| P | 0.016 | 0.002 | Ca | 0.0043 | 0.0006 |
| S | 0.018 | 0.001 | Co | 0.011 | 0.002 |
| Si | 0.33 | 0.01 | N | 0.0070 | 0.0005 |
| Cu | 0.200 | 0.010 | O | 0.0019 | 0.0005 |
| Ni | 0.19 | 0.01 | Sn | 0.012 | 0.001 |
| Cr | 1.00 | 0.02 | V | 0.005 | 0.001 |
| Mo | 0.229 | 0.010 | | | |

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.

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 3932-071994

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BS 3932

Certificate number 3932-071994

| Analysis | C | Mn | P | S | Si | Cu | Ni | Cr | Mo |
|-----------|--------|-------|--------|--------|--------|--------|--------|-------|--------|
| 1 | 0.319 | 0.530 | 0.0138 | 0.018 | 0.323 | 0.193 | 0.185 | 0.968 | 0.222 |
| 2 | 0.320 | 0.538 | 0.0157 | 0.018 | 0.323 | 0.194 | 0.187 | 1.00 | 0.226 |
| 3 | 0.320 | 0.538 | 0.0158 | 0.018 | 0.324 | 0.197 | 0.192 | 1.00 | 0.227 |
| 4 | 0.322 | 0.542 | 0.0159 | 0.018 | 0.325 | 0.197 | 0.192 | 1.002 | 0.227 |
| 5 | 0.322 | 0.544 | 0.017 | 0.0180 | 0.329 | 0.198 | 0.196 | 1.02 | 0.228 |
| 6 | 0.323 | 0.545 | 0.017 | 0.0197 | 0.337 | 0.200 | 0.198 | 1.025 | 0.230 |
| 7 | 0.324 | 0.548 | 0.0171 | 0.0200 | | 0.201 | 0.204 | | 0.231 |
| 8 | | 0.552 | | | | 0.201 | | | 0.234 |
| 9 | | 0.553 | | | | 0.203 | | | 0.239 |
| Average | 0.3214 | 0.543 | 0.0160 | 0.0185 | 0.3268 | 0.1982 | 0.1934 | 1.003 | 0.2293 |
| Std Dev | 0.0018 | 0.007 | 0.0012 | 0.0009 | 0.0055 | 0.0033 | 0.0065 | 0.020 | 0.0049 |
| Certified | 0.321 | 0.54 | 0.016 | 0.018 | 0.33 | 0.200 | 0.19 | 1.00 | 0.229 |

| Analysis | Al | As | Ca | Co | N | O | Sn | V |
|-----------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1 | 0.0199 | 0.0038 | 0.0036 | 0.0085 | 0.0068 | 0.0017 | 0.011 | 0.0035 |
| 2 | 0.020 | 0.0044 | 0.0040 | 0.0105 | 0.0069 | 0.0018 | 0.011 | 0.0048 |
| 3 | 0.0201 | 0.0049 | 0.0041 | 0.0105 | 0.0070 | 0.0018 | 0.0112 | 0.0049 |
| 4 | 0.0202 | 0.0050 | 0.0044 | 0.0106 | 0.0071 | 0.0023 | 0.0117 | 0.0049 |
| 5 | 0.0204 | | 0.0047 | 0.0107 | 0.0072 | | 0.012 | 0.0055 |
| 6 | 0.021 | | 0.0047 | 0.012 | | | 0.0125 | 0.0058 |
| 7 | 0.022 | | | 0.013 | | | | |
| Average | 0.0205 | 0.0045 | 0.0043 | 0.0108 | 0.0070 | 0.0019 | 0.0116 | 0.0049 |
| Std Dev | 0.0007 | 0.0006 | 0.0004 | 0.0014 | 0.0002 | 0.0003 | 0.0006 | 0.0008 |
| Certified | 0.020 | 0.004 | 0.0043 | 0.011 | 0.0070 | 0.0019 | 0.012 | 0.005 |

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 322, E 350, E 415, E 1019, plus additional ICP and AA spectrometric methods. The following Certified Reference Materials were used to validate the analytical data listed above: NIST SRM 361 - 365, 125b; JSS 003; ECRM 085-1, 088-1, 096-1, 097-1, 184-1, 481-1

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

Brammer Standard Co., Inc., Houston, Texas
 Crucible Specialty Metals, Syracuse, New York
 Hoesch Stahl AG, Dortmund, Germany
 J. Dirats and Co., Inc., Westfield, Massachusetts
 The Timken Company, Harrison Steel Plant, Canton, Ohio
 VHG Laboratories, Inc., Manchester, New Hampshire

Additional analytical data: This material was used as an unknown test specimen in the ASTM Proficiency Testing Program (PTP) for low-alloy steel. Most of the participating laboratories used ASTM Standard Test Methods E 322, E 415, and E 1019. The data shown below are the results from the PTP.

Instrument analysis using ASTM Standard Test Method E 1019

| | C | N | O |
|--------------------|--------|--------|--------|
| Number of Labs | 30 | 27 | 22 |
| Grand Average | 0.3154 | 0.0073 | 0.0031 |
| Standard Deviation | 0.0087 | 0.0006 | 0.0020 |

Optical Emission Spectrometric Analysis using ASTM Standard Test Method E 415

| | C | Mn | P | S | Si | Cu | Ni |
|--------------------|--------|--------|--------|--------|--------|--------|--------|
| Number of Labs | 30 | 34 | 34 | 29 | 35 | 33 | 33 |
| Grand Average | 0.3243 | 0.5389 | 0.0164 | 0.0189 | 0.3270 | 0.1973 | 0.1926 |
| Standard Deviation | 0.0089 | 0.0135 | 0.0013 | 0.0021 | 0.0115 | 0.0076 | 0.0068 |

| | Cr | Mo | Al | Co | Sn | V |
|--------------------|--------|--------|--------|--------|--------|--------|
| Number of Labs | 34 | 33 | 34 | 16 | 28 | 30 |
| Grand Average | 0.9967 | 0.2268 | 0.0228 | 0.0102 | 0.0109 | 0.0050 |
| Standard Deviation | 0.0243 | 0.0069 | 0.0025 | 0.0013 | 0.0009 | 0.0014 |

X-ray Emission Spectrometric Analysis using ASTM Standard Test Method E 322

| | Mn | Cu | Ni | Cr | Mo |
|--------------------|--------|--------|--------|--------|--------|
| Number of Labs | 11 | 10 | 11 | 11 | 11 |
| Grand Average | 0.5381 | 0.1975 | 0.1901 | 1.0024 | 0.2284 |
| Standard Deviation | 0.0084 | 0.0037 | 0.0056 | 0.0086 | 0.0065 |

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 - 1265a, 1761 - 1767; ECRM 186-1, 191-1; SS 457/1, 458/1; JSS 169-4, 170-6, 171-4.

Source: This material was produced in 1991 by the Copperweld Steel Company, Warren, Ohio. The material was made in an electric arc furnace and cast into ingots. The billets were hot rolled down to 1.50 inch diameter round bars.

Available Form: This Reference Material is available only in the form of a disc, approximately 37 mm (1.50") 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.

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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:

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Houston, Texas 77069-2895 USA Fax: (281) 440-4432

Certified by: _____ on July 19, 1994.
G. R. Brammer

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Referenced Documents

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

E 322 - 67 (Reapproved 1990) Standard Method for X-Ray Emission Spectrometric Analysis of Low-Alloy Steels and Cast Irons

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 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