

# Test Bar Manual

| Phi | Manual | Spec<br>Number | Revision<br>Number | Revision<br>Date | Reviewed<br>Date | Title   |
|-----|--------|----------------|--------------------|------------------|------------------|---|
| Ø   | ТВМ    | тс             | 57                 | 1/23/2024        |                  | Table of Contents   |
|     | ТВМ    | 1010           | 10                 | 3/12/2020        | 3/12/2020        | General Notes   |
|     | ТВМ    | 1020           | 27                 | 8/24/2023        | 8/24/2023        | Test Bar Machining  |
| Ø   | ТВМ    | 1020.01        | 8                  | 1/23/2024        | 1/23/2024        | Supplement 1 to TBM 1020  |
|     | ТВМ    | 1020.02        | Original           | 8/13/2018        | 8/13/2018        | Supplement 2 to TBM 1020  |
|     | ТВМ    |                |                    |                  |                  | DRAWINGS  |
|     | ТВМ    | 002            | 3                  | 4/23/2007        | 2/9/2023         | Carrot Test Bar   |
|     | ТВМ    | 011            | 3                  | 4/23/2007        | 2/9/2023         | Charpy Bar – Impact Test Bar  |
|     | ТВМ    | 014            | 3                  | 4/23/2007        | 2/9/2023         | Spectro Chemical Sample, Down Runner for<br>Standard Test Bars        |
|     | ТВМ    | 018            | 3                  | 4/23/2007        | 2/9/2023         | Tensile Test Bar  |
|     | ТВМ    | 020            | 2                  | 4/23/2007        | 2/9/2023         | Tensile Test Specimen   |
|     | ТВМ    | 025            | 3                  | 4/23/2007        | 2/9/2023         | DDX Wax Cast-to-Size Test Bar   |
|     | ТВМ    | 193            | 3                  | 4/23/2007        | 2/9/2023         | Plastic Test Specimen   |
|     | ТВМ    | 195            | 3                  | 4/23/2007        | 2/9/2023         | Plastic Oversized Test Specimen                                       |
|     | ТВМ    | 1000           | 5                  | 11/17/2009       | 2/9/2023         | Lycoming Test Specimen, 0.090"  |
|     | ТВМ    | 1106           | 4                  | 11/17/2009       | 2/9/2023         | 4mm Rolls Royce Test Specimen Equivalent to RLH 6100                  |
|     | ТВМ    | 1400           | 4                  | 11/17/2009       | 2/9/2023         | Test Specimen for Single Crystal Garrett Blades,<br>0.070"            |
|     | ТВМ    | 2020           | 3                  | 4/23/2007        | 2/9/2023         | Tensile & Stress Rupture Test Specimen, 0.125"                        |
|     | ТВМ    | 2100           | 3                  | 4/23/2007        | 2/9/2023         | Lycoming Test Specimen, 0.135"  |
|     | ТВМ    | 2120           | 3                  | 4/23/2007        | 2/9/2023         | Lycoming Test Specimen, 0.135"  |
|     | твм    | 2300           | 3                  | 4/23/2007        | 2/9/2023         | Test Specimen, 0.150"   |
|     | ТВМ    | 2500           | 2                  | 4/23/2007        | 2/9/2023         | PWAC Rupture Specimen, 0.155"   |
|     | ТВМ    | 3004           | 5                  | 3/1/2019         | 3/1/2019         | Creep Test Specimen with Grooves, 0.160"                              |
|     | TBM    | 3021           | Original           | 12/7/2023        | 12/7/2023        | TBM 3021 Derived from M3617 Rev. W Specimen<br>4. Testing for LaPorte |
|     | TBM    | 3030           | 4                  | 3/1/2019         | 3/1/2019         | Tensile & Stress Rupture Test Specimen, 0.160"                        |
|     | ТВМ    | 3031           | 1                  | 3/1/2019         | 3/1/2019         | Tensile & Stress Rupture Test Specimen, 0.160"<br>(E8M)               |
|     | TBM    | 3032           | Original           | 3/1/2019         | 3/1/2019         | Tensile Bar for TiAl, 0.16"   |

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|     | ТВМ    | 3040           | 4                  | 3/1/2019         | 3/1/2019         | Tensile and Stress Rupture Specimen, 0.160"                           |
|     | TBM    | 3104           | 3                  | 4/23/2007        | 2/9/2023         | Creep Test Specimen, 5/16 – 18 Thread – 0.177<br>Dia.                 |
|     | ТВМ    | 3110           | 3                  | 4/23/2007        | 2/9/2023         | Rolls Royce Specimen, 16 mm   |
|     | TBM    | 3120           | 3                  | 4/23/2007        | 2/9/2023         | Stress Rupture and Tensile Test Specimen - 0.177<br>Dia.              |
|     | ТВМ    | 3200           | 2                  | 4/23/2007        | 2/9/2023         | Stress Rupture & Tensile Test Specimen, 0.187"                        |
|     | твм    | 3300           | 3                  | 4/23/2007        | 2/9/2023         | Teledyne Test Specimen, 0.200"  |
|     | твм    | 3310           | 3                  | 4/23/2007        | 2/9/2023         | Turbomeca Test Specimen, 0.200"                                       |
|     | твм    | 3400           | Original           | 6/11/2019        | 6/11/2019        | Safran Tensile Test Bar with ANSI Threads                             |
|     | ТВМ    | 3404           | 1                  | 6/11/2019        | 6/11/2019        | Safran Creep Test Bar with ANSI Threads                               |
|     | TBM    | 4000           | 4                  | 3/1/2019         | 3/1/2019         | Test Specimen Machined from Oversized Bar w/o<br>Shoulder, 0.250"     |
|     | ТВМ    | 4004           | 6                  | 3/1/2019         | 3/1/2019         | Creep Test Specimen Grooves, 0.250"                                   |
|     | TBM    | 4005           | 1                  | 3/1/2019         | 3/1/2019         | Test Specimen Machined from Oversized Bar w/o<br>Shoulder, 0.25"      |
|     | ТВМ    | 4006           | Original           | 7/20/2010        | 2/9/2023         | Tensile Test Specimen   |
|     | ТВМ    | 4008           | Original           | 3/1/2019         | 3/1/2019         | Creep Test Specimen with Grooves, 0.222"                              |
|     | ТВМ    | 4009           | Original           | 3/1/2019         | 3/1/2019         | Creep Test Specimen with Grooves, 0.2"                                |
|     | ТВМ    | 4020           | 3                  | 3/1/2019         | 3/1/2019         | Creep Test Specimen, 0.250"   |
|     | твм    | 4030           | 4                  | 3/1/2019         | 3/1/2019         | Tensile & Stress Rupture Test Specimen, 0.250"                        |
|     | твм    | 4031           | 4                  | 3/1/2019         | 3/1/2019         | Tensile & Stress Rupture Test Specimen, 0.250"                        |
|     | твм    | 4032           | Original           | 3/1/2019         | 3/1/2019         | Tensile Bar for TiAl, 0.25"   |
|     | твм    | 4049           | 3                  | 10/10/2016       | 2/9/2023         | HNC Elevated Tensile Test Specimen                                    |
|     | твм    | 4050           | 4                  | 3/1/2019         | 3/1/2019         | Tensile & Stress Rupture Test Specimen, 0.250"                        |
|     | ТВМ    | 4051           | 3                  | 3/1/2019         | 3/1/2019         | Tensile & Stress Rupture Test Specimen, 0.250" -<br>Dover Alloy OSB   |
|     | твм    | 4052           | 1                  | 5/1/2019         | 5/1/2019         | 0.222" Creep Bar  |
|     | TBM    | 4053           | Original           | 1/18/2024        | 1/18/2024        | 4053 Derived from SPU N°3000-03060 & 1000 –<br>03060 Testing for HNC. |
|     | ТВМ    | 4058           | Original           | 3/1/2019         | 3/1/2019         | 0.222" Tensile Bar  |
|     | ТВМ    | 4200           | 8                  | 3/1/2019         | 3/1/2019         | C.A.E. Compressor Rotor (P/N C701883), 0.357"                         |
|     | TBM    | 4300           | 3                  | 3/1/2019         | 3/1/2019         | Test Specimen – 0.500" Dia.   |
|     | ТВМ    | 5262           | 4                  | 4/23/2007        | 2/9/2023         | HCF Fatigue Specimen, 0.160", 3D ASTM Standard                        |
|     | ТВМ    | 5270           | 3                  | 4/23/2007        | 2/9/2023         | LCF Specimen, 0.200", 3D  |
|     | ТВМ    | 5275           | 3                  | 4/23/2007        | 2/9/2023         | LaPorte LCF Specimen, 0.250", 3D                                      |
|     | TBM    | 5291           | 4                  | 4/23/2007        | 2/9/2023         | TiAl Tensile Specimen (up to 1500°F)                                  |

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|     | ТВМ    | 6010           | 5                  | 3/1/2019         | 3/1/2019         | Flat Specimen, 0.037" x 0.188"  |
|     | ТВМ    | 6050           | 3                  | 4/23/2007        | 2/9/2023         | Flat Tensile/Creep Specimen, TCR-100 Airesearch                               |
|     | ТВМ    | 6051           | 1                  | 12/7/2023        | 12/7/2023        | Mini-Flat Specimen Derived from MTL 1405-1                                    |
|     | ТВМ    | 6053           | 1                  | 12/7/2023        | 12/7/2023        | Mini-Flat Specimen Derived from MTL 1405-3                                    |
|     | ТВМ    | 6060           | 3                  | 4/23/2007        | 2/9/2023         | Flat Tensile/Creep Specimen, TCR-200 Airesearch,<br>0.063" Gage Length        |
|     | ТВМ    | 6070           | 3                  | 4/23/2007        | 2/9/2023         | Flat Tensile/Creep Specimen, PWA MERL 12,<br>0.080" x 0.187"                  |
|     | ТВМ    | 6095           | 6                  | 10/29/2007       | 2/9/2023         | ASTM E-8, Flat Specimen   |
|     | ТВМ    | 6115           | 4                  | 4/23/2007        | 2/9/2023         | Flat Tensile Specimen   |
|     | ТВМ    | 6120           | 7                  | 4/23/2007        | 2/9/2023         | Flat Specimen   |
|     | твм    | 6130           | 2                  | 4/23/2007        | 2/9/2023         | ASTM E-8 Compliant Flat Tensile Specimen                                      |
|     | ТВМ    | 7000           | 3                  | 4/23/2007        | 2/9/2023         | Combination Notch and Stress Rupture Test<br>Specimen, 0.200"                 |
|     | ТВМ    | 7001           | 3                  | 6/23/2021        | 6/23/2021        | Combination Notch and Stress Rupture Test<br>Specimen, 0.178"                 |
|     | ТВМ    | 7005           | 3                  | 4/23/2007        | 2/9/2023         | Combination Notch and Stress Rupture Test<br>Specimen                         |
|     | ТВМ    | 7010           | 4                  | 3/1/2019         | 3/1/2019         | Notched Stress Rupture Specimen   |
|     | ТВМ    | 7015           | 1                  | 6/23/2021        | 6/23/2021        | Combination Notch and Stress Rupture Bar<br>Derived from RLH6105, 0.178"      |
|     | ТВМ    | 7020           | 3                  | 4/23/2007        | 2/9/2023         | Notched Specimen, 0.345"  |
|     | ТВМ    | 7025           | Original           | 9/4/2020         | 9/4/2020         | Notched Stress Rupture Specimen 0.246"<br>(6.25mm)                            |
|     | ТВМ    | 7026           | Original           | 7/19/2022        | 7/19/2022        | Notched Stress Rupture Specimen 0.25", Kt=3.9,<br>derived from GE 4013195-022 |
|     | ТВМ    | 7030           | 3                  | 4/23/2007        | 2/9/2023         | Notched Stress Rupture Specimen   |
|     | ТВМ    | 7050           | Original           | 3/12/2020        | 3/12/2020        | Combination Notch and Stress Rupture Test<br>Specimen 0.252"                  |
|     | ТВМ    | 8020           | 2                  | 5/9/2012         | 2/9/2023         | Charpy Test Specimen  |
|     | ТВМ    | A1             | 3                  | 4/23/2007        | 2/9/2023         | Location of Test Bars Machined from Blades                                    |
|     | TBM    | A2             | 1                  | 4/23/2007        | 2/9/2023         | Location of Test Bars Machined from Blades                                    |
|     | TBM    | A8             | 4                  | 5/9/2012         | 2/9/2023         | Location of Test Material Machined from Blades                                |
|     | TBM    | A9             | 4                  | 5/9/2012         | 2/9/2023         | Location of Test Material Machined from Blades                                |
|     | TBM    | A10            | 4                  | 5/9/2012         | 2/9/2023         | Location of Test Material Machined from Blades                                |
|     | TBM    | A11            | 2                  | 4/23/2007        | 2/9/2023         | Location of Test Material for Honeywell                                       |



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# **GENERAL NOTES**

1. <u>SCOPE</u>:

This manual provides procedures and drawings for test material.

- 2. TEST BAR NUMBERING SYSTEM:
  - 2.1 The section for machined test bars uses four-digit numbers with the first digit separating bars by dimension or application and the first three digits reflecting similar bars.
  - 2.2 The first digit separates the grouping of bars:

Series Bar Grouping

| 1 | Up to 0.125" diameter      |
|---|----------------------------|
| 2 | 0.125" - 0.150" diameter   |
| 3 | 0.160" - 0.200" diameter   |
| 4 | 0.250" diameter and larger |
| 5 | Fatigue bars               |
| б | Flat bars                  |
| 7 | Notched bars               |
| 8 | Charpy Impact              |

- 2.3 The second section of the manual showing cast-to-size (CTS) specimens have three-digit numbers. The third section of the manual showing bar location have Test Bar Manual (TBM) numbers preceded by "A" (Example: TBM A1).
- 3. GENERAL NOTES:
  - 3.1 The dimensions of the machined drawings include a length of thread equivalent to six threads unless other noted.
  - 3.2 Some drawings are also noted with an "\*" after the TBM number. Bars designated in this manner should be used with caution because the gauge diameter is close to the theoretical diameters of the bottom of the threads. This could cause the fracture to occur in the threads.
  - 3.3 Requests for new drawings and changes in existing drawings should be submitted to Technical Services.
  - 3.4 Critical features/dimensions are defined as specimen characteristics which may affect test results. Critical features include the following:

Gauge length
Reduced/parallel section diameter (round specimens)
Width (flat specimens)
Thickness (flat specimens)
Notch dimensions (notched-rupture)
Radius (curved features in the reduced section)
Other features that are identified as being critical on the drawing.

- 3.5 Non-critical features/dimensions are those that do not impact test results. Non-critical features include the following:
  - ) Overall length of the specimen, provided changing the overall length does not affect the gauge length.
    - ) Thread/grip size, provided the minimum dimension is greater than the gauge diameter.

#### 3.6 Tolerances

- 3.6.1 Unless otherwise specified on the drawing, angles for critical dimensions have a tolerance of ± ½ degree; angles for non-critical dimensions have a tolerance of ± 1 degree.
- 3.6.2 Tolerances for decimals values are noted on the drawing. Unless specified on the drawing, tolerances are a ±0.03 inches for two-digit decimals and ± 0.020 inches for three-digit decimals.
- 3.7 Test bar types

| TB Type | Description                                      |
|---------|--|
| BLA     | Machine from aircraft turbine blades airfoil     |
| BLR     | Machine from root section of air turbine blades  |
| BUA     | Machine from A.F. section of land turbine bucket |
| BUR     | Machine from root section of land turbine bucket |
| CAR     | Carrot bar                                       |
| CFB     | Center fed bar                                   |
| CH      | Charpy impact specimen                           |
| COV     | Specimen machine cover plates                    |
| CS      | Chem slug  |
| CTS     | Cast to size specimen                            |
| DSR     | DS rods from tridents                            |
| DUB     | Dummy Blade                                      |
| FLT     | Flat specimen                                    |
| HG      | Hourglass specimen                               |
| HOB     | Hung on bar                                      |
| IZ      | Izod impact specimen                             |
| KEL     | Keel bar   |
| MCP     | Machined from cast plate                         |
| MFB     | Machined from blade                              |
| MFC     | Machined from casting                            |
| MFP     | Machined from part                               |
| MFS     | Machined from slab                               |
| MFV     | Machined from vane                               |
| MFW     | Machine from turbo charger wheel                 |
| MHS     | Machined HIP stem                                |
| NA      | Bar type not available                           |
| OSB     | Oversize specimen                                |
| PTB     | Pregnant test bar                                |
| RND     | Specimen machined from round slugs               |
| ROT     | Machined from rotor                              |
| SCR     | Single crystal rods from tridents                |
| STA     | Specimen machined from stators (nozzles)         |
| STR     | Specimen machined from structural members        |
| TUB     | Tubular specimen                                 |

#### 3.8 Bar Location

3.8.1 Bar location field on the sample envelope indicates specimen direction (transverse or longitudinal).

Note: MFS bars are typically machined transverse unless otherwise specified.

- 3.8.2 OSB and MFS test bars shall be machined as indicated in Figure 1 unless otherwise specified. Bar location guidelines if not otherwise specified:
  - ) The "slab" represents the area of the casting, which as parallel walls (starter and gate area should not be used). Do not use slab material ¾" from the bottom of slab, or 1" from the top of the slab.
  - ) Slabs should be identified as to top and bottom (bottom represents closest to the chill plate)
  - ) Longitudinal tensile bars should come from the OSB Bars.
  - ) Longitudinal stress rupture bars should come from the OSB Bars.
  - ) Transverse tensile and stress rupture should come from the slab.

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# TEST BAR MANUAL



Figure 1

#### 3.9 Quality Requirements

- 3.9.1 The manuals administrators shall ensure that the current revision of the test bar manual is on the Howmet Supplier Information website with password protection.
- 3.9.2 The manuals administrators shall provide password access to the test bar manual to machining suppliers on the Approved Supplier List.

- Denotes change from previous issue



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#### **TEST BAR MACHINING**

- 1. SCOPE:
- Ø To provide requirements for test bar machining, performed internally, by Howmet, or externally.
  - 2. REQUIREMENTS FOR TEST BAR MACHINING SOURCES:
- Ø 2.1 Supplier quality requirements applicable per Howmet specification, SQ Flowdown, latest revision, for external test specimen machining sources.
  - 2.2 Calibration system requirements shall be in accordance with ANSI Z540-1.
  - 2.3 Machining sources shall have written procedures that encompass the entire process, including the following:
    - 2.3.1 Machining of aluminum-, iron-, nickel-, cobalt-, titanium-base alloys, and other materials, as applicable.
    - 2.3.2 Process parameters, such as:
      - range of specifications of the grinding wheels;
      - wheel and work speed;
      - Blanking/rough finishing;
      - final grinding feeds and direction;
      - coolant;
      - finishing/polishing procedures
    - 2.3.3 Residual stress testing process verification requirements when machining to GE specification P1TF79:
      - 2.3.3.1 Shall be performed before initial processing and then annually using the X-Ray Diffraction method, per GE Aviation drawing number 4013195-991, using a source that is approved by GE. Lambda Technologies has historically held approval.
  - 2.3.3.2 Shall when I

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- 3.2 Shall be performed on alloy 718 and Ti-6-4 specimens when P1TF79 Class A (low stress ground and polished) is performed.
- 2.3.3.3 Shall be performed on one alloy 718 specimen when P1TF79 Class B (low stress ground) is performed.
- 2.3.3.4 Shall be performed on new equipment/processes or when a change is made to a currently verified process. This includes changes to the items listed in 2.3.2.

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- 2.3.3.5 The machining source shall assess residual stress results to the limits in P1TF79. If the residual stress exceeds the limits, machining shall be halted, HRC notified, and root cause corrective action initiated. Residual stress testing reports shall be submitted to the Howmet Research Center (HRC) Quality Assurance Manager for overcheck and confirmation of compliance to the limits in P1TF79.
- 2.3.4 Written procedures shall be made available to Howmet, Howmet customers or independent auditing bodies, if requested.
- 2.3.5 Machining sources shall report delivery performance to Howmet, monthly. Delivery performance shall be calculated based on date of receipt of test material to date of shipment to Howmet. Delivery performance shall be 95% of samples returned to Howmet within two (2) business days.
- 2.3.6 Production interruption that may affect ability to meet the required completion date/time, shall be reported to HRC within 24 hours of the onset of the issue. Examples include, but are not limited to power outage, natural disaster, equipment failure, lack of personnel or equipment resources.
- 2.4 Test Bar machining required certifications/accreditations:
  - 2.4.1 Machining source shall maintain accreditations to Nadcap AC7101/7 "Mechanical Test Specimen Preparation", codes Z, and Z3. Accreditation to code Z1 is required for suppliers performing low stress grinding. Accreditation to code Z2 may be required for fatigue specimens, TiAl specimens, or when specifically requested. Z2 specimens are those that require polishing, are used for fatigue testing, are used for TiAl testing, or will be specified by Howmet, in the test bar drawing or on the envelope.
  - 2.4.2 The supplier shall possess AS9100, AC7006, AC7004 or ISO\IEC 17025 accreditation.
    - 2.4.3 The supplier shall possess GE P1TF79 approval when P1TF79 Class A or B test specimen machining is required.
    - 2.4.4 Machining source shall notify Howmet within three (3) business days when accreditation status changes such that customers, test codes, or capabilities are added or removed.
- 2.5 Allowable machining methods for types Z, Z1 and Z2, unless otherwise specified by the customer.

| Material | Customer                                 | Rough<br>Machining | Low Stress<br>Grind | Lathe | Polish |
|----------|--|--------------------|---------------------|-------|--------|
| Titanium | Rolls-Royce,<br>MTU, Safran,<br>Lockheed | Х                  | Х                   | Χ*    |        |
| All      | GE Aviation<br>P1TF79 Class A            | Х                  | Х*                  |       | Х*     |
| All      | GE Aviation                              | Х                  | Х*                  |       |        |

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Internal Use

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|          | P1TF79 Class B |   |   |    |  |
|----------|----------------|---|---|----|--|
| All      | All other GE   | Х | Х | Χ* |  |
| Titanium | Others         | Х | Х | Х* |  |
| Nickel   | All            | Х | Х | Х  |  |
| Aluminum | All            | Х | Х | Х* |  |
| Iron     | All            | Х | Х |    |  |
| Cobalt   | All            | Х | Х |    |  |
| TiAl     | All            |   | Х |    |  |

\* Preferred method

- 2.5.1 When rough machining and low stress grinding are allowed, rough machining may be omitted and use low stress grind for the entire process.
- 2.5.2 When rough machining is used, at least 0.010" (0.25 mm) of material shall remain on each surface prior to the final low stress grinding operation.
- 2.5.3 Machining methods, including polishing, shall meet customer or industry standard requirements for machining type and parameters.
- 2.5.4 Specimens that are used for notched-rupture testing (test type = NSR), with notches in the reduced section, shall use low stress grinding for the notch, unless otherwise specified.
- 2.5.5 RR1000 alloy requires polishing, per the RRMS30020 Category 1 test piece requirements.
- 2.6 If electro-discharge machining (EDM) is used for blanking/rough machining, the remelt layer shall be completely removed prior to the final low stress grind.
- Ø 2.7 A Certificate of conformance (COC) shall be required for each shipment per SQ Flowdown, latest revision, for external machining sources.
- Ø 2.8 Traceability control of specimens to the representative component and the accompanying identification paperwork is required through the entire process. If the supplier loses traceability Howmet shall be notified.
- Ø 2.8.1 When samples are sufficiently large enough to dot peen or laser engrave using a mechanical device the entire sample ID shall be permanently marked on both ends of the specimen, in accordance with DMC0100. Vibratory or engraving hand tools are prohibited.
- Ø 2.8.2 When samples are too small to dot peen or laser engrave the entire sample ID on both ends of the specimen, traceability shall be maintained on the individual envelope containing the bar. When partial sample IDs are used on test bars, traceability shall be maintained on the individual envelope containing the bar.

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- 2.9 Equipment and coolants shall be free of contaminants that may be deleterious to test specimen alloys and shall conform to Howmet PM144, latest revision, for water-based coolants and PM100, latest revision, for oil-based coolants. Coolants shall be tested, upon initial use, at the cost of the machining source, but are not required to be routinely tested unless a known change was made to the coolant. Testing shall be performed per Howmet PM144. Additional testing requirements may be flowed down by Howmet or Howmet's customers, for specific materials. DMC0100 (Safran) specifies coolants shall be free of halogens.
  - 2.10 Clean the reduced section and parts of the specimen which contact the grips in clean alcohol, acetone, or other suitable solvent. Clean specimens should be handled carefully to avoid contamination of the specimen with skin oils.
- Ø 2.11 Test specimens shall be handled with care to avoid damage and contamination. They shall be placed in the protective sample envelope or other suitable protective container, when not being processed and after completion of machining.
- $\emptyset$  3. DIMENSIONS AND FEATURES:
- Ø 3.1 Dimensions and features (including surface finish) shall meet the drawing and customer requirements. They shall also meet the requirements of the drawings in this manual, when specified.
- Ø 3.2 Generally, surface finish shall be 15 rms to 25 rms on Z and Z1 test specimens (non-polished) and 8 rms or better (lower number than 8) on Z2 (polished) specimens. Z3 (as cast) specimens do not have specific surface finish requirements.
- Ø 3.3 Critical/significant dimensions and features, indicated by an asterisk (\*) on the drawing, shall be measured on every specimen (see TB1010 for more information on critical dimensions).
- Ø 3.4 A sampling plan may be established for Non-critical/non-significant dimensions and features. If sampling is used to reduce frequency of measurement, the machining source shall establish and document requirements for reducing frequency (sampling) and criteria that requires return to measurement of all dimensions. Criteria that may require return to measurement of all dimensions includes process changes, equipment changes, or out of control conditions.
- Ø 3.5 Test material that is outside of tolerance on any dimension or feature of the test bar shall be identified. The machining source shall communicate the sample ID and deviation reason to the test lab.

#### 4. INSPECTION:

4.1 Codes Z, Z1 and Z3 specimens shall be examined, visually, without magnification or at 1X magnification. Cracks, gouges, pores are not allowed.

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#### **TEST BAR MANUAL**

- 4.2 Code Z2 specimens shall be examined using a minimum magnification of 20X. In addition to the above items, machining marks are not allowed be present.
- Ø 4.3 The notch dimensions in notched-rupture specimens shall be verified at a minimum magnification of 20X to ensure the dimensional and tolerance requirements are met. Notches shall also have a smooth radius.
- Ø 4.4 Non-conforming test bars shall be identified and held for testing until a disposition is provided by HRC engineering or submitting plant.
  - 5. AUDITS:

Audits may be performed, per SQ Flowdown, to ensure compliance.

- 6. SPECIAL TEST BARS:
- Ø Bars that do not have TBM specifications shall be accompanied by documented (written or electronic) instructions from the submitting facility.

#### 7. CUSTOMER SPECIFICATIONS:

- 7.1 The latest revision of the following customer specifications and industry standards shall be used, as required. Copies are available from Howmet Research Center upon request.
  - 7.1.1 GE Aircraft Engines P1TF79
  - 7.1.2 GE 4013195-991 Residual Stress Measurement by X-Ray Diffraction
  - 7.1.3 Honeywell HPS1013
  - 7.1.4 Light Helicopter TEC LHG1335
  - 7.1.5 MTU MTN 70
  - 7.1.6 P&W Canada CPW372 Test Specimens Metallic Materials
  - 7.1.7 PRI/Nadcap AC7101/7
  - 7.1.8 Rolls Royce CME5036 Approved Test Piece Register
  - 7.1.9 Rolls-Royce RRMS30020

7.1.10 Safran DMC0100

7.1.11 Safran GRM-0123

- 7.2 End customer approval is required for the following customers and test specimen types. These shall not be machined without customer approval. If approval is rescinded, Howmet shall be notified.
  - 7.2.1 Rolls Royce UK Ltd single crystal product and some wrought alloys, such as RR1000 (RRMS30020).
  - 7.2.2 Honeywell mini-flat specimens, machined from casting airfoils.

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- 7.2.3 Machining sources shall be qualified by the Safran group company concerned in accordance with GRM-0123.
- 7.2.4 Machining sources shall be qualified by GE for P1TF79 Class A or B.
- 8. COMPLIANCE WITH ASTM E8 and ASTM E292:
- Ø In the absence of specific requirements in this manual, test specimen machining practice and dimensions shall conform to the requirements of ASTM E8 and ASTM E292. ASTM E8 and ASTM E292 address several bar types including round and rectangular. If a conflict exists between ASTM E8 or ASTM E292 and this manual, the Test Bar Manual requirements take precedence.

 $\varnothing$  - Denotes change from previous issue

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#### TABLE 1

# Test Bar Manual Specimen Selection Criteria

|        |                 |            |          |        |           | Gauge  | Overall |          | Grip      | Pin Hole | ASTM |                                   |
|--------|-----------------|------------|----------|--------|-----------|--------|---------|----------|-----------|----------|------|-----------------------------------|
| TBM    |                 | Test       | Diameter | Width  | Thickness | Length | Length  | Thread   | Dia/Width | Diameter |      |                                   |
| Number | Category        | Туре       | (inch)   | (inch) | (inch)    | (inch) | (inch)  | Size     | (inch)    | (inch)   |      | Remarks                           |
| 0.00   | 0               |            |          |        |           |        |         |          |           |          |      | Quarte Back Day                   |
| 002    | specially       | -          | -        | -      | -         | -      | -       | -        | -         | -        |      | Carrot Test Bar                   |
| 011    |                 | -          | -        | -      | -         | -      | -       | -        | -         | -        |      | Charpy Impact Bar                 |
| 014    |                 | _          | -        | -      | -         | -      | -       | -        | -         | -        |      | Spectro Chemical Sample           |
| 018    | Cast-to-Size    | TN, SR     | 0.300    | -      | -         | 1.370  | 3.780   | -        | 0.550     | -        |      |                                   |
| 020    |                 | TN, SR     | 0.250    | -      | -         | 1.250  | 3.38    | 1/2"-13  | -         | -        |      |                                   |
| 025    |                 | TN, SR     | 0.250    | -      | -         | 1.250  | 3.580   | 1/2"-13  | -         | -        |      |                                   |
| 158    | X-Ray Block     | -          | -        | -      | -         | -      | -       | -        | -         | -        |      | X-Ray Penetrator Block            |
| 159    |                 | _          | -        | -      | -         | -      | -       | -        | -         | -        |      | X-Ray Penetrator Block            |
| 193    | Cast-to-Size    | CR         | 0.250    | -      | -         | 1.250  | 3.580   | 1/2"-13  | -         | -        |      |                                   |
| 195    |                 | TN,SR      | 0.300    | -      | -         | 1.400  | 3.600   | -        | 0.560     | -        |      | Plastic Oversized Specimen        |
| 1000   | Mini-Round      | TN,SR,CR   | 0.090    | -      | -         | 0.255  | 0.660   | 1/4"-20  | -         | -        |      |                                   |
| 1106   |                 | TN,SR,CR   | 0.090    | -      | -         | 0.280  | 0.940   | 8-32     | -         | -        |      |                                   |
| 1400   |                 | TN,SR,CR   | 0.070    | -      | -         | 0.375  | 1.000   | 5-40     | -         | -        |      |                                   |
| 2020   | Small-Round     | TN,SR,CR   | 0.125    | -      | -         | 0.645  | 1.490   | 1/4"-20  | -         | -        |      |                                   |
| 2100   |                 | TN,SR,CR   | 0.135    | -      | -         | 0.420  | 0.920   | 1/4"-20  | -         | -        |      |                                   |
| 2120   |                 | TN,SR,CR   | 0.135    | -      | -         | 0.420  | 1.480   | 1/4"-20  | -         | -        |      |                                   |
| 2300   |                 | TN,SR,CR   | 0.150    | -      | -         | 0.620  | 1.450   | 1/4"-20  | -         | -        |      |                                   |
| 2500   |                 | TN,SR,CR   | 0.155    | -      | -         | 0.620  | 1.580   | 1/4"-20  | -         | -        |      |                                   |
| 3004   | Medium-Round    | CR         | 0.160    | -      | -         | 0.660  | 2.42    | 1/4"-20  | -         | -        |      |                                   |
| 3021   |                 | TN,SR,CR   | 0.135    | -      | -         | 0.55   | 1.20    | 1/4"-20  | -         | -        |      | Derived from M3617-W Spec. 4      |
| 3030   |                 | TN,SR,CR   | 0.160    | -      | -         | 0.820  | 1.63    | 1/4"-20  | -         | -        |      |                                   |
| 3031   |                 | TN,SR,CR   | 0.160    | -      | -         | 1.00   | 1.81    | 1/4"-20  | -         | -        |      | ASTME8M                           |
| 3032   |                 | TN         | 0.160    | -      | -         | 0.640  | 1.620   | 3/8"-16  |           |          |      | Modified 3030 for TiAl            |
| 3040   |                 | TN, SR, CR | 0.160    | -      | -         | 0.820  | 1.840   | 3/8"-16  | -         | -        |      |                                   |
| 3104   |                 | CR         | 0.177    |        |           | 0.730  | 2.660   | 5/16"-18 | -         | -        |      |                                   |
| 3110   |                 | TN, SR, CR | 0.177    | -      | -         | 0.256  | 1.160   | 5/16"-18 | -         | -        |      |                                   |
| 3120   |                 | TN,SR      | 0.177    |        |           | 0.905  | 1.880   | 5/16"-18 | -         | -        |      |                                   |
| 3200   |                 | TN, SR     | 0.187    | -      | -         | 0.955  | 2.010   | 5/16"-18 | -         | _        |      |                                   |
| 3300   |                 | TN, SR     | 0.200    | _      | -         | 0.820  | 1.770   | 5/16"-18 | -         | _        |      |                                   |
| 3310   |                 | TN, SR     | 0.200    | _      | -         | 0.935  | 1.970   | 3/8"-16  | -         | _        |      |                                   |
| 3400   |                 | TN         | 0.1575   | _      | -         | 0.866  | 2.103   | 3/8″-16  |           |          |      | Derived from Snecma 485-920-110-0 |
| 3404   |                 | SR         | 0.177    | -      | -         | 0.797  | 1.904   | 3/8″-16  |           |          |      | Derived from Snecma 485-920-302-0 |
| 4000   | Full-Size-Round | TN, SR     | 0.250    | -      | -         | 1.250  | 3.000   | 1/2"-13  | -         | -        |      |                                   |
| 4004   |                 | CR         | 0.250    | _      | _         | 1.250  | 3.000   | 1/2"-13  | _         | _        |      |                                   |
| 4005   |                 | TN         | 0.250    | -      | -         | 1.813  | 3.50    |          | -         | _        |      |                                   |
| 4006   |                 | TN         | 0.250    | -      | -         | 1.000  | 3.500   | -        | -         | -        |      |                                   |
| 4008   |                 | CR,SR      | 0.222    | -      | -         | 1.110  | 2.85    | 1/2"-13  | -         | -        |      |                                   |
| 4009   |                 | CR, SR     | 0.200    | -      | -         | 1.01   | 2.75    | 1/2"-13  | -         | -        |      |                                   |
| 4020   |                 | TN, SR     | 0.250    | -      | -         | 1.020  | 2.060   | 3/8″-16  | -         | -        |      |                                   |
| 4030   |                 | TN,SR      | 0.250    | -      | -         | 1.250  | 2.62    | 1/2"-13  | -         | -        |      |                                   |

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# TEST BAR MANUAL

|        |               |            |           |         |            | Gauge    | Overall   |            | Grip        | Pin Hole   | ASTM     |   |
|--------|---------------|------------|-----------|---------|------------|----------|-----------|------------|-------------|------------|----------|---|
| TBM    |               | Test       | Diameter  | Width   | Thickness  | Length   | Length    | Thread     | Dia/Width   | Diameter   |          |   |
| Number | Category      | Туре       | (inch)    | (inch)  | (inch)     | (inch)   | (inch)    | Size       | (inch)      | (inch)     |          | Remarks   |
| 1001   |               |            | 0.050     |         |            | 1.0      | 0.16      |            |             |            |          |   |
| 4031   |               | TN, SR, CR | 0.250     | -       | -          | 1.9      | 3.46      | 1/2"-13    | -           | -          |          |   |
| 4032   |               | TN         | 0.250     | -       | -          | 1.000    | 2.300     | 1/2"-13    | -           | -          |          | Modified 4030 for TiAl                              |
| 4049   |               | TN         | 0.250     | -       | -          | 1.000    | 2.904     | 3/8"-16    | -           | -          |          | HNC Elevated Tensile Specimen                       |
| 4050   |               | TN, SR     | 0.250     | -       | -          | 1.250    | 2.27      | 3/8"-16    | -           | -          |          |   |
| 4051   |               | TN,SR      | 0.250     | -       | -          | 1.250    | 3.63      | 3/8"-16    | -           | -          |          |   |
| 4052   |               | CR         | 0.222     | -       | -          | 1.11     | 2.85      | 3/8"-16    | -           | -          |          | Derived from CME5036/RLH6203                        |
| 4053   |               | TN, SR     | 0.197     | -       | -          | 1.10     | 2.05      | 3/8"-16    | -           | -          |          | Derived from Safran SPO N 3000-03060 & 1000 - 03060 |
| 4058   |               | TN         | 0.222     | -       | -          | 1.10     | 2.07      | 3/8"-16    | -           | -          |          | Derived from CME5036/RLH6017                        |
| 4200   |               | TN,SR      | 0.357     | -       | -          | 1.445    | 2.62      | 1/2"-13    | -           | -          |          |   |
| 4300   |               | TN,SR      | 0.500     | -       | -          | 2.500    | 4.500     | 3/4"-10    | -           | -          |          |   |
| 5262   | Fatigue       | HCF        | 0.160     | -       | -          | 0.500    | 3.800     | -          | 0.500       | -          |          |   |
| 5270   |               | HCF,LCF    | 0.200     | -       | -          | 0.650    | 4.500     | -          | 0.375       | -          |          |   |
| 5275   |               | LCF        | 0.250     | -       | -          | 0.605    | 4.100     | -          | 0.500       | -          |          |   |
| 5291   |               | TN         | 0.200     | -       | -          | 1.120    | 5.450     | -          | 0.375       | -          |          | TiAl Tensile Specimen                               |
| 6010   | Flat          | TN,SR,CR   | -         | 0.190   | 0.037      | 0.627    | 2.13      | -          | 0.64        | 0.251      |          |   |
| 6050   |               | TN,SR,CR   | -         | 0.100   | 0.200      | 0.312    | 1.260     | -          | 0.406       | 0.125      |          |   |
| 6051   |               | TN,SR,CR   | -         | 0.100   | 0.019      | 0.065    | 0.880     | -          | 0.40        | 0.125      |          | Derived from Honeywell MTL 1405-1                   |
| 6053   | Flat          | TN,SR,CR   | -         | 0.100   | 0.018      | 0.315    | 1.27      | -          | 0.40        | 0.125      |          | Derived from Honeywell MTL1405-3                    |
| 6060   |               | TN,SR,CR   | -         | 0.100   | 0.200      | 0.062    | 0.880     | -          | 0.406       | 0.125      |          |   |
| 6070   |               | TN,SR      | -         | 0.187   | 0.080      | 0.800    | 2.560     | -          | 0.710       | 0.252      |          |   |
| 6095   |               | TN         | -         | 0.250   | 0.250      | 1.250    | 6.000     | -          | 0.375       | None       |          |   |
| 6115   |               | TN         | -         | 0.300   | 0.150      | 0.600    | 4.200     | -          | 0.600       | None       |          |   |
| 6120   |               | TN,SR      | -         | 0.250   | 0.150      | 1.100    | 3.000     | -          | 0.800       | 0.250      |          |   |
| 6130   |               | TN         | -         | 0.250   | 0.090-     | 1.000    | 4.250     | -          | 0.750       | 0.250      |          |   |
|        |               |            |           |         | 0.250      |          |           |            |             |            |          |   |
| 7000   | Notched Combo | SR         | 0.200     | -       | -          | 0.800    | 3.000     | 3/8"-16    | -           | -          |          | Notched (Kt=3.0)                                    |
| 7001   | Notched Combo | SR         | 0.178     | -       | -          | 0.750    | 3.000     | 3/8″-16    | -           | -          | E-292    | Notched (Kt=3.9)                                    |
| 7005   | Notched Combo | SR         | 0.200     | -       | -          | 0.820    | 3.000     | 3/8"-16    | -           | -          |          | Notched (Kt-3.5)                                    |
| 7010   | Notched       | TN,SR      | 0.178     | -       | -          | None     | 2.150     | 3/8"-16    | -           | -          |          | Notched (Kt=3.9)                                    |
| 7015   | Notched Combo | SR         | 0.178     | -       | -          | 0.87     | 2.76      | 3/8"-24    | -           | -          | -        | Derived from CME5036/RLH6105                        |
| 7020   | Notched       | TN,SR      | 0.250     | -       | -          | None     | 2.750     | 1/2"-13    | -           | -          |          | Notched (Kt=4.3)                                    |
| 7025   | Notched       | SR         | 0.246     | -       | -          | None     | 2.374     | 1/2"-13    | -           | -          | -        | Derived from Exeter TBC for MHPS                    |
| 7026   | Notched       | SR         | 0.250     | -       | -          | None     | 3.250     | 1/2"-13    | -           | -          | -        | Derived from GE 4013195-022(Kt=3.9)                 |
| 7030   | Notched       | TN,SR      | 0.160     | -       | -          | None     | 2.150     | 3/8"-16    | -           | -          |          | Notched (Kt=3.5)                                    |
| 7050   | Notched Combo | SR         | 0.252     | -       | -          | 1.26     | 4.13      | 1/2"-13    | -           | -          | -        | Derived from HJL TBS-029                            |
| A1     | Location      | TN,SR,CR   | -         | -       | -          | -        | -         | -          | -           | -          |          | Specimen Removal Location                           |
| A2     |               | TN,SR,CR   | -         | -       | -          | -        | -         | -          | -           | -          |          | Specimen Removal Location                           |
| A8     |               | TN, SR, CR | -         | -       | -          | -        | -         | -          | -           | -          |          | Specimen Removal Location                           |
| A9     |               | TN, SR, CR | -         | -       | -          | -        | -         | -          | -           | -          |          | Specimen Removal Location                           |
| A10    |               | TN, SR, CR | -         | -       | -          | -        | -         | -          | -           | -          |          | Specimen Removal Location                           |
| A11    |               | TN, SR, CR | -         | -       | -          | -        | -         | -          | -           | -          |          | Specimen removal location                           |
|        | Te            | st Type.   | TN. Tensi | le: SR. | Stress Bur | ture: CB | . Creen I | Rupture: H | ICF. High C | vole Fatio | nie: T.C | F. Low Cycle Fatigue                                |

Ø - Denotes change from previous issue

# TABLE 2

# Specimen Replacement Guide

| TBM    | Suggested   |                    |
|--------|-------------|--------------------|
| Number | Alternative | Reason for Removal |
| 003    | None        | Not used           |
| 004    | None        | Not used           |
| 007    | None        | Not used           |
| 008    | None        | Not used           |
| 013    | None        | Not used           |
| 019    | None        | Not used           |
| 020    | 025         | Not used           |
| 030    | None        | Not used           |
| 031    | None        | Not used           |
| 032    | None        | Not used           |
| 044    | None        | Not used           |
| 045    | None        | Not used           |
| 065    | None        | Not used           |
| 067    | None        | Not used           |
| 069    | None        | Not used           |
| 079    | None        | Not used           |
| 073    | None        | Not used           |
| 075    | None        | Not used           |
| 077    | None        | Not used           |
| 079    | None        | Not used           |
| 084    | None        | Not used           |
| 085    | None        | Not used           |
| 086    | None        | Not used           |
| 092    | None        | Not used           |
| 101    | None        | Not used           |
| 107    | None        | Not used           |
| 111    | None        | Not used           |
| 117    | None        | Not used           |
| 118    | None        | Not used           |
| 121    | None        | Not used           |
| 123    | None        | Not used           |
| 124    | None        | Not used           |
| 126    | None        | Not used           |
| 128    | None        | Not used           |
| 129    | None        | Not used           |
| 130    | None        | Not used           |
| 131    | None        | Not used           |
| 138    | None        | Not used           |
| 150    | None        | Not used           |
| 151    | None        | Not used           |
| 152    | None        | Not used           |
| 154    | None        | Not used           |
| 155    | None        | Not used           |
| 156    | None        | Not used           |
| 157    | None        | Not used           |

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| TBM    | Suggested   |                    |
|--------|-------------|--------------------|
| Number | Alternative | Reason for Removal |
|        |             |                    |
| 162    | None        | Not used           |
| 163    | None        | Not used           |
| 164    | None        | Not used           |
| 165    | None        | Not used           |
| 166    | None        | Not used           |
| 167    | None        | Not used           |
| 168    | None        | Not used           |
| 169    | None        | Not used           |
| 170    | None        | Not used           |
| 171    | None        | Not used           |
| 172    | None        | Not used           |
| 173    | None        | Not used           |
| 174    | None        | Not used           |
| 175    | None        | Not used           |
| 176    | None        | Not used           |
| 177    | None        | Not used           |
| 178    | None        | Not used           |
| 179    | None        | Not used           |
| 180    | None        | Not used           |
| 181    | None        | Not used           |
| 182    | None        | Not used           |
| 183    | None        | Not used           |
| 184    | None        | Not used           |
| 185    | None        | Not used           |
| 186    | None        | Not used           |
| 187    | None        | Not used           |
| 194    | None        | Not used           |
| 1200   | 1000        | Seldom used        |
| 1301   | 2020        | Seldom used        |
| 1500   | 2020        | Seldom used        |
| 2001   | 2020        | Seldom used        |
| 2002   | 2020        | Seldom used        |
| 2003   | 2020        | Seldom used        |
| 2004   | 2020        | Seldom used        |
| 2005   | 2020        | Seldom used        |
| 2006   | 2020        | Seldom used        |
| 2008   | 2020        | Seldom used        |
| 2009   | 2020        | Seldom used        |
| 2010   | 2020        | Seldom used        |
| 2025   | 2020        | Seldom used        |
| 2110   | 2020        | Seldom used        |
| 2200   | 2020        | Seldom used        |
| 2310   | 2100        | Seldom used        |
| 2320   | 3030        | Seldom used        |
| 2510   | 2020        | Seldom used        |
| 2560   | 3300        | Seldom used        |
| 3001   | 3030        | Seldom used        |
| 3002   | 3030        | Seldom used        |
| 3003   | 3030        | Seldom used        |

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| TBM    | Suggested   |                    |
|--------|-------------|--------------------|
| Number | Alternative | Reason for Removal |
| 2000   | 2.2.2.2     |                    |
| 3008   | 3030        | Seldom used        |
| 3009   | 3030        | Seldom used        |
| 3010   | 3310        | Seldom used        |
| 3020   | 2020        | Seldem used        |
| 3035   | 2020        | Seldem used        |
| 2056   | 2020        | Seldem used        |
| 3050   | 3310        | Seldem used        |
| 3062   | 3310        | Seldom used        |
| 3063   | 3310        | Seldom used        |
| 3064   | 3310        | Seldom used        |
| 3065   | 3310        | Seldom used        |
| 3101   | 3300        | Seldom used        |
| 3102   | 3300        | Seldom used        |
| 3103   | 3300        | Seldom used        |
| 3108   | 3300        | Seldom used        |
| 3109   | 3300        | Seldom used        |
| 3114   | 3300        | Seldom used        |
| 3125   | 3300        | Seldom used        |
| 3130   | 3300        | Seldom used        |
| 3140   | 3300        | Seldom used        |
| 3200   | 3300        | Seldom used        |
| 4001   | 4000        | Seldom used        |
| 4002   | 4004        | Seldom used        |
| 4003   | 4004        | Seldom used        |
| 4011   | 40.50       | Seldom used        |
| 4012   | 40.50       | Seldom used        |
| 4014   | 4050        | Seldom used        |
| 4024   | 4004        | Seldom used        |
| 4025   | 4004        | Seldom used        |
| 4040   | 4030        | Seldom used        |
| 4070   | 4050        | Seldom used        |
| 4080   | None        | Not used           |
| 4150   | 4030        | Seldom used        |
| 5100   | 5262        | Obsolete           |
| 5130   | 5270        | Obsolete           |
| 5200   | 5262        | Obsolete           |
| 5210   | 5270        | Obsolete           |
| 5230   | 5262        | Obsolete           |
| 5260   | 5262        | Obsolete           |
| 6000   | 6010        | Seldom used        |
| 6010A  | 6010        | Seldom used        |
| 6010B  | 6010        | Seldom used        |
| 6015   | 6010        | Seldom used        |
| 6020   | 6010        | Seldom used        |
| 6030   | None        | Seldom used        |
| 6040   | 6050        | Seldom used        |
| 6052   | 6050        | Seldom used        |
| 6080   | 6010        | Seldom used        |

| TBM<br>Number | Suggested<br>Alternative | Reason for Removal |
|---------------|--------------------------|--------------------|
| 6090          | 6010                     | Seldom used        |
| 6100          | 6010                     | Seldom used        |
| 6110          | None                     | Seldom used        |
| 7011          | 7010                     | Duplication        |
| 7031          | 7030                     | Duplication        |

arnothing - Denotes change from previous issue



































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|--|--------------------------------------|---------------------------------|--|--|
| IESI BAR MANUAL                          |                                      |                                 |  |  |
| CREEP TEST SPECIMEN WITH GROOVES, 0.160" |                                      |                                 |  |  |




TBM 3021 Derived from M3617 Rev. W Specimen 4. Testing for LaPorte



|  | TBM 3030<br>Issued: 03/01/19<br>Revision: 4 |  |
|--|---|--|
| TEST BAR MANUAL                                | Page: 1 of 1                                |  |
| Tensile & Stress Rupture Test Specimen, 0.160" |   |  |



|  | T<br>Is<br>F<br>F | TBM<br>ssued:<br>Revision:<br>Page: | 3031<br>03/01/19<br>1<br>1 of 1 |
|--|-------------------|-------------------------------------|---------------------------------|
| TEST BAR MANUAL                                      |                   |                                     |                                 |
| Tensile & Stress Rupture Test Specimen, 0.160" (E8M) |                   |                                     |                                 |





**TBM 3040** 





















TBM 4000

CAD SYSTEM: SOLIDWORKS AUTHOR: JENNIE WANG

DRAWING DATE: 7/10/18



NOTES:

3) SURFACE FINISH IS A MAXIMUM VALUE.

5) CENTERS PERMISSIBLE. 6) REDUCED SECTION = 5D.

LARGER THREAD LENGTH.

2) ALL DIMENSIONS IN INCHES EXCEPT FOR SURFACE FINISH (MICRO-INCHES).

4) FILLET AND GAGE SECTION SHALL BLEND SMOOTHLY WITHOUT UNDERCUT.

7) OVERALL LENGTH IS AN APPROXIMATE VALUE. IT IS PERMISSIBLE TO USE A



|  | TBM 4000<br>Issued: 03/01/19<br>Revision: 4 |  |  |
|--|---|--|--|
| TEST BAR MANUAL  | Page: 1 of 1                                |  |  |
| Test Specimen Machined from Oversized Bar w/o Shoulder, 0.250" |   |  |  |







| TEST BAR MANUAL   | TBM 4005<br>Issued: 03/01/19<br>Revision: 1<br>Page: 1 of 1 |  |  |  |
|---|---|--|--|--|
| Test Specimen Machined from Oversized Bar w/o Shoulder, 0.25" |   |  |  |  |





|  | TBM 4008<br>Issued: 03/01/19<br>Revision: Original<br>Page: 1 of 1 |  |
|--|--|--|
| TEST BAR MANUAL                          |  |  |
| Creep Test Specimen with Grooves, 0.222" |  |  |



| HOWMET<br>AEROSPACE | TBM<br>Issued:<br>Revisio<br>Page: | 4009<br>03/01/19<br>n: Original<br>1 of 1 |
|---------------------|------------------------------------|---|
| TEST BAR MANUAL     |                                    |   |
| Creep Test Specimen | with Grooves, 0.2"                 |   |
|                     |                                    |   |





TBM 4030

### CAD SYSTEM: SOLID WORKS

AUTHOR: JENNIE WANG

DRAWING DATE: 7/10/18



NOTES:

1) DO NOT SCALETHIS DRAWING.

5) CENTERS PERMISSIBLE. 6) REDUCED SECTION = 5D.

LARGER THREAD LENGTH.

3) SURFACE FINISH IS A MAXIMUM VALUE.

81"SIGNIFICANT" DIMENSIONS MARKED BY ASTERISK.

2) ALL DIMENSIONS IN INCHES EXCEPT FOR SURFACE FINISH (MICRO-INCHES).

4) FILLET AND GAGE SECTION SHALL BLEND SMOOTHLY WITHOUT UNDERCUT.

7) OVERALL LENGTH IS AN APPROXIMATE VALUE. IT IS PERMISSIBLE TO USE A









NOTES: TBM 4032 1)DO NOT SCALE THIS DRAWING. 2)ALL DIMENSIONS IN INCHES EXCEPT FOR SURFACE FINISH (MICRO-INCHES). 3)SURFACE FINISH IS A MAXIMUM VALUE. 4)FILLET AND GAGE SECTION SHALL BLEND SMOOTHLY WITHOUT UNDERCUT. 5)CENTERS PERMISSIBLE. 6)REDUCED SECTION = 4D. 7)BAR CREATED FOR TESTING TO B50TF277 SPEC. 8)OVERALL LENGTH IS AN APPROXIMATE VALUE. IT IS PERMISSIBLE TO USE A LARGER THREAD LENGTH. 9)"SIGNIFICANT" DIMENSIONS MARKED BY ASTERISK.

CAD SYSTEM: SOLIDWORKS AUTHOR: BRENDAN MARTIN DRAWING DATE: 1/22/19 SCALED 10:1



ISO VIEW SCALED 8:1





## NOTES:

- 1. DO NOT SCALE THIS DRAWING.
- 2. ALL DIMENSIONS ARE IN INCHES.
- 3. FILLET AND GAUGE SECTION TO BLEND SMOOTHLY WITHOUT UNDERCUT.
- 4. #2 CENTERS ARE PERMISSIBLE.
- 5. REDUCED SECTION = 4D.
- 6. THIS BAR SHOULD BE USED WITH CAUTION SINCE THE GAUGE DIAMETER APPROACHES THAT OF THE MINOR THREAD DIAMETER.



|                                    | TBM<br>Issued | 4049<br>10/10/16 | TOLERANCES                           |
|------------------------------------|---------------|------------------|--------------------------------------|
|                                    | Revision      | 3                | DECIMALS                             |
| TEST BAR MANUAL                    | Page          | 1 of 1           | .XX = .03 TOTAL<br>.XXX = .020 TOTAL |
| HNC ELEVATED TENSILE TEST SPECIMEN |               |                  |                                      |

# TBM 4050

NOTES:

1) DO NOT SCALE THIS DRAWING.

2) ALL DIMENSIONS IN INCHES EXCEPT FOR SURFACE FINISH (MICRO-INCHES).

3) SURFACE FINISH IS A MAXIMUM VALUE.

4) FILLET AND GAGE SECTION SHALL BLEND SMOOTHLY WITHOUT UNDERCUT.
5) CENTERS PERMISSIBLE.

6) REDUCED SECTION = 5D.

7) THIS BAR SHOULD BE USED WITH CAUTION SINCE THE GAGE DIAMETER APPROACHES THAT OF THE MINOR THREAD DIAMETER. CONSIDER USING 4030 INSTEAD OF 4050, AS IT HAS A LARGER THREAD SIZE (1/2"). 8) OVERALL LENGTH IS AN APPROXIMATE VALUE. IT IS PERMISSIBLE TO USE A LARGER THREAD LENGTH.

9) "SIGNIFICANT" DIMENSIONS MARKED BY ASTERISK.







|  | TBM 4050<br>Issued: 03/01/19<br>Revision: 4<br>Page: 1 of 1 |  |
|--|---|--|
| TEST BAR MANUAL                                |   |  |
| Tensile & Stress Rupture Test Specimen, 0.250" |   |  |

DOCUMENT UNCONTROLLED WHEN PRINTED

CAD SYSTEM: SOLIDWORKS

AUTHOR: JENNIE WANG

DRAWING DATE: 7/10/18



|  | TBM<br>Issued:<br>Revision: | 4051<br>03/01/19<br>3 |  |  |
|--|-----------------------------|-----------------------|--|--|
| TEST BAR MANUAL  | Page:                       | 1 of 1                |  |  |
| Tensile & Stress Rupture Test Specimen, 0.250" - Dover Alloy OSB |                             |                       |  |  |



| HOWMET<br>AEROSPACE | TBM<br>Issued:<br>Revision | 4052<br>05/01/19<br>: 1 ∅ |  |
|---------------------|----------------------------|---------------------------|--|
| TEST BAR MANUAL     | Page:                      | 1 of 1                    |  |
| 0.222" Creep Bar    |                            |                           |  |

## NDTES:

BASED DN SAFRAN DRAWINGS 1000 - 03060 & 3000 - 03060

GENERAL SURFACE ROUGHNESS 1.8 MICROMETERS

ALL SHARP EDGES WITH RADIUS OR CHAMFER 0.2mm MAX





TBM 4053 Derived from SPU  $N^{\circ}3000-03060$  & 1000-03060 for HNC



|                    | TBM 4058<br>Issued: 03/01/19<br>Revision: Original<br>Page: 1 of 1 |
|--------------------|--|
| TEST BAR MANUAL    |  |
| 0.222" Tensile Bar |  |



| TEST BAR MANUAL                               | TBM 4200<br>Issued: 03/01/19<br>Revision: 8<br>Page: 1 of 1 |  |  |
|---|---|--|--|
| C.A.E. Compressor Rotor (P/N C701883), 0.357" |   |  |  |













#### NOTES:

HDO NOT SCALE THIS DRAWING. 2) ALL DIMENSIONS IN INCHES EXCEPT FOR SURFACE FINISH INCRO-INCHES). 3) SURFACE FINISH IS A MAXIMUM VALUE. 4) FILLET AND GAGE SECTION SHALL BLEND SMOOTHLY WITHOUT UNDERCUT. 5) FINAL MACHINING OF GAGE SECTION TO BE PARALLEL TO SPECIMEN AXIS. 6) "SIGNIFICANT" DIMENSIONS MARKED BY ASTERSK.

DIMENSIONAL GUIDELINES FOR CROSS SECTIONAL AREAS (WIDTH X THICKNESS) AND WIDTHS:

1 JCSA OF 2"[B] (FROM HOLE EDGES TO GRIP REGION EDGES) SHALL BE MIN 1.25X CSA OF GAGE SECTION [A]. 2]CSA OF PIN HOLE REGION SHALL BE MIN 1.25X CSA OF GAGE SECTION [A]. 3]PIN HOLE DIAMETER [C] SHALL BE MIN 1.25 THE WIDTH OF GAGE SECTION [A].



|                                | TBM 6010<br>Issued: 03/01/19<br>Revision: 5 |
|--------------------------------|---|
| TEST BAR MANUAL                | Page: 1 of 1                                |
| Flat Specimen, 0.037" x 0.188" |   |


NDTES: 1: DRAWING INTERPRETATION PER SC7000 2: MATERIAL TO BE SPECIFIED BY REQUESTOR 3: SPECIMEN SHOULD BE CLEARLY IDENTIFIED IN NON CRITICAL AREA (NOT GAGE SECTION). ALTERNATELY, A PROCEDURE TO KEEP SPECIMENS IN PROCESS CLEARLY ASSOCIATED WITH THE PARENT MATERIAL IS ACCEPTABLE 4: SPECIMENS SHALL BE PREPARED USING HONEYWELL APPROVED LOW STRESS GRINDING TECHNIQUES 4: SPECIMENS SHALL BE PREPARED USING HONEYWELL APPROVED LOW STRESS GRINDING TECHNIQUES 4: SPECIMENS SHALL BE PREPARED USING HONEYWELL APPROVED LOW STRESS GRINDING TECHNIQUES ALL OTHER SECTIONS 63

6: BLEND RADII AND GAGE AREA SHALL BE SMOOTH TRANSITION. NO UNDERCUT PERMITTED

7: BLADE CONTOUR IS PERMITTED IN THE GRIP AREA

8: MACHINE -3 UNLESS OTHERWISE SPECIFIED

9: DIMENSIONS NOTED WITH ASTERISK (\*) ARE CRITICAL DIMENSIONS AND REQUIRE INSPECTION AND RECORDING OF VALUES. ALL OTHER DIMENSIONS NOMINAL. 10: NO STRAIGHTENING OR FLATTENING OF MACHINED SPECIMENS IS PERMITTED.



| <b>Π</b> Π HOWMET | TBM:      | 6051    |
|-------------------|-----------|---------|
|                   | Issued:   | 12/7/23 |
|                   | Revision: | 1       |
| TEST BAR MANUAL   | Page:     | 1 of 1  |

MINI-FLAT SPECIMEN DERIVED FROM MTL 1405-1

NOTES:

- 1: DRAWING INTERPRETATION PER SC7000 2: MATERIAL TO BE SPECIFIED BY REQUESTOR

3: SPECIMEN SHOULD BE CLEARLY IDENTIFIED IN NON CRITICAL AREA (NOT GAGE SECTION). ALTERNATELY, A PROCEDURE TO KEEP SPECIMENS IN PROCESS CLEARLY ASSOCIATED WITH THE PARENT MATERIAL IS ACCEPTABLE

4: SPECIMENS SHALL BE PREPARED USING HIDREYWELL APPROVED LOW STRESS GRINDING TECHNIQUES 5: GAGE SECTION SURFACE ROUGHNESS 8 MICROINCHES MAXIMUM THROUGH 50% OF THE BLEND RADIUS AT EACH END. SURFACE ROUGHNESS ALL OTHER SECTIONS 63

MICRUINCHES MAX 6: BLEND RADII AND GAGE AREA SHALL BE SMOOTH TRANSITION. NO UNDERCUT PERMITTED

7: BLADE CONTOUR IS PERMITTED IN THE GRIP AREA

8: MACHINE -3 UNLESS OTHERWISE SPECIFIED

9: DIMENSIONS NOTED WITH ASTERISK (\*) ARE CRITICAL DIMENSIONS AND REQUIRE INSPECTION AND RECORDING OF VALUES. ALL OTHER DIMENSIONS NOMINAL.

10: NO STRAIGHTENING OR FLATTENING OF MACHINED SPECIMENS IS PERMITTED.



| HOWMET<br>LLJ AEROSPACE | Issued:   | 12/7/23 |
|-------------------------|-----------|---------|
|                         | Revision: | 1       |
| TEST BAR MANUAL         | Page:     | 1 of 1  |





















|                                 | TBM 7010<br>Issued: 03/01/19<br>Revision: 4 |  |  |
|---------------------------------|---|--|--|
| TEST BAR MANUAL                 | Page: 1 of 1                                |  |  |
| Notched Stress Rupture Specimen |   |  |  |

# SENSITIVE



Derived from RLH6105; 0.178"





# NOTES

- 1) SHALL CONFORM TO P1TF79 CL-B (METALLIC TEST SPECIMEN)
- 2) THE FOLLOWING DOCUMENTS ARE ALSO APPLICABLE TO THE EXTENT SPECIFIED ON THIS DRAWING: 4013195-851
- 3) TAG GE 4013195-022
- 4) UNLESS OTHERWISE SPECIFIED, REMOVE ALL BURRS & SHARP EDGES WITH .015 ± .005 RADIUS OR CHAMFER
- 5) RADIUS & GAUGE SECTION TO BLEND SMOOTHLY WITHOUT UNDERCUTS

















TBM A8

2. TAKE TCR SPECIMENS AS CLOSE TO TRAILING EDGE AS POSSIBLE. 3. ALL SPECIMENS SHALL HAVE ALL SURFACES OF GAGE AREA MACHINED A MINUMUM OF .002" BELOW THE AS-CAST SURFACE OR BELOW THE COATING DIFFUSION ZONE.

1. DO NOT SCALE THIS DRAWING.

NDTES:

4. FOR TCR SPECIMENS, GRINDING IN GAGE SECTION TO BE TRANSVERSE TO LONG AXIS OF SPECIMEN AND POLISHED IN DIRECTION PARALLEL TO LONG AXIS OF SPECIMEN TO FINISH REQUIREMENT OF THE APPLICABLE SPECIMEN DRAWING.

 Ø 5. REFERENCE: HONEYWELL EMS 52332.
6. SPECIMEN GAGE SECTION TAKEN FROM CORED LINE.

|  | TBM<br>Issued    | A8<br>05/09/12  | TOLERANCES                           |
|--|------------------|-----------------|--------------------------------------|
| <b>TEST BAR MANUAL</b>                         | Revision<br>Page | : 4<br>: 1 of 1 | .XX = .03 TOTAL<br>.XXX = .020 TOTAL |
| LOCATION OF TEST MATERIAL MACHINED FROM BLADES |                  | -               |                                      |

NDTES:

1. DO NOT SCALE THIS DRAWING. 2. TAKE TCR SPECIMENS AS CLOSE TO TRAILING EDGE AS POSSIBLE. 3. ALL SPECIMENS SHALL HAVE ALL SURFACES OF GAGE AREA MACHINED A MINUMUM OF .002" BELOW THE AS-CAST SURFACE OR BELOW THE COATING DIFFUSION ZONE. 4. FOR TCR SPECIMENS, GRINDING IN GAGE SECTION TO BE TRANSVERSE TO LONG AXIS OF SPECIMEN AND POLISHED IN DIRECTION PARALLEL TO LONG AXIS OF SPECIMEN TO FINISH REQUIREMENT OF THE APPLICABLE SPECIMEN DRAWING.

Ø 5. REFERENCE: HONEYWELL EMS 52332. 6. SPECIMEN GAGE SECTION TAKEN FROM CONCA∨E WALL.

|  | TBM              | A9<br>05/09/12 | TOLERANCES                           |
|--|------------------|----------------|--------------------------------------|
| <b>TEST BAR MANUAL</b>                         | Revision<br>Page | 4<br>1 of 1    | .XX = .03 TOTAL<br>.XXX = .020 TOTAL |
| LOCATION OF TEST MATERIAL MACHINED FROM BLADES |                  |                |                                      |

TBM A9



