

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

B.S. 42

**Reference Material for AISI Modified Grade 4150 Steel**

|                                      | 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>0.516</b>                 | 0.005                                | <b>Co</b> | <b>0.012</b>                 | 0.002                                |
| <b>Mn</b>                            | <b>1.24</b>                  | 0.02                                 | <b>N</b>  | <b>0.0080</b>                | 0.0005                               |
| <b>P</b>                             | <b>0.021</b>                 | 0.002                                | <b>Sn</b> | <b>0.012</b>                 | 0.002                                |
| <b>S</b>                             | <b>0.073</b>                 | 0.003                                | <b>V</b>  | <b>0.003</b>                 | 0.001                                |
| <b>Si</b>                            | <b>0.235</b>                 | 0.0061                               |           |                              |                                      |
| <b>Cu</b>                            | <b>0.252</b>                 | 0.005                                |           |                              |                                      |
| <b>Ni</b>                            | <b>0.183</b>                 | 0.006                                | <b>As</b> | (0.004) <sup>3</sup>         |                                      |
| <b>Cr</b>                            | <b>0.67</b>                  | 0.02                                 | <b>Nb</b> | (0.002)                      |                                      |
| <b>Mo</b>                            | <b>0.190</b>                 | 0.006                                | <b>Ti</b> | (0.003)                      |                                      |
| <b>Al</b>                            | <b>0.020</b>                 | 0.002                                | <b>W</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 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> Values in parentheses are not certified and are provided for information only.

See reverse side for more information.

Original Certificate Number 42-032092  
New Certificate Number **REV-42-120409p1**

**New Certificate Number REV-42-120409 Revised to show uncertainty values on December 4, 2009**

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BS 42

analysis listed as percent concentration

Certificate Number REV-42-120409p2

| Analysis  | C      | Mn    | P      | S      | Si    | Cu     | Ni     | Cr    | Mo     | Al     |
|-----------|--------|-------|--------|--------|-------|--------|--------|-------|--------|--------|
| 1         | 0.510  | 1.21  | 0.017  | 0.0688 | 0.23  | 0.248  | 0.177  | 0.65  | 0.182  | 0.019  |
| 2         | 0.510  | 1.227 | 0.020  | 0.069  | 0.23  | 0.25   | 0.18   | 0.658 | 0.184  | 0.019  |
| 3         | 0.5117 | 1.23  | 0.0205 | 0.072  | 0.231 | 0.25   | 0.18   | 0.66  | 0.19   | 0.02   |
| 4         | 0.517  | 1.23  | 0.021  | 0.0725 | 0.234 | 0.25   | 0.18   | 0.665 | 0.19   | 0.02   |
| 5         | 0.518  | 1.24  | 0.021  | 0.0728 | 0.238 | 0.255  | 0.186  | 0.67  | 0.19   | 0.022  |
| 6         | 0.519  | 1.24  | 0.022  | 0.074  | 0.24  | 0.258  | 0.19   | 0.674 | 0.192  | 0.023  |
| 7         | 0.520  | 1.25  | 0.023  | 0.0745 | 0.24  |        | 0.19   | 0.70  | 0.20   |        |
| 8         | 0.522  | 1.25  |        | 0.075  |       |        |        |       |        |        |
| 9         |        |       |        | 0.076  |       |        |        |       |        |        |
| Average   | 0.516  | 1.235 | 0.0206 | 0.0727 | 0.235 | 0.2518 | 0.1833 | 0.668 | 0.1897 | 0.0205 |
| Std Dev   | 0.0047 | 0.013 | 0.0019 | 0.0025 | 0.005 | 0.0038 | 0.0053 | 0.016 | 0.0058 | 0.0016 |
| Certified | 0.516  | 1.24  | 0.021  | 0.073  | 0.235 | 0.252  | 0.183  | 0.67  | 0.190  | 0.020  |
| t         | 2.36   | 2.36  | 2.45   | 2.31   | 2.45  | 2.57   | 2.45   | 2.45  | 2.45   | 2.57   |
| C(95%)    | 0.004  | 0.011 | 0.0017 | 0.0019 | 0.004 | 0.004  | 0.0049 | 0.015 | 0.0054 | 0.0017 |

| Analysis  | Co     | N       | Nb      | Sn     | V      | W       | As      | Ti      |
|-----------|--------|---------|---------|--------|--------|---------|---------|---------|
| 1         | 0.009  | 0.0077  | 0.001   | 0.01   | 0.002  | 0.002   | 0.0034  | 0.001   |
| 2         | 0.010  | 0.0079  | 0.002   | 0.011  | 0.0026 | 0.002   | 0.0055  | 0.0019  |
| 3         | 0.011  | 0.0081  | 0.003   | 0.012  | 0.003  | 0.003   |         | 0.003   |
| 4         | 0.012  | 0.0082  | 0.003   | 0.012  | 0.0038 | 0.003   |         | 0.004   |
| 5         | 0.013  | 0.0083  |         | 0.013  | 0.004  |         |         | 0.005   |
| 6         | 0.013  |         |         | 0.014  |        |         |         |         |
| 7         | 0.014  |         |         | 0.014  |        |         |         |         |
| Average   | 0.0117 | 0.00804 | 0.0023  | 0.0123 | 0.0031 | 0.0025  | 0.0045  | 0.003   |
| Std Dev   | 0.0019 | 0.00024 | 0.001   | 0.0015 | 0.0008 | 0.0006  | 0.0015  | 0.002   |
| Certified | 0.012  | 0.008   | (0.002) | 0.012  | 0.003  | (0.002) | (0.004) | (0.003) |
| t         | 2.45   | 2.78    | 3.18    | 2.45   | 2.78   | 3.18    | 12.71   | 2.78    |
| C(95%)    | 0.0017 | 0.0003  | 0.0015  | 0.0014 | 0.001  | 0.0009  | 0.0133  | 0.002   |

$C(95\%) = (t \times sd) / \sqrt{n}$  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.

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

Some of the co-operating laboratories were:

Allegheny Ludlum Steel Corp., Brackenridge, Pennsylvania  
 Allegheny Ludlum Steel Corp., Lockport, New York  
 Brammer Standard Co., Inc., Houston, Texas  
 Conam Inspection, Inc., Gary, Indiana  
 Crucible Specialty Metals, Syracuse, New York  
 J. Dirats and Co., Inc., Westfield, Massachusetts  
 Hoesch Stahl AG, Dortmund, Germany  
 Jessop Steel Company, Washington, Pennsylvania  
 Midstates Analytical Laboratories, Inc., Tulsa, Oklahoma  
 VHG Laboratories, Inc., Manchester, New Hampshire

**Certification Process:** The requirements of ISO Guide 31, ISO Guide 34, and ISO Guide 35 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 millings from cross-sections of the bars. 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 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

**Validity statement:** ISO Guide 31 states that the certification should contain an expiration date for all materials where instability has been demonstrated or is considered possible, after which the certified value is no longer guaranteed by the certifying body. Whereas this material is in a solid form and stable, no expiration date is specified.

**Homogeneity:** This Reference Material was tested for homogeneity using ASTM Standard Method E 826 and found acceptable. It was also examined by spark atomic emission spectrometry and found to be compatible with the following NIST Certified Reference Materials: SRM 1134, 1135, 1222, 1224, 1225, 1261A to 1265A, 1761 to 1767

**Form:** This Reference Material is machined in the form of a disc, approximately 44 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. The entire depth of the disc may be used.

**Use:** This Reference Material is intended for use in spark atomic emission and x-ray spectrometric methods of analysis. Refer to ISO Guide 33 for information about the use of Reference Materials.

**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 REV-42-120409px, where x indicates the page number. This BS 42 Certificate of Analysis was revised to show the estimate of uncertainty for the certified values. After reviewing the analytical data, a third decimal place was added to the Si, Cu, Ni, and Mo certified values. Also, the niobium and tungsten were changed from certified to uncertified due to the small amount of data .

The original date of certification was January 10, 1991. The first revision of the original certificate of analysis was made on March 20, 1992, after the material was retested by additional laboratories in 1991 and 1992. In 1992, additional elements were certified. Also, as a result of the retesting in 1992, the certified analysis was revised slightly for carbon, chromium, manganese, sulfur, titanium, and tin.

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:

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Houston, Texas 77069-2895 USA

Phone: (281) 440-9396

Fax: (281) 440-4432

web: [brammerstandard.com](http://brammerstandard.com)

email: [contact@brammerstandard.com](mailto:contact@brammerstandard.com)

Certified by: Beau R. Brammer on December 4, 2009.

**Certificate Number REV-42-120409p3**

**Brammer Standard Company, Inc., is accredited to ISO Guide 34 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials by A2LA (Certificate Number 656.02)**  
**The scope of accreditation is listed on the website: [www.brammerstandard.com](http://www.brammerstandard.com)**

**Brammer Standard Company's Chemical Laboratory is accredited to ISO Standard 17025 by A2LA.**  
**(Certificate Number 656.01)**

**By Certificate Number 10539, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9001:2000 by National Quality Assurance, U.S.A.**

## **Referenced Documents**

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

Versions available at the time of 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

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

- ISO Guide 30:1992 Terms and definitions used in connection with reference materials plus amendment of 2008
- ISO Guide 31:2000 Reference materials -Contents of certificates and labels
- ISO Guide 33:2000 Uses of certified reference materials
- ISO Guide 34:2009 General requirements for the competence of reference material producers
- ISO Guide 35:2006 Reference Materials - General and statistical principles for certification

*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 REV-42-120409p4**