

Brammer Standard Company, Inc.

Certificate of Analysis

B.S. 955B

Reference Material for Bronze CDA Grade 955

| | Certified Value ¹ | Estimate of Uncertainty ² | | Uncertified Value ³ |
|--------------------------------------|---------------------------------|---|-----------|-----------------------------------|
| Analysis listed as percent by weight | | | | |
| Cu | 81.5 | 0.12 | Sb | (0.002) |
| Sn | 0.024 | 0.002 | Ag | (0.009) |
| Pb | 0.051 | 0.003 | As | (0.002) |
| Zn | 0.052 | 0.003 | C | (0.007) |
| P | 0.017 | 0.003 | | |
| Ni | 4.11 | 0.05 | | |
| Fe | 3.79 | 0.06 | | |
| Mn | 0.12 | 0.006 | | |
| Si | 0.05 | 0.01 | | |
| Al | 10.30 | 0.05 | | |
| S | 0.002 | 0.0005 | | |

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 the 95% confidence interval. The half-width confidence interval C(95%) is shown on page 2.

³ Data in parentheses are not certified and are provided for information only.

See reverse side for more information.

Certificate Number 955B-090899p1

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| Analysis | * | Cu | * | Sn | * | Pb | * | Zn | * | P | * | Ni | * | Fe | * | Mn |
|-----------|----|--------|----|--------|---|--------|----|--------|---|--------|----|--------|----|--------|---|--------|
| 1 | 7 | 81.38 | 14 | 0.0222 | 1 | 0.049 | 1 | 0.046 | 1 | 0.012 | 1 | 4.06 | 17 | 3.66 | 2 | 0.116 |
| 2 | 11 | 81.45 | 1 | 0.0223 | 4 | 0.049 | 14 | 0.0479 | 4 | 0.016 | 1 | 4.06 | 1 | 3.686 | 1 | 0.1168 |
| 3 | 7 | 81.46 | 1 | 0.0235 | 4 | 0.050 | 1 | 0.0501 | 1 | 0.017 | 1 | 4.065 | 1 | 3.758 | 1 | 0.119 |
| 4 | 7 | 81.47 | 1 | 0.0240 | 1 | 0.050 | 1 | 0.0510 | 1 | 0.0174 | 2 | 4.07 | 4 | 3.78 | 1 | 0.122 |
| 5 | 1 | 81.5 | 4 | 0.025 | 1 | 0.0513 | 1 | 0.0515 | 4 | 0.018 | 4 | 4.08 | 2 | 3.78 | 4 | 0.123 |
| 6 | 8 | 81.50 | 2 | 0.025 | 1 | 0.0534 | 4 | 0.052 | 1 | 0.019 | 1 | 4.10 | 2 | 3.80 | 1 | 0.124 |
| 7 | 12 | 81.50 | 4 | 0.025 | 1 | 0.055 | 1 | 0.053 | 1 | 0.021 | 4 | 4.11 | 1 | 3.80 | 1 | 0.127 |
| 8 | 1 | 81.62 | 1 | 0.025 | | | 1 | 0.054 | | | 18 | 4.13 | 2 | 3.80 | 4 | 0.13 |
| 9 | 7 | 81.62 | 1 | 0.026 | | | 4 | 0.055 | | | 1 | 4.132 | 1 | 3.81 | 2 | 0.13 |
| 10 | | | | | | | 2 | 0.056 | | | 2 | 4.15 | 1 | 3.82 | 1 | 0.13 |
| 11 | | | | | | | | | | | 1 | 4.15 | 2 | 3.83 | | |
| 12 | | | | | | | | | | | 1 | 4.18 | 1 | 3.83 | | |
| 13 | | | | | | | | | | | | | 4 | 3.89 | | |
| Average | | 81.500 | | 0.0242 | | 0.0511 | | 0.0517 | | 0.0172 | | 4.1073 | | 3.788 | | 0.124 |
| Std Dev | | 0.078 | | 0.0013 | | 0.0023 | | 0.0031 | | 0.0028 | | 0.0410 | | 0.060 | | 0.005 |
| Certified | | 81.5 | | 0.024 | | 0.051 | | 0.052 | | 0.017 | | 4.11 | | 3.79 | | 0.12 |
| t | | 2.306 | | 2.306 | | 2.4469 | | 2.2622 | | 2.4469 | | 2.201 | | 2.1788 | | 2.2622 |
| C(95%) | | 0.060 | | 0.0010 | | 0.0021 | | 0.0022 | | 0.0026 | | 0.0261 | | 0.036 | | 0.004 |

continued from above

| Analysis | * | Si | * | Al | * | S | * | Sb | * | Ag | * | As | * | C |
|-----------|---|--------|----|--------|---|--------|----|---------|----|---------|----|---------|---|---------|
| 1 | 1 | 0.040 | 1 | 10.23 | 6 | 0.0014 | 3 | 0.00085 | 14 | 0.0066 | 1 | 0.0008 | 6 | 0.004 |
| 2 | 1 | 0.0401 | 10 | 10.28 | 6 | 0.0017 | 16 | 0.0012 | 1 | 0.0067 | 3 | 0.0011 | 6 | 0.005 |
| 3 | 4 | 0.043 | 4 | 10.28 | 6 | 0.002 | 1 | 0.0016 | 1 | 0.0068 | 16 | 0.0018 | 6 | 0.0056 |
| 4 | 1 | 0.047 | 15 | 10.30 | 6 | 0.002 | 14 | 0.0016 | 1 | 0.0069 | 4 | 0.002 | 6 | 0.012 |
| 5 | 1 | 0.049 | 1 | 10.323 | 4 | 0.002 | 4 | 0.004 | 13 | 0.0070 | 4 | 0.003 | | |
| 6 | 4 | 0.052 | 1 | 10.34 | 6 | 0.0024 | | | 3 | 0.0118 | | | | |
| 7 | 2 | 0.054 | 15 | 10.34 | 6 | 0.0024 | | | 1 | 0.0119 | | | | |
| 8 | 1 | 0.0599 | | | | | | | 1 | 0.0120 | | | | |
| Average | | 0.0481 | | 10.299 | | 0.0020 | | 0.0019 | | 0.0087 | | 0.0017 | | 0.0067 |
| Std Dev | | 0.0070 | | 0.040 | | 0.0004 | | 0.0012 | | 0.0026 | | 0.0009 | | 0.0036 |
| Certified | | 0.05 | | 10.30 | | 0.002 | | (0.002) | | (0.009) | | (0.002) | | (0.007) |
| t | | 2.3646 | | 2.4469 | | 2.4469 | | | | | | | | |
| C(95%) | | 0.0059 | | 0.037 | | 0.0003 | | | | | | | | |

* see page 3 for methods of analysis

Data in parentheses are not certified but provided for information only.
Data listed as mass fraction expressed as percent.

$C(95\%) = (t \times sd) / \sqrt{n}$ 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 35:1989 section 4.

Certification Process: The requirements of ISO Guide 31, ISO Guide 34, ISO Guide 35, and ASTM Standard Guides E 1724 and E 1831 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 chips prepared by a lathe from the certified portion of the bars. 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 ICP, OES, GFAA, and AA spectrometric methods plus classical wet methods.

Methods of analysis:

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| *Method | Description |
|---------|--|
| 1 | AES - Inductively Coupled Plasma |
| 2 | AAS - Atomic Absorption Spectrometry |
| 3 | FAAS - Flameless Atomic Absorption Spectrometry |
| 4 | AES - Optical Emission Spectrometry |
| 6 | Combustion-Infrared Absorption |
| 7 | ASTM E 76-88 sulfuric acid electrolytic |
| 8 | ASTM E 478-89a Electrolytic |
| 10 | Gravimetric |
| 11 | Cu by difference |
| 12 | Iodometric titration |
| 13 | Glow Discharge OES |
| 14 | Nuclear activation analysis INNA |
| 15 | EDTA titration following electrolysis, retitration after fluoride substitution of EDTA in Al complex |
| 16 | AAS - Atomic Absorption Spectrometry with hydride generation |
| 17 | MAS - Thiocyanate photometric |
| 18 | ASTM E 54-80 Dimethylglyoxime gravimetric |

AES = Atomic Emission Spectrometry

MAS = Molecular Absorption Spectrometry (photometric, spectrophotometric methods)

Co-operating Laboratories: The co-operating laboratories were:

Analytical Associates, Detroit, Michigan
Anarem, Praha, Czech Republic
Brammer Standard Co., Inc., Houston, Texas
W. B. Coleman Testing Laboratories, West Chester, Pennsylvania
J. Dirats and Co., Inc., Westfield, Massachusetts
Laboratory Testing Inc., Dublin, Pennsylvania
Leco Corporation, St. Joseph, Michigan
Andrew S. McCreath & Son Inc., Harrisburg, Pennsylvania
VHG Laboratories, Inc., Manchester, New Hampshire

By Certificate Number R-021, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9002 by the American Association for Laboratory Accreditation (A2LA).

**Brammer Standard Company's Chemical Laboratory is accredited to ISO Guide 25 by A2LA.
(Certificate Number 656.01)**

References:

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

E 54 - 80 (Reapproved 1996) Standard Test Methods for Chemical Analysis of Special Brasses and Bronzes

E 76 - 88 (Reapproved 1993) Standard Test Methods for Chemical Analysis of Nickel-Copper Alloys

E 478 - 89a (Reapproved 1996) Standard Test Methods for Chemical Analysis of Copper Alloys

E 826 - 85 (Reapproved 1990) Standard Practice for Testing Homogeneity of Materials for the Development of Reference Materials

E 1724 - 95 Standard Guide for Testing and Certification of Metal and Metal-Related Reference Materials

E 1831 - 96 Standard Guide for Preparing Certificates for Reference Materials Relating to Chemical Composition of Metals, Ores, and Related Materials.

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 34 (First edition, 1996), Quality system guidelines for the production of 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