

Brammer Standard Company, Inc.

Revised Certificate of Analysis

B.S. CA-4

Chill-cast Low Alloy Steel with Calcium

| | | | | | | | |
|-----------|-----------|----------|-----------|------------------|-----------|-----------|-----------|
| <u>C</u> | <u>Mn</u> | <u>P</u> | <u>S</u> | <u>Si</u> | <u>Cu</u> | <u>Ni</u> | <u>Cr</u> |
| 0.220 | 1.32 | 0.012 | 0.009 | 0.44 | 0.016 | 0.17 | 0.067 |
| | | | | Acid Soluble* | Total* | | |
| <u>Mo</u> | <u>Sn</u> | <u>V</u> | <u>Nb</u> | <u>Al</u> | <u>Al</u> | <u>As</u> | <u>Ca</u> |
| 0.038 | 0.023 | 0.011 | (0.002) | 0.010 | 0.016 | 0.051 | 0.0018 |

Data listed as percent by weight.

Acid mixture used for acid soluble aluminum was 2 parts water, 3 parts HCl, and 1 part HNO₃

* Acid soluble aluminum and total aluminum values were revised on March 15, 1993 with data from a new interlaboratory testing program. Original certificate date was November 1, 1985.

This Reference Material was chill-cast by a rapid unidirectional solidification procedure. The certified portion for each disk is the portion extending upward 10 mm from the larger diameter surface. Shrinkage cavities may appear in the top portion of some disks; they do not effect the certified portion.

This BS CA-4 Reference Material is part of a series of 5 calcium treated steels produced for the calibration and curve checking of optical emission and x-ray fluorescence spectrometers. An effort was made to maintain the C, Mn, P, S, Si, and Cu at similar levels in the different melts to produce a similar matrix. Nickel varies with the calcium content in the series since the calcium was added to each melt as a nickel-calcium alloy.

Sixteen laboratories in three countries cooperated in providing the certification data for this material. Listed below are some of the laboratories.

Allegheny Ludlum Steel Corp., Brackenridge, Pennsylvania
Armco Steel Corporation, Middletown, Ohio
Brammer Standard Company, Houston, Texas
Japan Inspection Company, Tokyo, Japan
Luvak, Inc., Boylston, Massachusetts
Midstates Analytical Laboratories, Inc., Tulsa, Oklahoma
Turret Alloys Ltd., Analytical Services, Sheffield, England
VHG Labs, Inc., Andover, Massachusetts

Producer analysis was provided by the American Cast Iron Pipe Company, (ACIPCO), Birmingham, Alabama.

See data on reverse side.

Certificate No. REVCA4-031593

Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895
Telephone (281) 440-9396 Fax (281) 440-4432

| Analysis Number | C | Mn | P | S | Si | Cu | Ni | Cr | Mo | Sn |
|-----------------|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1 | 0.217 | 1.30 | 0.010 | 0.0080 | 0.420 | 0.014 | 0.160 | 0.062 | 0.033 | 0.018 |
| 2 | 0.218 | 1.31 | 0.011 | 0.0080 | 0.428 | 0.016 | 0.166 | 0.065 | 0.035 | 0.022 |
| 3 | 0.219 | 1.32 | 0.012 | 0.0085 | 0.430 | 0.016 | 0.166 | 0.065 | 0.038 | 0.023 |
| 4 | 0.220 | 1.32 | 0.013 | 0.0088 | 0.442 | 0.016 | 0.168 | 0.068 | 0.038 | 0.025 |
| 5 | 0.220 | 1.33 | 0.013 | 0.0090 | 0.445 | 0.016 | 0.174 | 0.068 | 0.038 | 0.026 |
| 6 | 0.222 | 1.33 | 0.014 | 0.0090 | 0.447 | 0.016 | 0.175 | 0.069 | 0.039 | 0.026 |
| 7 | 0.224 | 1.35 | 0.014 | 0.0091 | 0.448 | 0.017 | 0.176 | 0.069 | 0.040 | |
| 8 | | | | | 0.452 | 0.018 | | 0.070 | 0.042 | |
| Average | 0.2200 | 1.323 | 0.0124 | 0.0086 | 0.4390 | 0.0161 | 0.1693 | 0.0670 | 0.0379 | 0.0233 |
| Std. Dev. | 0.0024 | 0.016 | 0.0015 | 0.0005 | 0.0115 | 0.0011 | 0.0059 | 0.0027 | 0.0028 | 0.0031 |
| Certified | 0.220 | 1.32 | 0.012 | 0.009 | 0.44 | 0.016 | 0.17 | 0.067 | 0.038 | 0.023 |

| Analysis Number | V | Nb | Acid sol. Al * | Total Al * | As | Ca | Pb | Ti | Co | Zr |
|-----------------|--------|---------|----------------|------------|--------|---------|--------|--------|--------|--------|
| 1 | 0.0090 | 0.0010 | 0.0088 | 0.012 | 0.048 | 0.0013 | 0.0005 | 0.0030 | 0.0030 | 0.0010 |
| 2 | 0.0095 | 0.0010 | 0.009 | 0.012 | 0.048 | 0.0016 | 0.0006 | 0.0040 | 0.0040 | 0.0012 |
| 3 | 0.0110 | 0.0014 | 0.0091 | 0.016 | 0.049 | 0.0017 | 0.0007 | 0.0041 | 0.0044 | 0.0014 |
| 4 | 0.0110 | 0.0020 | 0.0097 | 0.016 | 0.050 | 0.0017 | | | | |
| 5 | 0.0110 | 0.0020 | 0.0100 | 0.0167 | 0.051 | 0.0018 | | | | |
| 6 | 0.0115 | 0.0030 | 0.011 | 0.0169 | 0.053 | 0.0018 | | | | |
| 7 | 0.0120 | 0.0040 | 0.011 | 0.0174 | 0.055 | 0.0019 | | | | |
| 8 | | | 0.012 | 0.0175 | | 0.0020 | | | | |
| 9 | | | 0.0137 | 0.018 | | 0.002 | | | | |
| 10 | | | | 0.0212 | | | | | | |
| Average | 0.0107 | 0.0021 | 0.0105 | 0.0164 | 0.0506 | 0.00178 | 0.0006 | 0.0037 | 0.0038 | 0.0012 |
| Std. Dev. | 0.0011 | 0.0011 | 0.0016 | 0.0027 | 0.0026 | 0.00025 | | | | |
| Certified | 0.011 | (0.002) | 0.010 | 0.016 | 0.051 | 0.0018 | | | | |

* Acid soluble aluminum and total aluminum values were revised on March 15, 1993 with data from a new interlaboratory testing program. Original certificate date was November 1, 1985.

Chemical analyses were made on drillings obtained from the larger diameter surface to a depth of 10 mm. The methods of analysis were classical "wet" analysis, atomic absorption and plasma excitation techniques. Combustion instruments were used for carbon and sulfur analysis.

Note: Proper surface preparation is crucial in the instrumental determination of aluminum and calcium. Avoid grinding methods which contain significant levels of aluminum and calcium. Use the same method of surface preparation on all Reference Materials and test samples.

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

Certified by G. R. Brammer on March 15, 1993.