



Perry Johnson Laboratory Accreditation, Inc.

Calibration Scopes of Accreditation

2010



1.0 Purpose

- 1.1 This policy has been developed by PJLA and its technical committee in order to ensure consistency among calibration laboratory's scopes of accreditation. It establishes guidelines used by PJLA to determine the most accurate expression of range and best measurement capability on calibration scopes of accreditation. Additionally, this document includes an Appendix A outlining examples of appropriate entries for various calibration disciplines and Appendix B to provide guidance for the use of SI units on the scope of accreditation. All applicant and accredited laboratories shall adhere to this policy.

2.0 Scopes of Accreditation

- 2.1 The scope of accreditation is a formal document issued by PJLA to its accredited laboratories. It contains information expressing the calibration parameters, ranges over which a calibration applies, the uncertainty or BMC (Best Measurement Capability) associated with the calibration as well as pertinent information about the equipment, methods and references used in performing the calibration.
- 2.2 Prior to accreditation applicant laboratories are responsible for providing PJLA with the most accurate and current information available in regards to their intended scope of accreditation. This should be completed on an application (LF-1) and should comply with this policy. Prior to accreditation, PJLA will provide the laboratory with our proposed scope of accreditation for review. Once the laboratory accepts the scope of accreditation, PJLA will relay the scope to the assessor to verify on-site for accuracy and completeness. Once your assessor has agreed with the proposed scope of accreditation, both the laboratory and the assessor will sign the proposed scope and submit it to PJLA for review with the assessment package. Please note that the submitted scope of accreditation can be modified by PJLA after the technical review of the assessment package has been completed.
- 2.3 When accreditation is granted, PJLA will issue a final scope of accreditation certificate. A draft of this document will be submitted to the laboratory for review and approval. Following laboratory approval the final scope of accreditation will be accessible to the public through direct inquiry to PJLA or through the PJLA website. Per PJLA procedures a laboratory whose accreditation is suspended or terminated shall not use or display the scope of accreditation or the PJLA name and logo in any way.
- 2.4 The scope of accreditation will be reviewed at the accreditation and reaccreditation assessments in its entirety. During surveillance assessments, those areas of the scope of accreditation directly pertaining to the assessment will be reviewed in detail. Any changes or additions to the scope of accreditation, which have occurred



since the previous assessment or any areas affected by nonconformities identified during the previous assessment will also be reviewed.

3.0 Formatting the Scope of Accreditation

(Refer to Appendix A and Appendix B to view examples of this section)

3.1 Calibration Field

3.1.1 PJLA currently accredits laboratories performing calibrations in the following fields:

- Dimensional
- Electrical
- Time and Frequency
- Acoustic
- Mass, Force, and Weighing Devices
- Mechanical
- Chemical
- Thermodynamic
- Optical

Scopes of accreditation will contain calibration fields selected from the list above (as appropriate to the calibrations performed by the laboratory) and the related, Measured Instrument, Quantity or Gauge, Range, BMC and Remarks information necessary to define the calibration capability of the laboratory. Should a laboratory find that a calibration they perform does not fall into any of the above calibration fields; they are encouraged to contact PJLA for guidance.

3.2 Measured Instrument, Quantity or Gauge

3.2.1 This entry needs to represent the calibration that is being performed by the laboratory. For Example: Analytical Balances, AC Voltage-Measure, Rockwell Hardness or Outside Micrometers.

3.3 Range

3.3.1 The ranges stated on the certificate are the magnitudes between the lower and upper boundaries of the calibration parameter. Laboratories should determine whether including a zero as the lower boundary is appropriate. Zero should not be used if it is not an attainable measurement for the laboratory. An example of where zero should not be used is in scale calibration where the lower limit of the range should be the smallest weight the lab possesses in the specific weight class indicated for the calibration. Another example of when zero should not be used is in pressure gage calibration with a dead weight piston gage. This type of



gage has a lower limit of operability and cannot be used to calibrate all the way down to zero. An example of where zero may be used is in electrical calibration where the laboratory has a meter device that is capable of reading various electrical characteristics effectively down to zero. When stating the range, the calibration capabilities of the laboratory need to be fully expressed in an accurate and easy to understand format.

- 3.3.2 Care must be taken to ensure that measurement results produced as part of the calibration are expressed in acceptable units and that the expression of results is properly formatted. Mass measurements must be expressed in mass units, dimensional measurements must be expressed in dimensional units etc. Please refer to NIST SP 811 for guidance in the use of appropriate units and formatting of measurement expressions. In those instances where use of U.S. Customary units (USC) is deemed appropriate NIST SP 811 will govern formatting and is a reliable source of conversion factors between the SI and USC units.

3.4 Best Measurement Capability expressed as an uncertainty:

- 3.4.1 PJLA grants accreditation on the laboratory's capability to perform a calibration. This capability is partially defined by stating the magnitude or range of values over which the calibration capability applies. The definition of the calibration capability is completed by specifying the BMC associated with the magnitude or range stated. The BMC is expressed as an expanded uncertainty with a coverage factor "k" = 2 resulting in an approximate 95% confidence level. The BMC stated in the proposed scope, is defined as "*the smallest uncertainty a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations on a nearly ideal device being calibrated.*" The BMC stated on the scope supplement must be achievable by the laboratory when calibrating a nearly ideal UUT (Unit Under Test) and documentary evidence to that affect must be maintained.
- 3.4.2 Uncertainty occurs in one of three mathematical conditions.
- 1.) The first is a set of values that remain approximately constant over the stated range. BMC can be expressed on the scope of accreditation as an absolute uncertainty. In this situation one value is appropriate for all points in the stated range.
 - 2.) The second is a set of values that are linear meaning that they vary in approximate direct proportion to the increase in magnitude of the stated range. BMC can be expressed on the scope of accreditation as a relative uncertainty equation. The equation takes the form $(1.21 + 1.34L)$ where L is a variable representing the magnitude of any value within the stated range. Although an absolute uncertainty can be used for uncertainties of condition 2, the value must be the largest for any point in the range, which means that the BMC for all other values in the range will be overstated. An additional method of expressing BMC when the values resulting from calibration are linear is by means of a



relative accuracy statement. This typically takes the form of a percentage of the value resulting from the calibration (i.e. 0.03 % of reading).

- 3.) The third is a set of values that are non-linear meaning that they vary at a non-uniform rate relative to the increase in magnitude of the stated range. This third type of uncertainty would produce a curve if plotted. It is necessary to determine uncertainty at enough points in the range to understand the general shape of the curve it would produce if all points were plotted. Then break the stated range down into several smaller ranges, which are approximately linear and process them as if they satisfy condition 2.

Several discipline specific and general-purpose uncertainty calculator spreadsheets are available for download from the PJLA website. Others will be added as they become available. Also available is a spreadsheet to generate the relative uncertainty equation from two uncertainties, one determined near the low end and one determined near the high end of the range. It also has provisions to test intermediate points to verify linearity of the uncertainties.

3.5 Significant Digits

- 3.5.1 Values entered in the Range fields are not restricted with regard to significant digits however care should be taken to avoid expressing range values to unreasonable levels of precision. When the stated range is the result of conversion from one system of units to another (SI to USC as an example), the resulting stated value will typically require a larger number of significant digits in order to retain numerical equivalence.
- 3.5.2 Values entered in the BMC fields shall be entered using not more than 2 significant digits. When BMC is expressed as a Relative Uncertainty Equation it is permissible to employ a greater number of significant digits to preserve accuracy during computation of specific BMC values. This is done with the understanding that when the equation is solved for specific values of the variable, the solution will be reduced to not more than 2 significant digits prior to recording the result. When the stated BMC is the result of conversion from one system of units to another (SI to USC as an example), the resulting stated value will typically require a larger number of significant digits in order to retain numerical equivalence. The number of significant digits to be used in BMC expressions resulting from conversion shall be no greater than that which produces a stated value that will, upon conversion back to the original system of units, generate the original value. The number of significant digits in a result is simply the number of digits that are known with some degree of certainty. The number 13.2 is said to have 3 significant digits. The number 13.20 is said to have 4 significant digits. The rules,



which follow, will govern proper use of significant digits on scope of accreditation certificates.

3.5.3 Rules for determining the number of significant digits in a measured quantity:

(1) All nonzero digits are significant:

1.234 g has 4 significant digits,
1.2 g has 2 significant digits.

(2) Zeroes between nonzero digits are significant:

100 2 kg has 4 significant digits,
3.07 mL has 3 significant digits.

(3) Leading zeros to the left of the first nonzero digits are not significant; such zeroes merely indicate the position of the decimal point:

0.001 °C has only 1 significant digit,
0.012 g has 2 significant digits.

(4) Trailing zeroes that are also to the right of a decimal point in a number are significant:

0.023 0 mL has 3 significant digits,
0.20 g has 2 significant digits.

(5) When a number ends in zeroes that are not to the right of a decimal point, the zeroes are not necessarily significant:

190 miles may be 2 or 3 significant digits,
50 600 cal may be 3, 4, or 5 significant digits.

The potential ambiguity in the last rule can be avoided by the use of standard exponential, or "scientific," notation. For example, depending on whether the number of significant digits is 3, 4, or 5, we would write 50 600 cal as:

5.06×10^4 cal (3 significant digits)
 5.060×10^4 cal (4 significant digits), or
 5.0600×10^4 cal (5 significant digits).

3.6 Remarks

3.6.1 This field includes pertinent information related to the calibration of the device identified in the Measured Instrument, Quantity or Gauge field. Typical entries would include the type of standards used, reference documents and any pertinent information about the measurement method.



Appendix A

Example Calibration Scopes of Accreditation

Dimensional

MEASURED QUANTITY, INSTRUMENT OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	REMARKS
Cylindrical Diameter Outside	To 1 in	20 μ m	Universal Measuring Machine
	1 in to 5 in	(15 + 2.5L) μ m	
Cylindrical Diameter Inside	0.1 in to 0.5 in	26 μ m	
	0.5 in to 5 in	(18 + 2.5L) μ m	
Protractors	0° to 90°	0.01°	Gage Blocks/Sine Bar
Outside Micrometers	0.05 to 3 in	(50 + 3L) μ m	Gage Blocks
	3 in to 12 in	(81 + 10L) μ m	
Gage Blocks	0.05 in to 1 in	3.5 μ m	Gage Block Comparator and Master Blocks
	1 in to 2 in	5.0 μ m	
	2 in to 4 in	7.9 μ m	
Thread Plugs Pitch Diameter	0-80 to 4-12	140 μ m	Measurement over wires with Supermicrometer
Thread Plugs Major Diameter	0-80 to 4-12	67 μ m	Supermicrometer
Surface Plate Flatness Repeat Measurement	10 in to 72 in diagonal	(21 + 0.72D) μ m	Autocollimator
	0.002 in	60 μ m	Repeat-O-Meter

Electrical

MEASURED QUANTITY, INSTRUMENT OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	REMARKS	
DC Voltage-Measurement	To 200 mV	4.5 μ V/V + 0.1 μ V	Fluke 8508A	
	200 mV to 2 V	3 μ V/V + 0.4 μ V		
	2 V to 20 V	3 μ V/V + 4 μ V		
	20 V to 200 V	4.5 μ V/V + 40 μ V		
	200 V to 1 000 V	4.5 μ V/V + 500 μ V		
DC Voltage- Generate	0 mV to 220 mV	7.5 μ V/V + 0.4 μ V	Fluke 5720A	
	220 mV to 2.2 mV	5 μ V/V + 0.7 μ V		
	2.2 V to 11 V	3.5 μ V/V + 2.5 μ V		
	11 V to 22 V	3.5 μ V/V + 4 μ V		
	22 V to 220 V	5 μ V/V + 40 μ V		
AC Voltage- Measure At the listed frequencies			Fluke 8508A	
	1 Hz to 10 Hz	0 mV to 200 mV		0.165 mV/V + 70 μ V
	10 Hz to 40 Hz	0 mV to 200 mV		0.140 mV/V + 20 μ V
	40 Hz to 100 Hz	0 mV to 200 mV		0.115 mV/V + 20 μ V
	100 Hz to 2 kHz	0 mV to 200 mV		0.110 mV/V + 10 μ V
	2 kHz to 10 kHz	0 mV to 200 mV		0.135 mV/V + 20 μ V
	10 kHz to 30 kHz	0 mV to 200 mV		0.340 mV/V + 40 μ V
	30 kHz to 100 kHz	0 mV to 200 mV		0.765 mV/V + 0.10 μ V



Electrical

MEASURED QUANTITY, INSTRUMENT OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	REMARKS
AC Voltage- Generate At the listed frequencies			Fluke 5520A
10 Hz to 45 Hz	33 mV to 329.999 mV	0.30 mV/V + 8 μ V	
45 Hz to 10 kHz	33 mV to 329.999 mV	0.15 mV/V + 8 μ V	
10 kHz to 20 kHz	33 mV to 329.999 mV	0.16 mV/V + 8 μ V	
20 kHz to 50 kHz	33 mV to 329.999 mV	0.35 mV/V + 8 μ V	
50 kHz to 100 kHz	33 mV to 329.999 mV	0.80 mV/V + 32 μ V	
100 kHz to 500 kHz	33 mV to 329.999 mV	2.0 mV/V + 70 μ V	
Resistance-Generate Fixed Points	0.0 Ω	40 $\mu\Omega$	Fluke 5720A
	1 Ω	95 $\mu\Omega/\Omega$	
	1.9 Ω	95 $\mu\Omega/\Omega$	
	10 Ω	23 $\mu\Omega/\Omega$	
	19 Ω	23 $\mu\Omega/\Omega$	
	100 Ω	10 $\mu\Omega/\Omega$	
	10 k Ω	8.5 $\mu\Omega/\Omega$	
	19 k Ω	8.5 $\mu\Omega/\Omega$	
	100 k Ω	11 $\mu\Omega/\Omega$	
	190 k Ω	11 $\mu\Omega/\Omega$	
	1 M Ω	20 $\mu\Omega/\Omega$	
	1.9 M Ω	21 $\mu\Omega/\Omega$	
	10 M Ω	40 $\mu\Omega/\Omega$	
	19 M Ω	47 $\mu\Omega/\Omega$	
100 M Ω	100 $\mu\Omega/\Omega$		
pH Simulation- Generate	0 pH units to 14 pH units	0.01 pH	ESI DB877
Temperature Calibration, Indication and Control Equipment used with Thermocouple Type B	600 $^{\circ}$ C to 800 $^{\circ}$ C	0.44 $^{\circ}$ C	Fluke 5520A Electrical Simulation of Thermocouple Output
	800 $^{\circ}$ C to 1 000 $^{\circ}$ C	0.34 $^{\circ}$ C	
	1 000 $^{\circ}$ C to 1 550 $^{\circ}$ C	0.30 $^{\circ}$ C	
	1 550 $^{\circ}$ C to 1 820 $^{\circ}$ C	0.33 $^{\circ}$ C	
Temperature Calibration, Indication and Control Equipment used with Thermocouple Type C	0 $^{\circ}$ C to 150 $^{\circ}$ C	0.30 $^{\circ}$ C	
	150 $^{\circ}$ C to 650 $^{\circ}$ C	0.26 $^{\circ}$ C	
	650 $^{\circ}$ C to 1 000 $^{\circ}$ C	0.31 $^{\circ}$ C	
	1 000 $^{\circ}$ C to 1 800 $^{\circ}$ C	0.50 $^{\circ}$ C	
	1 800 $^{\circ}$ C to 2 316 $^{\circ}$ C	0.84 $^{\circ}$ C	



Time and Frequency

MEASURED QUANTITY, INSTRUMENT OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	REMARKS
Frequency-Generate	To 18 GHz	1 part in 10^{11} of Freq. + 1 LSD of generator	GPS Disciplined Oscillator and Signal Generators
Stopwatch Calibration	2 s to 28 800 s	0.05 s/day	Timometer

Acoustic

MEASURED QUANTITY, INSTRUMENT OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	REMARKS
Acoustic Level-Generate	3.15 Hz	0.11 dB	Pistophone reference standard
	63 Hz, 125 Hz, 250 Hz, 500 Hz	0.10 dB	
	1 kHz, 2 kHz, 4 kHz, 8 kHz	0.10 dB	
	12.5 kHz, 16 kHz	0.11 dB	
Calibration of Acoustic Calibrators 124 dB, re 2×10^{-5} Pa	250 Hz	0.05 dB	1 inch reference microphone

Mass, Force, and Weighing Devices

MEASURED QUANTITY, INSTRUMENT OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	REMARKS
Mass-Weights and Weight Sets	50 kg	20 mg	Double Substitution with Air Buoyancy correction. Class E2 mass set and Mass Comparators
	30 kg, 25 kg, 20 kg	11 mg	
	10 kg	0.49 mg	
	5 kg	0.32 mg	
	3 kg	0.14 mg	
	2 kg	0.13 mg	
	1 kg	0.040 mg	
	500 g	0.027 mg	
	300 g	0.024 mg	
	200 g	0.017 mg	
	100 g	0.017 mg	
50 g	8.7 μ g		
Force –Compression and Tension- Source and Measure	200 lbf to 5 000 lbf	1.2 lbf	Proving Rings and Morehouse Test Stand
	5 000 lbf to 20 000 lbf	4.2 lbf	
	20 000 lbf to 60 000 lbf	14 lbf	
Analytical Balances	1 mg to 200 g	(0.013 + 0.003Wt) mg	Class 1 weights



Mechanical

MEASURED QUANTITY, INSTRUMENT OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	REMARKS
Pressure- Pneumatic, Gage and Absolute	0.2 psi to 1 000 psi	0.002 5% of reading	Ruska 2465
Torque Wrenches	45 lbf·in to 450 lbf·in	0.026 lbf·in	Torque Transducers
	74 lbf·ft to 740 lbf·ft	1 lbf·ft	

Mechanical

MEASURED QUANTITY, INSTRUMENT OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	REMARKS
Indirect Verification of Rockwell Hardness Testers HRA	60 HRA to 69 HRA	0.32 HRA	ASTM E 18-08a and calibrated Rockwell Hardness Test Blocks
	70 HRA to 79 HRA	0.25 HRA	
	80 HRA to 93 HRA	0.23 HRA	
Indirect Verification of Rockwell Hardness Testers HRC	20 HRC to 39 HRC	0.58 HRC	
	40 HRC to 59 HRC	0.44 HRC	
	60 HRC to 70 HRC	0.41 HRC	
Direct Verification of Durometer Hardness Tester Types A, B, C, D, E, O & DO Extension at zero reading	2.46 mm to 2.54 mm	7.4 μ m	ASTM D-2240
		Video Comparator 20x	
Indenter Shape (Not all parameters apply to all of Durometer Types) Indenter Diameter Indenter Tip Diameter Indenter Tip Radius Indenter Tip Angle		7.4 μ m	Video Comparator 20x
		7.4 μ m	Video Comparator 20x
		7.4 μ m	Video Comparator 20x
		0.06°	Video Comparator 20x
Durometer Indenter Spring Types A, B, E & O Types C, D & DO	0.55 N to 8.05 N	1.4 N	Load Cell
	4.445 N to 44.45 N	1.4 N	Load Cell
Indirect Verification of Durometer Hardness Tester Types A, B, C, D, E, O & DO	0 Duro to 100 Duro	N / A	Test Blocks Indirect Verification is not an Accredited Calibration per ASTM D-2240 and is offered only as a service to the customer
Durometer Test Blocks	5 Duro to 100 Duro	0.52 Duro	ASTM D-2240
Indirect Verification of Brinell Hardness Tester HBW 10/3000	92.5 HBW to 650 HBW	4 HBW	Stage Micrometer ASTM E-10
Indirect Verification of Micro Hardness Tester Vickers	100 to 900 HV	15 HV	Stage Micrometer ASTM E384
Indirect Verification of Micro Hardness Tester Knoop	100 to 900 HK	17 HK	



Chemical

MEASURED QUANTITY, INSTRUMENT OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	REMARKS
pH meter/probe calibration	4 pH units to 10 pH units	0.027 pH units	pH Buffer Solutions
Conductivity meter/probe calibration	5 μ S to 10 μ S	0.47 μ S	Conductivity solutions
	10 μ S to 100 μ S	0.46 μ S	
	100 μ S to 10 000 μ S	3.2 μ S	
	10 000 μ S to 100 000 μ S	320 μ S	

Thermodynamic

MEASURED QUANTITY, INSTRUMENT OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	REMARKS
Temperature probes (RTD, TC, Thermistor)	-30 °C to 150 °C	0.010 °C	SPRT and Temp Bath
	150 °C to 400 °C	0.2 °C	SPRT and Dry Block
Humidity –Source - 20 °C to 70 °C	10 % RH to 95 % RH	1.0 % RH	Two Pressure Humidity Generator

Optical

MEASURED QUANTITY, INSTRUMENT OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	REMARKS
Fiber Optics Power 10 nW to 100 μ W	850 nm	1.6 %	Detector Based
	1 310 nm	1.6 %	
	1 550 nm	1.6 %	
Fiber Optic Wavelength	600 nm to 1 700 nm	0.2 nm	Spectrum analyzer and intrinsic source
Spectral Radiance- 300 nm to 1 600 nm	(1×10^{-9} to 1×10^{-5}) Wcm ⁻² sr ⁻¹ nm ⁻¹)	5 %	Detector and source based
Spectral Transmission (300 to 1500) nm	0 % to 100 %	3 %	Spectrophotometer
Photometric- Illuminance	10 fcd to 500 fcd	2 %	Detector and source based
Photometric- Luminance	10 fL to 10 000 fL	2 %	
Photometric- Color Temperature	2 000 K to 3 200 K	11 K	

1. Best measurement capability is expressed as expanded uncertainty at approximately the 95% confidence level using a coverage factor of $k = 2$.
2. The term L represents length in inches or millimeters appropriate to the uncertainty statement.
3. The term wt represents weight in pounds or grams (including SI multiple and submultiple units) appropriate to the uncertainty statement.
4. Remarks: This column shall include pertinent information about the calibration of the Measured Instrument or Parameter. The information should include the type of standards used and any pertinent information about the measurement method.



Appendix B

Guidelines for the use of SI units for the scope of accreditation

The General Conference on Weights and Measures established the International System of Units (SI). It is the modern metric system of measurement used throughout the world. PJLA policy strongly encourages the exclusive use of SI units for stating ranges and BMC's on scopes of accreditation. This policy calls for the use of NIST SP 811 and the ISO 31 series of documents for direct guidance on the use of symbols and numbers. NIST SP 811 is a publication that was created to provide assistance to those who use SI units in their work. In order to make scopes of accreditation more accessible to the U.S. market, PJLA does allow the use of USC (US Customary) units of measure. Any scopes with USC units of measure will conform to the formatting of Appendix B of NIST SP811.

It is the responsibility of the client to know and understand the requirements of the SI on their scope of accreditation. The NIST SP 811 is available on the Internet from the NIST website. The ISO 31 series of documents is available for purchase from the ISO website. The cost varies depending on which standards in the series you will need. If you choose to purchase these, we recommend at least acquiring the ISO 13-0, General Principles, and ISO 31-11, Mathematical signs and symbols for use in the physical sciences and technology.

The following pages contain a small sampling of guidelines and examples contained in the NIST SP 811.

Rule:	Example:	Instead Of:
Only units of the SI and those recognized by the SI are used.	10 m 100 °C	10 ft 100 °F
Abbreviations are avoided	s or second cm ³ or cubic centimeter	sec cc
Unit symbols are not modified in order to provide information about the quantity.	$V_{\max} = 1000 \text{ V}$	$V = 1000 V_{\max}$
The symbol “%” can be used in place of the number 0.01	$x_{\beta} = 0.0038 = 0.38 \%$	$x_{\beta} = 0.25 \text{ percent}$
Quantities are to be defined so that they can be expressed solely in acceptable units	The Ca content is 25 ng/L	25 ng Ca/L
Unit and mathematical symbols and names are not mixed	m/s or meter per second	meter/s
Values for quantities are expressed in acceptable units using Arabic numerals and the SI symbols for units	The weight of the box was 35 kg.	The length of the box was thirty-five kilograms.
There is always a space between the quantity and the unit symbol, except when it is a plane angle	189 kg 25 °C 357 Ω 24° (plane angle)	189kg 25°C 357Ω 24 ° (plane angle)



Rule:	Example:	Instead Of:
A thin space is used to separate digits with more than four per side of a decimal point	123 586 257.004 1	123586257.0041 or 123,586,257.0041
Quantity equations are preferred to numerical value equations	$l = vt$	$\{l\}_m = 3.6^{-1} \{v\}_{\text{km/h}} \{t\}_s$
A quotient quantity is expressed using “divided by” instead of “per unit”	Pressure is force divided by area.	Pressure is force per unit area.
Rule:	Example:	Instead Of:
The terms Normality and Molarity, symbols N and M respectively are obsolete. The preferred name is amount of substance concentration of B.	A solution having an amount of substance concentration of $c[(1/2)\text{H}_2\text{SO}_4]$	A 0.5 N solution of H_2SO_4
Values of quantities are to be written so that it is clear to which unit symbols the numerical values of the quantities belong.	51 mm x 51 mm x 25 mm	51 x 51 x 25 mm
The word “to” is used to indicate a range of values instead of a dash.	0 V to 5 V	0 V – 5 V

1. The word “weight” is used with the intended meaning clear. In science and technology, weight is defined as a force, for which the SI unit is the Newton. In commerce and everyday use, weight is used as a synonym for mass, for which the SI unit is the kilogram.
2. Standardized quantity symbols given in the ISO 31 series are used. Similarly, standardized mathematical signs and symbols such as those given in ISO 31-11 are used.