## Certification Requirements

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EL-ENG-12-01—Requirements for the Certification and Use of Measuring Apparatus - Electricity Meter Calibration Consoles

Adnan Rashid  
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Engineering and Laboratory Services Directorate  
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# Certification Requirements

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Requirements for the Certification and Use of Measuring Apparatus - Electricity Meter Calibration Consoles

1.0 Scope

1.1 This document applies to electricity calibration consoles used to assess meters for the purpose of verification, re-verification and/or dispute testing pursuant to the *Electricity and Gas Inspection Act*.

1.2 This document is supported by the procedures set out in P-E-01: Procedures for Calibrating and Certifying Electricity Calibration Consoles Pursuant to the Requirements for the Certification of Measuring Apparatus - Electricity Meter Calibration Consoles, EL-ENG-12-01

2.0 References

2.1 P-E-01: Procedures for Calibrating and Certifying Electricity Calibration Consoles Pursuant to the Requirements for the Certification of Measuring Apparatus - Electricity Meter Calibration Consoles, EL-ENG-12-01.

2.2 *Electricity and Gas Inspection Act* (EGIA).

2.3 *Electricity and Gas Inspection Regulations*.

3.0 Purpose

3.1 The purpose of this document is to establish requirements for the calibration, certification and use of electricity calibration consoles.

4.0 Terminology

**Burden**
The load usually expressed in VA, which is imposed on transformer secondaries by the associated meter coils, leads and/or other connected devices.

**Calibration**
A comparison between the readings of two instruments, measuring devices, or standards, one of which is of known accuracy.

**Calibration Console**
Electricity measuring apparatus used for the verification and/or reverification of single phase and/or polyphase energy and/or demand meters.

**Capacitive Burden**
A burden which causes a leading power factor condition.

**Creep (Zero Load)**
A condition of null current or energy passing through a meter-under-test position without a load being applied.
Distortion
An undesired change in waveform which results in a non-sinusoidal waveform.

Electromechanical Meter
An electricity meter that incorporates mechanical elements to measure and register metered quantities.

Electromechanical Demand Meter
An electricity meter which measures demand using a thermal element or mechanical gears that are driven by an electro-mechanical rotating energy disk.

Electronic Meter
A solid state electricity meter.

Electronic Demand Meter
An electricity meter which measures demand using solid state techniques such as digital sampling or Time Division Multiplication (TDM).

Fully Automatic Console
A console which is capable of setting and resetting all loads without direct operator intervention.

Ground
A conducting connection between an electric circuit or equipment and earth.

Hybrid Demand Meter
An electricity meter which uses electronics to calculate demand power and other electrical quantities by using input pulses from an electro-mechanical rotating energy disk.

Inductive Burden
A burden which causes a lagging power factor condition.

Line Conditioner
A device used to minimize distortion to the input voltage and/or current supplying a calibration console.

Manual Console
A console which operates in a manner such that an operator is required to manually set and reset all loads.

Owner (User)
Any organization owning a calibration console, including persons authorized by the organization to use the console for the purpose of verification or re-verification of electricity meters pursuant to the EGIA.

Recti-thermal Demand Meter
An electricity meter which measures demand power by means of a thermal element and an AC to DC rectifier circuit.

Reference Meter
A measuring instrument used to determine the error of a meter/device under test on a calibration console. The measuring instrument can be a stand alone device or an indicating device used in conjunction with a measuring device.

**Reference Standard**
A certified measuring instrument that has errors traceable to the National Research Council of Canada and is used to calibrate a Calibration Console.

**Regulator**
A device which ensures an electrical quantity is maintained at its desired set value.

**Reverification**
Any subsequent confirmation of a meter’s conformance to legal requirements following its initial verification of conformance with those same requirements, performed upon expiration of the meter’s re verification period (i.e. seal period).

**Self-Contained Meter**
A meter designed to be connected directly in a power circuit without the use of external devices such as instrument transformers or shunts.

**Selector Switch**
A device which allows for the selection of different current or voltage settings by selecting taps on one or more loading transformers.

**Semi-automatic Console**
A console which is capable of setting and resetting loads after initial setting by operator.

**Significant Digits**
The total number of digits beginning with the first non-zero digit to the left of the decimal point, or the first digit after the decimal point if there are no non-zero digits to the left of the decimal point and ending with the last digit to the right.

**Test Load**
Applied test voltage multiplied by the applied test current.

**Transformer-type Meter**
A meter designed to be used with instrument transformers.

**Verification**
The process by which an approved meter is evaluated for compliance to the metrological, technical and administrative requirements specified in the Act, Regulations and applicable specifications.
5.0 Administrative Requirements

5.1 General

5.1.1 Additional information related to administrative requirements may be found in P-E-01: Procedures for Calibrating and Certifying Calibration Consoles Pursuant to the Requirements for the Certification of Measuring Apparatus – Electricity Meter Calibration Consoles, EL-ENG-12-01.

5.2 Roles and Responsibilities

5.2.1 The person conducting calibration and certification shall be responsible for ensuring that reference standards, and transformers if required, have been certified by Measurement Canada (MC), the National Research Council of Canada (NRC), or an organization that is deemed by MC to provide recognizable traceability to the NRC. Reference standards shall be calibrated and certified for all functions used to assess meters on the console.

5.2.1.1 The following devices shall be calibrated and certified by Measurement Canada, the NRC or a facility which has ISO 17025 accreditation and whose scope includes the ability to calibrate the following devices:

(i) Voltage and current standards and current transformers if required, where these devices are required to check indicating instruments only;
(ii) Distortion Analyzers;
(iii) Phase Angle Meters.

5.2.1.2 Where a level or inclinometer is required for calibration and certification, the device shall be calibrated. The manufacturer’s certificate for the angle gauge block is acceptable; however, the gauge block shall be visually inspected each time it is used. Any evidence that the gauge block may not represent its original condition (i.e. damage, deterioration due to rust, etc.) will disqualify the use of the gauge block as equipment used for certification.

5.2.1.3 For the purpose of calibrating the power factor or phase angle indicating instruments installed on the calibration console, the power factor or phase angle reading from the standard may be used under the condition that this value is validated against the certified energy units of the standard or the value calibrated pursuant to 5.2.1.1(iii) above.

5.2.2 Calibrations and certifications of electricity consoles performed by organizations authorized by MC shall be conducted in accordance with the procedures set out in P-E-01. Organizations that wish to use procedures that differ from those set out in P-E-01 shall submit the relevant procedures and work instructions (if applicable) for review and acceptance by MC.

5.2.3 The owner of the calibration console is responsible for making available all information required by these requirements.

5.2.4 The owner of a calibration console is required to provide documented evidence that the console is capable of complying with all requirements set out in this document.

5.2.4.1 Compliance with 5.2.4 above shall be sufficiently met by compliance with section 5.2.5 under the following circumstances:
(a) The console has a certificate which is less than three years past its expiry date. 
(b) The console has not been altered or moved from the location at which it was previously certified. 
(c) The console’s scope of the certification has not changed.

5.2.5 For certified calibration consoles or calibration consoles that have expired certificates that are less than three years past expiry date, the owner shall ensure as a minimum that the console complies with all applicable performance requirements of section 7.

5.2.5.1 Compliance with section 7.8 may also be demonstrated by providing the results of section 6.1.2 weekly accuracy tests, performed on the calibration console since the last calibration and which demonstrate that the console has been verified at all applicable console certification test points.

5.2.6 In addition to any other information that may be required by these requirements, the owner shall also provide information needed to determine the manner in which the console will be used for verifying meters as follows:

(i) A list of all test points used for verifying meters for each electrical quantity to be verified without 1:1 transformers in the test circuit, including combinations of applicable voltage tap, current tap and/or loading transformer selector switch settings for each parallel and multiple potential connections.

(ii) A list of all test points, including all combinations of applicable voltage tap, current tap and/or loading transformer selector switch settings used for verifying meters for each electrical quantity to be verified with 1:1 transformers in the test circuit.

(iii) All electrical quantities to be verified (e.g. watt hours, watts, var hours, volt amperes, etc.).

(iv) Whether or not the console is to be used for verifying electro-mechanical demand meters.

(v) Whether or not the console is to be used for verifying single-phase meters, polyphase meters, or both.

(vi) An indication of the operational setups identified in section 7.2.1.3 which are applicable to the console.

(vii) A list of meters having voltage ratings at the applicable test voltage pursuant to section 7.2.2 and as applicable to each setup of section 7.2.1.3 with burden characteristics as follows:

(a) having the highest capacitive (voltage) burden 
(b) having the highest inductive (voltage) burden 
(c) having the lowest (voltage) burden 

(viii) The maximum pulse rate required to be verified for meters having pulse outputs.
(ix) The maximum input pulse rate required to verify meters (pulse recorders) equipped with pulse input.

(x) The number and type of reference meters to be used with the console at one time.

(xi) The maximum voltage of the meter having the highest voltage rating to be verified on the console.

(xii) The minimum current shown on the nameplate of the lowest current rated meter to be verified on the console.

(xiii) The maximum test current of the meter to be verified on the console, having the highest current rating.

(xiv) The largest test load at 0.5 Pf (or 1.0 Pf if 0.5 Pf is not used) used to verify exponential demand meters or block interval demand meters which cannot be verified pursuant to the requirements of section 6.4.9.

(xv) A list of all line conditioners, regulators, and any other equipment that is used with the console while it is being used for verifying meters.

(xvi) A list of all pulse generators that are not built into the console and are to be used with the console when verifying meter.

(xvii) A list of all pulse counters that are not built into the console and are to be used with the console when verifying meter.

5.2.7 The owner shall provide meters or burdens to perform all tests that require a burden.

5.2.8 The owner (other than MC) shall notify the local MC district office if a calibration console is required to be used for verifying meters outside the scope of certification. The owner shall also request the additional inspection required to expand the scope of the certification as needed to permit the use of the console to inspect the meters.

5.2.9 The owner shall ensure that the measuring apparatus is maintained in good repair and operating order.

5.2.10 The owner shall forthwith notify the local MC district office of any repair or adjustment to the measuring apparatus. The calibration console (including MC owned) shall not be used for verification or dispute testing until the declared repairs or adjustments have been evaluated by the MC regional electricity specialist.

5.2.11 The owner shall notify the Measurement Canada regional electricity specialist prior to undertaking any modification or relocation of the measuring apparatus. The regional specialist shall determine the impact of any modification or relocation and determine any actions prior to authorization.

5.3 Markings and Documentation
5.3.1 Nameplate
Calibration consoles shall be fitted with a legible, readily accessible nameplate indicating:

(i) Name of manufacturer
(ii) Model number
(iii) Serial number
(iv) Supply voltage and configuration

5.3.2 Records
5.3.2.1 Unless otherwise specified, all records shall be maintained for a minimum of 15 years.

5.3.2.2 The owner shall retain copies of the calibration console worksheets, the calibration console’s certificate as well as all data and/or information provided in support of the certification, including the information provided pursuant to section 5.2.6.

5.3.2.3 Records shall be maintained and made readily available by the owner of the calibration console. The records shall include dates and details, including identification of the person or persons performing all accuracy checks, adjustments, maintenance, repairs and modifications to the calibration console.

5.3.3 Operating Manuals and Schematics
The operating manuals and schematic drawings of the calibration console shall be up to date and readily available for the life of the console.

5.3.4 Calibration Console Markings
All controls, displays and switches shall be clearly identified.

6.0 Technical Requirements

6.1 Use Requirements

6.1.1 General
The owner of a calibration console shall be responsible for using the measuring apparatus in the manner for which it was intended in accordance with the requirements set out in this document and any terms and conditions set out in the certificate.

6.1.2 Accuracy Check
6.1.2.1 An accuracy check shall be conducted by the owner of the calibration console at least once per week during any week that the console is used to verify meters.

6.1.2.2 The accuracy check shall be conducted at one different test point for each day the console was used. The test points shall be selected from the test points that were used to evaluate meters during the week.

6.1.2.3 The accuracy checks performed over the course of a year shall ensure that each test point identified on the console’s certificate is assessed by the accuracy check at least once during
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the year. This may require performing accuracy checks at other test points in addition to those used in any particular week for testing meters.

#### 6.1.2.4 The accuracy check shall consist of, as a minimum, connecting a check device in a meter-under-test position and comparing the error established by the console with the known error of the check device. The check device may be a certified standard, certified reference meter, or reference meter which has been calibrated on a console that has been calibrated and certified within the preceding twelve months pursuant to these requirements.

#### 6.1.2.5 Where the error of the check device determined pursuant to the accuracy check differs from the known error of the device by more than ± 0.1 percent, the calibration console shall not be used until the cause of the change in error has been investigated and corrected. All meters verified during the period since the last confirmed accuracy check shall be reverified on a different certified console with confirmed accuracy check or on the same console after the condition that caused the failed accuracy check has been corrected.

#### 6.1.2.6 Records of accuracy checks shall be maintained.

### 6.2 Environmental Requirements

#### 6.2.1 Temperature
Calibration consoles shall be maintained at an ambient air temperature of 23 °C ± 5 °C.

### 6.3 Mechanical Requirements

#### 6.3.1 Master Control Switch and Indication of Energization
Calibration consoles shall have a readily accessible and clearly marked master on/off control for switching off all power sources to the console.

#### 6.3.2 Circuit Protection
The circuit protection features of the calibration console (e.g. fuses or breakers) shall be readily accessible.

#### 6.3.3 Grounding

##### 6.3.3.1 The potential between any exposed metal panels of the calibration console and (earth) ground shall not exceed 1 Vrms.

##### 6.3.3.2 Calibration consoles that are not grounded shall be equipped with a ground fault interrupting (GFI) circuit breaker. The device shall automatically interrupt any ground fault currents flowing between the console supply conductors and ground which exceed 10 mA.

### 6.3.4 Isolation

#### 6.3.4.1 Isolation from Ground
All test circuits of the calibration console shall be electrically isolated from ground such that the leakage current measured between any terminal and ground does not exceed 1 mA rms when the console is energized at its maximum operating current and voltage, or when it is energized at its maximum operating voltage and its minimum test current.
6.3.4.2 Isolation of Secondary Circuits from Primary Circuits
All secondary test circuits of the calibration console shall be electrically isolated from primary supply circuits.

6.3.5 Meter Mounting Arrangements
Calibration consoles shall have sufficient arrangements to allow for the mounting of all meter types identified in the information provided pursuant to section 5.2.6, such that the rotating disks of electromechanical integrating meters are within ±3.0° of true level once such meters are installed.

6.3.6 Operating Mode
Calibration consoles shall be capable of testing meters under single phase conditions with potential circuits connected in parallel and current circuits connected in series. A console that is capable of applying voltages and currents to the voltage and current circuits of a meter from independent sources shall be considered to meet this requirement if the applied voltages, currents, phase angles, and loads from each source are within the tolerances set out in Table 1 of section 6.4.3. The spread of the applied voltages, currents, phase angles, and loads, shall also be within the tolerances set out in Table 1 of section 6.4.3.

6.3.7 Individual Elements

6.3.7.1 Calibration consoles shall be capable of testing individual elements of meters.

6.3.7.2 Semi-automatic and fully automatic calibration consoles shall be capable of applying currents to individual elements of meters. The maximum spread of currents supplied, without operator intervention, when switching between the various elements of a meter, either individually or in series, shall not exceed 2.0% of the nominal current required to be supplied to any one element. If this tolerance cannot be met without operator intervention, the console may only be certified for use as a manual console.

6.3.7.3 Calibration consoles shall comply with this requirement at the highest test load current or 50 amps, whichever is lower, and at the lowest test load current used for verifying meters, as specified in the information provided pursuant to section 5.2.6.

6.4 Electrical Requirements

6.4.1 Creep (Zero Load) Switch

6.4.1.1 Where a calibration console incorporates a switch or other means intended to reduce the current supplied to the meter-under-test position(s) to zero, when the switch or other means has been activated with a standard in the meter-under-test position, and load voltage applied to each meter-under-test position, the energy recorded during a fifteen-minute interval shall not be greater than 0.1% of the energy that would be delivered if the load current was set at the minimum current shown on the nameplate of the lowest rated meter included in the information provided pursuant to section 5.2.6 and the load voltage was set to the maximum voltage of the highest voltage rated meter included in the information provided pursuant to section 5.2.6.
6.4.1.2 Calibration consoles that do not meet the above requirement or do not have a creep switch may be certified for testing meter creep if they can be configured to remove the current supplied to the meter(s) under test.

6.4.2 Indicating Instruments

6.4.2.1 Calibration consoles shall be equipped with indicating instruments that are capable of displaying the quantities listed below:

(a) Voltage (volts)
(b) Current (amps)
(c) Phase angle (degrees) or power factor (Pf)
(d) Power. The following are required as applicable:

(i) Watt meter, in the case of consoles used for watt or watt hour meter testing.
(ii) Volt ampere (average or rms, as applicable) meter, in the case of consoles used for va or va hour meter testing.
(iii) Var meter, in the case of consoles used for var or var hour meter testing.

If a power standard is used as an indicating instrument for monitoring power, its accuracy as an indicating instrument is sufficiently evaluated by assessments under section 7.8.

6.4.3 Indicating Instrument Test Points

These instruments shall be capable of indicating their respective quantities according to the tolerances specified in Table 1, and shall be capable of indicating all values required for verifying all meters specified in the information provided pursuant to section 5.2.6. When setting any of the quantities above, the respective indicating instrument shall be readily accessible with an unobstructed view.

6.4.3.1 The tolerances expressed in percentage are in percent of true value.

6.4.3.2 For the purpose of determining compliance with the above tolerances, the currents, voltages, phase angles, and loads shall be measured at a meter-under-test position using instrument transformers if necessary. The values provided in Tables 2, 3, 4, and 5 below, are sufficient for establishing compliance with indicating instrument requirements for meter verification test points which fall within the identified values. Only values which are applicable to the meters which are verified on the console are required to be assessed. Any values used for assessing meters which are not within the range of values found in these tables shall be assessed separately.

6.4.3.3 The requirements for power indicating instruments may be satisfied by calibration console reference meters that are also capable of displaying the power quantities set out in Table 1.

### Table 1

<table>
<thead>
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<th>Indicating Instrument Tolerances</th>
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<tr>
<td>Current</td>
<td>±2%</td>
</tr>
<tr>
<td>Voltage</td>
<td>±2%</td>
</tr>
<tr>
<td>Phase angle/power factor (at unity Pf)</td>
<td>±2.5°/±0.1%</td>
</tr>
<tr>
<td>Phase angle/power factor (at 0.5 Pf)</td>
<td>±1.0°/±3%</td>
</tr>
<tr>
<td>Power (active, reactive or apparent)</td>
<td>±2%</td>
</tr>
</tbody>
</table>

### Table 2

**Target Values for Voltage and Current Indicating Instruments**

<table>
<thead>
<tr>
<th>Voltage (rms) Targets</th>
<th>Current (rms) Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>0.25</td>
</tr>
<tr>
<td>240</td>
<td>0.5</td>
</tr>
<tr>
<td>360</td>
<td>2.5</td>
</tr>
<tr>
<td>480</td>
<td>5.0</td>
</tr>
<tr>
<td>600</td>
<td>10.0</td>
</tr>
<tr>
<td>0.25 A A A A A</td>
<td>0.5 A A n/a n/a n/a</td>
</tr>
<tr>
<td>0.5 A A n/a n/a n/a</td>
<td>2.5 B A&amp;B A A B</td>
</tr>
<tr>
<td>2.5 B A n/a n/a n/a</td>
<td>5.0 B A n/a n/a n/a</td>
</tr>
<tr>
<td>5 B A n/a n/a n/a</td>
<td>10.0 B A&amp;B B B B</td>
</tr>
<tr>
<td>25 B A n/a n/a n/a</td>
<td>25.0 B A n/a n/a n/a</td>
</tr>
<tr>
<td>50 B A n/a n/a n/a</td>
<td>50.0 B A n/a n/a n/a</td>
</tr>
<tr>
<td>100 B A&amp;B B B B</td>
<td>100.0 B A&amp;B B B B</td>
</tr>
</tbody>
</table>

### Table 3

**Watt and Volt Ampere Indicating Meter Test Points**

<table>
<thead>
<tr>
<th>Current set point (amps)</th>
<th>Voltage set point (volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>120</td>
</tr>
<tr>
<td>0.25</td>
<td>A</td>
</tr>
<tr>
<td>0.5</td>
<td>A</td>
</tr>
<tr>
<td>2.5</td>
<td>B</td>
</tr>
<tr>
<td>5</td>
<td>B</td>
</tr>
<tr>
<td>25</td>
<td>B</td>
</tr>
<tr>
<td>50</td>
<td>B</td>
</tr>
<tr>
<td>100</td>
<td>B</td>
</tr>
</tbody>
</table>
### Table 4
**Var Indicating Meter Test Points**

<table>
<thead>
<tr>
<th>Current set point (amps)</th>
<th>Voltage set point (volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>120</td>
</tr>
<tr>
<td>0.25</td>
<td>A</td>
</tr>
<tr>
<td>0.5</td>
<td>A</td>
</tr>
<tr>
<td>2.5</td>
<td>B</td>
</tr>
<tr>
<td>5</td>
<td>B</td>
</tr>
<tr>
<td>25</td>
<td>B</td>
</tr>
<tr>
<td>50</td>
<td>B</td>
</tr>
<tr>
<td>100</td>
<td>B</td>
</tr>
</tbody>
</table>

A: 0.5 Pf  
B: 0.866 Pf  
n/a: not applicable

### Table 5
**Phase Angle Indicating Meter Test Points**

<table>
<thead>
<tr>
<th>Current set point (amps)</th>
<th>Voltage set point (volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>120</td>
</tr>
<tr>
<td>2.5</td>
<td>A,B&amp;C</td>
</tr>
<tr>
<td>50</td>
<td>A,B&amp;C</td>
</tr>
</tbody>
</table>

For consoles used for watt and volt ampere meter testing  
A: 0.5 Pf  B: 1.0 Pf  

For consoles used for var meter testing  
C: 0.866 Pf  

A: 1.0 Pf  
B: 0.5 Pf  
n/a: not applicable
6.4.4 Accuracy and Repeatability of Load Settings

6.4.4.1 Calibration consoles shall be capable of setting all currents, voltages, phase angles, and loads within the tolerances set out in Table 1 of section 6.4.3 for all meters required to be verified pursuant to section 5.2.6.

6.4.4.2 Calibration consoles which are capable of setting loads automatically, whether with, or without initial load setting by the operator, and which reset set loads without any further operator intervention shall meet the requirements of (i) and (ii) below:

(i) The calibration console shall set currents, voltages, phase angles, and loads within the tolerances set out in Table 1 of section 6.4.3. The console shall be capable of achieving required settings within one minute of any change in setting.

(ii) The calibration console shall be capable of automatically setting and resetting the load determined pursuant to section 7.2.2 at least three successive times. The resulting current, voltage, phase angle and power observed at a meter-under-test position for the successive observations shall be within the tolerances set out in Table 1 of section 6.4.3 for the respective quantities.

6.4.4.3 Calibration consoles which do not meet requirements (i) and (ii) above may only be certified for use as a manual console.

6.4.5 Calibration Console Reference Meters

6.4.5.1 Calibration consoles intended to verify energy meters or calibration consoles which meet the requirements of section 6.4.9 and are intended to verify block interval demand meters shall be equipped by their owners with one or more energy reference meters. Calibration consoles intended to verify exponential demand meters or calibration consoles intended to verify block interval demand meters and which do not meet the requirements of section 6.4.9 shall be equipped with one or more demand (power) reference meters. Calibration consoles intended to verify average responding demand meters shall be equipped with one or more average responding reference meters. Calibration consoles intended to verify demand meters with root mean square (rms) response shall be equipped with one or more rms responding reference meters.

6.4.6 Energy Reference Meters

6.4.6.1 Calibration consoles which automatically determine and display meter-under-test errors and which are not equipped with energy reference meters that emit at least one pulse for every 0.003 units of energy (i.e. watt hours, varhours, volt ampere hours etc.) shall display the errors to a resolution of at least two significant digits to the right of the decimal point when the console is undergoing calibration tests pursuant to these specifications.

6.4.6.2 Calibration consoles which do not automatically determine and display meter-under-test errors shall be equipped with energy reference meters that emit at least one pulse for every 0.003 units of energy (i.e. watt hours, varhours, volt ampere hours etc.) applied to the energy reference meter.
6.4.7 Demand Reference Meters

6.4.7.1 Calibration consoles intended to verify exponential demand meters or calibration consoles intended to verify block interval demand meters and which do not meet the requirements of section 6.4.9 shall be equipped with one or more power meters (i.e. watt, va, or var meter) which shall serve as the demand reference meter(s). A demand reference meter value shall be established by averaging at least three power readings taken periodically during the demand verification period. The demand reference meter(s) shall be capable of displaying power to a resolution of 5 significant digits in the case of consoles used to verify electronic or hybrid demand meters, and 4 significant digits in the case of consoles used to verify electromechanical type demand meters.

6.4.8 Control Circuits for Energy Meters

6.4.8.1 Calibration consoles intended to verify energy meters and which do not automatically determine and display meter-under-test errors shall have at least one meter-under-test position which is equipped with a device to automatically count the disk revolutions of an electromechanical meter or the test energy pulses provided by an electronic meter. Such consoles shall also be equipped with a device to predetermine the number of revolutions or pulses of a meter under test and to count the pulses emitted by the energy reference meter during the predetermined number of revolutions.

6.4.9 Control Circuits for Demand Meters

6.4.9.1 Calibration consoles intended to verify block interval demand meters may be equipped to start and stop the accumulation of energy by an energy reference meter simultaneously with the start and stop of the demand interval(s). If such a device is not provided, the console shall be equipped with a demand reference meter pursuant to section 6.4.7, and shall meet the regulation requirements of section 7.6.

7.0 Metrological Requirements

7.1 General

7.1.1 Manual Correction Factors

7.1.1.1 All tolerances for calibration consoles set out in this document shall be achieved without the manual application of correction factors.

7.1.2 Error Calculations - All Consoles

7.1.2.1 The error of a calibration console at any test point is the difference between the results obtained for the standard (and transformer combination) when its apparent error is measured on the calibration console, and the errors set out in the certificates for the standards.

At any test point the following equation for error shall apply:
Measuring apparatus error is equal to [Apparent error of standard (and transformers)] minus [Certified (or calculated) error of standard (and transformers)]

7.1.2.2 The apparent error of the standard (and transformer combination) is either read directly off the calibration console or calculated by the operator according to the operating principle of the console. The certified error of the standard is used if no instrument transformers are necessary. Where instrument transformers are necessary, the calculated error of the standard and transformer combination is determined according to the formula provided below:

\[
E_{\text{Cons}} = E_{\text{SM}} - E_{\text{C}}
\]

where:
- \( E_{\text{Cons}} \) = calibration console error in percent
- \( E_{\text{SM}} \) = measured error of the standard (and transformer combination) in percent
- \( E_{\text{C}} \) = certified error of the standard or the calculated error of the standard and transformer combination at the test load in percent

The calculated error of the standard and transformer combination \( E_{\text{C}} \) is determined as follows:

\[
E_{\text{C}} = \left[ \left( \left( E_s \div 100 \right) + 1 \right) \cos \theta \times \left( RCFe \times RCFi \times \left( \cos \beta + \tau + \theta \right) \right) - 1 \right] \times 100
\]

where:
- \( E_{\text{C}} \) = calculated error of the standard and transformer combination in percent
- \( E_s \) = certified error of the standard in percent at a given test load from the calibration certificate for the standard
- \( RCFe \) = certified ratio correction factor for the voltage transformer at the ratio and burden used
- \( RCFi \) = certified ratio correction factor for the current transformer at the ratio and burden used
- \( \beta \) = certified phase angle error of current transformer at the ratio and burden used in degrees
- \( \tau \) = certified phase angle error of voltage transformer at the ratio and burden used in degrees
- \( \theta \) = phase angle between voltage and current in degrees

7.1.3 Minimum Duration of Accuracy Tests

7.1.3.1 The minimum duration of each accuracy test performed on calibration consoles intended to verify energy or block interval demand meters for the purpose of certifying the calibration console shall be as follows:

(a) In the case of consoles equipped with energy reference meters that emit pulses, at least 10,000 pulses shall be emitted by the energy reference meter.

(b) In the case of consoles not equipped with reference meters that emit pulses, the tests shall be conducted for a period of time equivalent to the minimum duration required to verify a meter at the test load.

7.1.3.2 The minimum duration of accuracy tests performed on calibration consoles intended to verify exponential demand meters shall be the time required to record the necessary readings.

7.2 Console Configurations, Test Loads and Burdens
7.2.1 Console Configurations

7.2.1.1 Unless otherwise stated, test loads and test positions shall be established on the basis of operational setups and meters to be verified on the console pursuant to the information provided in section 5.2.6.

7.2.1.2 Console calibration tests shall be conducted with the console setup such that meters are tested with all current elements connected in series. Unless stated otherwise, consoles which energize meter elements from independent sources shall have each source assessed for compliance with the requirements of section 7.0.

7.2.1.3 Consoles shall be assessed for the following configurations as applicable:

(a) Consoles using 1:1 current transformers in order to assess meters without potential test links or meters with test links closed (e.g. single phase meters).
(b) Consoles having multiple potential transformers which are used without 1:1 current transformers in circuit in order to assess meters.
(c) Consoles used to test transformer type only or transformer type in addition to self-contained meters, which may be tested without the use of isolation transformers.
(d) Consoles used to test only self-contained meters which may be tested without the use of isolation transformers.

7.2.2 Test Loads

7.2.2.1 Unless otherwise stated, test loads for the corresponding setups identified above shall be as follows:

(a) 240V, 50A, 0.5 power factor
(b) 120V, 50A, 0.5 power factor
(c) 120V, 2.5A, 0.5 power factor
(d) 120V, 50A, 0.5 power factor

7.2.2.1.1 In the case of test setups for consoles intended to verify meters with current ratings lower than the applicable test load of 7.2.2, the test load shall be the highest verification test current of the meter with the highest rated current.

7.2.2.1.2 In the case of consoles that are not used to verify meters at 0.5 power factor for a setup identified in 7.2.1.3, the test load shall be set at unity power factor.

7.2.3 Test Burdens

7.2.3.1 Conditions for Metrological Characteristics
This section establishes the voltage burdens which will be used when performing metrological tests in section 7.

7.2.3.1.1 Burden assessments shall be sufficient to ensure that the effect of various burdens is evaluated for all setups and connections used to verify meters identified in the list of meters pursuant to section 5.2.6.
7.2.3.2 For each operational setup identified in 7.2.1.3 above, meters having a voltage rating equivalent to the applicable test voltage identified in 7.2.2 above shall be selected from the lists provided pursuant to section 5.2.6 which represent burdens as follows:

(i) highest inductive burden,
(ii) highest capacitive burden, and
(iii) lowest burden.

7.2.3.2.1 The lowest burden may be represented by using zero burden (i.e. shorting bars without any additional potential burden).

7.2.3.2.2 If a console is used to assess meters having only capacitive or only inductive burden properties, the burden type which is not applicable shall be replaced by a burden which represents the most common burden for the meters types to be verified on the console.

7.2.3.2.3 The burden shall be represented by appropriate meters. The test burden shall be installed in the meter-under-test positions, including the position having the standard.

7.3 Burden Effects

7.3.1 Maximum Permissible Errors

7.3.1.1 The change in calibration console error resulting from the installation of different burdens equivalent to those of meters from the list of test points provided pursuant to section 5.2.6 shall not exceed 0.1%.

7.3.1.2 The calibration console error resulting from the installation of any burden equivalent to that of a meter from the list of test points provided pursuant to section 5.2.6 shall not exceed the applicable tolerance set out in section 7.8.

7.3.2 Conditions for Metrological Characteristics

7.3.2.1 All calibration consoles shall be tested for the effects of varying burden conditions.

7.3.2.2 For calibration consoles used with setups 7.2.1.3(a) and (b), burden errors shall be established at each meter-under-test position for each burden determined pursuant to section 7.2.3.2 with a similar burden installed in each other meter-under-test position.

7.3.2.3 For calibration consoles used with setups 7.2.1.3(c) or (d), burden errors shall be established at one meter-under-test position using each burden determined pursuant to section 7.2.3.2 with a similar burden installed in each other meter-under-test position.

7.3.2.4 Multi-position consoles which will be used with meters installed in the meter-under-test positions that have varying burden characteristics shall be assessed for the effect of variations in burden conditions introduced by such meters for all setups of 7.2.1.3, as applicable.

7.3.2.4.1 In the case of consoles used as identified in 7.3.2.4 above, console errors shall be determined with the highest inductive burden in one meter-under-test position and the highest
7.3.2.5 Pursuant to the tests set forth in 7.3.2.2 and 7.3.2.3, the burden which represents the median value of meter burdens shall be used as the general test burden for each applicable test setup for the tests pursuant to sections 7.8.

7.3.2.6 The burden which causes the greatest error of the applicable tests of 7.3.2.2, 7.3.2.3 and 7.3.2.4 shall be used as the general test burden as applicable for tests pursuant to sections 7.4, 7.5 and 7.7.

7.4 Variations from Position to Position

7.4.1 Maximum Permissible Errors

7.4.1.1 The spread of errors from position to position on a calibration console shall not exceed 0.1 percent.

7.4.1.2 No position error shall exceed the applicable tolerance set out in section 7.8.

7.4.2 Conditions for Metrological Characteristics

7.4.2.1 Consoles which are used with setups identified in 7.2.1.3(c) or (d) shall be calibrated at each meter-under-test position using the burden determined pursuant to 7.3.2.6 at the applicable test load with similar burdens connected in each other meter-under-test position.

7.5 Distortion

7.5.1 Maximum Permissible Errors

7.5.1.1 The distortion in either the current or voltage circuit of calibration consoles intended to verify thermal demand meters shall not exceed 3 percent.

7.5.1.2 The distortion in either the current or voltage circuit of calibration consoles intended to verify meters other than thermal demand meters shall not exceed 5 percent.

7.5.2 Conditions for Metrological Characteristics

7.5.2.1 General Set-up Conditions for Distortion tests

7.5.2.1.1 The distortion in the current and voltage circuits of calibration consoles shall be measured with both circuits energized when conducting these tests. These tests shall be conducted with any regulators or line conditioners in circuit and repeated with the regulators or line conditioners out of circuit, as applicable.
7.5.2.2.1 The distortion assessment shall be conducted on all voltage and current sources used to energize meters during verification tests. The distortion tests identified below shall be conducted at 0.5 power factor.

7.5.2.3 Recti-thermal Demand Meters

Calibration consoles intended for verifying recti-thermal demand meters, or other meters known to cause distortion, shall have such meters installed in all but one meter-under-test position as stated below.

7.5.2.3.1 Current circuit distortion shall be measured at any meter-under-test position at:

(a) 2.5 amperes with transformer type meters installed, and
(b) the maximum demand verification test current with meters representing the test current installed.

These two tests shall be repeated with no meters installed.

7.5.2.3.2 Potential circuit distortion shall be measured at any meter-under-test position at:

(a) 120 volts with transformer type meters installed, and
(b) the maximum demand verification test voltage with meters representing the test voltage installed.

These two tests shall be repeated with no meters installed.

7.5.2.4 1:1 Current Transformers and/or Multiple Potential Transformers

7.5.2.4.1 Calibration consoles used with 1:1 current transformers and/or multiple potential transformers shall be tested for distortion at any one meter-under-test position with all such transformers in circuit. The tests shall be conducted with the applicable meter burden determined pursuant to section 7.3.2.6 installed at each meter-under-test position.

7.5.2.4.2 Current circuit distortion shall be measured at 2.5 amperes and at the maximum test current used for verifying meters that require the use of 1:1 transformers.

7.5.2.4.3 Potential circuit distortion shall be measured at 120 volts and at the maximum test voltage used for verifying meters that require the use of multiple potential transformers.

7.5.2.5 Other Meters (No 1:1 current or multiple potential transformers in circuits)

7.5.2.5.1 Calibration consoles other than those identified in 7.5.2.3 and 7.5.2.4 above shall be tested for distortion with the applicable meter burden determined pursuant to section 7.3.2.6 installed at each meter-under-test position.

7.5.2.5.2 Current circuit distortion shall be measured at any meter-under-test position at 2.5 amperes and at the maximum test current used for verifying meters having the burden determined pursuant to section 7.3.2.6.
7.5.2.5.3 Potential circuit distortion shall be measured at any meter-under-test position at 120 volts and at the maximum test voltage used for verifying meters having the burden determined pursuant to section 7.3.2.6.

7.5.3 Distortion may be calculated using either of following two formulae:

\[
\text{%Distortion} = \left( \frac{\text{rms}}{\text{fundamental plus harmonics}} \right) \times 100
\]

\[
\text{%Distortion} = \left( \frac{\text{rms}}{\text{fundamental}} \right) \times 100
\]

7.6 Regulation

7.6.1 Calibration consoles intended to verify exponential demand meters or calibration consoles intended to verify block interval demand meters which do not meet the requirements of section 6.4.9 shall meet the requirements of sections 7.6.1.1 to 7.6.1.3.

7.6.1.1 Calibration consoles shall be capable of maintaining test loads for a period which is the shorter of the following:

(a) 60 minutes
(b) two times the maximum period required to verify demand meters identified in the list provided in section 5.2.6

The calibration console shall be allowed to warm up for up to one hour if required, in order to meet this requirement. The calculation of the expected delivered energy shall be determined using the value of the load indicated on the reference meter following the warm-up period.

7.6.1.1.1 The energy delivered during the established period above shall be monitored at nominally, one-minute intervals. Each one-minute period shall be within ±0.05% of one minute.

(i) In the case of consoles intended for verifying electronic demand meters, the energy recorded during each one-minute interval shall not exceed ±0.2% of the energy expected to be delivered in a one-minute period at the load shown on the reference meter at the start of this test.

(ii) In the case of consoles intended for verifying electromechanical demand meters only, the energy recorded during each one-minute interval shall not exceed ±0.3% of the energy expected to be delivered in a one-minute period at the load shown on the reference meter at the start of this test.

7.6.1.2 Calibration consoles shall be evaluated for compliance with the requirements of section 7.6.1.1 at the test load of 2.5A, 120V, 0.5 Pf with high burden transformer type meters installed
in all meter-under-test positions and at the highest demand verification test current at the corresponding voltage with the applicable self-contained meter burdens installed.

7.6.1.3 The energy recorded during the tests above shall be in watt hours and the tests repeated for var hours and va hours, as applicable.

7.7 Current Switching Effects

7.7.1 Maximum Permissible Errors

7.7.1.1 Current switching effects in semi-automatic and automatic consoles shall not introduce error changes greater than 0.1%.

7.7.1.2 Any error resulting from current switching shall not exceed the applicable tolerance set out in section 7.8.

7.7.2 Conditions for Metrological Characteristics

7.7.2.1 Semi-automatic and automatic calibration consoles which have current, potential and/or 1:1 isolation transformers connected between the reference meter and the meter-under-test position(s) shall be tested for current switching effects. The current switching effects shall be assessed by calibrating the console using the burden as determined in 7.3.2.6 at the corresponding test load. Using the normal operating mode of the console, the current shall be switched to 10 percent of the applicable test current and back to its original value.

7.7.2.2 This test shall be conducted five times. If the normal operating procedure for the console requires that the load be removed when switching from one setting to another, this shall be done when conducting this test.

7.7.2.3 Tests shall be performed with 1:1 transformers in circuit and repeated for any other current transformers which may be required to set and maintain test loads.

7.8 Console Calibration

7.8.1 Maximum Permissible Errors

7.8.1.1 Calibration consoles intended to verify energy meters, including the energy reference meter with which the console is equipped and any other reference meters that may simultaneously be in circuit while the console is used for verifying meters shall not exhibit an error greater than ±0.2 percent of reading at any test point.

7.8.1.2 Calibration consoles intended to verify electronic or hybrid demand meters, including the demand reference meter with which the console is equipped and any other reference meters that may simultaneously be in circuit while the console is used for verifying meters shall not exhibit an error greater than ±0.2 percent of reading at any test point.

7.8.1.3 Calibration consoles intended to verify electromechanical demand meters, including the demand reference meter with which the console is equipped and any other reference meters that
may simultaneously be in circuit while the console is used for verifying meters, shall not exhibit an error greater than ±0.5 percent of reading at any test point.

7.8.2 Conditions for Metrological Characteristics
The errors of calibration consoles shall be determined as follows:

7.8.2.1 Calibration consoles used with the setup of 7.2.1.3(a) and/or (b) shall be calibrated:

(a) at each meter-under-test position, and
(b) at each test point used to verify meters, as identified in the list provided pursuant to section 5.2.6.

7.8.2.2 Calibration consoles used with the setup of 7.2.1.3(c) or (d) and which have current and/or potential transformers connected between the reference meter(s) and the meter-under-test position(s) shall be calibrated:

(a) at any one meter-under-test position,
(b) at the maximum and minimum test loads at each combination of voltage tap, current tap and selector switch setting at unity power factor as well as at all other power factors to be used to verify meters, as identified in the list provided pursuant to section 5.2.6.

7.8.2.3 Calibration consoles used with the setup of 7.2.1.3(c) or (d) and which do not have current and/or potential transformers connected between the reference meter(s) and the meter-under-test position(s) shall be calibrated:

(a) at any one meter-under-test position,
(b) at the minimum, median and maximum test loads of the range of loads at each test voltage at unity power factor as well as at all other power factors to be used to verify meters using the setup above and are identified in the list provided pursuant to section 5.2.6.

7.8.2.4 Calibration consoles which apply voltages and or currents to individual circuits (elements) of a meter from independent sources shall have each source or combination of sources calibrated as follows:

(a) For each element or combination of elements for each test point to be used to verify meters included in the applicable list provided pursuant to section 5.2.6.
(b) At meter-under-test positions as stated in 7.8.2.1 to 7.8.2.3, as applicable.

7.8.2.5 Errors determined per sections 7.8.2.2 to 7.8.2.4 at one meter-under-test positions only shall apply to each meter-under-test position.

7.8.2.6 For all tests set out in 7.8.2.1 through 7.8.2.4 above, the test burden determined pursuant to section 7.3.2.5 shall be connected in each meter-under-test position, except the position with the standard (and transformer combination); this position shall have the applicable voltage burden connected in parallel with the standard. In the case where the test load exceeds the voltage or current rating of the meters used to burden the meter-under-test position, higher rated meters shall be used to burden the meter-under-test positions.
7.8.2.6.1 Burdens are not required to be installed for 7.8 testing if the errors determined pursuant to applicable subsections of section 7.3 differ by 0.05 percent or less.

7.8.2.6.2 In the case of test burdens which are required and rated lower than the voltage which is being calibrated, burdens having voltage ratings equal to calibration voltage shall be used as required.

7.8.2.7 Calibration consoles equipped with more than one reference meter shall be calibrated with all reference meters which will be in circuit simultaneously while the console is used for verification of meters. Calibration consoles used with more than one reference meter either in or out of circuit shall be calibrated for all combinations of reference meters that will be in circuit simultaneously while the console is being used for verifying meters.

7.8.2.8 Where a console is used with variable combinations of reference meters in or out of circuit, the console shall be calibrated at the test load and test burden pursuant to section 7.2 for each combination of reference meter in or out of circuit. The console shall be deemed acceptable for use for each combination of reference meter in or out of circuit that results in errors that are within 0.05% of each other.

7.8.2.9 The certificate of errors for the calibration console shall indicate which reference meters are in circuit for the errors set out in the certificate. The certificate shall also indicate all certified combinations of reference meters used with the console.

7.9 Measurement Uncertainty

7.9.1 General
The certified console errors shall be provided with uncertainty figures.

7.9.2 Combined Console Uncertainty

7.9.2.1 Influences
The combined uncertainty of the calibration console errors shall include the following sources of uncertainty:

(a) Burden effects
(b) Variation from position to position
(c) Regulation
(d) Current switching effects
(e) Reference standard
(f) Repeatability

7.9.3 Reduction Equation for Console Uncertainty
The basic equation for uncertainties shall be applied for console configurations for which errors are established and uncertainties are required. The uncertainties can be determined by the following basic equation:
\[ U_{c(\text{con})} = \sqrt{\left(\frac{U_{be}}{3}\right)^2 + \left(\frac{U_{pp}}{3}\right)^2 + \left(\frac{U_{cse}}{3}\right)^2 + \left(\frac{U_{cm}}{3}\right)^2 + \left(\frac{U_{rs}}{2}\right)^2 + \left(\frac{U_{rep}}{2}\right)^2} \]

where: \( U_{c(\text{con})} \) = Standard uncertainty of console  
\( U_{be} \) = Uncertainty due to burden  
\( U_{pp} \) = Uncertainty due to position to position errors  
\( U_{cse} \) = Uncertainty due to current switching effects  
\( U_{cm} \) = Uncertainty due to load regulation (applicable to demand test points)  
\( U_{rs} \) = Uncertainty due to reference standard used to calibrate console  
\( U_{rep} \) = Uncertainty due to repeatability

### 7.9.3.1 Influence Factor Uncertainties
The uncertainties due to various influence factors identified in the equation shall be determined pursuant to sections 7.9.3.1.1 to 7.9.3.1.6 below.

#### 7.9.3.1.1 Uncertainty due to burden effects
The uncertainty due to burden effects shall be established by the difference in errors as determined pursuant to the requirements of sections 7.3.2.2 to 7.3.2.4. An uncertainty value can be established for each of the configurations for which burden tests are conducted. Alternatively, the largest spread may be used as the uncertainty figure due to burden effects for all calibration errors.

#### 7.9.3.1.2 Uncertainty due to position to position errors
The uncertainty due to position to position errors shall be established by using the largest spread of errors established by the test in section 7.4.2.1.

#### 7.9.3.1.3 Uncertainty due to Regulation
The uncertainty due to console regulation is applicable to console errors for demand legal units of measure. This uncertainty figure is not applicable to calibration errors for energy functions.

The uncertainty value shall be the largest percent deviation observed between any one-minute energy value and the expected energy value pursuant to section 7.6.1.2 or 7.6.1.3, as applicable.

#### 7.9.3.1.4 Uncertainty due to Current Switching Effects
The uncertainty due to current switching effects shall be the value of the largest spread in errors determined pursuant to the requirements of section 7.7.

#### 7.9.3.1.5 Uncertainty due to the Reference Standard
The uncertainty of the reference meter shall be the value(s) provided by the certificate of calibration for the device.

#### 7.9.3.1.6 Console Repeatability
The uncertainty due to repeatability shall be established on the basis of five repetitions of a test-point.
7.9.3.1.6.1 The uncertainty due to repeatability shall be established for each test point included in the console’s certificate of calibration, for consoles that have fewer than 100 test points.

7.9.3.1.6.2 Consoles having greater than 100 test points shall establish uncertainty due to repeatability on the basis of the following test points:

7.9.3.1.6.2.1 Test-point Selection
For each combination of console configuration and measurement unit, the following test points shall be assessed 5 times as applicable:

(a) The smallest test load used in 7.8 for this combination. The tests shall be performed at unity power factor for Watt / Wh and at 0.5 power factor for VA / VAh & VAR / VARh, and
(b) The maximum test load used in 7.8 for this combination. The tests shall be performed at 0.5 power factor for Watt / Wh & VA / VAh, and at 0.866 power factor for VAR / VARh.
(c) The lowest and highest current test points for the I-squared hour function
(d) The lowest and highest voltage test point for the V-squared hour function

7.9.3.1.6.2.2 Test Positions
On multi-position consoles, the tests shall be performed five times at each meter-under-test position as follows:

(a) For console configuration as per 7.2.1.3 (a) and/or (b), the smallest and the largest test loads shall be assessed in the odd and even meter-under-test positions respectively.
(b) For console configurations as per 7.2.1.3 (c) or (d), the tests shall be conducted at any one meter-under-test position.

7.9.3.1.6.3 Effective Uncertainty due to Repeatability
(a) For consoles which have fewer than 100 test points, the certified error shall be the average of five repetitions and the uncertainty for each test point shall be determined by the following equation:

\[ s = \sqrt{\frac{1}{(n-1)} \sum_{i=1}^{n} (x_i - \bar{x})^2} \]

Where:
s = standard uncertainty
n = number of tests
x = test point error
\( \bar{x} \) = average error
(b) For consoles which have greater than 100 test points, uncertainties shall be determined for each test point determined pursuant to 7.9.3.1.6.2 using the following formula based on five repetitions:

\[
s = \sqrt{\frac{1}{(n-1)} \sum_{i=1}^{n} i(x - \bar{x})^2}
\]

Where:
- \(s\) = standard uncertainty
- \(n\) = number of tests
- \(x\) = test point error
- \(\bar{x}\) = average error

7.9.4 Official Uncertainty Figures
The values determined by the use of the reduction equation above (7.9.3) for all test points, or all applicable test points used for combinations of console configurations, measurement units, test types (energy or demand) and influence factors are the standard uncertainty figures. A coverage factor of \(k = 2.0\) shall be applied for reporting these figures on the console’s certificate of calibration.

7.9.4.1 The uncertainty figures shall be recorded on the console’s certificate as highest values for each of the following configurations, as applicable:

(i) Console using parallel transformer connections
(ii) Console using 1:1 isolation transformers
(iii) Console using multiple transformers without 1:1 isolation transformers

7.9.4.2 The uncertainty figures determined in 7.9.4.1 shall be established and reported separately for energy and demand applications.

7.10 Pulse Counters and Generators

7.10.1 Maximum Permissible Errors
Internal or external pulse counters and pulse generators utilized with calibration consoles which are intended to be used for verifying devices to be used for revenue metering shall not exhibit errors exceeding plus or minus one count.

7.10.2 Conditions for Metrological Characteristics

7.10.2.1 Internal or external pulse counters and pulse generators utilized with calibration consoles intended to be used for verifying devices to be used for revenue metering shall be tested by connecting them to an appropriate pulse generator or pulse counter, respectively. For testing pulse counters, the frequency setting of the pulse generator used shall be the maximum pulse rate specified pursuant to section 5.2.6 for meters with pulse output(s). For testing pulse generators, the maximum frequency required to verify meter pulse inputs specified pursuant to section 5.2.6 shall be used. The duration of tests shall be such that at least 1,000 pulses are generated.
7.11 Rangeability

7.11.1 Maximum Permissible Errors
Calibration consoles or accessories that automatically calculate meter errors shall be capable of accurately performing such calculations over a range of errors suitable for assessing meters under Measurement Canada verification programs.