

Brammer Standard Company, Inc.
Certificate of Analysis

B.S. 59C

AISI 4140 Low Alloy Steel

| | | | |
|------------|-------|----------|--------|
| Carbon | 0.41 | Aluminum | 0.022 |
| Manganese | 0.88 | Cobalt | 0.010 |
| Phosphorus | 0.010 | Nitrogen | 0.0059 |
| Sulfur | 0.020 | Tin | 0.009 |
| Silicon | 0.22 | Titanium | 0.002 |
| Copper | 0.11 | Vanadium | 0.003 |
| Nickel | 0.16 | | |
| Chromium | 0.99 | | |
| Molybdenum | 0.16 | | |

(analysis listed as percent by weight)

Some of the co-operating laboratories were:

Analytical Process Laboratories, Milwaukee, Wisconsin
Brammer Standard Co., Inc., Houston, Texas
Chicago Spectro Service Laboratory, Chicago, Illinois
Crucible Specialty Metals, Syracuse, New York
Hoesch Stahl AG, Dortmund, Germany
J. Dirats and Co., Inc., Westfield, Massachusetts
Midstates Analytical Laboratories, Inc., Tulsa, Oklahoma
VHG Laboratories, Inc., Manchester, New Hampshire

Note: This is a revision of the original certificate of analysis. The material was retested by additional laboratories in 1991 and 1992. Additional elements are now certified. Also, as a result of the retesting, the certified analysis has been revised slightly for P, S, Sn, and Al.

See reverse side for more information.

Certificate Number REV59C-040892

Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069
Telephone (281) 440-9396 Fax (281) 440-4432

| Analysis | C | Mn | P | S | Si | Cu | Ni | Cr | Mo |
|-----------|-------|-------|--------|--------|-------|-------|-------|-------|-------|
| 1 | 0.402 | 0.87 | 0.009 | 0.019 | 0.20 | 0.10 | 0.148 | 0.969 | 0.155 |
| 2 | 0.402 | 0.877 | 0.0094 | 0.0198 | 0.21 | 0.11 | 0.152 | 0.97 | 0.156 |
| 3 | 0.406 | 0.88 | 0.010 | 0.020 | 0.215 | 0.113 | 0.153 | 0.98 | 0.157 |
| 4 | 0.409 | 0.88 | 0.010 | 0.0208 | 0.217 | 0.114 | 0.16 | 0.989 | 0.16 |
| 5 | 0.411 | 0.90 | 0.010 | 0.022 | 0.224 | 0.117 | 0.16 | 0.99 | 0.16 |
| 6 | 0.412 | | 0.011 | | 0.23 | 0.118 | 0.16 | 1.00 | 0.16 |
| 7 | 0.417 | | 0.012 | | | 0.119 | 0.163 | 1.022 | 0.166 |
| 8 | 0.42 | | | | | | | | |
| Average | 0.410 | 0.881 | 0.0102 | 0.0203 | 0.216 | 0.113 | 0.157 | 0.989 | 0.159 |
| Std Dev | 0.007 | 0.011 | 0.0010 | 0.0011 | 0.011 | 0.007 | 0.006 | 0.018 | 0.004 |
| Certified | 0.41 | 0.88 | 0.010 | 0.020 | 0.22 | 0.11 | 0.16 | 0.99 | 0.16 |

| Analysis | Al | Co | N | Sn | Ti | V |
|-----------|--------|--------|---------|--------|--------|--------|
| 1 | 0.0186 | 0.009 | 0.0057 | 0.0073 | 0.0007 | 0.002 |
| 2 | 0.020 | 0.010 | 0.0058 | 0.0076 | 0.002 | 0.002 |
| 3 | 0.021 | 0.010 | 0.0058 | 0.008 | 0.002 | 0.0025 |
| 4 | 0.0227 | 0.0101 | 0.0060 | 0.008 | 0.002 | 0.003 |
| 5 | 0.024 | 0.013 | 0.0060 | 0.010 | 0.0025 | 0.0033 |
| 6 | 0.025 | | | 0.010 | 0.004 | 0.004 |
| 7 | | | | 0.010 | | |
| Average | 0.0219 | 0.0104 | 0.00586 | 0.0087 | 0.0022 | 0.0028 |
| Std Dev | 0.0024 | 0.0015 | 0.00013 | 0.0012 | 0.0011 | 0.0008 |
| Certified | 0.022 | 0.010 | 0.0059 | 0.009 | 0.002 | 0.003 |

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. 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

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

The bar stock used for this material was produced by hot-rolling billets and annealing. The entire depth of the disc may be used.

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 March 20, 1992.

G. R. Brammer