# BRAMMER STANDARD COMPANY, INC.

## Certificate of Analysis

## BS TRM-2A

Certified Reference Material for Inconel 600 - UNS Number N06600

| | Certified Value[1] | Estimate of Uncertainty[2] |
|---|---|---|
| **Yield Strength, KSI** | **116.2** | 0.9 |
| **Tensile Strength, KSI** | **125.6** | 0.7 |
| **Total Elongation, %** | **20.1** | 0.6 |
| **Reduction, %** | **57.7** | 0.9 |
| **Hardness, HRB[3]** | **103** | 2 |

[1] For each property the certified value listed is the present best estimate of the true value based on the mean of the weighted results of an interlaboratory testing program. See page 2 for more information on its calculation.

[2] For each property, the uncertainty listed is based on a statistical evaluation of the contributions of homogeneity and the interlaboratory testing program. See page 2 for more information on its calculation.

[3] Hardness determined by the Rockwell B scale; 100 kgf 1/16" diameter.

The requirements of ISO Guides 30, 31, and 35 were followed for the preparation of this Certified Reference Material and certificate of analysis.

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| Analysis | Yield, KSI | Tensile, KSI | Elongation, % | Reduction, % | Hardness, HRB |
|---|---|---|---|---|---|
| 1 | 114.2 | 124.5 | 19.2 | 56.3 | 100 |
| 2 | 114.7 | 124.9 | 19.5 | 56.4 | 101 |
| 3 | 114.7 | 125.1 | 19.6 | 56.7 | 102 |
| 4 | 116.2 | 125.4 | 20.0 | 57.5 | 103 |
| 5 | 116.3 | 125.6 | 20.3 | 57.5 | 103 |
| 6 | 116.6 | 125.7 | 20.3 | 57.6 | 103.25 |
| 7 | 116.9 | 125.8 | 20.4 | 57.9 | 105 |
| 8 | 116.968 | 125.8 | 20.5 | 59.0 | 106.0 |
| 9 | 117.7 | 125.9 | 20.6 | 60.6 | 106 |
| 10 | 117.8 | 126.1 | 21.0 | | 106 |
| 11 | | 126.57 | | | |
| Average | 116.21 | 125.58 | 20.14 | 57.72 | 103.38 |
| Std dev | 0.84 | 0.85 | 0.25 | 0.54 | 0.59 |
| H | 0.593691 | 0.643511 | 0.105752 | 0.291621 | 0.526091 |
| $U_1$ | 1.03 | 1.06 | 0.27 | 0.62 | 0.79 |
| T-statistic | 2.26 | 2.23 | 2.26 | 2.31 | 2.26 |
| $U_2$ | 2.33 | 2.37 | 0.62 | 1.42 | 1.80 |
| $U_3$ | 0.74 | 0.71 | 0.20 | 0.47 | 0.57 |
| **Certified** | **116.2** | **125.6** | **20.1** | **57.7** | **103** |
| **Uncertainty** | **0.9** | **0.7** | **0.6** | **0.9** | **2** |
| Tolerance | 2.7 | 2.4 | 1.8 | 2.7 | 6 |

*For each property, in accordance with the requirements of ISO Guides 34 and 35, an effort must be made to account for the effects on the certified value of the uncertainty estimate from homogeneity testing (H) and the combined uncertainties of the contributing laboratories. The average (A) is calculated using a weighted mean where the reciprocal of the square of each laboratory's combined uncertainty ($C_L$), calculated from its standard deviation ($S_L$) and its uncertainty estimate ($U_L$), is used as the weight ($W_L$) for it's mean ($M_L$). The standard deviation (S) is calculated as the square root of the reciprocal of the sum of the weights. $U_1$ is the combined uncertainty from homogeneity and labs. $U_2$ is $U_1$ times the coverage factor (95 % t-statistic). $U_3$ is $U_2$ divided by the square root of the number of determinations (n). Thus:*

$$C_L = \sqrt{S_L^2 + U_L^2} \quad W_L = \frac{1}{C_L^2} \quad A = \frac{\sum_{i=1}^{n} W_L M_L}{\sum_{i=1}^{n} W_L} \quad S = \frac{1}{\sqrt{\sum_{i=1}^{n} W_L}} \quad U_1 = \sqrt{H^2 + S^2} \quad U_2 = t \times U_1 \quad U_3 = \frac{U_2}{\sqrt{n}}$$

*All but the final reported values are taken to two significant figures as determined by each quantity's uncertainty estimate. The final reported Uncertainty is $U_3$ rounded to one significant figure and represents the half width of the 95 % confidence interval for the **Certified** value. The final reported **Certified** value is A rounded to the same decimal place as the Uncertainty. The Tolerance is the half width of the 95 % confidence interval for measurements rounded to the same decimal place as the Uncertainty. The Uncertainty is a measure of the quality of the **Certified** value. The Tolerance is a measure of the expected performance of an analysis.*

*For further information regarding the confidence interval for the certified value see ISO Guide 35:2006 section 6.*

| Lab Name | Location | Registrar | Accreditation |
|---|---|---|---|
| Tensile Testing Metallurgical Laboratory | Cleveland, OH | A2LA | 17025 |
| Element Materials Technology | Glendale Heights, IL | A2LA | 17025 |
| Anderson Laboratories, Inc | Greendale, WI | A2LA | 17025 |
| Dirats Laboratories | Westfield,MA | PRI/Nadcap | 17025 |
| Element Materials Techology | Santa Fe Springs, CA | Nadcap | 17025 |

A2LA = American Association for Laboratory Accreditation
Nadcap = National Aerospace and Defense Contractors Accreditation Program

**Analysis:** Tensile testing was performed on samples prepared by machining from representative samples of the certified portion of the lot in accordance with ASTM Standard Test Method E8/E8M. The laboratories participating in the testing followed the requirements of ISO Standard 17025.

**Traceability:** No Certified Reference Materials were used to validate the analytical data listed on page 2. Traceability is to the calibration of the testing equipment, which meets ISO 17025 requirements.

**Homogeneity:** This Certified Reference Material (CRM) was tested for homogeneity using a modified version of ASTM Standard Method E826 and found acceptable.

**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 TRM-2A-082119 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 rod stock for this CRM was produced by Deutsche Nickel GMBH, Schwerte, Germany

**Form:** This CRM is machined in the form of a rod, approximately 25.4 mm (1.00") in diameter by 158 mm (6.25") long by Brammer Standard Company, Inc.

**Use:** This CRM is intended for use in tensile testing methods of analysis. Refer to ISO Guide 33 for information about the use of Certified Reference Materials.

**Certified Area:** The entirety of the CRM may be used.

**Sample Preparation:** For best analytical results, use the same method for preparing CRMs as you use for production specimens. Avoid overheating the sample during preparation as this can cause a change in the measured properties.

**Certificate Number:** The unique identification number for this certificate of analysis is TRM-2A-082118. You may obtain information on revisions of certificates from the internet at **www.brammerstandard.com**.

**Safety Notice:** A Material Safety Data Sheet (MSDS) is not required for this material. This CRM 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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**Email: contact@brammerstandard.com**

**Brammer Standard Company, Inc., is accredited by the American Association For Laboratory Accreditation (A2LA) to ISO Guide 34 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials (Certificate Number 656.02)**

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

**By Certificate Number 10539, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9001:2008 by National Quality Assurance (NQA), U.S.A.**

**The scopes of accreditation are listed on the website: www.brammerstandard.com**

## References:

Versions used were those available at the time of testing and characterization

E826 Standard Practice for Testing Homogeneity of a Metal Lot or Batch in Solid Form by Spark Atomic Emission Spectrometry

E8/E 8M Standard Test Methods for Tension Testing of Metallic Materials

ISO Standard 17025:2005 General requirements for the competence of testing and calibration laboratories

ISO Standard 9001:2008 Quality Management Systems - Requirements

ISO Guide 30:2015 Terms and definitions used in connection with reference materials + 2008 amendment

ISO Guide 31:2015 Reference materials - Contents of certificates and labels

ISO Guide 33:2015 Uses of certified reference materials

ISO Guide 35:2006 Reference Materials - General and statistical principles for certification

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

*ISO Guides and Standards available from Global Engineering - www.global.ihs.com*

*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

Certified by: _____ on August 21, 2018.

Beau R. Brammer

President