



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017  
& ANSI/NCSL Z540-1-1994

ACCREDITED LABS DBA  
PRECISION CALIBRATION SYSTEMS  
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CALIBRATION

Valid To: March 31, 2027

Certificate Number: 1509.03

In recognition of the successful completion of the A2LA evaluation process (including an assessment of the organization's compliance with R205 – A2LA's Calibration Program Requirements), accreditation is granted to this laboratory to perform the following calibrations<sup>1, 5</sup>:

I. Chemical

| Parameter/Equipment             | Range                                                                        | CMC <sup>2</sup> (±)                                                        | Comments                  |
|---------------------------------|------------------------------------------------------------------------------|-----------------------------------------------------------------------------|---------------------------|
| pH Meter <sup>3</sup>           | 4 pH<br>7 pH<br>10 pH                                                        | 0.022 pH<br>0.022 pH<br>0.027 pH                                            | Std buffer solution       |
| Conductivity Meter <sup>3</sup> | 1 µS/cm<br>10 µS/cm<br>100 µS/cm<br>1000 µS/cm<br>1413 µS/cm<br>10 000 µS/cm | 0.56 µS/cm<br>0.63 µS/cm<br>2.1 µS/cm<br>5.8 µS/cm<br>7.5 µS/cm<br>55 µS/cm | Std conductivity solution |

II. Dimensional

| Parameter/Equipment      | Range                                           | CMC <sup>2, 4</sup> (±)                             | Comments                      |
|--------------------------|-------------------------------------------------|-----------------------------------------------------|-------------------------------|
| Micrometers <sup>3</sup> | Up to 12 in<br>(>12 to 36) in<br>(>36 to 60) in | (70 + 22L) µin<br>(90 + 24L) µin<br>(190 + 27L) µin | Gage blocks, length standards |

| Parameter/Equipment                                                               | Range                                                                                                                                                                                                         | CMC <sup>2, 4</sup> (±)                                                                                                                                        | Comments                                                                       |
|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Caliper, Bore Gage, Snap Gage <sup>3</sup>                                        | Up to 60 in                                                                                                                                                                                                   | $(290 + 27L) \mu\text{in}$                                                                                                                                     | Gage blocks, length standards                                                  |
| Standard Length <sup>3</sup><br>(including Feeler Gages, Snap Gages, Taper Gages) | Up to 12 in<br>(>12 to 40) in                                                                                                                                                                                 | $(7.7 + 0.6L) \mu\text{in}$<br>$(5.1 + 0.9L) \mu\text{in}$                                                                                                     | Universal measurement machine                                                  |
| Pin & Plug Gages <sup>3</sup>                                                     | Up to 12 in                                                                                                                                                                                                   | $(7.7 + 0.6L) \mu\text{in}$                                                                                                                                    | Universal measurement machine                                                  |
| External Threads Major Diameter <sup>3</sup>                                      | Up to 12 in                                                                                                                                                                                                   | $(7.7 + 0.6L) \mu\text{in}$                                                                                                                                    | Universal measurement machine                                                  |
| External Threads Pitch Diameter <sup>3</sup>                                      | Up to 12 in                                                                                                                                                                                                   | 86 $\mu\text{in}$                                                                                                                                              | Universal measurement machine, thread wires                                    |
| Ring Gages <sup>3</sup>                                                           | Up to 12 in                                                                                                                                                                                                   | $(9 + 1.8L) \mu\text{in}$                                                                                                                                      | Universal measurement machine                                                  |
| Dimensional Measurement<br>(including Radius Gages, Fillet Gages, Angle Blocks)   | X/Y Axis: Up to 12 in<br>X/Y Axis: Up to 8 in<br>Z Axis: Up to 6 in<br>Z Axis: Up to 2 in<br>Angle Measurement:<br>Up to 180°<br>Angle Measurement:<br>Up to 180°<br>Z Axis: Up to 40 in<br>Angle: Up to 180° | $(180 + 11L) \mu\text{in}$<br>$(190 + 22L) \mu\text{in}$<br>470 $\mu\text{in}$<br>380 $\mu\text{in}$<br>0.007°<br>0.005°<br>$(49 + 21L) \mu\text{in}$<br>0.08° | Vision system<br><br><br><br><br><br><br>2D height gauge<br>Digital protractor |
| Surface Finish – Measurement                                                      | (10 to 320) $\mu\text{in Ra}$                                                                                                                                                                                 | 2.2 $\mu\text{in Ra}$                                                                                                                                          | Profilometer                                                                   |

| Parameter/Equipment                                                                             | Range                                                                                   | CMC <sup>2, 4, 6</sup> ( $\pm$ )                                                                          | Comments                                                               |
|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Surface Finish Equipment <sup>3</sup>                                                           | (10 to 320) $\mu$ in Ra                                                                 | 2.2 $\mu$ in Ra                                                                                           | Master finish standards                                                |
| Height Gauges <sup>3</sup>                                                                      | Up to 40 in                                                                             | (15 + 22L) $\mu$ in                                                                                       | Length standard, gage blocks                                           |
| Dial/Digital Indicators <sup>3</sup>                                                            | Up to 4 in<br>Up to 1 in                                                                | (220 + 3L) $\mu$ in<br>(170 + 160L) $\mu$ in                                                              | Gage blocks<br>Indicator calibrator                                    |
| Vision Machine <sup>3</sup><br>X/Y Axis<br>Z Axis<br>Angle<br>Measuring Microscope <sup>3</sup> | Up to 12 in<br>Up to 6 in<br>(1 to 90) $^{\circ}$<br>(0.01 to 1) mm                     | 140 $\mu$ in<br>150 $\mu$ in<br>0.026 $^{\circ}$<br>9 $\mu$ m                                             | Gage blocks / glass masters, angle blocks                              |
| Gage Blocks                                                                                     | Up to 12 in<br>(>12 to 20) in<br>(>20 to 40) in                                         | (6 + 0.73L) $\mu$ in<br>(4 + 0.93L) $\mu$ in<br>(3.1 + 1L) $\mu$ in                                       | Universal measurement machine, master gage blocks                      |
| Thread Ring –<br>Pitch Diameter<br>Minor Diameter                                               | Up to 5 in<br>(0.2 to 1.2) in                                                           | (51 + 17L) $\mu$ in<br>250 $\mu$ in                                                                       | Universal measurement machine, inside micrometer                       |
| Tapered Thread Plug                                                                             | Up to 4 in                                                                              | (140 + 18L) $\mu$ in                                                                                      | Universal measurement machine, thread wires, height gauge              |
| ULM <sup>3</sup> –<br>Length<br>Parallelism<br>Flatness<br>Tailstock Force                      | Up to 4 in<br>(4 to 12) in<br>(12 to 24) in<br>Up to 4 in<br>Up to 4 in<br>Up to 40 ozf | (10 + 2.8L) $\mu$ in<br>(16 + 1.3L) $\mu$ in<br>(7 + 2.3L) $\mu$ in<br>3 $\mu$ in<br>10 $\mu$ in<br>2.9 % | Gage blocks/length standards<br>Gage ball<br>Optical flat<br>Load cell |

| Parameter/Equipment                                                             | Range                                                                     | CMC <sup>2, 4, 6</sup> ( $\pm$ )                          | Comments                                                                     |
|---------------------------------------------------------------------------------|---------------------------------------------------------------------------|-----------------------------------------------------------|------------------------------------------------------------------------------|
| Steel Rules & Tape Measures <sup>3</sup>                                        | Up to 40 ft                                                               | (0.011 + 0.000 25L) in                                    | Length standard, reticle, push-pull block                                    |
| Displacement <sup>3</sup><br>(Extensometers)                                    | Up to 0.005 in<br>(0.005 to 0.02) in<br>(0.02 to 0.2) in<br>(0.2 to 2) in | 17 $\mu$ in<br>41 $\mu$ in<br>48 $\mu$ in<br>240 $\mu$ in | Linear displacement calibrator                                               |
| Optical Comparators <sup>3</sup> –<br>X & Y Linearity<br>Magnification<br>Angle | Up to 20 in<br>Up to 6 in<br>(1 to 90)°                                   | 0.0006 in<br>0.0025 in<br>0.047°                          | Glass master, gage blocks<br>Glass master, caliper, pin gage<br>Angle blocks |
| Protractors <sup>3</sup>                                                        | (1 to 90)°<br>(Up to 45)°                                                 | 0.044°<br>0.024°                                          | Angle blocks, surface plate<br>Sine plate, gage blocks                       |
| Precision Levels                                                                | Up to 0.1 in per ft<br>Deviation<br>Level                                 | 0.0006 in<br>60 $\mu$ in                                  | Surface plate, sine plate, gage blocks<br>Surface plate                      |
| Crimpers <sup>3</sup> –<br>Crimp Height<br>Crimp Die Diameter                   | Up to 1 in<br>Up to 1 in                                                  | 180 $\mu$ in<br>240 $\mu$ in                              | Crimp micrometer<br>Pin/plug sets                                            |
| Coating Thickness Testers <sup>3</sup>                                          | Up to 80 mils                                                             | 0.7 % + 0.012 mils                                        | Thickness standards                                                          |
| Coating Thickness Standards                                                     | Up to 200 mils                                                            | (0.007 + 0.000 14L) mils                                  | Universal measurement machine, gage blocks                                   |

### III. Electrical – DC/Low Frequency

| Parameter/Range                    | Frequency                                                                                            | CMC <sup>2, 8</sup> ( $\pm$ )                                                                                                                              | Comments                  |
|------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| AC Current – Generate <sup>3</sup> |                                                                                                      |                                                                                                                                                            |                           |
| (29 to 330) $\mu$ A                | (10 to 20) Hz<br>(20 to 45) Hz<br>(0.45 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz<br>(10 to 30) kHz | 1.8 mA/A + 0.1 $\mu$ A<br>1.4 mA/A + 0.1 $\mu$ A<br>1.2 mA/A + 0.1 $\mu$ A<br>2.7 mA/A + 0.15 $\mu$ A<br>6.7 mA/A + 0.2 $\mu$ A<br>13 mA/A + 0.4 $\mu$ A   | Multi-function calibrator |
| 330 $\mu$ A to 3.3 mA              | (10 to 20) Hz<br>(20 to 45) Hz<br>(0.45 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz<br>(10 to 30) kHz | 1.6 mA/A + 0.15 $\mu$ A<br>1.0 mA/A + 0.15 $\mu$ A<br>0.82 mA/A + 0.15 $\mu$ A<br>1.6 mA/A + 0.2 $\mu$ A<br>4 mA/A + 0.3 $\mu$ A<br>7.9 mA/A + 0.6 $\mu$ A |                           |
| (3.3 to 33) mA                     | (10 to 20) Hz<br>(20 to 45) Hz<br>(0.45 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz<br>(10 to 30) kHz | 1.5 mA/A + 2 $\mu$ A<br>0.76 mA/A + 2 $\mu$ A<br>0.38 mA/A + 2 $\mu$ A<br>0.68 mA/A + 2 $\mu$ A<br>1.6 mA/A + 3 $\mu$ A<br>3.2 mA/A + 4 $\mu$ A            |                           |
| (33 to 330) mA                     | (10 to 20) Hz<br>(20 to 45) Hz<br>(0.45 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz<br>(10 to 30) kHz | 1.5 mA/A + 20 $\mu$ A<br>0.76 mA/A + 20 $\mu$ A<br>0.38 mA/A + 20 $\mu$ A<br>0.9 mA/A + 50 $\mu$ A<br>1.8 mA/A + 100 $\mu$ A<br>3.6 mA/A + 200 $\mu$ A     |                           |
| 330 mA to 1.1 A                    | (10 to 45) Hz<br>(0.45 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz                                    | 1.5 mA/A + 100 $\mu$ A<br>0.53 mA/A + 100 $\mu$ A<br>5.4 mA/A + 1 mA<br>23 mA/A + 5 mA                                                                     |                           |

| Parameter/Range                                                                       | Frequency                                                                                                   | CMC <sup>2, 8</sup> ( $\pm$ )                                                                                                                            | Comments                     |
|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| AC Current – Generate <sup>3</sup><br>(con't)                                         |                                                                                                             |                                                                                                                                                          |                              |
| (1.1 to 3) A                                                                          | (10 to 45) Hz<br>(0.45 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz                                           | 1.5 mA/A + 100 $\mu$ A<br>0.64 mA/A + 100 $\mu$ A<br>4.5 mA/A + 1 mA<br>21 mA/A + 5 mA                                                                   | Multi-function<br>calibrator |
| (3 to 11) A                                                                           | (45 to 100) Hz<br>(0.1 to 1) kHz<br>(1 to 5) kHz                                                            | 0.83 mA/A + 2 mA<br>1.9 mA/A + 2 mA<br>24 mA/A + 2 mA                                                                                                    |                              |
| (11 to 20.5) A                                                                        | (45 to 100) Hz<br>100 Hz to 1 kHz<br>(1 to 5) kHz                                                           | 16 mA/A + 5 mA<br>17 mA/A + 5 mA<br>24 mA/A + 5 mA                                                                                                       |                              |
| Clamp-on Only<br>(16.5 to 55) A<br>(55 to 150) A<br>(150 to 550) A<br>(550 to 1020) A | (45 to 440) Hz<br>(45 to 440) Hz<br>(45 to 440) Hz<br>(45 to 440) Hz                                        | 0.6 A<br>1.1 A<br>3.0 A<br>8.7 A                                                                                                                         | w/ 50-turn coil              |
| AC Voltage – Generate <sup>3</sup>                                                    |                                                                                                             |                                                                                                                                                          |                              |
| (1 to 33) mV                                                                          | (10 to 45) Hz<br>45 Hz to 10 kHz<br>(10 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz<br>(100 to 500) kHz | 1.7 mV/V + 6 $\mu$ V<br>1.3 mV/V + 6 $\mu$ V<br>1.7 mV/V + 6 $\mu$ V<br>2.1 mV/V + 6 $\mu$ V<br>3.6 mV/V + 12 $\mu$ V<br>9.3 mV/V + 50 $\mu$ V           | Multi-function<br>calibrator |
| (33 to 330) mV                                                                        | (10 to 45) Hz<br>45 Hz to 10 kHz<br>(10 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz<br>(100 to 500) kHz | 0.44 mV/V + 8 $\mu$ V<br>0.29 mV/V + 8 $\mu$ V<br>0.6 mV/V + 8 $\mu$ V<br>0.88 mV/V + 8 $\mu$ V<br>2.2 mV/V + 32 $\mu$ V<br>4.7 mV/V + 70 $\mu$ V        |                              |
| (0.33 to 3.3) mV                                                                      | (10 to 45) Hz<br>45 Hz to 10 kHz<br>(10 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz<br>(100 to 500) kHz | 0.44 mV/V + 50 $\mu$ V<br>0.39 mV/V + 60 $\mu$ V<br>0.59 mV/V + 60 $\mu$ V<br>0.83 mV/V + 50 $\mu$ V<br>1.5 mV/V + 130 $\mu$ V<br>4.1 mV/V + 600 $\mu$ V |                              |
| (3.3 to 33) V                                                                         | (10 to 45) Hz<br>45 Hz to 10 kHz<br>(10 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz                     | 0.41 mV/V + 650 $\mu$ V<br>0.26 mV/V + 600 $\mu$ V<br>0.56 mV/V + 600 $\mu$ V<br>0.8 mV/V + 600 $\mu$ V<br>1.8 mV/V + 1.6 mV                             |                              |

| Parameter/Range                                                                                                                              | Frequency                                                                              | CMC <sup>2, 6, 8</sup> ( $\pm$ )                                                                                                                                     | Comments                        |
|----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| AC Voltage – Generate <sup>3</sup><br>(con't)                                                                                                |                                                                                        |                                                                                                                                                                      |                                 |
| (33 to 330) V                                                                                                                                | 45 Hz to 1 kHz<br>(1 to 10) kHz<br>(10 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz | 0.4 mV/V + 2 mV<br>0.65 mV/V + 6 mV<br>0.73 mV/V + 6 mV<br>0.97 mV/V + 6 mV<br>2.1 mV/V + 50 mV                                                                      | Multi-function calibrator       |
| (330 to 1020) V                                                                                                                              | 45 Hz to 1 kHz<br>(1 to 5) kHz<br>(5 to 10) kHz                                        | 0.41 mV/V + 10 mV<br>0.64 mV/V + 10 mV<br>0.72 mV/V + 10 mV                                                                                                          |                                 |
| AC Current – Measure <sup>3</sup>                                                                                                            |                                                                                        |                                                                                                                                                                      |                                 |
| (5 to 100) $\mu$ A<br>100 $\mu$ A to 1 mA<br>(1 to 10 mA)<br>(10 to 100) mA<br>(100 to 400) mA<br>400 mA to 1 A<br>(1 to 3) A<br>(3 to 10) A | 10 Hz to 5 kHz                                                                         | 0.18 % + 0.07 $\mu$ A<br>0.12 % + 0.5 $\mu$ A<br>0.18 % + 7 $\mu$ A<br>0.12 % + 19 $\mu$ A<br>0.12 % + 0.47 mA<br>0.12 % + 0.57 mA<br>0.18 % + 7 mA<br>0.18 % + 9 mA | Precision multimeter            |
| (10 to 1000) A                                                                                                                               | (50 to 400) Hz                                                                         | 6 %                                                                                                                                                                  | Clamp meter                     |
| AC Voltage – Measure <sup>3</sup>                                                                                                            |                                                                                        |                                                                                                                                                                      |                                 |
| Up to 100 mV<br>100 mV to 1 V<br>(1 to 10) V<br>(10 to 100) V<br>(100 to 1000) V                                                             | 10 Hz to 20 kHz                                                                        | 0.07 % + 47 $\mu$ V<br>0.07 % + 0.46 mV<br>0.07 % + 4.6 mV<br>0.07 % + 36 mV<br>0.07 % + 0.32 V                                                                      | Precision multimeter            |
| Up to 100 mV<br>100 mV to 1 V<br>(1 to 10) V<br>(10 to 100) V<br>(100 to 1000) V                                                             | (20 to 100) kHz                                                                        | 0.7 % + 94 $\mu$ V<br>0.7 % + 0.94 mV<br>0.7 % + 9.4 mV<br>0.7 % + 94 mV<br>0.7 % + 1.1 V                                                                            |                                 |
| (1 to 20) kV                                                                                                                                 | 50-60 Hz                                                                               | 5.9 %                                                                                                                                                                | Multimeter & high voltage probe |
| (1 to 10) kV                                                                                                                                 | 50-60 Hz                                                                               | 0.15 %                                                                                                                                                               | High voltage meter              |

| Parameter/Equipment                    | Range                                                                                                                                                                                                                                                                                                                                                                                                    | CMC <sup>2, 6, 8</sup> ( $\pm$ )                                                                                                                                                                                                                                         | Comments                                                                    |
|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| DC Current –<br>Generate <sup>3</sup>  | Up to 329.999 $\mu$ A<br>329.999 $\mu$ A to 3.299 99 mA<br>(3.299 999 9 to 32.999 99) mA<br>(32.999 99 to 329.9999) mA<br>329.999 mA to 1.099 99 A<br>(1.1 to 2.999 99) A<br>(2.999 99 to 10.9999) A<br>(10.9999 to 20) A<br><br>(20 to 1010) A                                                                                                                                                          | 270 $\mu$ A/A + 0.02 $\mu$ A<br>140 $\mu$ A/A + 0.05 $\mu$ A<br>97 $\mu$ A/A + 0.25 $\mu$ A<br>98 $\mu$ A/A + 2.5 $\mu$ A<br>380 $\mu$ A/A + 40 $\mu$ A<br>310 $\mu$ A/A + 40 $\mu$ A<br>510 $\mu$ A/A + 500 $\mu$ A<br>810 $\mu$ A/A + 750 $\mu$ A<br><br>0.5 % + 0.5 A | Multi-function<br>calibrator<br><br><br><br><br><br><br><br>w/ 50 turn coil |
| DC Voltage –<br>Generate <sup>3</sup>  | Up to 330 mV<br>330 mV to 3.299 999 V<br>(3.299 999 to 32.999 99) V<br>(32.999 99 to 329.9999) V<br>(329.9999 to 1020) V                                                                                                                                                                                                                                                                                 | 54 $\mu$ V/V + 1 $\mu$ V<br>40 $\mu$ V/V + 2 $\mu$ V<br>44 $\mu$ V/V + 20 $\mu$ V<br>44 $\mu$ V/V + 150 $\mu$ V<br>44 $\mu$ V/V + 1.5 mV                                                                                                                                 | Multi-function<br>calibrator                                                |
| Capacitance –<br>Generate <sup>3</sup> | (0.22 to 1.099) nF<br>(1.1 to 3.299) nF<br>(3.3 to 10.999) nF<br>(11 to 32.999) nF<br>(33 to 109.999) nF<br>(110 to 329.999) nF<br>(0.33 to 1.099) $\mu$ F<br>(1.1 to 3.299) $\mu$ F<br>(3.3 to 10.999) $\mu$ F<br>(11 to 32.999) $\mu$ F<br>(33 to 109.999) $\mu$ F<br>(110 to 329.999) $\mu$ F<br>(0.33 to 1.099) mF<br>(1.1 to 3.299) mF<br>(3.3 to 10.999) mF<br>(11 to 32.999) mF<br>(33 to 110) mF | 0.013 nF<br>0.023 nF<br>0.031 nF<br>0.17 nF<br>0.53 nF<br>1.1 nF<br>3.3 nF<br>9.2 nF<br>35 nF<br>0.14 $\mu$ F<br>0.49 $\mu$ F<br>1.4 $\mu$ F<br>4.7 $\mu$ F<br>14 $\mu$ F<br>47 $\mu$ F<br>0.22 mF<br>1.0 mF                                                             | Multi-function<br>calibrator                                                |

| Parameter/Equipment                                                                                           | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CMC <sup>2, 8</sup> ( $\pm$ )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Comments                  |
|---------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Resistance – Generate <sup>3</sup>                                                                            | Up to 10.999 $\Omega$<br>(11 to 32.999) $\Omega$<br>(32.999 to 109.999) $\Omega$<br>(109.999 to 329.999) $\Omega$<br>330 $\Omega$ to 1.099 99 k $\Omega$<br>(1.1 to 3.299 99) k $\Omega$<br>(3.3 to 10.999) k $\Omega$<br>(11 to 32.999) k $\Omega$<br>(33 to 109.999) k $\Omega$<br>(110 to 329.999) k $\Omega$<br>330 k $\Omega$ to 1.0999 M $\Omega$<br>(1.1 to 3.2999) M $\Omega$<br>(3.3 to 10.9999) M $\Omega$<br>(11 to 32.999) M $\Omega$<br>(33 to 109.999) M $\Omega$<br>(110 to 329.999) M $\Omega$<br>(330 to 1100) M $\Omega$ | 170 $\mu\Omega/\Omega$ + 1 m $\Omega$<br>130 $\mu\Omega/\Omega$ + 1.5 m $\Omega$<br>82 $\mu\Omega/\Omega$ + 1.4 m $\Omega$<br>76 $\mu\Omega/\Omega$ + 2 m $\Omega$<br>73 $\mu\Omega/\Omega$ + 2 m $\Omega$<br>76 $\mu\Omega/\Omega$ + 20 m $\Omega$<br>73 $\mu\Omega/\Omega$ + 20 m $\Omega$<br>76 $\mu\Omega/\Omega$ + 0.2 $\Omega$<br>88 $\mu\Omega/\Omega$ + 0.2 $\Omega$<br>98 $\mu\Omega/\Omega$ + 2 $\Omega$<br>0.12 m $\Omega/\Omega$ + 2 $\Omega$<br>0.13 m $\Omega/\Omega$ + 30 $\Omega$<br>0.47 m $\Omega/\Omega$ + 50 $\Omega$<br>0.84 m $\Omega/\Omega$ + 2.5 k $\Omega$<br>3.9 m $\Omega/\Omega$ + 3 k $\Omega$<br>4.2 m $\Omega/\Omega$ + 0.1 M $\Omega$<br>12 m $\Omega/\Omega$ + 0.5 M $\Omega$ | Multi-function calibrator |
| Temperature Calibration, Indication, & Control Equipment Used with RTD – (Electrical Simulation) <sup>3</sup> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                           |
| Cu 42 710 $\Omega$                                                                                            | (-100 to 260) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.31 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Multi-function calibrator |
| PT 385 100 $\Omega$                                                                                           | (-200 to 630) $^{\circ}\text{C}$<br>(630 to 800) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0.15 $^{\circ}\text{C}$<br>0.25 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| PT 385 200 $\Omega$                                                                                           | (-200 to 260) $^{\circ}\text{C}$<br>(260 to 630) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0.07 $^{\circ}\text{C}$<br>0.17 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| PT 385 500 $\Omega$                                                                                           | (-200 to 260) $^{\circ}\text{C}$<br>(260 to 630) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0.07 $^{\circ}\text{C}$<br>0.12 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| PT 3 851 000 $\Omega$                                                                                         | (-200 to 600) $^{\circ}\text{C}$<br>(600 to 630) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0.07 $^{\circ}\text{C}$<br>0.24 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| PT 3 916 100 $\Omega$                                                                                         | (-200 to -190) $^{\circ}\text{C}$<br>(-190 to 600) $^{\circ}\text{C}$<br>(600 to 630) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                   | 0.26 $^{\circ}\text{C}$<br>0.11 $^{\circ}\text{C}$<br>0.24 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |
| PT 3 926 100 $\Omega$                                                                                         | (-200 to 100) $^{\circ}\text{C}$<br>(100 to 630) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0.08 $^{\circ}\text{C}$<br>0.13 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| PtNi 385 120 $\Omega$                                                                                         | (-80 to 100) $^{\circ}\text{C}$<br>(100 to 260) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0.09 $^{\circ}\text{C}$<br>0.15 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |

| Parameter/Equipment                                                                         | Range                                                                          | CMC <sup>2,8</sup> (±)                   | Comments                     |
|---------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|------------------------------------------|------------------------------|
| Temperature – Instruments<br>(Electrical Simulation) –<br>Thermocouple Devices <sup>3</sup> |                                                                                |                                          |                              |
| Type B                                                                                      | (600 to 800) °C<br>(800 to 1800) °C                                            | 0.41 °C<br>0.33 °C                       | Multi-function<br>calibrator |
| Type C                                                                                      | (0 to 1000) °C<br>(1000 to 1800) °C<br>(1800 to 2316) °C                       | 0.25 °C<br>0.41 °C<br>0.66 °C            |                              |
| Type E                                                                                      | (-250 to -100) °C<br>(-100 to 650) °C<br>(650 to 1000) °C                      | 0.39 °C<br>0.13 °C<br>0.17 °C            |                              |
| Type J                                                                                      | (-210 to -100) °C<br>(-100 to 760) °C<br>(760 to 1200) °C                      | 0.21 °C<br>0.15 °C<br>0.19 °C            |                              |
| Type K                                                                                      | (-200 to -100) °C<br>(-100 to 120) °C<br>(120 to 1000) °C<br>(1000 to 1372) °C | 0.26 °C<br>0.15 °C<br>0.21 °C<br>0.32 °C |                              |
| Type N                                                                                      | (-200 to -100) °C<br>(-100 to 120) °C<br>(120 to 410) °C<br>(410 to 1300) °C   | 0.32 °C<br>0.18 °C<br>0.21 °C<br>0.30 °C |                              |
| Type R                                                                                      | (0 to 250) °C<br>(250 to 1000) °C<br>(1000 to 1767) °C                         | 0.45 °C<br>0.29 °C<br>0.37 °C            |                              |
| Type S                                                                                      | (0 to 250) °C<br>(250 to 1000) °C<br>(1000 to 1400) °C<br>(1400 to 1767) °C    | 0.49 °C<br>0.38 °C<br>0.32 °C<br>0.39 °C |                              |
| Type T                                                                                      | (-250 to -150) °C<br>(-150 to 0) °C<br>(0 to 120) °C<br>(120 to 400) °C        | 0.49 °C<br>0.38 °C<br>0.31 °C<br>0.39 °C |                              |
| Type U                                                                                      | (-200 to 0) °C<br>(0 to 600) °C                                                | 0.44 °C<br>0.22 °C                       |                              |

| Parameter/Equipment                                      | Range                                                                                                                                                                                                                                       | CMC <sup>2, 6, 8</sup> ( $\pm$ )                                                                                                                                                                                                                     | Comments                                                |
|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|
| DC Current – Measure <sup>3</sup>                        | (1 to 100) $\mu$ A<br>100 $\mu$ A to 1 mA<br>(1 to 100) mA<br>(100 to 400) mA<br>400 mA to 1 A<br>(1 to 3) A<br>(3 to 10) A                                                                                                                 | 0.06 % + 0.06 $\mu$ A<br>0.06 % + 0.6 $\mu$ A<br>0.06 % + 6 $\mu$ A<br>0.06 % + 24 $\mu$ A<br>0.06 % + 28 $\mu$ A<br>0.12 % + 2.4 mA<br>0.18 % + 4.4 mA                                                                                              | Precision multimeter                                    |
|                                                          | (10 to 1000) A                                                                                                                                                                                                                              | 2.6 %                                                                                                                                                                                                                                                | Clamp meter                                             |
| DC Voltage – Measure <sup>3</sup>                        | (0.01 to 100) mV<br>100 mV to 1 V<br>(1 to 10) V<br>(10 to 100) V<br>(100 to 1000) V                                                                                                                                                        | 0.004 % + 5 $\mu$ V<br>0.003 % + 13 $\mu$ V<br>0.003 % + 86 $\mu$ V<br>0.004 % + 0.94 mV<br>0.005 % + 14 mV                                                                                                                                          | Precision multimeter                                    |
|                                                          | (1 to 20) kV                                                                                                                                                                                                                                | 2.4 %                                                                                                                                                                                                                                                | Multimeter & high voltage probe                         |
|                                                          | (1 to 10) kV                                                                                                                                                                                                                                | 0.05 %                                                                                                                                                                                                                                               | High voltage meter                                      |
| Capacitance – Measure <sup>3</sup>                       | Up to 1 nF<br>(1 to 10) nF<br>(10 to 100) nF<br>100 nF to 1 $\mu$ F<br>(1 to 10) $\mu$ F<br>(10 to 100) $\mu$ F<br>100 $\mu$ F to 1 mF<br>(1 to 10) mF<br>(10 to 100) mF                                                                    | 2.4 % + 0.034 nF<br>1.2 % + 0.09 nF<br>1.2 % + 0.65 nF<br>1.2 % + 7.4 nF<br>1.2 % + 73 nF<br>1.2 % + 0.77 $\mu$ F<br>1.2 % + 7.8 $\mu$ F<br>1.2 % + 78 $\mu$ F<br>4.7 % + 1.3 mF                                                                     | Precision multimeter                                    |
| Resistance – Measure <sup>3</sup><br>Equipment to Source | Up to 10 $\Omega$<br>(10 to 100) $\Omega$<br>100 $\Omega$ to 1 k $\Omega$<br>(1 to 10) k $\Omega$<br>(10 to 100) k $\Omega$<br>100 k $\Omega$ to 1 M $\Omega$<br>(1 to 10) M $\Omega$<br>(10 to 100) M $\Omega$<br>(100 to 1000) M $\Omega$ | 0.012 % + 3.5 m $\Omega$<br>0.012 % + 5.7 m $\Omega$<br>0.012 % + 15 m $\Omega$<br>0.012 % + 0.34 $\Omega$<br>0.012 % + 0.36 $\Omega$<br>0.012 % + 0.58 $\Omega$<br>0.046 % + 0.79 k $\Omega$<br>0.93 % + 0.14 M $\Omega$<br>2.3 % + 0.14 M $\Omega$ | Precision multimeter                                    |
|                                                          | 10 M $\Omega$<br>100 M $\Omega$<br>1 G $\Omega$<br>10 G $\Omega$<br><br>(8 to 1200) $\Omega$                                                                                                                                                | 0.04 M $\Omega$<br>0.26 M $\Omega$<br>2 M $\Omega$<br>0.19 G $\Omega$<br><br>3.6 m $\Omega$                                                                                                                                                          | Insulation resistance standard<br><br>Transfer standard |

#### IV. Fluid Quantities

| Parameter/Equipment                                                                                                                                           | Range                                                                                                                                               | CMC <sup>2, 6</sup> ( $\pm$ )                                                                    | Comments                                                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| Liquid Flow Meter <sup>3</sup>                                                                                                                                | Up to 500 GPM                                                                                                                                       | 2 %                                                                                              | Ultrasonic flow meter                                           |
| Liquid Flow Meter <sup>3</sup>                                                                                                                                |                                                                                                                                                     |                                                                                                  |                                                                 |
| Rate                                                                                                                                                          | Up to 30 GPM<br>(31 to 200) GPM                                                                                                                     | 0.16 %<br>0.13 %                                                                                 | Coriolis flow meter                                             |
| Totalization                                                                                                                                                  | Up to 6 kg                                                                                                                                          | 0.11 %                                                                                           | Balance                                                         |
| POVA (Piston/Plunger<br>Operated Volumetric<br>Apparatus) <sup>3</sup> –<br>Including But Not<br>Limited To: Pipettes,<br>Syringes, Dispensers, &<br>Burettes | (0.1 to 20) $\mu$ L<br>(20 to 200) $\mu$ L<br>(200 to 1000) $\mu$ L<br>(1000 to 10 000) $\mu$ L<br>(10 000 to 20 000) $\mu$ L<br><br>(10 to 100) mL | 0.16 $\mu$ L<br>0.22 $\mu$ L<br>0.53 $\mu$ L<br>5 $\mu$ L<br>11 $\mu$ L<br><br>(0.58 % + 0.3) mL | Micro balance<br><br><br><br><br><br>Balance                    |
| Graduated<br>Cylinder/Flask/Beaker <sup>3</sup>                                                                                                               | (50 to 6000) mL                                                                                                                                     | (0.98 % + 0.16) mL                                                                               | Balance                                                         |
| Viscometers <sup>3</sup>                                                                                                                                      | Up to 10 000 cP                                                                                                                                     | 1.7 %                                                                                            | Viscosity reference standards                                   |
| Anemometers                                                                                                                                                   | (400 to 3000) fpm                                                                                                                                   | 2.3 %                                                                                            | Differential pressure<br>transducer, wind tunnel, pitot<br>tube |

#### V. Mechanical

| Parameter/Equipment                                                      | Range                                 | CMC <sup>2, 6</sup> ( $\pm$ ) | Comments                                         |
|--------------------------------------------------------------------------|---------------------------------------|-------------------------------|--------------------------------------------------|
| Force Gages <sup>3</sup>                                                 | Up to 500 lbf                         | 0.11 %                        | Calibrated weights                               |
| Load Cells, Load Stands<br>& Tension/Compression<br>Testers <sup>3</sup> | Up to 500 lbf<br><br>(20 to 1000) lbf | 0.11 %<br><br>0.21 %          | Calibrated weights<br><br>Load cells w/indicator |

| Parameter/Equipment                                                        | Range                                                                                                                                        | CMC <sup>2, 6</sup> (±)                                                                                                                      | Comments                              |
|----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| Load Cells, Load Stands & Tension/Compression Testers <sup>3</sup> (con't) | (500 to 5000) lbf<br>(2000 to 20 000) lbf<br>(500 to 25 000) lbf<br>(5000 to 50 000) lbf                                                     | 0.24 %<br>0.24 %<br>0.20 %<br>0.24 %                                                                                                         | Load cells w/indicator                |
| Compression Only                                                           | (28 200 to 500 000) lbf                                                                                                                      | 0.20 %                                                                                                                                       |                                       |
| Weighing Instruments/Scales <sup>3, 9</sup>                                | Up to 10 000 lb                                                                                                                              | 0.013 %                                                                                                                                      | ASTM Class 6 weights, Class F weights |
| Analytical Balance <sup>3, 9</sup>                                         | Up to 500 mg<br>500 mg to 5 g<br>10 g<br>20 g<br>50 g<br>100 g<br>200 g<br>500 g<br>1 kg<br>2 kg<br>5 kg<br>10 kg<br>20 kg<br>30 kg<br>50 lb | 13 µg<br>41 µg<br>61 µg<br>90 µg<br>0.15 mg<br>0.31 mg<br>0.61 mg<br>1.5 mg<br>3.1 mg<br>6.2 mg<br>15 mg<br>31 mg<br>62 mg<br>92 mg<br>73 mg | ASTM Class 6 weights, Class F weights |
| Crimpers <sup>3</sup> –                                                    |                                                                                                                                              |                                                                                                                                              |                                       |
| Pull Force                                                                 | Up to 500 lbf                                                                                                                                | 6.4 %                                                                                                                                        | Force gauge                           |
| Jaw Force                                                                  | Up to 15 Tons                                                                                                                                | 2.8 %                                                                                                                                        | Load cell                             |

| Parameter/Equipment         | Range                                                                                                                                                                                                                                  | CMC <sup>2, 6</sup> (±)                                                                                                                                                                                                                     | Comments                            |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| Mass – Fixed Points         | (1 to 500) mg<br>1 g<br>2 g<br>5 g<br>10 g<br>20 g<br>50 g<br>100 g<br>200 g<br>300 g<br>500 g<br>1000 g<br>2000 g<br>5000 g<br>10 000 g<br>20 000 g<br>30 000 g<br>0.5 lb<br>1 lb<br>2 lb<br>5 lb<br>10 lb<br>20 lb<br>25 lb<br>50 lb | 41 µg<br>39 µg<br>40 µg<br>42 µg<br>44 µg<br>51 µg<br>77 µg<br>0.13 mg<br>0.25 mg<br>2.8 mg<br>3.0 mg<br>3.1 mg<br>3.9 mg<br>6.9 mg<br>39 mg<br>45 mg<br>55 mg<br>0.80 mg<br>3.2 mg<br>4.3 mg<br>8.6 mg<br>16 mg<br>49 mg<br>54 mg<br>88 mg | Class 1 weights,<br>mass comparator |
| Pressure Gauge <sup>3</sup> | Up to 1 in H <sub>2</sub> O<br>(1 to 10) in H <sub>2</sub> O<br><br>Up to 1 psi<br>(1 to 15) psi<br>(15 to 300) psi<br>(300 to 1000) psi<br>(1000 to 10 000) psi<br><br>Up to 30 psia                                                  | 0.0017 in H <sub>2</sub> O<br>0.012 in H <sub>2</sub> O<br><br>0.0024 psi<br>0.0045 psi<br>0.092 psi<br>0.28 psi<br>2.8 psi<br><br>0.02 psia                                                                                                | Reference pressure<br>gauges        |
| Absolute                    | (10 to 10 000) psi                                                                                                                                                                                                                     | 0.015 %                                                                                                                                                                                                                                     | Deadweight tester                   |
| Vacuum Gauge <sup>3</sup>   | (-14 to -1) psi<br>(-1 to 0) psi<br><br>(-10 to -1) in H <sub>2</sub> O<br>(-1 to 0) in H <sub>2</sub> O                                                                                                                               | 0.009 psi<br>0.0024 psi<br><br>0.012 in H <sub>2</sub> O<br>0.0017 in H <sub>2</sub> O                                                                                                                                                      | Reference pressure<br>gauges        |

| Parameter/Equipment                                             | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | CMC <sup>2, 6</sup> (±)                                                                                                                                                                                                                                                                                        | Comments                    |
|-----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| Indirect Verification of Rockwell Hardness Testers <sup>3</sup> | HRC<br>(20 to 35) HRC<br>(35 to 59) HRC<br>(60 to 70) HRC<br><br>HRBW<br>(40 to 59) HRB<br>(60 to 87) HRB<br>(88 to 99) HRB<br><br>HRA<br>(20 to 69) HRA<br>(70 to 79) HRA<br>(80 to 99) HRA<br><br>HR15N<br>(70 to 77) HR15N<br>(78 to 89) HR15N<br>(90 to 99) HR15N<br><br>HR30N<br>(40 to 54) HR30N<br>(55 to 76) HR30N<br>(77 to 90) HR30N<br><br>HR15TW<br>(65 to 80) HR15TW<br>(81 to 86) HR15TW<br>(87 to 99) HR15TW<br><br>HR30TW<br>(43 to 56) HR30TW<br>(57 to 69) HR30TW<br>(70 to 90) HR30TW | 0.45 HRC<br>0.41 HRC<br>0.33 HRC<br><br>0.37 HRB<br>0.37 HRB<br>0.34 HRB<br><br>0.34 HRA<br>0.34 HRA<br>0.33 HRA<br><br>0.37 HR15N<br>0.34 HR15N<br>0.35 HR15N<br><br>0.37 HR30N<br>0.38 HR30N<br>0.35 HR30N<br><br>0.35 HR15TW<br>0.33 HR15TW<br>0.40 HR15TW<br><br>0.44 HR30TW<br>0.37 HR30TW<br>0.35 HR30TW | Hardness test block masters |
| Knoop Hardness Testers HK, (Indirect Verification) <sup>3</sup> | (250 to 650) HK<br>(651 to 750) HK                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 10 HK<br>16 HK                                                                                                                                                                                                                                                                                                 | Hardness test block masters |

| Parameter/Equipment                                                                                     | Range                                                                                                                                                                                           | CMC <sup>2, 6</sup> ( $\pm$ )                                                                                                                                                                       | Comments                                                    |
|---------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| Vickers Hardness Testers HV, (Indirect Verification) <sup>3</sup>                                       | (240 to 600) HV<br>(601 to 750) HV                                                                                                                                                              | 10 HV<br>16 HV                                                                                                                                                                                      | Hardness test block masters                                 |
| Brinell Hardness Testers HBW, (Indirect Verification) <sup>3</sup>                                      | (125 to 225) HBW<br>>225 HBW                                                                                                                                                                    | 4.1 HBW<br>10 HBW                                                                                                                                                                                   | Hardness test block masters, Brinell scope                  |
| Durometers <sup>10</sup> –<br><br>Force<br><br><br><br><br>Displacement Length<br><br>Indenter Geometry | Up to 90 Duros<br>Type A, B, E, O<br><br>Type C, D, DO<br><br>Type M, OO, OOO, OOO-S<br><br>Up to 0.2 in<br><br>Length, Diameter, Radius<br><br>Angle                                           | (1 % + 0.3) Duros<br><br>(0.25 % + 0.38) Duros<br><br>(0.4 % + 1.3) Duros<br><br>0.0007 in<br><br>200 $\mu$ in<br><br>0.01°                                                                         | Balance<br><br><br><br><br>Gage blocks<br><br>Vision system |
| Torque Wrenches <sup>3</sup>                                                                            | (4 to 40) ozf·in<br>(1 to 10) lbf·in<br>(2 to 20) lbf·in<br>(2.5 to 25) lbf·in<br>(1.5 to 29.5) lbf·ft<br>(5 to 50) lbf·ft<br>(25 to 250) lbf·ft<br>(22 to 1100) lbf·ft<br>(200 to 1000) lbf·ft | 0.7 % + 0.051 ozf·in<br>0.7 % + 0.014 lbf·in<br>0.7 % + 0.024 lbf·in<br>0.7 % + 0.032 lbf·in<br>0.7 % + 0.04 lbf·ft<br>0.7 % + 0.07 lbf·ft<br>0.7 % + 0.034 lbf·ft<br>0.81 % + 0.4 lbf·ft<br>0.82 % | Torque transducers                                          |
| Torque Testers <sup>3</sup>                                                                             | Up to 150 lbf·in<br>Up to 750 lbf·ft                                                                                                                                                            | 0.18 %<br>0.14 %                                                                                                                                                                                    | Torque arm, weights                                         |

| Parameter/Equipment                                      | Range                                                             | CMC <sup>2, 4, 6, 7, 11</sup> (±)                                | Comments                                   |
|----------------------------------------------------------|-------------------------------------------------------------------|------------------------------------------------------------------|--------------------------------------------|
| Rate of Rotation –<br>Measurement Equipment <sup>3</sup> |                                                                   |                                                                  |                                            |
| Contact                                                  | (10 to 3800) RPM                                                  | 0.05 % + 0.015 RPM                                               | Reference<br>tachometer                    |
| Non-Contact                                              | (5 to 999) RPM<br>(1000 to 9999) RPM<br>(10 000 to 99 999) RPM    | 0.013 % + 0.0014 RPM<br>0.006 % + 0.008 RPM<br>0.003 % + 0.4 RPM | Reference strobe                           |
| Rate of Rotation –<br>Measure <sup>3</sup>               |                                                                   |                                                                  |                                            |
| Length                                                   | Up to 1000 FPM                                                    | 0.21 % + 0.9 FPM                                                 | Reference<br>tachometer<br>w/wheel         |
| Non-Contact                                              | (6 to 8299) RPM<br>(8300 to 24 999) RPM<br>(25 000 to 99 999) RPM | 1.7 RPM<br>2.7 RPM<br>0.007 % + 1.5 RPM                          | Reference<br>tachometer                    |
| Machine Displacement <sup>3</sup>                        | Up to 4 in                                                        | (290 + 74L) μin                                                  | Linear<br>displacement<br>indicator        |
| Machine Speed <sup>3</sup>                               | Up to 12 in/min                                                   | $\sqrt{(0.017T) + (0.00074V)^2} + (0.1/T) V^2$<br>in/min         | Linear<br>displacement<br>indicator, timer |

## VI. Optical

| Parameter/Equipment              | Range           | CMC <sup>2, 6</sup> (±) | Comments                                              |
|----------------------------------|-----------------|-------------------------|-------------------------------------------------------|
| Spectrophotometer <sup>3</sup> – |                 |                         |                                                       |
| Photometric Accuracy             | (250 to 635) nm | 0.0044 AU               | Neutral density<br>filter,<br>holmium oxide<br>filter |
| Wavelength Accuracy              | (240 to 640) nm | 0.28 nm                 |                                                       |

| Parameter/Equipment      | Range                                                         | CMC <sup>2, 6</sup> ( $\pm$ ) | Comments                         |
|--------------------------|---------------------------------------------------------------|-------------------------------|----------------------------------|
| Light Meters             |                                                               |                               |                                  |
| Visible Light            | (400 to 700) nm/<br>(0.01 to 50 000) Lux                      | 6.1 %                         | Light meter,<br>broadband sensor |
| UVA Light                | (315 to 390) nm/<br>(2.0 E-2 to 2.0 E-8)<br>W/cm <sup>2</sup> | 6.9 %                         |                                  |
| Light Booth <sup>3</sup> |                                                               |                               |                                  |
| Visible Light            | (400 to 700) nm/<br>(0.01 to 50 000) Lux                      | 6.1 %                         | Light meter,<br>broadband sensor |
| UVA Light                | (315 to 390) nm/<br>(2.0 E-2 to 2.0 E-8)<br>W/cm <sup>2</sup> | 6.6 %                         |                                  |

## VII. Thermodynamics

| Parameter/Equipment                                                  | Range                                                                               | CMC <sup>2, 6, 7</sup> ( $\pm$ )                                   | Comments                   |
|----------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------|----------------------------|
| Temperature Measuring Equipment – Infrared Thermometers <sup>3</sup> | (50 to 500) °C<br><br>Fixed Points<br>50 °C<br>150 °C<br>250 °C<br>350 °C<br>500 °C | 1.5 % + 0.9 °C<br><br>1.7 °C<br>3 °C<br>4.5 °C<br>5.6 °C<br>8.6 °C | Black body calibrator      |
| Thermohygrometers – Humidity (% RH) <sup>3</sup>                     | (20 to 90) % RH                                                                     | 2 % RH                                                             | Reference thermohygrometer |
| Thermohygrometers – Temperature <sup>3</sup>                         | (5 to 55) °C                                                                        | 0.15 °C                                                            | Reference thermohygrometer |

| Parameter/Equipment                            | Range            | CMC <sup>2, 6, 7</sup> (±) | Comments                            |
|------------------------------------------------|------------------|----------------------------|-------------------------------------|
| Temperature – Measurement <sup>3</sup>         | (-200 to 0) °C   | 0.020 °C                   | PRT w/readout                       |
|                                                | (0 to 200) °C    | 0.033 °C                   |                                     |
|                                                | (200 to 420) °C  | 0.048 °C                   |                                     |
|                                                | (420 to 660) °C  | 0.065 °C                   |                                     |
|                                                | (-100 to 300) °C | 1.7 °C                     |                                     |
|                                                | (300 to 1372) °C | 3.2 °C                     | Portable calibrator, K thermocouple |
|                                                | (-250 to 0) °C   | 1.1 °C                     | Portable calibrator, T thermocouple |
|                                                | (0 to 400) °C    | 0.76 °C                    |                                     |
|                                                | (200 to 700) °C  | 2.5 °C                     | Portable calibrator, S thermocouple |
|                                                | (700 to 1767) °C | 3.9 °C                     |                                     |
|                                                | (50 to 500) °C   | 5.6 % + 0.3 °C             | IR thermometer                      |
| Temperature – Measuring Equipment <sup>3</sup> | (-90 to 40) °C   | 0.025 °C                   | PRT w/readout                       |
|                                                | (40 to 300) °C   | 0.04 °C                    |                                     |
|                                                | (300 to 660) °C  | 0.065 °C                   |                                     |
|                                                | (660 to 1200) °C | 3.9 °C                     | Portable calibrator, S thermocouple |

#### VIII. Time & Frequency

| Parameter/Equipment               | Range               | CMC <sup>2, 6</sup> (±) | Comments                  |
|-----------------------------------|---------------------|-------------------------|---------------------------|
| Timers & Stopwatches <sup>3</sup> | (0.01 to 3600) s    | 0.13 s                  | Calibrated stopwatch      |
|                                   | (3600 to 86 400) s  | 3.1 s                   |                           |
| Frequency – Source <sup>3</sup>   | (0.1 to 119.99) Hz  | 0.004 Hz                | Multi-function calibrator |
|                                   | (120 to 1199.99) Hz | 0.025 Hz                |                           |
|                                   | (1.2 to 11.999) kHz | 0.24 Hz                 |                           |
|                                   | (1.2 to 119.99) kHz | 2.4 Hz                  |                           |
|                                   | (120 to 1199.9) kHz | 24 Hz                   |                           |
|                                   | (1.2 to 2.000) MHz  | 40 Hz                   |                           |
| Frequency – Measure <sup>3</sup>  | (3 to 5) Hz         | 0.13 %                  | Precision multimeter      |
|                                   | (5 to 10) Hz        | 0.07 %                  |                           |
|                                   | (10 to 40) Hz       | 0.04 %                  |                           |
|                                   | 40 Hz to 300 kHz    | 0.02 %                  |                           |
|                                   | 300 kHz to 1 MHz    | 0.04 %                  |                           |

# SATELLITE

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## CALIBRATION

### I. Chemical

| Parameter/Equipment             | Range                                                                        | CMC <sup>2</sup> (±)                                                        | Comments                  |
|---------------------------------|------------------------------------------------------------------------------|-----------------------------------------------------------------------------|---------------------------|
| pH Meter <sup>3</sup>           | 4 pH<br>7 pH<br>10 pH                                                        | 0.022 pH<br>0.022 pH<br>0.027 pH                                            | Std buffer solution       |
| Conductivity Meter <sup>3</sup> | 1 µS/cm<br>10 µS/cm<br>100 µS/cm<br>1000 µS/cm<br>1413 µS/cm<br>10 000 µS/cm | 0.56 µS/cm<br>0.63 µS/cm<br>2.1 µS/cm<br>5.8 µS/cm<br>7.5 µS/cm<br>55 µS/cm | Std conductivity solution |

### II. Dimensional

| Parameter/Equipment                                                               | Range                                           | CMC <sup>2, 4</sup> (±)                             | Comments                      |
|-----------------------------------------------------------------------------------|-------------------------------------------------|-----------------------------------------------------|-------------------------------|
| Micrometers <sup>3</sup>                                                          | Up to 12 in<br>(>12 to 36) in<br>(>36 to 60) in | (70 + 22L) µin<br>(90 + 24L) µin<br>(190 + 27L) µin | Gage blocks, length standards |
| Caliper, Bore Gage, Snap Gage <sup>3</sup>                                        | Up to 60 in                                     | (290 + 27L) µin                                     | Gage blocks, length standards |
| Standard Length <sup>3</sup><br>(including Feeler Gages, Snap Gages, Taper Gages) | Up to 11 in                                     | (12 + 2.9L) µin                                     | Universal measurement machine |

| Parameter/Equipment                                                                                 | Range                                                     | CMC <sup>2, 4, 7</sup> ( $\pm$ )                                      | Comments                                    |
|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------|---------------------------------------------|
| Pin & Plug Gages <sup>3</sup>                                                                       | Up to 5 in                                                | $(19 + 18L) \mu\text{in}$                                             | Universal measurement machine               |
| External Threads Major Diameter <sup>3</sup>                                                        | Up to 5 in                                                | $(17 + 22L) \mu\text{in}$                                             | Universal measurement machine               |
| External Threads Pitch Diameter <sup>3</sup>                                                        | Up to 5 in                                                | $(51 + 17L) \mu\text{in}$                                             | Universal measurement machine, thread wires |
| Ring Gages <sup>3</sup>                                                                             | Up to 6 in<br>(>6 to 11) in                               | $(21 + 3.1L) \mu\text{in}$<br>$(7 + 6.6L) \mu\text{in}$               | Universal measurement machine               |
| Dimensional Measurement <sup>3</sup>                                                                | Z Axis: Up to 24 in<br>Angle: Up to 180°                  | $(360 + 3L) \mu\text{in}$<br>0.08°                                    | 2D height gauge<br>Digital protractor       |
| Surface Finish Equipment <sup>3</sup>                                                               | $(10 \text{ to } 320) \mu\text{in Ra}$                    | 2.2 $\mu\text{in Ra}$                                                 | Master finish standards                     |
| Height Gages <sup>3</sup>                                                                           | Up to 40 in                                               | $(15 + 22L) \mu\text{in}$                                             | Length standard, gage blocks                |
| Dial/Digital Indicators <sup>3</sup>                                                                | Up to 4 in<br>Up to 1 in                                  | $(220 + 3L) \mu\text{in}$<br>$(170 + 160L) \mu\text{in}$              | Gage blocks<br>Indicator calibrator         |
| Vision Machine <sup>3</sup><br><br>X/Y Axis<br>Z Axis<br>Angle<br>Measuring Microscope <sup>3</sup> | Up to 12 in<br>Up to 6 in<br>(1 to 90)°<br>(0.01 to 1) mm | 140 $\mu\text{in}$<br>150 $\mu\text{in}$<br>0.029°<br>9 $\mu\text{m}$ | Gage blocks / glass masters, angle blocks   |

| Parameter/Equipment                                                                         | Range                                                                                       | CMC <sup>2, 4, 6</sup> ( $\pm$ )                                                                              | Comments                                                                             |
|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| ULM <sup>3</sup> –<br><br>Length<br><br>Parallelism<br>Flatness<br>Tailstock Force          | Up to 4 in<br>(4 to 12) in<br>(12 to 24) in<br><br>Up to 4 in<br>Up to 4 in<br>Up to 40 ozf | (10 + 2.8L) $\mu$ in<br>(16 + 1.3L) $\mu$ in<br>(7 + 2.3L) $\mu$ in<br><br>3 $\mu$ in<br>10 $\mu$ in<br>2.9 % | Gage blocks/length standards<br><br>Gage ball<br>Optical flat<br>Load cell           |
| Steel Rules & Tape Measures <sup>3</sup>                                                    | Up to 40 ft                                                                                 | (0.011 + 0.000 25L) in                                                                                        | Length standard, reticle, push-pull block                                            |
| Displacement <sup>3</sup><br>(Extensometers)                                                | Up to 0.005 in<br>(0.005 to 0.02) in<br>(0.02 to 0.2) in<br>(0.2 to 2) in                   | 17 $\mu$ in<br>41 $\mu$ in<br>48 $\mu$ in<br>240 $\mu$ in                                                     | Linear displacement calibrator                                                       |
| Optical Comparators <sup>3</sup> –<br><br>X & Y Linearity<br><br>Magnification<br><br>Angle | Up to 20 in<br><br>Up to 6 in<br><br>(1 to 90)°                                             | 0.0006 in<br><br>0.0025 in<br><br>0.047°                                                                      | Glass master, gage blocks<br><br>Glass master, caliper, pin gage<br><br>Angle blocks |
| Protractors <sup>3</sup>                                                                    | (1 to 90)°<br><br>Up to 45°                                                                 | 0.044°<br><br>0.024°                                                                                          | Angle blocks, surface plate<br><br>Sine plate, gage blocks                           |
| Precision Levels                                                                            | Up to 0.1 in per ft Deviation<br><br>Level                                                  | 0.0006 in<br><br>60 $\mu$ in                                                                                  | Surface plate, sine plate, gage blocks<br><br>Surface plate                          |
| Crimpers <sup>3</sup> –<br><br>Crimp Height<br><br>Crimp Die Diameter                       | Up to 1 in<br><br>Up to 1 in                                                                | 180 $\mu$ in<br><br>240 $\mu$ in                                                                              | Crimp micrometer<br><br>Pin/plug sets                                                |
| Coating Thickness Testers <sup>3</sup>                                                      | Up to 80 mils                                                                               | 0.7 % + 0.012 mils                                                                                            | Coating thickness standards                                                          |

### III. Electrical – DC/Low Frequency

| Parameter/Range                    | Frequency                                                                                            | CMC <sup>2, 8</sup> ( $\pm$ )                                                                                                                            | Comments                  |
|------------------------------------|------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| AC Current – Generate <sup>3</sup> |                                                                                                      |                                                                                                                                                          |                           |
| (29 to 330) $\mu$ A                | (10 to 20) Hz<br>(20 to 45) Hz<br>(0.45 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz<br>(10 to 30) kHz | 1.8 mA/A + 0.1 $\mu$ A<br>1.4 mA/A + 0.1 $\mu$ A<br>1.2 mA/A + 0.1 $\mu$ A<br>2.7 mA/A + 0.15 $\mu$ A<br>6.7 mA/A + 0.2 $\mu$ A<br>13 mA/A + 0.4 $\mu$ A | Multi-function calibrator |
| 330 $\mu$ A to 3.3 mA              | (10 to 20) Hz<br>(20 to 45) Hz<br>(0.45 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz<br>(10 to 30) kHz | 1.6 mA/A + 0.15 $\mu$ A<br>1 mA/A + 0.15 $\mu$ A<br>0.82 mA/A + 0.15 $\mu$ A<br>1.6 mA/A + 0.2 $\mu$ A<br>4 mA/A + 0.3 $\mu$ A<br>7.9 mA/A + 0.6 $\mu$ A |                           |
| (3.3 to 33) mA                     | (10 to 20) Hz<br>(20 to 45) Hz<br>(0.45 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz<br>(10 to 30) kHz | 1.5 mA/A + 2 $\mu$ A<br>0.76 mA/A + 2 $\mu$ A<br>0.38 mA/A + 2 $\mu$ A<br>0.68 mA/A + 2 $\mu$ A<br>1.6 mA/A + 3 $\mu$ A<br>3.2 mA/A + 4 $\mu$ A          |                           |
| (33 to 330) mA                     | (10 to 20) Hz<br>(20 to 45) Hz<br>(0.45 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz<br>(10 to 30) kHz | 1.5 mA/A + 20 $\mu$ A<br>0.76 mA/A + 20 $\mu$ A<br>0.38 mA/A + 20 $\mu$ A<br>0.9 mA/A + 50 $\mu$ A<br>1.8 mA/A + 100 $\mu$ A<br>3.6 mA/A + 200 $\mu$ A   |                           |
| 330 mA to 1.1 A                    | (10 to 45) Hz<br>(0.45 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz                                    | 1.5 mA/A + 100 $\mu$ A<br>0.53 mA/A + 100 $\mu$ A<br>5.4 mA/A + 1 mA<br>23 mA/A + 5 mA                                                                   |                           |
| (1.1 to 3) A                       | (10 to 45) Hz<br>(0.45 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz                                    | 1.5 mA/A + 100 $\mu$ A<br>0.64 mA/A + 100 $\mu$ A<br>4.9 mA/A + 1 mA<br>21 mA/A + 5 mA                                                                   |                           |
| (3 to 11) A                        | (45 to 100) Hz<br>(0.1 to 1) kHz<br>(1 to 5) kHz                                                     | 0.83 mA/A + 2 mA<br>1.1 mA/A + 2 mA<br>24 mA/A + 2 mA                                                                                                    |                           |
| (11 to 20.5) A                     | (45 to 100) Hz<br>100 Hz to 1 kHz<br>(1 to 5) kHz                                                    | 16 mA/A + 5 mA<br>17 mA/A + 5 mA<br>24 mA/A + 5 mA                                                                                                       |                           |

| Parameter/Range                            | Frequency                                                                                                   | CMC <sup>2, 6, 8</sup> ( $\pm$ )                                                                                                                         | Comments                     |
|--------------------------------------------|-------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| AC Current – Generate <sup>3</sup> (cont.) |                                                                                                             |                                                                                                                                                          |                              |
| Clamp-on Only                              |                                                                                                             |                                                                                                                                                          |                              |
| (16.5 to 55) A                             | (45 to 440) Hz                                                                                              | 0.6 A                                                                                                                                                    | w/ 50-turn coil              |
| (55 to 150) A                              | (45 to 440) Hz                                                                                              | 1.1 A                                                                                                                                                    |                              |
| (150 to 550) A                             | (45 to 440) Hz                                                                                              | 3 A                                                                                                                                                      |                              |
| (550 to 1020) A                            | (45 to 440) Hz                                                                                              | 8.7 A                                                                                                                                                    |                              |
| AC Voltage – Generate <sup>3</sup>         |                                                                                                             |                                                                                                                                                          |                              |
| (1 to 33) mV                               | (10 to 45) Hz<br>45 Hz to 10 kHz<br>(10 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz<br>(100 to 500) kHz | 1.7 mV/V + 6 $\mu$ V<br>1.3 mV/V + 6 $\mu$ V<br>1.7 mV/V + 6 $\mu$ V<br>2.1 mV/V + 6 $\mu$ V<br>3.6 mV/V + 12 $\mu$ V<br>9.3 mV/V + 50 $\mu$ V           | Multi-function<br>calibrator |
| (33 to 330) mV                             | (10 to 45) Hz<br>45 Hz to 10 kHz<br>(10 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz<br>(100 to 500) kHz | 0.44 mV/V + 8 $\mu$ V<br>0.29 mV/V + 8 $\mu$ V<br>0.6 mV/V + 8 $\mu$ V<br>0.88 mV/V + 8 $\mu$ V<br>2.2 mV/V + 32 $\mu$ V<br>4.7 mV/V + 70 $\mu$ V        |                              |
| (0.33 to 3.3) mV                           | (10 to 45) Hz<br>45 Hz to 10 kHz<br>(10 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz<br>(100 to 500) kHz | 0.44 mV/V + 50 $\mu$ V<br>0.39 mV/V + 60 $\mu$ V<br>0.59 mV/V + 60 $\mu$ V<br>0.83 mV/V + 50 $\mu$ V<br>1.9 mV/V + 130 $\mu$ V<br>4.1 mV/V + 600 $\mu$ V |                              |
| (3.3 to 33) V                              | (10 to 45) Hz<br>45 Hz to 10 kHz<br>(10 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz                     | 0.41 mV/V + 650 $\mu$ V<br>0.26 mV/V + 600 $\mu$ V<br>0.56 mV/V + 600 $\mu$ V<br>0.8 mV/V + 600 $\mu$ V<br>1.8 mV/V + 1.6 mV                             |                              |
| (33 to 330) V                              | 45 Hz to 1 kHz<br>(1 to 10) kHz<br>(10 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz                      | 0.4 mV/V + 2 mV<br>0.65 mV/V + 6 mV<br>0.73 mV/V + 6 mV<br>0.97 mV/V + 6 mV<br>2.1 mV/V + 50 mV                                                          |                              |
| (330 to 1020) V                            | 45 Hz to 1 kHz<br>(1 to 5) kHz<br>(5 to 10) kHz                                                             | 0.41 mV/V + 10 mV<br>0.64 mV/V + 10 mV<br>0.72 mV/V + 10 mV                                                                                              |                              |

| Parameter/Range                                                                                                                              | Frequency       | CMC <sup>2, 6, 8</sup> ( $\pm$ )                                                                                                                                     | Comments                        |
|----------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| AC Current – Measure <sup>3</sup>                                                                                                            |                 |                                                                                                                                                                      |                                 |
| (5 to 100) $\mu$ A<br>100 $\mu$ A to 1 mA<br>(1 to 10) mA<br>(10 to 100) mA<br>(100 to 400) mA<br>400 mA to 1 A<br>(1 to 3) A<br>(3 to 10) A | 10 Hz to 5 kHz  | 0.18 % + 0.07 $\mu$ A<br>0.12 % + 0.5 $\mu$ A<br>0.18 % + 7 $\mu$ A<br>0.12 % + 19 $\mu$ A<br>0.12 % + 0.47 mA<br>0.12 % + 0.57 mA<br>0.18 % + 7 mA<br>0.18 % + 9 mA | Precision multimeter            |
| (10 to 1000) A                                                                                                                               | (50 to 400) Hz  | 6 %                                                                                                                                                                  | Clamp meter                     |
| AC Voltage – Measure <sup>3</sup>                                                                                                            |                 |                                                                                                                                                                      |                                 |
| Up to 100 mV<br>100 mV to 1 V<br>(1 to 10) V<br>(10 to 100) V<br>(100 to 1000) V                                                             | 10 Hz to 20 kHz | 0.07 % + 47 $\mu$ V<br>0.07 % + 0.46 mV<br>0.07 % + 4.6 mV<br>0.07 % + 36 mV<br>0.07 % + 0.32 V                                                                      | Precision multimeter            |
| Up to 100 mV<br>100 mV to 1 V<br>(1 to 10) V<br>(10 to 100) V<br>(100 to 1000) V                                                             | (20 to 100) kHz | 0.7 % + 94 $\mu$ V<br>0.7 % + 0.94 mV<br>0.7 % + 9.4 mV<br>0.7 % + 94 mV<br>0.7 % + 1.1 V                                                                            |                                 |
| (1 to 20) kV                                                                                                                                 | (50 to 60) Hz   | 5.9 %                                                                                                                                                                | Multimeter & high voltage probe |
| (1 to 10) kV                                                                                                                                 | (50 to 60) Hz   | 0.15 %                                                                                                                                                               | High voltage meter              |

| Parameter/Equipment                 | Range                                                                                                                                                                                                                                                                                                                                                                                                    | CMC <sup>2, 6, 8</sup> ( $\pm$ )                                                                                                                                                                                                                                       | Comments                                                                 |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| DC Current – Generate <sup>3</sup>  | Up to 329.999 $\mu$ A<br>329.999 $\mu$ A to 3.299 99 mA<br>(3.299 999 9 to 32.999 99) mA<br>(32.999 99 to 329.9999) mA<br>329.999 mA to 1.099 99 A<br>(1.1 to 2.999 99) A<br>(2.999 99 to 10.9999) A<br>(10.9999 to 20) A<br><br>(20 to 1010) A                                                                                                                                                          | 270 $\mu$ A/A + 0.02 $\mu$ A<br>140 $\mu$ A/A + 0.05 $\mu$ A<br>97 $\mu$ A/A + 0.25 $\mu$ A<br>98 $\mu$ A/A + 2.5 $\mu$ A<br>38 $\mu$ A/A + 40 $\mu$ A<br>310 $\mu$ A/A + 40 $\mu$ A<br>510 $\mu$ A/A + 500 $\mu$ A<br>81 $\mu$ A/A + 750 $\mu$ A<br><br>0.5 % + 0.5 A | Multi-function calibrator<br><br><br><br><br><br><br><br>w/ 50 turn coil |
| DC Voltage – Generate <sup>3</sup>  | Up to 330 mV<br>330 mV to 3.299 999 V<br>(3.299 999 to 32.999 99) V<br>(32.999 99 to 329.9999) V<br>(329.9999 to 1020) V                                                                                                                                                                                                                                                                                 | 54 $\mu$ V/V + 1 $\mu$ V<br>40 $\mu$ V/V + 2 $\mu$ V<br>44 $\mu$ V/V + 20 $\mu$ V<br>44 $\mu$ V/V + 150 $\mu$ V<br>44 $\mu$ V/V + 1.5 mV                                                                                                                               | Multi-function calibrator                                                |
| Capacitance – Generate <sup>3</sup> | (0.22 to 1.099) nF<br>(1.1 to 3.299) nF<br>(3.3 to 10.999) nF<br>(11 to 32.999) nF<br>(33 to 109.999) nF<br>(110 to 329.999) nF<br>(0.33 to 1.099) $\mu$ F<br>(1.1 to 3.299) $\mu$ F<br>(3.3 to 10.999) $\mu$ F<br>(11 to 32.999) $\mu$ F<br>(33 to 109.999) $\mu$ F<br>(110 to 329.999) $\mu$ F<br>(0.33 to 1.099) mF<br>(1.1 to 3.299) mF<br>(3.3 to 10.999) mF<br>(11 to 32.999) mF<br>(33 to 110) mF | 0.013 nF<br>0.023 nF<br>0.031 nF<br>0.17 nF<br>0.53 nF<br>1.1 nF<br>3.3 nF<br>9.2 nF<br>35 nF<br>0.14 $\mu$ F<br>0.49 $\mu$ F<br>1.4 $\mu$ F<br>4.7 $\mu$ F<br>14 $\mu$ F<br>47 $\mu$ F<br>0.22 mF<br>1.1 mF                                                           | Multi-function calibrator                                                |

| Parameter/Equipment                                                                                           | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CMC <sup>2, 8</sup> ( $\pm$ )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Comments                  |
|---------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Resistance – Generate <sup>3</sup>                                                                            | Up to 10.999 $\Omega$<br>(11 to 32.999) $\Omega$<br>(32.999 to 109.999) $\Omega$<br>(109.999 to 329.999) $\Omega$<br>330 $\Omega$ to 1.099 99 k $\Omega$<br>(1.1 to 3.299 99) k $\Omega$<br>(3.3 to 10.999) k $\Omega$<br>(11 to 32.999) k $\Omega$<br>(33 to 109.999) k $\Omega$<br>(110 to 329.999) k $\Omega$<br>330 k $\Omega$ to 1.0999 M $\Omega$<br>(1.1 to 3.2999) M $\Omega$<br>(3.3 to 10.9999) M $\Omega$<br>(11 to 32.999) M $\Omega$<br>(33 to 109.999) M $\Omega$<br>(110 to 329.999) M $\Omega$<br>(330 to 1100) M $\Omega$ | 170 $\mu\Omega/\Omega$ + 1 m $\Omega$<br>130 $\mu\Omega/\Omega$ + 1.5 m $\Omega$<br>82 $\mu\Omega/\Omega$ + 1.4 m $\Omega$<br>76 $\mu\Omega/\Omega$ + 2 m $\Omega$<br>73 $\mu\Omega/\Omega$ + 2 m $\Omega$<br>76 $\mu\Omega/\Omega$ + 20 m $\Omega$<br>73 $\mu\Omega/\Omega$ + 20 m $\Omega$<br>76 $\mu\Omega/\Omega$ + 0.2 $\Omega$<br>88 $\mu\Omega/\Omega$ + 0.2 $\Omega$<br>98 $\mu\Omega/\Omega$ + 2 $\Omega$<br>0.12 m $\Omega/\Omega$ + 2 $\Omega$<br>0.13 m $\Omega/\Omega$ + 30 $\Omega$<br>0.47 m $\Omega/\Omega$ + 50 $\Omega$<br>0.84 m $\Omega/\Omega$ + 2.5 k $\Omega$<br>3.9 m $\Omega/\Omega$ + 3 k $\Omega$<br>4.2 m $\Omega/\Omega$ + 0.1 M $\Omega$<br>12 m $\Omega/\Omega$ + 0.5 M $\Omega$ | Multi-function calibrator |
| Temperature Calibration, Indication, & Control Equipment Used with RTD – (Electrical Simulation) <sup>3</sup> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                           |
| Cu 42 710 $\Omega$                                                                                            | (-100 to 260) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.31 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Multi-function calibrator |
| PT 385 100 $\Omega$                                                                                           | (-200 to 630) $^{\circ}\text{C}$<br>(630 to 800) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0.15 $^{\circ}\text{C}$<br>0.25 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| PT 385 200 $\Omega$                                                                                           | (-200 to 260) $^{\circ}\text{C}$<br>(260 to 630) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0.07 $^{\circ}\text{C}$<br>0.17 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| PT 385 500 $\Omega$                                                                                           | (-200 to 260) $^{\circ}\text{C}$<br>(260 to 630) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0.07 $^{\circ}\text{C}$<br>0.12 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| PT 3 851 000 $\Omega$                                                                                         | (-200 to 600) $^{\circ}\text{C}$<br>(600 to 630) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0.07 $^{\circ}\text{C}$<br>0.24 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| PT 3 916 100 $\Omega$                                                                                         | (-200 to -190) $^{\circ}\text{C}$<br>(-190 to 600) $^{\circ}\text{C}$<br>(600 to 630) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                   | 0.26 $^{\circ}\text{C}$<br>0.11 $^{\circ}\text{C}$<br>0.24 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |
| PT 3 926 100 $\Omega$                                                                                         | (-200 to 100) $^{\circ}\text{C}$<br>(100 to 630) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0.08 $^{\circ}\text{C}$<br>0.13 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| PtNi 385 120 $\Omega$                                                                                         | (-80 to 100) $^{\circ}\text{C}$<br>(100 to 260) $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0.09 $^{\circ}\text{C}$<br>0.15 $^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |

| Parameter/Equipment                                                                            | Range                                                                          | CMC <sup>2, 6, 8</sup> ( $\pm$ )         | Comments                     |
|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|------------------------------------------|------------------------------|
| Temperature –<br>Instruments<br>(Electrical Simulation) –<br>Thermocouple Devices <sup>3</sup> |                                                                                |                                          |                              |
| Type B                                                                                         | (600 to 800) °C<br>(800 to 1800) °C                                            | 0.41 °C<br>0.33 °C                       | Multi-function<br>calibrator |
| Type C                                                                                         | (0 to 1000) °C<br>(1000 to 1800) °C<br>(1800 to 2316) °C                       | 0.25 °C<br>0.41 °C<br>0.66 °C            |                              |
| Type E                                                                                         | (-250 to -100) °C<br>(-100 to 650) °C<br>(650 to 1000) °C                      | 0.39 °C<br>0.13 °C<br>0.17 °C            |                              |
| Type J                                                                                         | (-210 to -100) °C<br>(-100 to 760) °C<br>(760 to 1200) °C                      | 0.21 °C<br>0.15 °C<br>0.19 °C            |                              |
| Type K                                                                                         | (-200 to -100) °C<br>(-100 to 120) °C<br>(120 to 1000) °C<br>(1000 to 1372) °C | 0.26 °C<br>0.15 °C<br>0.21 °C<br>0.32 °C |                              |
| Type N                                                                                         | (-200 to -100) °C<br>(-100 to 120) °C<br>(120 to 410) °C<br>(410 to 1300) °C   | 0.32 °C<br>0.18 °C<br>0.21 °C<br>0.30 °C |                              |
| Type R                                                                                         | (0 to 250) °C<br>(250 to 1000) °C<br>(1000 to 1767) °C                         | 0.45 °C<br>0.29 °C<br>0.37 °C            |                              |
| Type S                                                                                         | (0 to 250) °C<br>(250 to 1000) °C<br>(1000 to 1400) °C<br>(1400 to 1767) °C    | 0.49 °C<br>0.38 °C<br>0.32 °C<br>0.39 °C |                              |
| Type T                                                                                         | (-250 to -150) °C<br>(-150 to 0) °C<br>(0 to 120) °C<br>(120 to 400) °C        | 0.49 °C<br>0.38 °C<br>0.31 °C<br>0.39 °C |                              |
| Type U                                                                                         | (-200 to 0) °C<br>(0 to 600) °C                                                | 0.44 °C<br>0.22 °C                       |                              |

| Parameter/Equipment                                      | Range                                                                                                                                                                                                                                       | CMC <sup>2, 6, 8</sup> ( $\pm$ )                                                                                                                                                                                                                     | Comments                                                |
|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|
| DC Current – Measure <sup>3</sup>                        | (1 to 100) $\mu$ A<br>100 $\mu$ A to 1 mA<br>(1 to 100) mA<br>(100 to 400) mA<br>400 mA to 1 A<br>(1 to 3) A<br>(3 to 10) A                                                                                                                 | 0.06 % + 0.06 $\mu$ A<br>0.06 % + 0.6 $\mu$ A<br>0.06 % + 6 $\mu$ A<br>0.06 % + 24 $\mu$ A<br>0.06 % + 28 $\mu$ A<br>0.12 % + 2.4 mA<br>0.18 % + 4.4 mA                                                                                              | Precision multimeter                                    |
|                                                          | (10 to 1000) A                                                                                                                                                                                                                              | 2.6 %                                                                                                                                                                                                                                                | Clamp meter                                             |
| DC Voltage – Measure <sup>3</sup>                        | (0.01 to 100) mV<br>100 mV to 1 V<br>(1 to 10) V<br>(10 to 100) V<br>(100 to 1000) V                                                                                                                                                        | 0.004 % + 5 $\mu$ V<br>0.003 % + 13 $\mu$ V<br>0.003 % + 86 $\mu$ V<br>0.004 % + 0.94 mV<br>0.005 % + 14 mV                                                                                                                                          | Precision multimeter                                    |
|                                                          | (1 to 20) kV                                                                                                                                                                                                                                | 2.4 %                                                                                                                                                                                                                                                | Multimeter & high voltage probe                         |
|                                                          | (1 to 10) kV                                                                                                                                                                                                                                | 0.05 %                                                                                                                                                                                                                                               | High voltage meter                                      |
| Capacitance – Measure <sup>3</sup>                       | Up to 1 nF<br>(1 to 10) nF<br>(10 to 100) nF<br>100 nF to 1 $\mu$ F<br>(1 to 10) $\mu$ F<br>(10 to 100) $\mu$ F<br>100 $\mu$ F to 1 mF<br>(1 to 10) mF<br>(10 to 100) mF                                                                    | 2.4 % + 0.034 nF<br>1.2 % + 0.09 nF<br>1.2 % + 0.65 nF<br>1.2 % + 7.4 nF<br>1.2 % + 73 nF<br>1.2 % + 0.77 $\mu$ F<br>1.2 % + 7.8 $\mu$ F<br>1.2 % + 78 $\mu$ F<br>4.7 % + 1.3 mF                                                                     | Precision multimeter                                    |
| Resistance – Measure <sup>3</sup><br>Equipment to Source | Up to 10 $\Omega$<br>(10 to 100) $\Omega$<br>100 $\Omega$ to 1 k $\Omega$<br>(1 to 10) k $\Omega$<br>(10 to 100) k $\Omega$<br>100 k $\Omega$ to 1 M $\Omega$<br>(1 to 10) M $\Omega$<br>(10 to 100) M $\Omega$<br>(100 to 1000) M $\Omega$ | 0.012 % + 3.5 m $\Omega$<br>0.012 % + 5.7 m $\Omega$<br>0.012 % + 15 m $\Omega$<br>0.012 % + 0.34 $\Omega$<br>0.012 % + 0.36 $\Omega$<br>0.012 % + 0.58 $\Omega$<br>0.046 % + 0.79 k $\Omega$<br>0.93 % + 0.14 M $\Omega$<br>2.3 % + 0.14 M $\Omega$ | Precision multimeter                                    |
|                                                          | 10 M $\Omega$<br>100 M $\Omega$<br>1 G $\Omega$<br>10 G $\Omega$<br><br>(8 to 1200) $\Omega$                                                                                                                                                | 0.04 M $\Omega$<br>0.26 M $\Omega$<br>2 M $\Omega$<br>0.19 G $\Omega$<br><br>3.6 m $\Omega$                                                                                                                                                          | Insulation resistance standard<br><br>Transfer standard |

#### IV. Fluid Quantities

| Parameter/Equipment                                                                                                                                           | Range                                                                                                                                               | CMC <sup>2, 6</sup> ( $\pm$ )                                                                    | Comments                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|----------------------------------------------|
| Liquid Flow Meter <sup>3</sup>                                                                                                                                | Up to 500 GPM                                                                                                                                       | 2 %                                                                                              | Ultrasonic flow meter                        |
| Liquid Flow Meter <sup>3</sup>                                                                                                                                |                                                                                                                                                     |                                                                                                  |                                              |
| Rate                                                                                                                                                          | Up to 30 GPM<br>(31 to 200) GPM                                                                                                                     | 0.16 %<br>0.13 %                                                                                 | Coriolis flow meter                          |
| Totalization                                                                                                                                                  | Up to 6 kg                                                                                                                                          | 0.11 %                                                                                           | Balance                                      |
| POVA (Piston/Plunger<br>Operated Volumetric<br>Apparatus) <sup>3</sup> –<br>Including But Not<br>Limited To: Pipettes,<br>Syringes, Dispensers, &<br>Burettes | (0.1 to 20) $\mu$ L<br>(20 to 200) $\mu$ L<br>(200 to 1000) $\mu$ L<br>(1000 to 10 000) $\mu$ L<br>(10 000 to 20 000) $\mu$ L<br><br>(10 to 100) mL | 0.16 $\mu$ L<br>0.22 $\mu$ L<br>0.53 $\mu$ L<br>5 $\mu$ L<br>11 $\mu$ L<br><br>(0.58 % + 0.3) mL | Micro balance<br><br><br><br><br><br>Balance |
| Graduated<br>Cylinder/Flask/Beaker <sup>3</sup>                                                                                                               | (50 to 6000) mL                                                                                                                                     | (0.98 % + 0.16)<br>mL                                                                            | Balance                                      |
| Viscometers <sup>3</sup>                                                                                                                                      | Up to 10 000 cP                                                                                                                                     | 1.7 %                                                                                            | Viscosity reference<br>standards             |

#### V. Mechanical

| Parameter/Equipment       | Range         | CMC <sup>2, 6</sup> ( $\pm$ ) | Comments           |
|---------------------------|---------------|-------------------------------|--------------------|
| Force Gauges <sup>3</sup> | Up to 500 lbf | 0.11 %                        | Calibrated weights |

| Parameter/Equipment                                                | Range                                                                                                                                                            | CMC <sup>2, 6</sup> (±)                                                                                                                      | Comments                                     |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| Load Cells, Load Stands & Tension/Compression Testers <sup>3</sup> | Up to 500 lbf<br>(20 to 1000) lbf<br>(500 to 5000) lbf<br>(2000 to 20 000) lbf<br>(500 to 25 000) lbf<br>(5000 to 50 000) lbf                                    | 0.11 %<br>0.21 %<br>0.24 %<br>0.24 %<br>0.20 %<br>0.24 %                                                                                     | Calibrated weights<br>Load cells w/indicator |
| Compression Only                                                   | (28 200 to 500 000) lbf                                                                                                                                          | 0.20 %                                                                                                                                       |                                              |
| Weighing Instruments/Scales <sup>3, 9</sup>                        | Up to 10 000 lb                                                                                                                                                  | 0.013 %                                                                                                                                      | ASTM Class 6 weights, Class F weights        |
| Analytical Balance <sup>3, 9</sup>                                 | Up to 500 mg<br>500 mg to 5 g<br>10 g<br>20 g<br>50 g<br>100 g<br>200 g<br>500 g<br>1 kg<br>2 kg<br>5 kg<br>10 kg<br>20 kg<br>30 kg<br>50 lb                     | 13 µg<br>41 µg<br>61 µg<br>90 µg<br>0.15 mg<br>0.31 mg<br>0.61 mg<br>1.5 mg<br>3.1 mg<br>6.2 mg<br>15 mg<br>31 mg<br>62 mg<br>92 mg<br>73 mg | ASTM Class 1 mass                            |
| Crimpers <sup>3</sup> –                                            |                                                                                                                                                                  |                                                                                                                                              |                                              |
| Pull Force                                                         | Up to 500 lbf                                                                                                                                                    | 6.4 %                                                                                                                                        | Force gauge                                  |
| Jaw Force                                                          | Up to 15 Tons                                                                                                                                                    | 2.8 %                                                                                                                                        | Load cell                                    |
| Pressure Gauge <sup>3</sup>                                        | Up to 1 in H <sub>2</sub> O<br>(1 to 10) in H <sub>2</sub> O<br><br>Up to 1 psi<br>(1 to 15) psi<br>(15 to 300) psi<br>(300 to 1000) psi<br>(1000 to 10 000) psi | 0.0017 in H <sub>2</sub> O<br>0.012 in H <sub>2</sub> O<br><br>0.0024 psi<br>0.0045 psi<br>0.092 psi<br>0.28 psi<br>2.8 psi                  | Reference pressure gauges                    |
| Absolute                                                           | Up to 30 psia                                                                                                                                                    | 0.02 psia                                                                                                                                    |                                              |

| Parameter/Equipment                                             | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | CMC <sup>2, 6</sup> (±)                                                                                                                                                                                                                                                                                        | Comments                    |
|-----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| Vacuum Gauge <sup>3</sup>                                       | (-14 to -1) psi<br>(-1 to 0) psi<br><br>(-10 to -1) in H <sub>2</sub> O<br>(-1 to 0) in H <sub>2</sub> O                                                                                                                                                                                                                                                                                                                                                                                                 | 0.009 psi<br>0.0024 psi<br><br>0.012 in H <sub>2</sub> O<br>0.0017 in H <sub>2</sub> O                                                                                                                                                                                                                         | Reference pressure gauges   |
| Indirect Verification of Rockwell Hardness Testers <sup>3</sup> | HRC<br>(20 to 35) HRC<br>(35 to 59) HRC<br>(60 to 70) HRC<br><br>HRBW<br>(40 to 59) HRB<br>(60 to 87) HRB<br>(88 to 99) HRB<br><br>HRA<br>(20 to 69) HRA<br>(70 to 79) HRA<br>(80 to 99) HRA<br><br>HR15N<br>(70 to 77) HR15N<br>(78 to 89) HR15N<br>(90 to 99) HR15N<br><br>HR30N<br>(40 to 54) HR30N<br>(55 to 76) HR30N<br>(77 to 90) HR30N<br><br>HR15TW<br>(65 to 80) HR15TW<br>(81 to 86) HR15TW<br>(87 to 99) HR15TW<br><br>HR30TW<br>(43 to 56) HR30TW<br>(57 to 69) HR30TW<br>(70 to 90) HR30TW | 0.45 HRC<br>0.41 HRC<br>0.33 HRC<br><br>0.37 HRB<br>0.37 HRB<br>0.34 HRB<br><br>0.34 HRA<br>0.34 HRA<br>0.33 HRA<br><br>0.37 HR15N<br>0.34 HR15N<br>0.35 HR15N<br><br>0.37 HR30N<br>0.38 HR30N<br>0.35 HR30N<br><br>0.35 HR15TW<br>0.33 HR15TW<br>0.40 HR15TW<br><br>0.44 HR30TW<br>0.37 HR30TW<br>0.35 HR30TW | Hardness test block masters |

| Parameter/Equipment                                                  | Range                                                                                                                                                                                           | CMC <sup>2, 6</sup> (±)                                                                                                                                                                             | Comments                                   |
|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| Knoop Hardness Testers<br>HK (Indirect Verification) <sup>3</sup>    | (250 to 650) HK<br>(651 to 750) HK                                                                                                                                                              | 10 HK<br>16 HK                                                                                                                                                                                      | Hardness test block masters                |
| Vickers Hardness Testers<br>HV (Indirect Verification) <sup>3</sup>  | (240 to 600) HV<br>(601 to 750) HV                                                                                                                                                              | 10 HV<br>16 HV                                                                                                                                                                                      | Hardness test block masters                |
| Brinell Hardness Testers<br>HBW (Indirect Verification) <sup>3</sup> | (125 to 225) HBW<br>>225 HBW                                                                                                                                                                    | 4.1 HBW<br>10 HBW                                                                                                                                                                                   | Hardness test block masters, Brinell scope |
| Torque Wrenches <sup>3</sup>                                         | (4 to 40) ozf·in<br>(1 to 10) lbf·in<br>(2 to 20) lbf·in<br>(2.5 to 25) lbf·in<br>(1.5 to 29.5) lbf·ft<br>(5 to 50) lbf·ft<br>(25 to 250) lbf·ft<br>(22 to 1100) lbf·ft<br>(200 to 1000) lbf·ft | 0.7 % + 0.051 ozf·in<br>0.7 % + 0.014 lbf·in<br>0.7 % + 0.024 lbf·in<br>0.7 % + 0.032 lbf·in<br>0.7 % + 0.04 lbf·ft<br>0.7 % + 0.07 lbf·ft<br>0.7 % + 0.034 lbf·ft<br>0.81 % + 0.4 lbf·ft<br>0.82 % | Torque transducers                         |
| Rate of Rotation –<br>Measurement Equipment <sup>3</sup>             |                                                                                                                                                                                                 |                                                                                                                                                                                                     |                                            |
| Contact                                                              | (10 to 3800) RPM                                                                                                                                                                                | 0.05 % + 0.015 RPM                                                                                                                                                                                  | Reference tachometer                       |
| Non-Contact                                                          | (5 to 999) RPM<br>(1000 to 9999) RPM<br>(10 000 to 99 999) RPM                                                                                                                                  | 0.013 % + 0.0014 RPM<br>0.006 % + 0.008 RPM<br>0.003 % + 0.4 RPM                                                                                                                                    | Reference strobe                           |
| Rate of Rotation –<br>Measure <sup>3</sup>                           |                                                                                                                                                                                                 |                                                                                                                                                                                                     |                                            |
| Length                                                               | Up to 1000 FPM                                                                                                                                                                                  | 0.21 % + 0.9 FPM                                                                                                                                                                                    | Reference tachometer w/wheel               |
| Non-Contact                                                          | (6 to 8299) RPM<br>(8300 to 24 999) RPM<br>(25 000 to 90 000) RPM                                                                                                                               | 1.7 RPM<br>2.7 RPM<br>0.007 % + 1.5 RPM                                                                                                                                                             | Reference tachometer                       |

| Parameter/Equipment               | Range           | CMC <sup>2, 4, 6, 11</sup> (±)                            | Comments                             |
|-----------------------------------|-----------------|-----------------------------------------------------------|--------------------------------------|
| Machine Displacement <sup>3</sup> | Up to 4 in      | $(290 + 74L) \mu\text{in}$                                | Linear displacement indicator        |
| Machine Speed <sup>3</sup>        | Up to 12 in/min | $\sqrt{(0.017/T) + (0.000\ 074V)^2} + (0.1/T) V^2$ in/min | Linear displacement indicator, timer |

## VI. Optical

| Parameter/Equipment                                      | Range           | CMC <sup>2</sup> (±) | Comments               |
|----------------------------------------------------------|-----------------|----------------------|------------------------|
| Spectrophotometer <sup>3</sup> –<br>Photometric Accuracy | (250 to 635) nm | 0.0044 AU            | Neutral density filter |
| Wavelength Accuracy                                      | (240 to 640) nm | 0.28 nm              | Holmium oxide filter   |

## VII. Thermodynamics

| Parameter/Equipment                                                  | Range                                                                           | CMC <sup>2, 6, 7</sup> (±)                                         | Comments                   |
|----------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------|----------------------------|
| Temperature Measuring Equipment – Infrared Thermometers <sup>3</sup> | (50 to 500) °C<br>Fixed Points<br>50 °C<br>150 °C<br>250 °C<br>350 °C<br>500 °C | 1.5 % + 0.9 °C<br><br>1.7 °C<br>3 °C<br>4.5 °C<br>5.6 °C<br>8.6 °C | Black body calibrator      |
| Thermohygrometers – Humidity (% RH) <sup>3</sup>                     | (20 to 90) % RH                                                                 | 2 % RH                                                             | Reference thermohygrometer |
| Thermohygrometers – Temperature <sup>3</sup>                         | (5 to 55) °C                                                                    | 0.15 °C                                                            | Reference thermohygrometer |

| Parameter/Equipment                            | Range            | CMC <sup>2, 6, 7</sup> ( $\pm$ ) | Comments                            |
|------------------------------------------------|------------------|----------------------------------|-------------------------------------|
| Temperature – Measurement <sup>3</sup>         | (-200 to 0) °C   | 0.020 °C                         | PRT w/readout                       |
|                                                | (0 to 200) °C    | 0.033 °C                         |                                     |
|                                                | (200 to 420) °C  | 0.048 °C                         |                                     |
|                                                | (420 to 660) °C  | 0.065 °C                         |                                     |
|                                                | (-100 to 300) °C | 1.7 °C                           |                                     |
|                                                | (300 to 1372) °C | 3.2 °C                           | Portable calibrator, K thermocouple |
|                                                | (-250 to 0) °C   | 1.1 °C                           | Portable calibrator, T thermocouple |
|                                                | (0 to 400) °C    | 0.76 °C                          |                                     |
|                                                | (200 to 700) °C  | 2.5 °C                           | Portable calibrator, S thermocouple |
|                                                | (700 to 1767) °C | 3.8 °C                           |                                     |
|                                                | (50 to 500) °C   | 5.6 % + 0.3 °C                   | IR thermometer                      |
| Temperature – Measuring Equipment <sup>3</sup> | (-90 to 40) °C   | 0.025 °C                         | PRT w/readout                       |
|                                                | (40 to 300) °C   | 0.04 °C                          |                                     |
|                                                | (300 to 660) °C  | 0.065 °C                         |                                     |
|                                                | (660 to 1200) °C | 3.9 °C                           | Portable calibrator, S thermocouple |

#### VIII. Time & Frequency

| Parameter/Equipment               | Range                                                                                                                                | CMC <sup>2, 6, 7</sup> ( $\pm$ )                            | Comments                  |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|---------------------------|
| Timers & Stopwatches <sup>3</sup> | (0.01 to 3600) s<br>(3600 to 86 400) s                                                                                               | 0.13 s<br>3.1 s                                             | Calibrated stopwatch      |
| Frequency – Source <sup>3</sup>   | (0.1 to 119.99) Hz<br>(120 to 1199.99) Hz<br>(1.2 to 11.999) kHz<br>(1.2 to 119.99) kHz<br>(120 to 1199.9) kHz<br>(1.2 to 2.000) MHz | 0.004 Hz<br>0.025 Hz<br>0.24 Hz<br>2.4 Hz<br>24 Hz<br>40 Hz | Multi-function calibrator |
| Frequency – Measure <sup>3</sup>  | (3 to 5) Hz<br>(5 to 10) Hz<br>(10 to 40) Hz<br>40 Hz to 300 kHz<br>300 kHz to 1 MHz                                                 | 0.13 %<br>0.07 %<br>0.04 %<br>0.02 %<br>0.04 %              | Precision multimeter      |

<sup>1</sup> This laboratory offers commercial calibration service and field calibration service.

<sup>2</sup> Calibration and Measurement Capability Uncertainty (CMC) is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards of nearly ideal measuring equipment. CMCs represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of  $k = 2$ . The actual measurement uncertainty of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer's device and to influences from the circumstances of the specific calibration.

<sup>3</sup> Field calibration service is available for this calibration. Please note the actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the CMC found on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC.

<sup>4</sup> In the statement of CMC,  $L$  is length measured in inches.

<sup>5</sup> This scope meets A2LA's *P112 Flexible Scope Policy*.

<sup>6</sup> In the statement of CMC, percentages are percentage of reading, unless otherwise indicated.

<sup>7</sup> The type of instrument or material being calibrated is defined by the parameter. This indicates the laboratory is capable of calibrating instruments that measure or generate the values in the ranges indicated for the listed measurement parameter

<sup>8</sup> The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.

<sup>9</sup> The uncertainties for scales and balances are highly dependent upon the resolution of the unit under test. The uncertainties presented here do not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.

<sup>10</sup> In the statement of CMC,  $H$  is the hardness value displayed in Durometer units.

<sup>11</sup> In the statement of CMC,  $T$  is the gate time used to compute speed by displacement over time and  $V$  is the speed of the device under test (measurand), expressed in in/min, at the nominal/indicated value.



## Accredited Laboratory

A2LA has accredited

**ACCREDITED LABS DBA PRECISION CALIBRATION SYSTEMS**

*Morristown, TN*

for technical competence in the field of

**Calibration**

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets the requirements of ANSI/NCSL Z540-1-1994 and R205 – Specific Requirements: Calibration Laboratory Accreditation Program. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).



Presented this 20<sup>th</sup> day of May 2025.

A blue ink signature of Mr. Trace McInturff.

Mr. Trace McInturff, Vice President, Accreditation Services  
For the Accreditation Council  
Certificate Number 1509.03  
Valid to March 31, 2027  
Revised August 17, 2026

*For the calibrations to which this accreditation applies, please refer to the laboratory's Calibration Scope of Accreditation.*