

Brammer Standard Company, Inc.

Provisional Certificate of Analysis

BS 291HH

Certified Reference Material for Chill Cast Iron

Analysis listed as percent by weight

| | Estimated Analysis ¹ | | Estimated Analysis ¹ |
|----|---------------------------------|----|---------------------------------|
| Al | 0.038 | Ni | 0.10 |
| As | 0.005 | O | <0.05 |
| B | 0.014 | P | 0.025 |
| C | 3.35 | Pb | 0.0002 |
| Ca | 0.001 | S | 0.009 |
| Co | 0.005 | Sb | 0.007 |
| Cr | 0.037 | Si | 2.31 |
| Cu | 0.21 | Sn | 0.056 |
| Fe | 93.2 | Ta | <0.05 |
| H | <0.005 | Ti | 0.023 |
| Mg | 0.044 | V | 0.021 |
| Mn | 0.53 | W | 0.006 |
| Mo | 0.030 | Zn | <0.05 |
| N | <0.05 | Zr | 0.002 |
| Nb | 0.002 | | |

¹ The estimated value listed is the present best estimate of the true value. Values are given in weight percent.

Form: This CRM is machined in the form of a disc, approximately 35mm in diameter and 30mm thick by Brammer Standard Company, Inc.

A detailed final certificate of analysis will be supplied by July 28, 2025

| 291HH | Al | As | B | Be | Bi | C | Ca | Ce | Co | Cr | Cu | Fe | H | Mg |
|--------------------|--------------|--------------|--------------|----|----|-------------|--------------|----|--------------|--------------|-------------|-------------|------------------|--------------|
| CSONH | | | | | | 3.39 | | | | | | | 0.00054 | |
| SAES 5/26 | 0.037 | 0.0044 | 0.0147 | | | 3.36 | 0.0011 | | 0.006 | 0.0353 | 0.212 | 93.14 | | 0.044 |
| SAES 6/1 | 0.039 | 0.0045 | 0.0146 | | | 3.34 | 0.001 | | 0.0052 | 0.0356 | 0.213 | 93.17 | | 0.044 |
| SAES 6/6 | 0.037 | 0.0046 | 0.0147 | | | 3.38 | 0.0009 | | 0.0051 | 0.0353 | 0.21 | 93.14 | | 0.044 |
| SAES 6/16 | 0.037 | 0.0051 | 0.0147 | | | 3.33 | 0.0009 | | 0.0061 | 0.036 | 0.211 | 93.21 | | 0.044 |
| SAES 6/22 | 0.038 | 0.0048 | 0.0146 | | | 3.38 | 0.001 | | 0.0055 | 0.0354 | 0.213 | 93.11 | | 0.044 |
| SAES Depth | 0.038 | 0.005 | 0.0147 | | | 3.32 | 0.0015 | | 0.0056 | 0.0357 | 0.212 | 93.19 | | 0.044 |
| GDS 5/26 | 0.037 | | 0.0145 | | | 3.34 | 0.0011 | | 0.0034 | 0.0348 | 0.211 | 93.17 | | 0.044 |
| GDS 6/1 | 0.038 | | 0.0147 | | | 3.35 | 0.0011 | | 0.0023 | 0.035 | 0.211 | 93.16 | | 0.044 |
| GDS 6/8 | 0.039 | | 0.0146 | | | 3.35 | 0.0011 | | 0.0011 | 0.035 | 0.211 | 93.17 | | 0.044 |
| GDS 6/16 | 0.038 | | 0.0146 | | | 3.36 | 0.0011 | | 0.0013 | 0.0349 | 0.212 | 93.16 | | 0.044 |
| GDS 6/22 | 0.038 | | 0.0144 | | | 3.33 | 0.0011 | | 0.0041 | 0.0354 | 0.211 | 93.18 | | 0.044 |
| GDS Depth | 0.038 | | 0.0146 | | | 3.31 | 0.001 | | 0.0043 | 0.0354 | 0.211 | 93.19 | | 0.044 |
| Homogeneity | 0.039 | 0.00486867 | 0.01286109 | | | 3.38811316 | | | | 0.03188957 | 0.22175797 | | | 0.044 |
| Trump | 0.038 | 0.0050 | 0.015 | | | 3.35 | 0.0051 | | 0.016 | 0.067 | 0.229 | | | 0.044 |
| | 0.039 | | | | | | | | | | | | | 0.044 |
| | 0.038 | | | | | | | | | | | | | 0.044 |
| | 0.037 | | | | | | | | | | | | | 0.044 |
| | 0.038 | | | | | | | | | | | | | 0.044 |
| | 0.037 | | | | | | | | | | | | | 0.044 |
| | 0.039 | | | | | | | | | | | | | 0.044 |
| | 0.037 | | | | | | | | | | | | | 0.044 |
| Average | 0.037904762 | 0.004783584 | 0.014518649 | | | 3.351874211 | 0.001384615 | | 0.005076923 | 0.037334969 | 0.213482712 | 93.16583333 | 0.00054 | 0.044 |
| Certificate | 0.038 | 0.005 | 0.014 | | | 3.35 | 0.001 | | 0.005 | 0.037 | 0.21 | 93.2 | <0.005 | 0.044 |

| 291HH | Mn | Mo | N | Nb | Ni | O | P | Pb | S | Sb | Si | Sn | Ta | Ti |
|--------------------|-------------|--------------|-----------------|--------------|-------------|-----------------|--------------|---------------|--------------|--------------|-------------|--------------|-----------------|--------------|
| CSONH | | | 0.0068 | | | 0.0016 | | | 0.0095 | | | | | |
| SAES 5/26 | 0.524 | 0.0313 | | 0.0019 | 0.102 | | 0.0243 | | 0.0076 | 0.0064 | 2.33 | 0.0551 | | 0.0222 |
| SAES 6/1 | 0.53 | 0.0312 | | 0.0015 | 0.102 | | 0.0245 | 0.0001 | 0.008 | 0.0059 | 2.32 | 0.0552 | 0.0025 | 0.0221 |
| SAES 6/6 | 0.527 | 0.0309 | | 0.0014 | 0.103 | | 0.0238 | | 0.0077 | 0.0057 | 2.32 | 0.0544 | | 0.0219 |
| SAES 6/16 | 0.532 | 0.0317 | | 0.0013 | 0.101 | | 0.0241 | | 0.0082 | 0.0066 | 2.3 | 0.0547 | | 0.0221 |
| SAES 6/22 | 0.528 | 0.0314 | | 0.0021 | 0.102 | | 0.0244 | 0.0003 | 0.0079 | 0.0061 | 2.33 | 0.0554 | | 0.0221 |
| SAES Depth | 0.532 | 0.0315 | | 0.002 | 0.101 | | 0.0256 | 0.0002 | 0.0101 | 0.0054 | 2.32 | 0.0568 | | 0.0222 |
| GDS 5/26 | 0.536 | 0.0297 | | 0.0027 | 0.101 | | 0.0241 | | 0.0092 | 0.0053 | 2.31 | 0.0557 | | 0.0221 |
| GDS 6/1 | 0.536 | 0.0293 | | 0.0028 | 0.102 | | 0.0238 | | 0.009 | 0.0061 | 2.31 | 0.0563 | | 0.0218 |
| GDS 6/8 | 0.536 | 0.0298 | | 0.0027 | 0.102 | | 0.0239 | | 0.0091 | 0.0092 | 2.31 | 0.0574 | | 0.0223 |
| GDS 6/16 | 0.534 | 0.0299 | | 0.0031 | 0.102 | | 0.0241 | 0.000061 | 0.009 | 0.0103 | 2.31 | 0.0581 | | 0.0222 |
| GDS 6/22 | 0.535 | 0.0298 | | 0.0029 | 0.101 | | 0.0242 | 0.0001 | 0.0091 | 0.0095 | 2.31 | 0.0569 | | 0.0221 |
| GDS Depth | 0.53 | 0.0293 | | 0.0031 | 0.101 | | 0.0247 | 0.0005 | 0.0098 | 0.0092 | 2.32 | 0.0579 | | 0.0225 |
| Homogeneity | 0.54002065 | 0.02986866 | | | 0.10085941 | | 0.02449758 | | 0.00946204 | | 2.29512595 | 0.05543877 | | 0.02395359 |
| Trump | 0.501 | 0.032 | | | 0.102 | | 0.032 | | 0.016 | | 2.29 | | | 0.027 |
| Average | 0.530072904 | 0.030547761 | 0.0068 | 0.00229 | 0.10163282 | 0.0016 | 0.02485697 | 0.00021017 | 0.009310803 | 0.007141667 | 2.312508996 | 0.056102982 | 0.0025 | 0.022610971 |
| Certificate | 0.53 | 0.030 | <0.05 | 0.002 | 0.10 | <0.05 | 0.025 | 0.0002 | 0.009 | 0.007 | 2.31 | 0.056 | <0.05 | 0.023 |

| 291HH | V | W | Zn | Zr |
|--------------------|--------------|--------------|-----------------|--------------|
| CSONH | | | | |
| SAES 5/26 | 0.02 | 0.0031 | | 0.0017 |
| SAES 6/1 | 0.0191 | 0.0037 | | 0.0018 |
| SAES 6/6 | 0.0199 | 0.0028 | | 0.0017 |
| SAES 6/16 | 0.0199 | 0.0033 | | 0.0015 |
| SAES 6/22 | 0.0205 | 0.0034 | | 0.0018 |
| SAES Depth | 0.0209 | 0.0033 | | 0.0019 |
| GDS 5/26 | 0.0208 | 0.0159 | | 0.0023 |
| GDS 6/1 | 0.0207 | 0.0177 | | 0.0023 |
| GDS 6/8 | 0.0207 | 0.002 | | 0.0023 |
| GDS 6/16 | 0.0209 | 0.0021 | | 0.0023 |
| GDS 6/22 | 0.021 | 0.0028 | | 0.0023 |
| GDS Depth | 0.0213 | 0.0058 | | 0.0024 |
| Homogeneity | 0.02094237 | | | |
| Trump | 0.032 | 0.018 | 0.009 | |
| Average | 0.021331598 | 0.006453846 | 0.009 | 0.00203 |
| Certificate | 0.021 | 0.006 | <0.05 | 0.002 |

Homogeneity: This Certified Reference Material (CRM) was tested for homogeneity using ASTM Standard Method E826 and found acceptable. It was also examined by spark atomic emission spectrometry and found to be compatible with the following Reference Materials: BS C14, 7A, 8, 291, 291EB, 291GI; CZ SPL 17 31A, SPL 17 36A; SRM 1140, 1141A.

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. The certification of BS 291HH is valid indefinitely. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

Storage: This CRM must be stored in a cool, dry, non-corrosive environment.

Source: The cast stock for this CRM was produced by Shijazhuang Trump Scientific Co, LTD; Shijazhuang, China.

Certified Area: The certified area of each disc is the portion extending several mm inward from each surface.

Note: Shrinkage cavities may appear in the horizontal center of some discs. These cavities are normal and will not affect the certified portions of the disc.

Sample Preparation: For best analytical results, use the same method for preparing the analytical surface on all reference materials as used for production specimens. Avoid overheating the sample during surface preparation.

Caution: CRM contains significant insoluble soft metal inclusions. Surface smearing may occur. Spark atomic emission spectrometers may require extended preburns to compensate.

Safety Notice: A Safety Data Sheet (SDS) 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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Certified by: _____ on July 28, 2023.

Beau R. Brammer
President