

CALIBRATION LABORATORIES

NVLAP LAB CODE 200301-0


**SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017**

|   |   |
|---|---|
| <p><b>Instron Calibration Laboratory</b><br/>825 University Avenue<br/>Norwood, MA 02062-2643<br/>Mr. James O'Donovan<br/>Phone: 781-575-5526 Fax: 781-575-5764<br/>E-mail: <a href="mailto:james_odonovan@instron.com">james_odonovan@instron.com</a><br/>URL: <a href="http://www.instron.com">http://www.instron.com</a></p> | <p><b>Fields of Calibration</b><br/>Dimensional<br/>Electromagnetics – DC/Low Frequency<br/>Time &amp; Frequency<br/>Mechanical<br/>Thermodynamic</p> <p>This laboratory is compliant to ANSI/NC SL Z540-1-1994; Part 1. (NVLAP Code: 20/A01)</p> |
|---|---|

**CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) <sup>Notes 1,2</sup>**

| Measured Parameter or Device Calibrated  | Range               | Expanded Uncertainty <sup>Notes 3,5,8</sup>    | Remarks  |
|--|---------------------|--|--|
| <b>DIMENSIONAL</b>   |                     |  |  |
| <b>ANGULAR (20/D01)</b>  |                     |  |  |
| Rotary Stroke – Clockwise and Counter-Clockwise<br>Field calibrations only <sup>Note 4</sup> | 0.5° to 360°        | 0.16°  | Instron Internal Method with rotary encoder  |
| Rotary Speed<br>Field calibrations only <sup>Note 4</sup>                                    | 0.1 rpm to 120 rpm  | 0.00021 rpm + 0.00030 rpm/rpm                  | Comparison to time base oscillator   |
| <b>LENGTH and DIAMETER; STEP GAGES (20/D05)</b>  |                     |  |  |
| Displacement Measuring Device, in Lab  | Up to 1100 mm       | 0.0021 mm + 0.000049L mm                       | Instron Internal Method using laser interferometer<br>Note: Calibration of these displacement measuring devices is only done at our facility at C/Argenters 2, Parque Tecnológico del Vallés, Cerdanyola, Barcelona 08290 Spain. |
| Alignment Electronics Calibration, in lab <sup>Note 10</sup>                                 | Up to 2000 μ-strain | 2.5 S, where S is reading in units of μ-strain | Instron Internal Method  |

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**CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) <sup>Notes 1,2</sup>**

| <b>Measured Parameter or Device Calibrated</b>  | <b>Range</b>   | <b>Expanded Uncertainty <sup>Notes 3,5,8</sup></b>  | <b>Remarks</b>  |
|---|--|---|---|
| Alignment Transducer Verification, in lab <sup>Note 10</sup>  | Up to 2000 $\mu$ -strain   | -0.00024 <i>S</i> % + 1.7 %   | Instron Internal Method   |
| Alignment of Materials Testing System<br>Field calibrations only <sup>Notes 4</sup><br>Extensometer Calibration Apparatus, in lab | Up to 2000 $\mu$ -strain<br><br>0.01 mm to 60 mm   | 0.0082 <i>S</i> % + 0.23 %<br><br>0.099 $\mu$ m + 0.13 <i>L</i> $\mu$ m   | ASTM E1012, Nadcap AC7101, AC7122 specimen alignment (used in determination of % bend)<br><br>Instron Internal Method<br>Note: Calibration of these displacement measuring devices is only done at our facility at C/Argenters 2, Parque Tecnológico del Vallés, Cerdanyola, Barcelona 08290 Spain. |
| Strain<br>Field calibrations only <sup>Note 4</sup>   |  |   | ASTM E83, ISO 9513, ISO 5893, ISO 527 or Internal Method  |
| Gage length   | 0.1 in to 0.3 in<br>> 0.3 in to 4.0 in<br>> 4 in to 12 in<br>> 12 in to 72 in  | 0.000074 in + 0.000024 <i>L</i> in<br>0.0008 in + 0.0002 <i>L</i> in<br>0.0024 in + 0.000027 <i>L</i> in<br>0.017 in  | Gage bars, rulers or digital calipers   |
| Displacement  | 0.0002 in to 0.00475 in<br>> 0.00475 in to 0.006 in<br>> 0.006 in to 0.02 in<br>> 0.02 in to 0.25 in<br>> 0.25 in to 1.0 in<br>> 1.0 in to 2.0 in<br>> 2 in to 10 in<br>> 10 in to 40 in | 0.000012 in<br>0.000015 in<br>0.00002 in + 0.000071 <i>L</i> in<br>0.000043 in + 0.00014 <i>L</i> in<br>0.000053 in + 0.00021 <i>L</i> in<br>0.000078 in + 0.00022 <i>L</i> in<br>0.00011 in + 0.00016 <i>L</i> in<br>0.000022 in + 0.00017 <i>L</i> in | Linear displacement scales  |

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**CALIBRATION AND MEASUREMENT CAPABILITIES (CMC)** Notes 1,2

| <b>Measured Parameter or Device Calibrated</b>   | <b>Range</b>  | <b>Expanded Uncertainty</b> <small>Notes 3,5,8</small>  | <b>Remarks</b>  |
|--|---|---|---|
| Specimen Measuring Device (SMD)<br>Field calibrations only <small>Note 4</small>                     |   |   |   |
| Vertical   |   |   |   |
| Width  | Up to 40 mm   | 0.00069 mm  | Instron Internal Procedure using gage blocks  |
| Thickness  | Up to 15 mm   | 0.00063 mm  |   |
| Parallelism  |   |   |   |
| Width  | Up to 1.3 mm  | 1.1 µm  | Instron Internal Procedure using ball gage  |
| Thickness  | Up to 1.3 mm  | 0.95 µm   |   |
| Flatness   |   |   |   |
| Horizontal   |   |   |   |
| Width  | Up to 40 mm   | 0.0012 mm   | Instron Internal Procedure using gage blocks  |
| Thickness  | Up to 15 mm   | 0.00067 mm  |   |
| Material Testing System<br>Crosshead Displacement or Actuator Stroke                                 |   |   | ASTM E2309 or Internal Method with digital linear encoders with digital linear or wire encoders |
| Field calibrations only <small>Note 4</small>  | Up to 10 in<br>> 10 in to 40 in<br>> 40 in to 60 in                                     | 0.00011 in + 0.00016L in<br>0.000022 in + 0.00017L in<br>0.0002 in + 0.0016L in   |   |
| Material Testing System<br>Crosshead/Actuator Speed<br>Field calibrations only <small>Note 4</small> | Up to 0.2 mm/min<br><br>> 0.2 mm/min to 1270 mm/min<br><br>> 1270 mm/min to 3000 mm/min | 0.000013 mm/min + 0.00093v mm/min, where v is measured value<br><br>-0.000036 mm/min + 0.0011v mm/min, where v is measured value<br><br>-0.27 mm/min + 0.0014 v mm/min, where v is measured value | ASTM E2658 or Internal Method with linear encoders and comparison to time base oscillator       |

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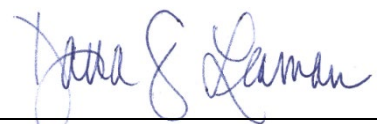
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**CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) <sup>Notes 1,2</sup>**

| <b>Measured Parameter or Device Calibrated</b>   | <b>Range</b>   | <b>Expanded Uncertainty <sup>Notes 3,5,8</sup></b> | <b>Remarks</b>  |
|--|--|--|---|
| Hardness XY Stage Micrometer<br>Field calibrations only <sup>Note 4</sup>              | Up to 1 in   | 0.00003 in + 0.00018L in                           | Internal Method,<br>linear encoder                                      |
| Rheological Testing System<br>Speed<br>Field calibrations only <sup>Note 4</sup>       | Up to 600 mm/min<br>12 mm/s to 15708 mm/s  | 2.0 %<br>1.2 %                                     | Caliper and stopwatch<br>Caliper and tachometer                         |
| Impact Testing System<br>Speed<br>Field calibrations only <sup>Note 4</sup>            | Up to 24 m/s   | 1.1 %  | Caliper and oscilloscope  |
| Linearity of C.O.D. Gauges<br>Field calibrations only <sup>Note 4</sup>                | 0.01 in to 0.32 in   | 0.000012 in + 0.00015L in                          | Displacement ASTM E399  |
| Rheological Equipment<br>Field calibrations only <sup>Note 4</sup>                     |  |  |   |
| Inside Diameter  | 2 mm to 2.5 mm<br>8 mm to 10 mm<br>9.5 mm to 12.7 mm<br>> 12.7 mm to 16 mm<br>> 16 mm to 20 mm | 0.004 mm   | Holematic Mark II or<br>go/no-go gage<br><br>Setting ring and bore gage |
| Outside Diameter   | Up to 3 mm<br>Up to 30 mm<br>Up to 152 mm  | 0.08 mm<br>0.0027 mm<br>0.018 mm                   | 12X eye loupe<br>Micrometer calipers                                    |
| Linear Displacement  | Up to 40.2 mm  | 0.037 mm   | Gage blocks   |
| Heat Deflection Machines<br>(HDT & VICAT)<br>Field calibrations only <sup>Note 4</sup> |  |  |   |
| Linear Displacement  | Up to 2 mm   | 0.012 mm   | Gage blocks   |
| Outside Diameter   | Up to 30 mm  | 0.0027 mm  | Micrometer  |

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| <b>Measured Parameter or Device Calibrated</b>  | <b>Range</b>  | <b>Expanded Uncertainty <sup>Notes 3,5,8</sup></b>  | <b>Remarks</b>   |
|---|---|---|--|
| Impact Testers<br>Field calibrations only <sup>Note 4</sup><br>Radius of Curvature<br>Length<br>Length, falling weight tester<br>Outside Diameter | Up to 3 mm<br>Up to 150 mm<br>Up to 2 m<br>Up to 30 mm  | 0.08 mm<br>0.027 mm<br>2.0 mm<br>0.0027 mm  | 12 X eye loupe<br>Caliper<br>Tapes<br>Micrometer   |
| <b>ELECTROMAGNETICS – DC/LOW FREQUENCY</b>  |   |   |  |
| <b>AC RESISTANCE AND CURRENT (20/E02)</b>   |   |   |  |
| AC Current<br>Field calibrations only <sup>Note 4</sup>   | 0 A to 10 A   | 0.3 A   | Multimeter   |
| <b>DC VOLTAGE (20/E06)</b>  |   |   |  |
| DC Voltage – Measure<br>In lab <sup>Note 9</sup><br><br>Field calibrations <sup>Note 4</sup><br><br>Ratio, in lab                                 | 0 mV to 300 mV<br>0 V to 3 V<br><br>0.05 V to 1000 V<br><br>200 $\mu$ V/10 V to<br>40 mV/10 V | 0.096 mV<br>0.14 mV<br>0.00058 V + 0.0069v V,<br>where v is the measured value<br><br>0.055 % | HP 3478A<br><br>Multimeter<br><br>Signametrics SMX2060<br>Digital Multimeter<br>Note: These ratio calibrations are only performed at our facility at Coronation Road, High Wycombe, HP12 3SY, Buckinghamshire, UK. |
| <b>LF AC VOLTAGE (20/E09)</b>   |   |   |  |
| AC Voltage<br>Field calibrations only <sup>Note 4</sup>   | 40 V to 1000 V<br>1 kV to 6 kV  | 1.4 % of reading<br>1.2 %   | Multimeter<br>Multimeter with HV probe   |

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|--|--|---|---|
| <b>TIME &amp; FREQUENCY</b>                                    |  |   |   |
| <b>FREQUENCY DISSEMINATION (20/F01)</b>                        |  |   |   |
| Frequency Measure<br>Field calibrations only <sup>Note 4</sup> | 0.5 Hz to 2.0 Hz<br>Up to 100 MHz  | 1.4 <i>f</i> % + 0.97 %,<br>where <i>f</i> is nominal freq. value<br>0.94 % | Timer<br>Oscilloscope   |
| <b>STOPWATCHES &amp; TIMERS (20/F05)</b>                       |  |   |   |
| Timers<br>Field calibrations only <sup>Note 4</sup>            | 0.7 ms to 5 ms<br>Up to 500 s  | 0.94 %<br>0.22 s  | Oscilloscope<br>Stopwatch   |
| <b>MECHANICAL</b>  |  |   |   |
| <b>FORCE (20/M06)</b>  |  |   |   |
| Force <sup>Note 7</sup><br>In lab <sup>Note 11</sup>           | 0.1 lbf to 130 000 lbf<br>130 000 lbf to<br>240 000 lbf<br>240 000 lbf to<br>1 000 000 lbf | 0.005 %<br>0.01 %<br>0.05 %   | ASTM E74, ISO 376, and<br>internally developed<br>methods<br>Primary standard<br>Secondary standard |
| Field calibrations <sup>Note 4</sup>                           | 1 gf to 500 000 kgf<br>(0.01 N to 5 MN)<br>1 gf to 500 000 kgf<br>(0.01 N to 5 MN)         | 0.12 %<br>0.12 %  | ASTM E4, ISO 7500-1,<br>ISO 7500-2, and internally<br>developed methods<br>Compression<br>Tension   |
| Falling Weight Impact<br>Tester, in lab <sup>Note 9</sup>      | 1 kN to 25 kN<br>1 kN to 222 kN  | 0.7 % of full scale<br>0.11 %   | Interface 9840 and load<br>cell   |
| Falling Weight Impact<br>Tester, in field <sup>Note 4</sup>    | Up to 3.25 N   | 9.8 x10 <sup>-5</sup> N + 0.024 % of full<br>scale                          | Load cell and<br>readout device;<br>Instron internal method   |

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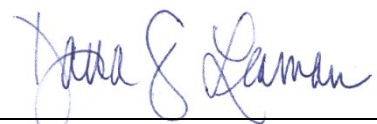
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|--|--|--|-------------------------------------|
| Rheological Equipment<br>Field calibrations only <sup>Note 4</sup>   | > 3.25 kN to 22 kN<br><br>> 22 kN to 100 kN<br><br>Up to 250 g | 1.7 x10 <sup>-5</sup> N + 0.016 % of full scale<br><br>-5.03x10 <sup>-06</sup> N % + 0.78 % rdg.<br><br>0.31 % | Interface 9840 & load cell          |
| Heat Deflection Equipment<br>Field calibrations only <sup>Note 4</sup>   | Up to 250 g  | 0.31 %   | Interface 9840 & load cell          |
| <b>HARDNESS (20/M13)</b>   |  |  |                                     |
| Hardness<br>Indirect verification of Rockwell Hardness testing machines<br>Field calibrations only <sup>Note 4</sup> |  |  |                                     |
| HRA Carbide  | 93 Rockwell Points<br>91 Rockwell Points<br>85 Rockwell Points | 0.07 Rockwell Points<br>0.11 Rockwell Points<br>0.17 Rockwell Points   | ASTM B294 Annex A3                  |
| HRA Steel Scale  | 83 Rockwell Points<br>73 Rockwell Points<br>63 Rockwell Points | 0.10 Rockwell Points<br>0.27 Rockwell Points<br>0.15 Rockwell Points   | ASTM E18 Annex A4 & ISO 6508-1 & -2 |
| HRBW Scale   | 95 Rockwell Points<br>70 Rockwell Points<br>40 Rockwell Points | 0.17 Rockwell Points<br>0.31 Rockwell Points<br>0.48 Rockwell Points   |                                     |
| HRC Scale  | 63 Rockwell Points<br>45 Rockwell Points<br>25 Rockwell Points | 0.16 Rockwell Points<br>0.18 Rockwell Points<br>0.18 Rockwell Points   |                                     |
| HRD Scale  | 73 Rockwell Points<br>59 Rockwell Points<br>43 Rockwell Points | 0.05 Rockwell Points<br>0.13 Rockwell Points<br>0.14 Rockwell Points   |                                     |

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|--|---|--|----------------|
| HREW Scale                                     | 92 Rockwell Points<br>87 Rockwell Points<br>81 Rockwell Points    | 0.11 Rockwell Points<br>0.24 Rockwell Points<br>0.14 Rockwell Points |                |
| HRFW Scale                                     | 98 Rockwell Points<br>91 Rockwell Points<br>80 Rockwell Points    | 0.11 Rockwell Points<br>0.16 Rockwell Points<br>0.13 Rockwell Points |                |
| HRGW Scale                                     | 77 Rockwell Points<br>56 Rockwell Points<br>23 Rockwell Points    | 0.18 Rockwell Points<br>0.28 Rockwell Points<br>0.45 Rockwell Points |                |
| HRHW Scale                                     | 100 Rockwell Points<br>97 Rockwell Points<br>91 Rockwell Points   | 0.16 Rockwell Points<br>0.22 Rockwell Points<br>0.16 Rockwell Points |                |
| HRK Scale                                      | 91 Rockwell Points<br>75 Rockwell Points<br>57 Rockwell Points    | 0.20 Rockwell Points<br>0.21 Rockwell Points<br>0.39 Rockwell Points |                |
| HRLW Scale                                     | 124 Rockwell Points<br>116 Rockwell Points<br>106 Rockwell Points | 0.05 Rockwell Points<br>0.10 Rockwell Points<br>0.15 Rockwell Points |                |
| HRM Scale                                      | 120 Rockwell Points<br>105 Rockwell Points<br>90 Rockwell Points  | 0.07 Rockwell Points<br>0.13 Rockwell Points<br>0.30 Rockwell Points |                |
| HR15N Scale                                    | 91 Rockwell Points<br>83 Rockwell Points<br>71 Rockwell Points    | 0.08 Rockwell Points<br>0.09 Rockwell Points<br>0.09 Rockwell Points |                |
| HR30N Scale                                    | 80 Rockwell Points<br>64 Rockwell Points<br>46 Rockwell Points    | 0.15 Rockwell Points<br>0.23 Rockwell Points<br>0.16 Rockwell Points |                |
| HR45N Scale                                    | 70 Rockwell Points  | 0.13 Rockwell Points   |                |

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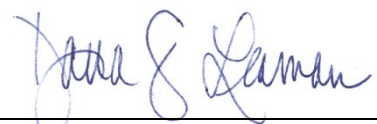
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|--|---------------------|--|----------------|
| HRPW Scale                                     | 49 Rockwell Points  | 0.12 Rockwell Points                               |                |
|  | 24 Rockwell Points  | 0.19 Rockwell Points                               |                |
| HRRW Scale                                     | 108 Rockwell Points | 0.15 Rockwell Points                               |                |
|  | 99 Rockwell Points  | 0.23 Rockwell Points                               |                |
|  | 88 Rockwell Points  | 0.26 Rockwell Points                               |                |
| HRSW Scale                                     | 121 Rockwell Points | 0.12 Rockwell Points                               |                |
|  | 119 Rockwell Points | 0.12 Rockwell Points                               |                |
|  | 116 Rockwell Points | 0.12 Rockwell Points                               |                |
| HR15TW Scale                                   | 114 Rockwell Points | 0.12 Rockwell Points                               |                |
|  | 109 Rockwell Points | 0.15 Rockwell Points                               |                |
|  | 106 Rockwell Points | 0.16 Rockwell Points                               |                |
| HR30TW Scale                                   | 90 Rockwell Points  | 0.05 Rockwell Points                               |                |
|  | 83 Rockwell Points  | 0.27 Rockwell Points                               |                |
|  | 76 Rockwell Points  | 0.17 Rockwell Points                               |                |
| HR45TW Scale                                   | 70 Rockwell Points  | 0.20 Rockwell Points                               |                |
|  | 56 Rockwell Points  | 0.20 Rockwell Points                               |                |
|  | 43 Rockwell Points  | 0.29 Rockwell Points                               |                |
| HRVWW Scale                                    | 67 Rockwell Points  | 0.10 Rockwell Points                               |                |
|  | 41 Rockwell Points  | 0.33 Rockwell Points                               |                |
|  | 23 Rockwell Points  | 0.21 Rockwell Points                               |                |
| HR15WW Scale                                   | 106 Rockwell Points | 0.17 Rockwell Points                               |                |
|  | 98 Rockwell Points  | 0.21 Rockwell Points                               |                |
|  | 95 Rockwell Points  | 0.22 Rockwell Points                               |                |
| HR15WW Scale                                   | 94 Rockwell Points  | 0.08 Rockwell Points                               |                |
|  | 88 Rockwell Points  | 0.07 Rockwell Points                               |                |
|  | 84 Rockwell Points  | 0.11 Rockwell Points                               |                |

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|--|--|--|----------------|
| HR30WW Scale                                   | 88 Rockwell Points<br>75 Rockwell Points<br>69 Rockwell Points | 0.09 Rockwell Points<br>0.13 Rockwell Points<br>0.24 Rockwell Points |                |
| HR45WW Scale                                   | 82 Rockwell Points<br>69 Rockwell Points<br>50 Rockwell Points | 0.08 Rockwell Points<br>0.23 Rockwell Points<br>0.11 Rockwell Points |                |
| HR15XW Scale                                   | 97 Rockwell Points<br>95 Rockwell Points<br>90 Rockwell Points | 0.08 Rockwell Points<br>0.08 Rockwell Points<br>0.10 Rockwell Points |                |
| HR30XW Scale                                   | 93 Rockwell Points<br>88 Rockwell Points<br>80 Rockwell Points | 0.11 Rockwell Points<br>0.16 Rockwell Points<br>0.12 Rockwell Points |                |
| HR45XW Scale                                   | 90 Rockwell Points<br>82 Rockwell Points<br>71 Rockwell Points | 0.08 Rockwell Points<br>0.11 Rockwell Points<br>0.18 Rockwell Points |                |
| HR15YW Scale                                   | 97 Rockwell Points<br>95 Rockwell Points<br>92 Rockwell Points | 0.12 Rockwell Points<br>0.15 Rockwell Points<br>0.10 Rockwell Points |                |
| HR30YW Scale                                   | 94 Rockwell Points<br>91 Rockwell Points<br>83 Rockwell Points | 0.09 Rockwell Points<br>0.19 Rockwell Points<br>0.41 Rockwell Points |                |
| HR45YW Scale                                   | 91 Rockwell Points<br>86 Rockwell Points<br>75 Rockwell Points | 0.10 Rockwell Points<br>0.18 Rockwell Points<br>0.11 Rockwell Points |                |

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|---|---|--|------------------------------------|
| Brinell, Knoop and Vickers hardness testing machines<br>Field calibrations only <sup>Note 4</sup>   |   |  |                                    |
| Brinell Microscope<br>Type A Microscope<br>Type B Microscope  | 10X to 100X Magnification<br>10X to 100X Magnification                                      | 1.6 µm<br>21 µm                                      | ASTM E10 &<br>ISO 6506-1 & -2      |
| Vickers and Knoop Microscope<br>Indirect Verification of Brinell, Knoop and Vickers testing machines<br>Field calibrations only <sup>Note 4</sup> | 30X to 1000X Magnification  | 0.9 µm   | ASTM E384, E92, or ISO 6507-1 & -2 |
| Brinell Hardness<br>Applied Forces of 10 kgf to 3000 kgf; ball diameter of 1 mm to 10 mm  |   |  | ASTM E10 &<br>ISO 6506-1 & -2      |
| Low Hardness  | 94 HBW 10/500<br>100 HBW 2.5/62.5<br>111 HBW 10/3000<br>139 HBW 2.5/62.5<br>140 HBW 10/1000 | 1.1 HBW<br>0.98 HBW<br>1.4 HBW<br>1.7 HBW<br>1.9 HBW |                                    |
| Mid Hardness  | 183 HBW 10/3000<br>199 HBW 2.5/187.5<br>200 HBW 2.5/187.5<br>200 HBW 10/1500                | 2.4 HBW<br>2.8 HBW<br>1.6 HBW<br>1.7 HBW             |                                    |
| High Hardness   | 315 HBW 10/3000<br>326 HBW 5/750<br>462 HBW 10/3000   | 2.6 HBW<br>4.0 HBW<br>5.0 HBW                        |                                    |

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**CALIBRATION AND MEASUREMENT CAPABILITIES (CMC)** Notes 1,2

| <b>Measured Parameter or Device Calibrated</b>  | <b>Range</b>   | <b>Expanded Uncertainty</b> <small>Notes 3,5,8</small>   | <b>Remarks</b>                     |
|---|--|--|------------------------------------|
| Vickers Hardness<br>Field calibrations only <small>Note 4</small><br>Applied Forces of 10 gf to 120 kgf         |  |  | ASTM E384, E92, or ISO 6507-1 & -2 |
| Low Hardness  | 129 HV/0.1<br>212 HV/10<br>217 HV/0.5<br>255 HV/15<br>261 HV/100             | 1.6 HV<br>1.4 HV<br>2.4 HV<br>1.8 HV<br>1.8 HV           |                                    |
| Mid Hardness  | 321 HV/5<br>388 HV/0.5<br>395 HV/0.1<br>441 HV/100                           | 3.9 HV<br>4.2 HV<br>6.4 HV<br>2.8 HV                     |                                    |
| High Hardness   | 598 HV/30<br>611 HV/5<br>694 HV/0.5<br>697 HV/100<br>705 HV/0.2<br>719 HV/30 | 5.8 HV<br>3.5 HV<br>5.5 HV<br>5.5 HV<br>9.1 HV<br>3.6 HV |                                    |
| Knoop Indentation Hardness<br>Field calibrations only <small>Note 4</small><br>Applied forces of 10 gf to 1 kgf |  |  | ASTM E384 or E92                   |
| Low Hardness  | 112 HK/0.01<br>142 HK/0.1<br>238 HK/0.5                                      | 5.2 HK<br>2.3 HK<br>3.8 HK                               |                                    |
| Mid Hardness  | 319 HK/0.2<br>516 HK/1<br>524 HK/0.1   | 3.5 HK<br>4.8 HK<br>5.8 HK                               |                                    |

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**CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) <sup>Notes 1,2</sup>**

| <b>Measured Parameter or Device Calibrated</b>  | <b>Range</b>  | <b>Expanded Uncertainty <sup>Notes 3,5,8</sup></b>  | <b>Remarks</b>  |
|---|---|---|---|
| High Hardness<br><br>Direct Verification of Rockwell testing machines<br>Field calibrations only <sup>Note 4</sup><br><br>Testing Time Cycle<br>Indenter Contact Velocity<br>Preliminary Force Dwell<br>Additional Force Application<br>Total Force Dwell<br>Elastic Recovery Dwell | 637 HK/0.1<br>700 HK/0.025<br>741 HK/0.5<br><br><br><br><br><br><br><br><br><br>Up to 180 s | 9.5 HK<br>13 HK<br>6.2 HK<br><br><br><br><br><br><br><br><br><br>0.000012T s + 0.46 s, where T is time in seconds | ASTM E18 Annex A1<br>ISO 6508-1 & -2                            |
| Test Force<br>Depth Measuring Device<br>Test Machine Level<br>Machine Hysteresis  | 3 kgf to 150 kgf  | 0.13 %<br>0.05 μm<br>0.0005 in/ft elevation<br>0.01 Rockwell Points   | Instron Internal Method<br>ASTM E18 Annex A1<br>ISO 6508-1 & -2 |
| Direct Verification of Brinell testing machines & measuring equipment<br>Field calibrations only <sup>Note 4</sup><br><br>Test Force<br>Time<br>Length  | From HB 10/3000 to 1/10   | 0.23 %<br>0.000012T s + 0.46 s<br>2.0 μm  | ASTM E10 &<br>ISO 6506-1 & -2                                   |

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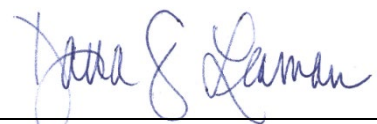
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**CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) <sup>Notes 1,2</sup>**

| Measured Parameter or Device Calibrated  | Range   | Expanded Uncertainty <sup>Notes 3,5,8</sup>    | Remarks  |
|--|---|--|--|
| Direct Verification of Vickers testing machines & measuring equipment<br>Field calibrations only <sup>Note 4</sup><br>Test Force<br>Time<br>Length | Vickers scales:<br>HV 5 to HV 100<br>HV 0.1 to HV 3   | 0.23 %<br>0.0000127 s + 0.46 s<br>2.0 µm       | ASTM E92,<br>ISO 6507-1 & -2   |
| <b>TORQUE (20/M15)</b>   |   |  |  |
| Torque – Calibration of Torque devices, Clockwise And Counter-Clockwise<br>Field calibrations only <sup>Note 4</sup>                               | Up to 2 lbf-in<br>Up to 200 lbf-in<br>1 lbf-in to 110 lbf-in<br>10 lbf-in to 2213 lbf-in<br>50 lbf-in to 50000 lbf-in | 0.13 %<br>0.11 %<br>0.12 %<br>0.11 %<br>0.13 % | ASTM E2624 or Internal Method<br><br>2 in beam and deadweight<br>10 in beam and deadweight<br>Torque transducers |
| <b>IMPACT (20/M17)</b>   |   |  |  |
| Impact Testing Machines<br>Field calibrations only <sup>Note 4</sup>   | (Absorbed energy in Joules)   |  |  |
| Metals   | 150 J to 900 J  | 0.40 J   | ASTM E23 or ISO 148 including proof testing using certified Specimens  |
| Plastics   | 0.5 J to 7.5 J<br>15 J<br>25 J<br>50 J  | 0.015 J<br>0.030 J<br>0.042 J<br>0.081 J       | ISO 13802, ASTM D256, ISO 8256, ISO179-1, ISO 180, ISO 7628-2, ISO 9854-1, ASTM D6110, ASTM D1822                |

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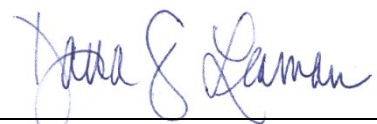
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**CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) <sup>Notes 1,2</sup>**

| Measured Parameter or Device Calibrated                                      | Range  | Expanded Uncertainty <sup>Notes 3,5,8</sup>  | Remarks                                 |
|--|--|--|---|
| <b>THERMODYNAMIC</b>   |  |  |   |
| <b>LABORATORY THERMOMETERS, DIGITAL and ANALOG (20/T03)</b>                  |  |  |   |
| In-situ Temperature Measurement<br>Field calibrations only <sup>Note 4</sup> |  |  |   |
| Temperature  | -200 °C to -150 °C<br>> -150 °C to -100 °C<br>> -100 °C to 0 °C  | 1.3 °C<br>1.2 °C<br>1.1 °C   | Type T thermocouple with Fluke 714      |
| Temperature  | 0 °C to 100 °C<br>> 100 °C to 200 °C<br>> 200 °C to 300 °C<br>> 300 °C to 400 °C<br>> 400 °C to 500 °C<br>> 500 °C to 600 °C<br>> 600 °C to 700 °C<br>> 700 °C to 800 °C<br>> 800 °C to 900 °C | 0.7 °C<br>1.2 °C<br>2.1 °C<br>2.6 °C<br>3.2 °C<br>3.7 °C<br>4.7 °C<br>4.8 °C<br>5.3 °C | Type K Thermocouple with Fluke 714      |
| <b>PRESSURE INDICATORS (20/T05)</b>  |  |  |   |
| Pressure Indicators<br>Field calibrations only <sup>Note 4</sup>             | 0 bar to 300 bar<br>0 bar to 2000 bar  | 0.2 bar<br>1.1 bar   | Pressure Gage and Hydraulic Pump        |
| <b>RESISTANCE THERMOMETRY (20/T07)</b>                                       |  |  |   |
| Temperature<br>Field calibrations only <sup>Note 4</sup>                     | -75 °C to 0 °C<br>> 0 °C to 400 °C   | 0.14 °C<br>0.05 °C   | PRT 100 and Hart Scientific Black Stack |
| HDT / Vicat Systems  | 0 °C to 500 °C   | 0.13 °C  |   |

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| <b>Measured Parameter or Device Calibrated</b>                           | <b>Range</b> | <b>Expanded Uncertainty</b> <small>Notes 3,5,8</small> | <b>Remarks</b>                             |
|--|--------------|--|--|
| <b>TEMPERATURE INDICATORS (20/T08)</b>                                   |              |  |  |
| Thermocouple Simulation<br>Field calibrations only <small>Note 4</small> | Type K       | 1.3 °C   | Sensor substitution method using Fluke 714 |
|  | Type J       | 0.9 °C   |  |
|  | Type B       | 2.6 °C   |  |
|  | Type E       | 0.9 °C   |  |
|  | Type T       | 0.9 °C   |  |
|  | Type R       | 2.4 °C   |  |
|  | Type S       | 2.4 °C   |  |
|  | Type U       | 0.9 °C   |  |
|  | Type L       | 0.8 °C   |  |
| <b>END</b>   |              |  |  |

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Notes

**Note 1:** A Calibration and Measurement Capability (CMC) is a description of the best result of a calibration or measurement (result with the smallest uncertainty of measurement) that is available to the laboratory's customers under normal conditions, when performing more or less routine calibrations of nearly ideal measurement standards or instruments. The CMC is described in the laboratory's scope of accreditation by: the measurement parameter/device being calibrated, the measurement range, the uncertainty associated with that range (see note 3), and remarks on additional parameters, if applicable.

**Note 2:** Calibration and Measurement Capabilities are traceable to the national measurement standards of the U.S. or to the national measurement standards of other countries and are thus traceable to the internationally accepted representation of the appropriate SI (Système International) unit.

**Note 3:** The uncertainty associated with a measurement in a CMC is an expanded uncertainty with a level of confidence of approximately 95 %, typically using a coverage factor of  $k = 2$ . However, laboratories may report a coverage factor different than  $k = 2$  to achieve the 95 % level of confidence. Units for the measurand and its uncertainty are to match. Exceptions to this occur when marketplace practice employs mixed units, such as when the artifact to be measured is labeled in non-SI units and the uncertainty is given in SI units (Example: 5 lb weight with uncertainty given in mg).

**Note 3a:** The uncertainty of a specific calibration by the laboratory may be greater than the uncertainty in the CMC due to the condition and behavior of the customer's device and specific circumstances of the calibration. The uncertainties quoted do not include possible effects on the calibrated device of transportation, long-term stability, or intended use.

**Note 3b:** As the CMC represents the best measurement results achievable under normal conditions, the accredited calibration laboratory shall not report smaller uncertainty of measurement than that given in a CMC for calibrations or measurements covered by that CMC.

**Note 3c:** As described in Note 1, CMCs cover calibrations and measurements that are available to the laboratory's customers under *normal conditions*. However, the laboratory may have the capability to offer special tests, employing special conditions, which yield calibration or measurement results with lower uncertainties. Such special tests are not covered by the CMCs and are outside the laboratory's scope of accreditation. In this case, NVLAP requirements for the labeling, on calibration reports, of results outside the laboratory's scope of accreditation apply. These requirements are set out in Annex A.5 of NIST Handbook 150, Procedures and General Requirements.

**Note 4:** Uncertainties associated with field service calibration may be greater as they incorporate on-site environmental contributions, transportation effects, or other factors that affect the measurements. (This note applies only if marked in the body of the scope.)

**Note 5:** Values listed with percent (%) are percent of reading or generated value unless otherwise noted.

**Note 6:** NVLAP accreditation is the formal recognition of specific calibration capabilities. Neither NVLAP nor NIST guarantee the accuracy of individual calibrations made by accredited laboratories.

**Note 7:** For ASTM E74 the uncertainties of the measured value are determined by the statistics of the test and the artifact tested but are typically better than  $\pm 0.05$  % for class AA instruments,  $\pm 0.25$  % for class A instruments, and  $\pm 0.1$  % for class A1 instruments.

**Note 8:** Where  $L$  is the measured value, in same units as the range.

**Note 9:** These calibrations are only performed at our primary facility in Norwood.

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**Notes**

**Note 10:** These calibrations can be performed at either laboratory facility: Norwood or High Wycombe.

**Note 11:** These calibrations can be performed at any of these laboratory facilities: Norwood, High Wycombe, or C/ Argenters 2, Parque Tecnológico del Vallés, Cerdanyola, Barcelona 08290 Spain.

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