Calibration Laboratory Assessment Service

CLAS Certificate Number 2000-03

Transmation Canada Inc.
CAL-MATRIX Metrology Inc.
916 Gateway
Burlington, Ontario
Canada L7L 5K7

Contact: Robert Whittaker

Tel	(905) 632-5869
Toll Free	(800) 897-0067
Fax	(905) 632-3741
Email	Robert.Whittaker@cal-matrix.com
Website	http://www.cal-matrix.com

Clients Served: All interested parties. On-site calibration services are available for Type III calibration capabilities and those Type II capabilities specifically indicated in the remarks column.

Field(s) of Calibration: Dimensional, mechanical and electrical (dc and low frequency)

SCC Accreditation: (ISO/IEC 17025) Accredited Laboratory No. 22
First issued 1985-10-08

This scope of calibration capabilities is published by CLAS of the National Research Council of Canada (NRC) in close co-operation with PALCAN of the Standards Council of Canada (SCC), Canada's accreditation body for calibration and testing laboratories. The SCC accredits the capability of the named laboratory for being able to perform the listed calibrations at the given Calibration and Measurement Capabilities (CMC) with traceability to the International System of Units (SI) or to standards acceptable to CLAS.

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Measured Quantity & Range or Instrument	CMC expressed as an Uncertainty	Type	Remarks
Gauge Block, length: Steel, Rectangular and Square		**I**	
Inch, up to 4 inches	± (0.5 + 1.85L) µinch or ± 2.5 µinch, whichever greater (Note: L in 'inches')		See notes 1, 2 and 5 a)
Inch, 5 to 20 inches	± (1.5 + 1.3L) µinch (Note: L in 'inches')		
Metric, up to 100 mm	± (0.013 + 0.002L) µm or ± 0.064 µm, whichever greater (Note: L in 'mm')		
Metric, 125 to 500 mm	± (0.16 + 0.001L) µm (Note: L in 'mm')		
Variation in length of gauge blocks (parallelism):	± 1 µinch or ± 0.025 µm		See note 3
Optical Flatness		**II**	
Measurement of optical flatness of gauge blocks and 4 inch diameter optical flats	± 3 µinch		See note 4
Ring gauge cylindrical, diameter:		**I**	
Inch, up to 12 inches	± (5 + 5.2L) µin (Note: L in 'inches')		See notes 2, 5 b) and 6
Metric, up to 305 mm	± (0.12 + 0.0052L) µm (Note: L in 'mm')		
Plug gauge cylindrical, diameter:		**I**	
Inch, up to 12 inches	± (5 + 5.2L) µin (Note: L in 'inches')		See notes 2, 5 c) and 6
Metric, up to 305 mm	± (0.12 + 0.0052L) µm (Note: L in 'mm')		

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Measured Quantity & Range or Instrument	CMC expressed as an Uncertainty	Type	Remarks
Thread wire, diameter:		I	
Inch, up to 1 inch	± 10 µin		See notes 2 and 5 d)
Metric, up to 25 mm	± 0.25 µm		
Caliper: Outside		II III	
Inch, up to 12 inches	± 310 µin		See notes 2 and 5 e)
Inch, over 12 to 24 inches	± 450 µin		
Inch, over 24 to 40 inches	± 640 µin		
Metric, up to 300 mm	± 8 µm		
Metric, from 300 to 600 mm	± 12 µm		
Metric, from 600 to 1000 mm	± 16 µm		
Caliper: Inside		II III	
Inch, up to 12 inches	± 310 µin		See notes 2 and 5 e)
Metric, up to 300 mm	± 8 µm		
Caliper: Depth		II III	
Inch, up to 12 inches	± 330 µin		See notes 2 and 5 e)
Metric, up to 300 mm	± 9 µm		
Dial and Test Indicators:		II III	
Inch, 0.001 inch resolution	± 140 µin		See notes 2 and 5 f)
Inch, 0.0001 inch resolution	± 48 µin		
Inch, 0.00002 inch resolution	± 16 µin		
Metric, 0.02 mm resolution	± 4 µm		
Metric, 0.002 mm resolution	± 1.2 µm		
Metric, 0.0005 mm resolution	± 0.4 µm		

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Measured Quantity & Range or Instrument	CMC expressed as an Uncertainty	Type	Remarks
Micrometers: Outside		**II** **III**	
Inch, up to 6 in	± (34 + 3.1L) µin (Note: L in 'inches')		See notes 2 and 5 g)
Over 6 to 36 in	± (50 + 7L) µin (Note: L in 'inches')		
Metric, up to 150 mm	± (0.86 + 0.0031L) µm (Note: L in 'mm')		
Over 150 to 900 mm	± (1.27 + 0.007L) µm (Note: L in 'mm')		
Micrometers: Inside		**II** **III**	
Inch, head travel of 1 in	± 60 µin		See notes 2 and 5 g)
Inch, up to 36 in	± (40 + 6L) µin (Note: L in 'inches')		
Metric, head travel of 25.4 mm	± 1.5 µm		
Metric, up to 900 mm	± (1.0 + 0.006L) µm (Note: L in 'mm')		
Micrometer head		**II**	
Spindle displacement: • up to 1 inch • up to 25.4 mm	 ± 10 µinch ± 0.26 µm		See note 2
Optical comparator:		**III**	
• lens magnification	< 0.1 %		
• horizontal encoder with digital readout	± 100 µin		
• horizontal encoder with digital readout	± 100 µin		
• angle	± 2.2 minutes of arc		

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Measured Quantity & Range or Instrument	CMC expressed as an Uncertainty	Type	Remarks
Micrometer setting standards:		**II**	
Inch, up to 36 inches	± (30 + 4L) µin (Note: L in 'inches')		See notes 2, 5 g)
over 36 up to 80 inches	± (200 + 5L) µin (Note: L in 'inches')		
Metric, up to 900 mm	± (0.8 + 0.004L) µm (Note: L in 'mm')		
over 900 up to 2000 mm	± (5 + 0.005L) µm (Note: L in 'mm')		
Rules, measuring		**II**	
Inch, length up to 48 inches	± (30 + 8L) µin (Note: L in 'inches')		See notes 2 and 5 h)
Metric, length up to 1000 mm	± (0.8 + 0.008L) µm (Note: L in 'mm')		
Torque transducers: **Clockwise and counter clockwise**		**II**	
50 lb•in to 250 lb•ft	± 0.25 % of reading		See notes 2 and 5 i)
5.65 N•m to 339 N•m	± 0.25 % of reading		
Torque wrenches & screwdrivers: **Clockwise and counter clockwise**		**II** **III**	
50 lb•in to 250 lb•ft	± 0.5 % of reading		See notes 2 and 5 i)
5.65 N•m to 339 N•m	± 0.5 % of reading		
Measured Quantity & Range	CMC expressed as an	Type	Remarks

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or Instrument	Uncertainty		
Surface Plate Flatness up to 20 foot diagonal	± (43+2D) µinch, where, D is the length of the diagonal in inches.	**III**	See note 5 j)
Thread plug gauge and thread setting plug gauge, 60 degree: • Pitch diameter (measured over thread wires) - Inch, up to 1.5 inches - over 1.5 up to 6 inches - over 6 up to 12 inches - Metric, up to 35 mm - over 35 up to 150 mm - over 150 up to 300 mm • Major diameter - Inch, up to 12 inches - Metric, to 300 mm	 ± 100 µin ± 200 µin ± 300 µin ± 2.5 µm ± 5.1 µm ± 7.6 µm ± (10 + 6L) µin (Note: L in 'inches') ± (0.25 + 0.006L) µm (Note: L in 'millimetres')	**II**	See notes 2, 5 k) and 7
Thread ring gauge, solid, 60 degree parallel: • Pitch diameter (measured over balls) - Inch, up to 5.5 inches - Metric, up to 139 mm	 ± 90 µin ± 2.3 µm	**II**	See notes 2, 5 k) and 7
Thread ring gauge, adjustable, 60 degree parallel:		**II**	
• Set to thread setting plug - Inch, up to 12 inches - Metric, up to 305 mm	The adjustable thread ring gauge is set to the functional diameter of the thread setting plug.		See notes 2, 5 k)

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Measured Quantity & Range or Instrument	CMC expressed as an Uncertainty	Type	Remarks
Pressure, Gauges, Controllers, & Transducers			See Note 1
Gauge, Pneumatic			
• 0.2 to 25 psig	± 0.0035 % of Reading	**I**	Ruska 2465-745
• 2 to 1000 psig	± 0.0035 % of Reading	**I**	Pressure Balance
• 1.4 to 174 kPa	± 0.0035 % of Reading	**I**	Ruska 2465-745
• 14 to 70,000 kPa	± 0.0035 % of Reading	**I**	Pressure Balance
• Pressure Range (-17, 0.5, 1.0, 10.0, 15.0 30.0, 100.0, 50.0, 250.0, 500,0, 750,0 1,500) psig	± 0.01 % of Full Scale for each range	**II & III**	Mensor APC 600 Multiple-Range Pressure Controller
• Pressure Range -100 to 10,000 kPa	± 0.01 % of Full Scale for each range	**II & III**	
• 0 to 4,500 psig	± 0.01 % of Full Scale	**II & III**	Mensor 2106-4.5k
• 0 to 31,000 kPa	± 0.01 % of Full Scale		Pressure Gauge
Gauge, Hydraulic			
• 10 to 16,000 psig	± 0.025 % of Reading	**I**	Budenberg 580HXA Pressure Balance
• 0 to 4,500 psig	± 0.01 % of Full Scale	**I & II**	Mensor 2106-4.5k
• 0 to 31,000 kPa	± 0.01 % of Full Scale		Pressure Gauge
Absolute, Pneumatic			
• 0.2 to 25 psia	± 0.0035 % of Reading	**I**	Ruska 2465-745
• 2 to 1000 psia	± 0.0035 % of Reading	**I**	Pressure Balance
• 1.4 to 174 kPa	± 0.0035 % of Reading	**I**	Ruska 2465-745
• 14 to 70,000 kPa	± 0.0035 % of Reading	**I**	Pressure Balance

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Measured Quantity & Range or Instrument	CMC expressed as an Uncertainty	Type	Remarks
Absolute, Pneumatic		**II & III**	Mensor APC 600 Multiple-Range Pressure Controller
• Pressure Ranges (0.5, 1.0, 10.0, 15.0,30.0, 50.0, 100,250.0, 500,0, 750,0 1,500) psia	± 0.01 % of Full Scale for each range	**II & III**	
• Pressure Range 0 to 70,000 kPa	± 0.01 % of Full Scale for each range	**II & III**	Mensor APC 600 Pressure Controller Barometric Reference
• Barometric Range 758 to 1172 hPa	± 0.01 % of Reading		
HARDNESS			
Indirect verification of Rockwell Hardness Testers:		**II & III**	
• HRA, HRBW, HRC, HREW	Governed by the uncertainty of the standardized test block used to perform the indirect verification		**ASTM E18** Standardized Test Blocks per ASTM E18 See notes 9 & 10
Indirect verification of Rockwell Superficial Hardness Testers:		**II & III**	
• HR15N, HR15TW, HR15YW • HR30N, HR30TW • HR45N, HR45TW	Governed by the uncertainty of the standardized test block used to perform the indirect verification		**ASTM E18** Standardized Test Blocks per ASTM E18 See notes 9 & 10

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Measured Quantity & Range or Instrument	CMC expressed as an Uncertainty	Type	Remarks
Indirect verification of Vickers Micro Indentation Hardness Testers:		**II & III**	
• HV	Governed by the uncertainty of the standardized test block used to perform the indirect verification		**ASTM E384** Standardized Test Blocks per ASTM E384 See notes 9 & 12
Indirect verification of Knoop Micro Indentation Hardness Testers:		**II & III**	
• HK	Governed by the uncertainty of the standardized test block used to perform the indirect verification	**II & III**	**ASTM E384** Standardized Test Blocks per ASTM E384 See notes 9 & 12
Indirect verification of Brinell Hardness Testers HBW	Governed by the uncertainty of the standardized test block used to perform the indirect verification	**II & III**	**ASTM E10** Standardized Test Blocks per ASTM E10 See notes 9 & 11

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Measured Quantity & Range or Instrument	Frequency	CMC expressed as an Uncertainty (±)	Type	Remarks
Frequency	10 MHz 0.01 Hz to 2 MHz	1 part in 10^{-10} 2.5 ppm + 5 µHz	II	For the calibration of the normalized frequency offset averaged over 24 hours of stable frequency sources and measuring devices using a frequency standard and GPS system Generate using a multifunction calibrator. On-site calibration available
Voltage, DC 1 mV to 22 V 22 V to 1100 V 0 V to 100 mV 100 mV to 1 V 1V to 10 V 10 V to 100 V 100 V to 1000 V 1 kV to 100 kV		0.041 % to 3.7 ppm 3.7 ppm to 6.9 ppm 5.5 ppm + 0.3 µV 4.5 ppm + 0.3 µV 4.5 ppm + 0.5 µV 6.5 ppm + 30 µV 18 ppm + 100 µV 0.1 % to 0.5 %	II	Generate using a multifunction calibrator. For the calibration of voltage measuring devices. On-site calibration available. Measure. For the calibration of dc voltage generating devices. On-site calibration available. Measure: For the calibration of dc voltage generating devices.
	10 Hz to 1 MHz 1 Hz to 2 MHz 60 Hz	49 ppm to 8 % 142 ppm to 1.5 % 0.1 % to 0.5 %	II	Generate. For the calibration of AC current measuring devices. See Annex A for detailed capabilities Measure. For the calibration of voltage sources using a digital multiumeter. On-site calibration available. Measure: For the calibration of ac voltage generating devices.

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Measured Quantity & Range or Instrument	Frequency	CMC expressed as an Uncertainty (±)	Type	Remarks
Current, DC 10 µA to 2.2 A 100 µA to 11 A 11 A to 20 A 100 nA to 1.0 A 10 A to 100 A		0.064 % to 38 ppm 0.05 % + 500 µA 0.1 % + 750 µA 430 ppm to 28 ppm 100 ppm	II	Generate. For the calibration of dc current measuring devices. On-site calibration available. Measure. For the calibration of dc current generating devices. On-site calibration available. Measure using dc shunts and 8.5 digit DMM.
Current, AC 29 µA to 2.2 A 3 A to 20 A 1 µA to 1.0 A	10 Hz to 10 kHz 45 Hz to 5 kHz 10 Hz to 100 kHz	7 % to 136 ppm 0.08 % to 3 % 0.05 % to 1 %	II	Generate. For the calibration of sinewave current measurement devices. See Annex B for details. On-site calibration available. Measure. For the calibration of sinewave current generating devices. On-site calibration available
Resistance 1 mΩ to 100 MΩ 1 MΩ to 100 GΩ 1 mΩ to 1 GΩ		10 ppm to 100 ppm 100 ppm to 1000 ppm 11 ppm to 0.6 %	II	Source: For the calibration of resistance measuring devices. On-site calibration available. For the calibration of insulation resistance measurement instruments Measure. On-site calibration available

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Measured Quantity & Range or Instrument	Frequency	CMC expressed as an Uncertainty (±)	Type	Remarks
Oscilloscope			II	Source. For the calibration of oscilloscopes. On-site calibration available
Amplitude DC 1.0 mV to 130 V (1 MΩ) 1.0 mV to 6.6 V (50 Ω)		0.05 % of output + 40 µV 0.25 % of output + 40 µV		
Square wave 1.0 mV to 130 V p-p (1 MΩ) 1.0 mV to 6.6 p-p V (50 Ω)	10 Hz to 10 kHz 10 Hz to 10 kHz	0.25 % of output + 40 µV 0.25 % of output + 40 µV		
Flatness. Leveled Sine Wave 5 mV to 5.5 V relative to 50 kHz	50 kHz to 100 MHz 100 MHz to 300 MHz 300 MHz to 600 MHz 600 MHz to 1.1 GHz	1.5 % + 100 µV 2 % + 100 µV 4 % + 100 µV 5 % + 100 µV		
Time Marker 1 ns to 20 ms 50 ms to 5 s				
Rise Time	1 kHz to 2 MHz 2 MHz to 10 MHz	(25 + 1000T) ppm (Note: T in seconds)		
Input Resistance 40 Ω to 60 Ω 500 KΩ to 1.5 MΩ		300 ps 350 ps		
Input Capacitance 5 pF to 50 pF (1 MΩ)		0.1 % 0.1 % 5 % + 0.5 pF		

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Measured Quantity & Range or Instrument	Frequency	CMC expressed as an Uncertainty (±)	Type	Remarks
Capacitance			II	Source synthesized capacitance using a multiproduct calibrator. For the calibration of capacitance measuring devices. On-site calibration available.
0.19 nF to 1.1 nF	10 Hz to 10 kHz	0.5 % to 5.8 %		
1.1 nF to 3.3 nF	10 Hz to 3 kHz	0.8 % to 1.4 %		
3.3 nF to 333 nF	10 Hz to 1 kHz	0.34 % to 0.55 %		
0.33 µF to 1.1 µF	10 Hz to 600 Hz	0.35 % to 0.55 %		
1.1 µF to 3.3 µF	10 Hz to 300 Hz	0.34 % to 0.52 %		
3.3 µF to 11 µF	10 Hz to 150 Hz	0.34 % to 0.55 %		
11µF to 33 µF	10 Hz to 120 Hz	0.49 % to 0.67 %		
33 µF to 110 µF	10 Hz to 80 Hz	0.54 % to 0.75 %		
110µF to 333 µF	DC to 50 Hz	0.54 % to 0.72 %		
0.33 mF to 1.1mF	DC to 20 Hz	0.45 % to 0.75 %		
1.1 mF to 3.3 mF	DC to 6 Hz	0.54 % to 0.72 %		
3.3 mF to 11 mF	DC to 2 Hz	0.55 % to 0.75 %		
11 mF to 33 mF	DC to 0.6 Hz	0.84 % to 1.0 %		
33 mF to 110 mF	DC to 0.2 Hz	1.2 % to 1.4 %		
Current clamp calibration			II	Source using a multifunction calibrator and a 50 turn coil. For the calibration of clamp meters.
Effective DC current output				
10 to 16.5 A Turns		0.5 % + 20 mA		
16.5 to 150 A Turns		0.5 % + 140 mA		
150 to 1025 A Turns		0.5 % + 500 mA		
Effective AC current output				
20 to 150 A Turns	65 to 440 Hz	0.8 %		
150 to 1000 A Turns	65 to 440 Hz	0.8 %		

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Measured Quantity & Range or Instrument	Frequency	CMC expressed as an Uncertainty (±)	Type	Remarks
Electrical Calibration of Temperature Indicators and Simulators			II	Source for types B, E, J, K,, N, R, S and T thermocouples using multifunction calibrators. Suitable for the calibration of temperature indicators and process calibrators by electrical simulation of temperature. On-site calibration available.
Thermocouple simulation				
-250°C to 2316°C		0.16°C to 0.84°C		
RTD simulation				
-200°C to 630°C		0.04°C to 0.23°C		

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Notes

1 Limited to calibrations performed by comparison with individual inch-sized steel gauge blocks covering the range from 0.05 inch through 20 inches (or mm equivalent) where the reference standards have been calibrated and traceable to the International System of Units (SI).

2 The *CMC* listed can be achieved only if the standards being calibrated are suitable for such a measurement. The uncertainty stated on a calibration report will reflect the uncertainty contribution of the standards that were calibrated.

3 This measured quantity is commonly known as parallelism of gauge blocks.

4 Limited to the measurement of optical flatness of gauge blocks and 4 inch diameter optical flats by the use of a reference optical flat and monochromatic light source.

5 Where applicable, CAL-MATRIX Metrology's internally developed calibration procedures are based upon the following standards. Also, statements of compliance may be made against the following performance specifications (if not available, manufacturer's or client's specified tolerances are generally used):

a) gauge block: GGG-G-15C, ASME B89.1.9
b) ring gauge: ASME B89.1.6M
c) plug gauge: ASME B89.1.5
d) thread wire: ASME B89.1.17
e) caliper: Federal Standard GGG-C-111
f) dial indicator: ASME B89.1.10M
g) micrometer and micrometer setting standard: Federal Specification GGG-C-105, ASME B89.1.13
h) measuring rules: Federal Specification GGG-R-791H
i) torque: Federal Specification GGG-W-686
j) surface plate: Federal Specification GGG-P-463 (using a HP 5529A Laser Interferometer)
k) threaded gauge: ANSI/ASME B1.2, ANSI/ASME B1.6

6 Laboratory primary gauge blocks are used as reference standards for plain ring and master cylindrical plug gauge measurement. The Type I uncertainties as listed are representative of laboratory "best practice" with the device under measurement being "in new" or "like new" condition. For plain ring measurement, single gauge blocks wrung with "end caps" are used as reference length standards; uncertainties are based on a one to one size relationship between the device under measurement and the gauge block reference standard.

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Notes

7 In normal commercial gauging practice, the pitch diameter of a thread plug gauge is determined by measuring the diameter over thread wires inserted in the thread groove on opposite sides of the axis. The preferred term for this measurement is 'thread groove diameter'. Other names for this measurement are 'simple effective diameter' and 'simple pitch diameter'.

8 Calibration made using dead weight tester. For on-site calibrations, the local gravity is taken into consideration.

9 ASTM E10, E18 and E384 are published by the American Society for Testing and Materials.

10 The Indirect Verification of Rockwell Hardness testers and Rockwell Superficial Hardness Testers is performed according to the requirements of ASTM E18-08a, section A1.4

11 The Indirect Verification of Brinell Hardness Testers is performed according to the requirements of ASTM E10-07a, section A1.4

12 The Indirect Verification of Knoop and Vickers Micro Hardness Testers is performed according to the requirements of ASTM E384-08a, section A1.4

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Supplementary Notes

A. Calibration capabilities are traceable to the national measurement standards of Canada held or accepted by the National Research Council (NRC) or, with the agreement of NRC, to the national measurement standards of other countries and are thus traceable to the internationally accepted representation of the appropriate SI (Système International) unit.

B. The laboratory's specific measurement capabilities are certified by the NRC's Calibration Laboratory Assessment Service (CLAS) and accredited by the Standards Council of Canada (SCC) in accordance with the following definitions:

Type I: A capability of which the primary purpose is the calibration of measurement standards for other calibration laboratories. A laboratory with this type of capability has the appropriate reference standards, working standards, check standards, and calibration systems to be able to assess dynamically and to quantify its measurement uncertainty, and is able to monitor its measurement processes continually. The environmental conditions that affect the laboratory's measurements are closely monitored and controlled. A laboratory with this type of capability usually reports a measurement value accompanied by a comprehensive statement of uncertainty. A laboratory with this type of capability is often referred to as a standards or standards calibration laboratory.

Type II: A capability of which the main purpose is the calibration and adjustment of test, measurement and diagnostic equipment for use in product testing, manufacturing, servicing, etc. A laboratory with this type of capability has the appropriate working standards and calibration systems to be able to calibrate to a manufacturer's specification and tolerance or calibrate to a written standard, using appropriate test uncertainty ratios (TUR). A laboratory with this type of capability usually reports a measurement value and indicates if the test equipment complies with a specification, tolerance or a written standard. It will, usually, base its capabilities on the specifications and tolerances of the working standards being used. It also has, normally, the means to check its working standards between calibrations and has available the appropriate environment(s). A laboratory with this type of capability is often referred to as a test equipment calibration laboratory.

Type III: A calibration capability, within a laboratory, mobile or fixed, with the appropriate reference or working standards, of which the main purpose is to provide a reference. A laboratory with this type of capability usually has minimal means to monitor its calibration system. It relies mainly on the values assigned by higher echelon laboratories to its standards and uses these values with few other considerations to assign values or verify the compliance of equipment being calibrated to their specifications and tolerances or to written standards. This could be an on-site service subject to a wide range of environmental factors.

C. The CMC of the laboratory includes the uncertainty associated with the calibration of the laboratory's reference or transfer standard by NRC, or by a laboratory acceptable to CLAS, uncertainties caused by the transportation of the calibrated reference standard from NRC (or other laboratories) to the laboratory, uncertainties of the calibration process in the laboratory, and uncertainties due to the behaviour of the most ideal available standard or measurement device for a specific measurement technology. These uncertainties include components which could have been evaluated by statistical methods on a series of repeated measurements and which can be characterised by experimental standard deviations. The other components, which can also be characterized by standard deviations, are evaluated from assumed probability distributions based on experience or other information. These have been combined to form an expanded uncertainty $U = ku_c$ with U determined from a combined standard uncertainty u_c and a coverage factor $k = 2$. Since it can be assumed that the probability distribution characterised by the reported result and u_c is approximately normal, the value of a calibrated device can be asserted to lie in the interval represented by the expanded uncertainty U with a level of confidence of approximately 95 percent. The uncertainties quoted do not include the possible effects on the calibrated device because of transportation, long term stability or intended use.

D. The uncertainty of a specific calibration by the laboratory can be greater than the CMC because it will include uncertainties due to the actual condition and behaviour of the customer's device during its calibration.

E. CLAS certification and SCC accreditation is the formal recognition of specific calibration capabilities. Neither the NRC nor SCC guarantee the accuracy of individual calibrations by the laboratory.

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Annex A
Uncertainty, ± { (% of reading) + residual }, of AC voltage measurement for the calibration of digital multimeters and voltage measuring devices

Voltage, AC	Frequency							
	10 Hz to 20 Hz	20 Hz to 40 Hz	40 Hz to 20 kHz	20 kHz to 50 kHz	50 kHz to 100 kHz	100 kHz to 300 kHz	300 kHz to 500 kHz	500 kHz to 1 MHz
220 µV to 2.2 mV	0.0240 % + 4 µV	0.009 % + 4 µV	0.008 % + 4 µV	0.020 % + 5 µV	0.050 % + 5 µV	0.11 % + 10 µV	0.14 % + 20 µV	0.27 % + 20 µV
2.2 mV to 22 mV	0.024 % + 4 µV	0.009 % + 4 µV	0.008 % + 4 µV	0.020 % + 4 µV	0.05 % + 5 µV	0.11 % + 10 µV	0.14 % + 20 µV	0.27 % + 20 µV
22 mV to 220 mV	0.024 % + 12 µV	0.009 % + 7 µV	0.008 % + 7 µV	0.02 % + 7 µV	0.046 % + 17 µV	0.09 % + 20 µV	0.14 % + 25 µV	0.27 % + 45 µV
220 mV to 2.2 V	0.024 % + 40 µV	0.009 % + 15 µV	0.0045 % + 8 µV	0.0075 % + 10 µV	0.011 % + 30 µV	0.042 % + 80 µV	0.10 % + 200 µV	0.17 % + 300 µV
2.2 V to 22 V	0.024 % + 400 µV	0.009 % + 150 µV	0.0045 % + 50 µV	0.0075 % + 100 µV	0.010 % + 200 µV	0.0275 % + 600 µV	0.10 % + 2000 µV	0.15 % + 3200 µV
22 V to 220 V	0.024 % + 4 mV	0.009 % + 1.5 mV	0.0052 % + 0.6 mV	0.008 % + 1 mV	0.015 % + 2.5 mV	0.09 % + 16 mV	0.44 % + 40 mV	0.8 % + 80 mV

Voltage, AC	Frequency				
	15 Hz to 50 Hz	50 Hz to 1 kHz			
220 V to 1100 V	0.03 % + 16 mV	0.007 % + 3.5 mV			

The PDF version is provided for convenience, the NRC web-site remains the authoritative source for the current approved calibration and measurement capabilities

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CAL-MATRIX Metrology Inc.
Burlington, Ontario

Annex B

Uncertainty, ± { (% of reading) + residual }, of AC current measurement for the calibration of digital multimeters and current measuring devices

Current, AC	Frequency				
	10 Hz to 20 Hz	20 Hz to 40 Hz	40 Hz to 1 kHz	1 kHz to 5 kHz	5 kHz to 10 kHz
1 nA to 220 uA	0.025 % + 16 nA	0.016 % + 10 nA	0.012 % + 8 nA	0.028 % + 12 nA	1.1 % + 65 nA
220 uA to 2.2 mA	0.025 % + 40 nA	0.016 % + 35 nA	0.012 % + 35 nA	0.02 % + 110 nA	1.1 % + 650 nA
2.2 mA to 22 mA	0.025 % + 400 nA	0.016 % + 350 nA	0.012 % + 350 nA	0.02 % + 550 nA	1.1 % + 5000 nA
22 mA to 220 mA	0.025 + 4 µA	0.016 % + 3.5 µA	0.012 % + 2.5 µA	0.02 % + 3.5 µA	1.1 % + 10 µA
220 mA to 2.2 A	N/A	N/A	0.065 % + 35 µA	0.075 % + 80 µA	8.5 % + 160 µA

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